REVA UNIVERSITY
Bengaluru, India

School of Computer Science & Engineering

B. Tech. in Artificial Intelligence and Data Science

Handbook 2021-2025

Rukmini Knowledge Park
Kattigenahalli, Yelahanka, Bengaluru – 560064
www.reva.edu.in

REVA UNIVERSITY
Bengaluru, India

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Handbook

B. Tech. in Artificial Intelligence and Data Science

2021-2025

Rukmini Knowledge Park,
Kattigenahalli, Yelahanka, Bangalore - 560 064
Phone No: +91-080-66226622, Fax: 080-28478539

Rukmini Educational
Charitable Trust

www.reva.edu.in

Chancellor's Message

"Education is the most powerful weapon which you can use to change the world."
- Nelson Mandela.

There was a time when survival depended on just the realization of physiological needs. We are indeed privileged to exist in a time when 'intellectual gratification' has become indispensable. Information is easily attainable for the soul that is curious enough to go look for it. Technological boons enable information availability anywhere anytime. The difference, however, lies between those who look for information and those who look for knowledge.

It is deemed virtuous to serve seekers of knowledge. As educators, it is in the ethos at REVA University to empower every learner who chooses to enter our portals. Driven by our founding philosophy of 'Knowledge is Power', we believe in building a community of perpetual learners by enabling them to look beyond their abilities and achieve what they assumed impossible.

India has always been beheld as a brewing pot of unbelievable talent, acute intellect and immense potential. All it takes to turn those qualities into power is a spark of opportunity. Being at a University is an exciting and rewarding experience with opportunities to nurture abilities, challenge cognizance and gain competence.

For any University, the structure of excellence lies in the transitional abilities of its faculty and its facility. I'm always in awe of the efforts that our academic board puts in to develop the team of subject matter experts at REVA. My faculty colleagues understand our core vision of empowering our future generation to be ethically, morally and intellectually elite. They practice the art of teaching with a student-centered and transformational approach. The excellent infrastructure at the University, both educational and extra-curricular, magnificently demonstrates the importance of ambience in facilitating focused learning for our students.

A famous British politician and author from the 19th century - Benjamin Disraeli, once said 'A University should be a place of light, of liberty and of learning'. Centuries later this dictum still inspires me and I believe, it takes team-work to build successful institutions. I welcome you to REVA University to join hands in laying the foundation of your future with values, wisdom and knowledge.

Dr. P. Shyama Raju
The Founder and Hon'ble Chancellor, REVA University

Vice-Chancellor's Message

The last two decades have seen a remarkable growth in higher education in India and across the globe. The move towards inter-disciplinary studies and interactive learning have opened up several options as well as created multiple challenges. India is at a juncture where a huge population of young crowd is opting for higher education. With the tremendous growth of privatization of education in India, the major focus is on creating a platform for quality in knowledge enhancement and bridging the gap between academia and industry.

A strong believer and practitioner of the dictum "Knowledge is Power", REVA University has been on the path of delivering quality education by developing the young human resources on the foundation of ethical and moral values, while boosting their leadership qualities, research culture and innovative skills. Built on a sprawling 45 acres of green campus, this 'temple of learning' has excellent and state-of-the-art infrastructure facilities conducive to higher teaching-learning environment and research. The main objective of the University is to provide higher education of global standards and hence, all the programs are designed to meet international standards. Highly experienced and qualified faculty members, continuously engaged in the maintenance and enhancement of student-centric learning environment through innovative pedagogy, form the backbone of the University.

All the programs offered by REVA University follow the Choice Based Credit System (CBCS) with Outcome Based Approach. The flexibility in the curriculum has been designed with industry-specific goals in mind and the educator enjoys complete freedom to appropriate the syllabus by incorporating the latest knowledge and stimulating the creative minds of the students. Bench marked with the course of studies of various institutions of repute, our curriculum is extremely contemporary and is a culmination of efforts of great think-tanks - a large number of faculty members, experts from industries and research level organizations. The evaluation mechanism employs continuous assessment with grade point averages. We believe sincerely that it will meet the aspirations of all stakeholders – students, parents and the employers of the graduates and postgraduates of REVA University.

At REVA University, research, consultancy and innovation are regarded as our pillars of success. Most of the faculty members of the University are involved in research by attracting funded projects from various research level organizations like DST, VGST, DBT, DRDO, AICTE and industries. The outcome of the research

is passed on to students through live projects from industries. The entrepreneurial zeal of the students is encouraged and nurtured through EDPs and EACs.

REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students. REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students become skilled with relevant to industry requirements. Structured training programs on soft-skills and preparatory training for competitive exams are offered here to make students more employable. 100% placement of eligible students speaks the effectiveness of these programs. The entrepreneurship development activities and establishment of "Technology Incubation Centers" in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise.

With firm faith in the saying, "Intelligence plus character –that is the goal of education" (Martin Luther King, Jr.), I strongly believe REVA University is marching ahead in the right direction, providing a holistic education to the future generation and playing a positive role in nation building. We reiterate our endeavor to provide premium quality education accessible to all and an environment for the growth of over-all personality development leading to generating "GLOBAL PROFESSIONALS".

Welcome to the portals of REVA University!

Dr. M Dhanamjaya

Vice-Chancellor, REVA University

Director's Message

Congratulations and welcome all new students to the prestigious Department of Computer Science and Engineering. The Department has a rich blend of experienced and energetic faculty who are well-qualified in various aspects of electronics, Computer Science and Engineering. The Department possesses numerous state-of-the-art digital classrooms and laboratories having contemporary computing equipment, including cloud-based systems. The Department offers B.Tech. in Computer Science and Engineering, B Tech Artificial Intelligence and Data Science, M.Tech in Computer Science and Engineering (Full Time) and M.Tech in Computer Science and Engineering (Part-Time). In addition, the Department has a research center in which a student can conduct cutting-edge research leading to a Ph.D. degree. The faculties pursue research in areas like Data Mining. Healthcare Systems, Blockchain, Wireless Networks and Computing, Cloud Computing, Image Processing, Software Architecture, and Machine Learning Applications.

Curricula of both undergraduate and postgraduate programmes have been designed through a collaboration of alumni, academic, research, and industry experts to bridge the gap between industry and academia and inculcate innovation and leadership qualities. This makes the programme highly practical and industry-oriented. The B.Tech. programme aims to create quality human resources to play leading roles in the contemporary, competitive industrial and corporate world. The Master's Degrees focus on quality research and design in the core and application areas to foster a sustainable world and enhance the global quality of life by adopting enhanced design techniques and applications. This thought is reflected in the various courses offered in the masters' programmes. Research degree programmes aim to design and develop solutions to contemporary computer and engineering technologies oriented towards human development.

Welcome to the Department of Computer Science and Engineering at REVA University for better learning and becoming future leaders for the nation's socio-economic growth and the world.

The curriculum caters to and has relevance to local, regional, national, global, developmental needs. Maximum number of courses are integrated with cross cutting issues with relevant to professional ethics, gender, human values, environment and sustainability.

Dr. Ashwinkumar U Motagi

Director, Department of CSE

CONTENTS

Sl.no	Particulars	Page.no
1.	Message from the Hon'ble Chancellor	2
2.	Message from the Pro Vice- Chancellor	3
3.	Message from Director	5
4.	Rukmini Educational Charitable Trust	7
5.	About REVA University, Vision, Mission, Objectives	8
6.	About Department of Computer Science and Engineering - Vision - Mission - BoS	13
7.	Programme Overview Programme Educational Objectives Programme Outcomes Programme Specific Outomes Mapping of Course Outcomes with programme Outcomes Mapping programme outcomes with Programme Educational Objectives	17
8.	Regulations Governing B.Tech. programmes	23
9.	Scheme of Instructions & Curriculum of B. Tech in Artificial Intelligence and Data Science	39

RUKMINI EDUCATIONAL CHARITABLE TRUST

It was the dream of late Smt. Rukmini Shyama Raju to impart education to millions of underprivileged children as she knew the importance of education in the contemporary society. The dream of Smt. Rukmini Shyama Raju came true with the establishment of **Rukmini Educational Charitable Trust (RECT),** in the year 2002. Rukmini Educational Charitable Trust (RECT) is a Public Charitable Trust, set up in 2002 with the objective of promoting, establishing and conducting academic activities in the fields of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology, among others. In furtherance of these objectives, the Trust has set up the REVA Group of Educational Institutions comprising of REVA Institute of Technology & Management (RITM), REVA Institute of Science and Management (RISM), REVA Institute of Management Studies (RIMS), REVA Institute of Education (RIE), REVA First Grade College (RFGC), REVA Independent PU College at Kattigenahalli, Ganganagar and Sanjaynagar and now REVA University. Through these institutions, the Trust seeks to fulfill its vision of providing world class education and create abundant opportunities for the youth of this nation to excel in the areas of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology.

Every great human enterprise is powered by the vision of one or more extraordinary individuals and is sustained by the people who derive their motivation from the founders. The Chairman of the Trust is Dr. P. Shyama Raju, a developer and builder of repute, a captain of the industry in his own right and the Chairman and Managing Director of the DivyaSree Group of companies. The idea of creating these top notched educational institutions was born of the philanthropic instincts of Dr. P. Shyama Raju to do public good, quite in keeping with his support to other socially relevant charities such as maintaining the Richmond Road Park, building and donating a police station, gifting assets to organizations providing accident and trauma care, to name a few.

The Rukmini Educational Charitable Trust drives with the main aim to help students who are in pursuit of quality education for life. REVA is today a family of ten institutions providing education from PU to Post Graduation and Research leading to PhD degrees. REVA has well qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 15,000+ students study various courses across REVA's three campuses equipped with exemplary state-of-the-art infrastructure and conducive environment for the knowledge driven community.

ABOUT REVA UNIVERSITY

REVA University has been established under the REVA University Act, 2012 of Government of Karnataka and notified in Karnataka State Gazette dated 7th February, 2013. The University is recognised by UGC under Sec 2 (f) and empowered under Sec.22 of the UGC Act, 1956 to award degrees in any branch of knowledge. The Programs of the University are approved by All India Council for Technical Education (AICTE), University Grants Commission (UGC), Bar Council of India (BCI), and Council of Architecture (COA). The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

REVA University located in between Kempegowda International Airport and Bangalore city, has a sprawling green campus spread over 45 acres of land and equipped with state-of-the-art infrastructure that provide conducive environment for higher learning and research. The REVA campus has well equipped laboratories, auditoriums, seminar halls, custom-built teaching facilities, fully air-conditioned library and central computer centre, well-planned sports facility with cricket ground, running track & variety of indoor and outdoor sports activities, facilities for cultural programs. The unique feature of REVA campus is the largest residential facility for students, faculty members and supportive staff.

The University is presently offering 26 Post Graduate Degree programs, 35 Undergraduate programs in various branches of studies and has 15000+ students studying in various branches of knowledge at graduate and post graduate level and 494 Scholars pursuing research leading to PhD in 19 disciplines. It has 900+ well qualified, experienced and committed faculty members of whom majority are doctorates in their respective areas and most of them are guiding students pursuing research leading to PhD.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis on knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed universities / institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given importance while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The system also allows students to move forward under the fast track for those who have the capabilities to surpass others. These programs are taught by well experienced qualified faculty supported by the experts from industries, business sectors and such other organizations. REVA University has also initiated many supportive measures such as bridge courses, special coaching, remedial

classes, etc., for slow learners so as to give them the needed input and build in them confidence and courage to move forward and accomplish success in their career. The University has also entered into MOUs with many industries, business firms and other institutions seeking their help in imparting quality education through practice, internship and also assisting students' placements.

REVA University recognizing the fact that research, development and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology and other areas of study.

The interdisciplinary-multidisciplinary research is given the top most priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image Processing, Network Security, Big data analytics, Information Retrival,VLSIand Embedded Systems, Wireless Sensor Networks, Artificial Intelligance, Computer Networks, IOT, MEMS, Nano- Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, , LED Lighting, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nano Tribology, Fuel Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

The REVA University has also given utmost importance to develop much required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) Department with world class infrastructure, headed by a dynamic experienced Professor and Dean, and supported by well experienced Trainers, Counselors and Placement Officers. The University also has University-Industry Interaction (UIIC) and Skill Development Centre headed by a Senior Professor and Director facilitating skill related training to REVA students and other unemployed students. The University has been recognized as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana. The Centre conducts several add-on courses in challenging areas of development. It is always active in facilitating student's variety of Skill Development Training programs, Entrepreneurship

activities, and IPR workshops. UIIC has established REVA NEST, an incubation center for promoting start up industries.

The University has collaborations with Industries, universities abroad, research institutions, corporate training organizations, and Government agencies such as Florida International University, Okalahoma State University, Western Connecticut University, University of Alabama, University of California Berkeley, Arkansas State University, Columbia University, Huntsville, Oracle India Ltd, Texas Instruments, Nokia University Relations, EMC^2, VMware, SAP, Apollo etc, to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreign universities also facilitate students to study some of the programs partly in REVA University and partly in foreign university, viz, M.S in Computer Science one year in REVA University and the next year in the University of Alabama, Huntsville, USA.

The University has also given greater importance to quality in education, research, administration and all activities of the university. Therefore, it has established an independent Internal Quality division headed by a senior professor as Dean of Internal Quality. The division works on planning, designing and developing different quality tools, implementing them and monitoring the implementation of these quality tools. It concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat Ratna Prof. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr. Balaram, Former Director I.I.Sc., and noted Scientist, Dr. V S Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of Defence Dr. Sathish Reddy, Scientific Advisor, Ministry of Defence, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

As a part of our effort in motivating and inspiring youth of today, REVA University also has instituted awards and prizes to recognize the services of teachers, researchers, scientists, entrepreneurs, social workers and such others who have contributed richly for the development of the society and progress of the country. One of such awards instituted by REVA University is **'Life Time Achievement Award'** to be awarded to successful personalities who have made mark in their field of work. This award is presented on occasion of the **"Founders' Day Celebration"** of REVA University on 6th January of every year in presence of dignitaries, faculty members and students gathering. The first "**REVA Life Time Achievement Award**" for

the year 2015 has been awarded to Shri. Kiran Kumar, Chairman ISRO, followed by Shri. Shekhar Gupta, renowned Journalist for the year 2016, Dr K J Yesudas, renowned play back singer for the year 2017. REVA also introduced "**REVA Award of Excellence"** in the year 2017 and the first Awardee of this prestigious award is Shri Ramesh Aravind, Actor, Producer, Director, Screen Writer and Speaker.

REVA organizes various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVOTHASAVA conducted every year.

The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions and variety of cultural events. Another important event is ShubhaVidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also recognized by distributing awards and prizes. The founders have also instituted medals and prizes for sports achievers every year. The physical education Department conducts regular yoga classes every day to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

Within short span of time, REVA University has been recognised as a fast growing university imparting quality higher education to the youth of the country and received many awards, ranks, and accolades from various agencies, institutions at national and international level. These include: Asia's Greatest Brand and Leaders, by Asia One, National Award of Leadership Excellence, by ASSOCHAM India, Most promising University, by EPSI, Promising Upcoming Private University in the Country, by The Economic Times, Best University of India (South), by Dialogue India, Gold Brand by QS University Ranking, placed under 151-200 band by NIRF, 6^{TH} Rank in the Super Excellence category by GHRDC, 6^{TH} Rank in All India Law DEPARTMENT Survey, ranked among Top 30 Best B DEPARTMENTs by Business World, India's Best Law Institution by Careers 360, to mention a few.

REVA University

Vision

''REVA University aspires to become an innovative university by developing excellent human resources with leadership qualities, ethical and moral values, research culture and innovative skills through higher education of global standards".

Mission

- To create excellent infrastructure facilities and state-of-the-art laboratories and incubation centers
- To provide student-centric learning environment through innovative pedagogy and education reforms
- To encourage research and entrepreneurship through collaborations and extension activities
- To promote industry-institute partnerships and share knowledge for innovation and development
- To organize society development programs for knowledge enhancement in thrust areas
- To enhance leadership qualities among the youth and enrich personality traits, promote patriotism and moral values.

Objectives

- Creation, preservation and dissemination of knowledge and attainment of excellence in different disciplines
- Smooth transition from teacher - centric focus to learner - centric processes and activities
- Performing all the functions of interest to its major constituents like faculty, staff, students and the society to reach leadership position
- Developing a sense of ethics in the University and Community, making it conscious of its obligations to the society and the nation
- Accepting the challenges of globalization to offer high quality education and other services in a competitive manner.

ABOUT THE DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

The department has a rich blend of experienced and committed faculty who are well qualified in various aspects of Computer Science and Engineering apart from the numerous state-of-the-art digital classrooms and laboratories having modern computing equipment. The Department offers B Tech in Computer Science and Engineering, B Tech in Artificial Intelligence and Data Science and postgraduate programs offered are: M Tech in Computer Science and Engineering (Both Full time and Part time).

In addition, the department has a unique academic collaboration with the University of Alabama in Huntsville to jointly offer an MS program in Computer Science. In addition, the Department has a research center in which students can conduct cutting edge research leading to a PhD degree.

Curricula of both undergraduate and postgraduate programs have been designed through a collaboration of academic and industry experts in order to bridge the growing gap between industry and academia. This makes the program highly practical-oriented, and thus industry-resilient. The B Tech program aims to create quality human resources to play leading roles in the contemporary, competitive industrial and corporate world.

The masters' degrees focus on quality research and design in the core and application areas of computing to foster a sustainable world and to enhance the global quality of life by adopting enhanced design techniques and applications. This thought is reflected in the various courses offered in the masters' programs.

Vision

Department of Computer Science and Engineering aspires to create a pool of high-calibre technologists and researchers in the field of computer science and engineering who have potential to contribute for development of the nation and society with their expertise, skills, innovative problem-solving abilities and strong ethical values.

Mission

MD1: To create center of excellence where new ideas flourish and from which emerge tomorrow's researchers, scholars, leaders, and innovators.

MD2: Provide quality education in both theoretical and applied foundations of computer science and engineering, related inter-disciplinary areas and train students to effectively apply the knowledge to solve real-world problems.

MD3: Amplify student's potential for life-long high-quality careers and make them competitive in ever-changing and challenging global work environment.

MD4: Forge research and academic collaboration with industries and top global universities in order to provide students with greater opportunities.

MD5: Support the society by encouraging and participating in technology transfer.

Quality Policy

The Department of Computer Science and Engineering is committed to excellence through following policies.

1. Impart quality education by providing state of art curriculum, experimental learning, and state of the art labs.
2. Enhance skill set of faculty members through faculty development programmes and interaction with academia and industries.
3. Inculcate the competency in software/hardware design and programming through co-curricular activities like Hackathon, Project exhibition, Internship and Entrepreneurship Programme.
4. Provide soft skill and skill development training for personality development and better placement.
5. Promote innovation and research culture among students and support faculty members for better research and development activity.

ADVISORY BOARD

S. No.	Name	Designation
1	Dr. Bhanu Prasad	Professor, Department of Computer and Information Sciences, Florida A & M University (FAMU) , USA
2	Dr. Rajkumar Buyya	Director, Cloud Computing and Distributed Systems Laboratory, Department of Computing and Information Systems, University of Melbourne, Australia
3	Dr. Heggere S. Ranganathi	Professor and Chair, Computer Science Department, University of Alabama in Huntsville, Huntsville, AL 35899, USA.
4	Dr. S. S. Iyengar	Professor, Louisiana State University (LSU), USA.
5	Dr. Manjunath Joshi	Professor, Dhirubhai Ambani Institute of Information and Communication Technology, Gandhinagar
6	Dr. L. M. Patnaik	Adjunct Professor and INSA Senior Scientist Consciousness Studies Program, National Institute of Advanced Studies, IISc Campus. Bengaluru.
7	Mr. P. B. Kotur	Head - Global Freshers Engagement Program, Wipro Limited, Bengaluru.
8	Dr. Vivek Venkobarao	Continental Corporation Limited, Bengaluru.

CORPORATE ADVISORY BOARD

S. No.	Name	Designation
1	Mr. Suresh Kumar R	CTO CCS India & Digital Incubators at GE-Healthcare Bengaluru, Karnataka, India.
2	Mr. Abhas Abhinav	Entrepreneur specializing in Free Software and Liberated Hardware, Bengaluru, Karnataka, India.
3	Mr. Manjunath D S	Senior Micro Architect, IntelTechnologies India Pvt. Ltd., Bengaluru, Karnataka, India.
4	Mr. T Sabapathy	Nominations Committee Member, CSI, Bengaluru, Karnataka, India.
5	Mr. PrabhugoudaBiradar	VP-Engineering, Huawei Technologies India Pvt. Ltd., Bengaluru, Karnataka, India.
6	Mr. Kiran N	Leader Strategic Enterprise Architecture, Boeing, Bangalore Urban, Karnataka, India.

MEMBERS OF BOARD OF STUDIES

Sl.NO	Name, Designation and Affiliation	Status	Correspondence Address
1.	**Dr. Sanjay Chitnis** **Professor and Dean** DEPARTMENT of CSE and CIT, REVA University	Chair Person	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
2.	**Dr Ashwin Kumar U M** **Professor and Deputy Director** DEPARTMENT of CSE, REVA University	Member (Internal)	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
3.	**Dr Sunil Kumar S Manvi** **Professor and Dean** Faculty of Engineering and Technology REVA University	Member (Internal)	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
4.	**Dr Kiran Kumari Patil**, Professor, DEPARTMENT of CSE, Director UIIC, REVA University	Member (Internal)	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
5.	**Dr Mallikarjuna M Kodabagi**, Professor and Deputy Director IQAC, REVA University	, Member (Internal)	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
6.	**Dr. Meenakshi Sundaram** Associate Professor, DEPARTMENT of CSE, REVA University	Member (Internal)	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
7.	**Dr. Amuthabala** Associate Professor, DEPARTMENT of CSE, REVA University	Member (Internal)	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
8.	**Dr. Shantala Devi Patil** Associate Professor, DEPARTMENT of CSE, REVA University	Member (Internal)	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
9.	**Dr. Vishwanath Y**, Associate Professor DEPARTMENT of CSE, REVA University	Member (Internal)	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
10.	**Mr. Chetan Shivakumar,** CEO & Cofounder, Aikaan Labs Pvt Ltd, Bengaluru	Member	CEO & Cofounder, Aikaan Labs Pvt Ltd, Bengaluru
11.	**Mr. MuralidharJahagirdhar**, Practice Head Engineering, ATMECS Technology Pvt Ltd, Hyderabad	Member	Practice Head Engineering, ATMECS Technology Pvt Ltd, Hyderabad
12.	**Mr. RavikantSoni**, Technical Manager, Solution Architect, Standard Chartered bank, Bengaluru.	Member	Technical Manager, Solution Architect, Standard Chartered bank, Bengaluru.
13.	**Dr Sanjay**, HoD Dept. of ISE, NITTE Meenakshi Institute of Technology, Bengaluru	Member	HoD Dept. of ISE, NITTE Meenakshi Institute of Technology, Bengaluru
14.	**Dr Raghavendra Kulkarni**, Director of Academics, M. S. Ramaiah University of Applied Sciences, Bengaluru	Member	Director of Academics, M. S. Ramaiah University of Applied Sciences, Bengaluru

B.TECH in ARTIFICIAL INTELLIGENCE AND DATA SCIENCE PROGRAM

Program Overview

The Department of Computer Science and Engineering at REVA UNIVERSITY proudly launches an innovative B. Tech in Artificial Intelligence and Data Science programme during the academic year 2021–2022. Due to the exploration of the Internet, AI and DS deliver data-driven solutions using computational principles, methods, and systems for extracting information from data and modern computational systems that reveal capabilities of insight, way of thinking, learning, and action that are typical of human intelligence. This course to create motivated, innovative, creative thinking graduates to fill ICT positions across sectors who can conceptualize, design, analyze, and develop ICT applications to meet the modern-day requirements.

B. Tech in Artificial Intelligence & Data Science Programme prepares students with the skills to perform intelligent data analysis which is a key component in numerous real-world applications. During the past ten years, data science has emerged as one of the most high-growth, dynamic, and lucrative careers in technology. This course aims at providing not only the core technologies such as artificial intelligence, data mining, and data modeling but also gives intensive inputs in areas of machine learning and big data analytics. By this course, the students will gain cross-disciplinary skills across fields such as statistics, computer science, machine learning, and logic, data scientists and may have career opportunities in healthcare, business, e-commerce, social networking companies, climatology, biotechnology, genetics, and other important areas. The major focus of this programme is to equip students with statistical, mathematical reasoning, machine learning, knowledge discovery, and visualization skills.

The course covers the core principles of Data Science, the process of ethically acquiring, engineering, analyzing, visualizing, and ultimately monetizing data. It equips it with the basic tools and techniques of data handling, exploratory data analysis, data visualization, and data-based inference.

The course also introduces the fundamentals of Artificial Intelligence – state-space representation, search strategies, and learning algorithms. The course motivates students to work closely with data and make data-driven decisions in the field of study. The course also touches upon the ethical issues in Data Science and Artificial Intelligence and motivates students to explore the cutting-edge applications related to Big Data, Neural Networks, and Deep Learning. Applications like Alexa/Siri, Erica/Sophia, Tesla's driverless car, Chatbot, etc are becoming common. AI-powered Robots can take over human life-endangering jobs like firefighting, deep-sea oil drilling, mining works with high mortality rates, etc.

The B. Tech., in Artificial Intelligence and Data Science curriculum developed by the faculty at the Department of Computer Science and Engineering, is outcome-based and it comprises required theoretical concepts and practical skills in the domain. By undergoing this programme, students

develop critical, innovative, creative thinking and problem-solving abilities for a smooth transition from academic to the real-life work environment. In addition, students are trained in interdisciplinary topics and attitudinal skills to enhance their scope. The above-mentioned features of the programme, advanced teaching, and learning resources, and the experience of the faculty members with their strong connections with the ICT sector make this programme unique.

Program Educational Objectives (PEOs)

The program helps to develop critical, analytical, innovative, creative and problem-solving abilities amongst its graduates. The programme makes the graduates employable as Software Engineers across sectors. With further education and earning of higher-level degrees help the graduates to pursue a career in academics or scientific organisations as researchers.

The Program Educational Objectives (PEOs):

After few years of graduation, the graduates of B. Tech in Artificial Intelligence& Data Science will be able to:

- **PEO-1:** Have a successful professional career in industry, government, academia and defence as an innovative engineer in a team.
- **PEO-2:** Develop a code and solutions to industry and societal needs in a rapid changing technological environment and communicate with clients as an entrepreneur.
- **PEO-3:** Pursue higher studies and continue to learn by participating in conferences, seminars, etc.

Program Outcomes (POs)

On successful completion of the program, the graduates of B. Tech in Artificial Intelligence & Data Science program will be able to:

- **PO-1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals for the solution of complex problems in Artificial Intelligence & Data Science.

- **PO-2: Problem analysis:** Identity, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.

- **PO-3: Design/development of solution:** Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for public health and safety, and the cultural, societal, and environmental considerations.

- **PO-4: Conduct Investigation of complex problem:** Use research-based knowledge including design of experiments, analysis, and interpretation of data, and synthesis of the information to provide valid conclusions.

- **PO-5: Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- **PO-6: Engineering and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

- **PO-7: Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

- **PO-8: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

- **PO-9: Indiviual and Team work:** Function effectively as an individual, and as a member or leader in teams, and multidisciplinary settings.

- **PO-10: Communication:** Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective report documentation. Make effective presentations, and give and receive clear instructions.

- **PO-11: Project management and finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's work, as a member and leader in a team. Manage projects in multidisciplinary environments.

- **PO-12: Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes (PSOs)

On successful completion of the program, the graduates of B. Tech in Artificial Intelligence & Data Science program will be able to:

- **PSO-1:** Understand, analyze and develop essential proficiency in the areas related to data science and artificial intelligence in terms of underlying statistical and computational principles and apply the knowledge to solve practical problems.

- **PSO-2:** Ability to implement Artificial Intelligence and data science techniques such as search algorithms, neural networks, machine learning, and data analytics for solving a problem and designing novel algorithms for successful career and entrepreneurship.

- **PSO-3:** Use modern tools and techniques in the area of Artificial Intelligence& Data Science.

REVA University Academic Regulations

B. Tech., Degree Programs

(Applicable for the programs offered from 2021-25 Batch)

Regulations – B. Tech., Degree Program
Academic Year 2021-22 Batch

(Framed as per the provisions under Section 35 (ii), Section 7 (x) and Section 8 (xvi) & (xxi) of the REVA University Act, 2012)

1. Title and Commencement:

1.1 These Regulations shall be called **"REVA University Academic Regulations – B. Tech., Degree Program 2021-22 Batch subject to amendments from time to time by the Academic Council on recommendation of respective Board of Studies and approval of Board of Management**

1.2 These Regulations shall come into force from the date of assent of the Chancellor.

2. The Programs:

These regulations cover the following B. Tech., Degree programs of REVA University offered during 2019-20.

B Tech in:
Bioelectronics Engineering
Civil Engineering
Computer Science and Engineering
Artificial Intelligence and Data Science
Computer Science and Information Technology
Computer Science and Systems Engineering
Computer Science and Engineering (AI and ML)
Electrical and Electronics Engineering
Electrical and Computer Engineering
Electronics and Communication Engineering
Electronics and Computer Engineering
Information Science and Engineering
Mechanical Engineering
Mechatronics Engineering

3. Duration and Medium of Instructions:

3.1 Duration: The duration of the B.Tech degree program shall be FOUR years comprising of **EIGHT** Semesters. A candidate can avail a maximum of 16 semesters - 8 years as per double duration norm, in one stretch to complete B. Tech degree, including blank semesters, if any. Whenever a candidate opts for blank semester, he/she has to study the prevailing courses offered by the

Department when he/she resumes his/her studies.

3.2 The medium of instruction shall be English.

4. Definitions:

4.1 Course: "Course" means a subject, either theory or practical or both, listed under a programme; Example: "Fluid Mechanics" in B Tech Civil Engineering program, Engineering Thermodynamics in B. Tech., Mechanical program are examples of courses to be studied under respective programs.

Every course offered will have three components associated with the teaching-learning process of the course, namely:

L	**Lecture**
T	**Tutorial**
P	**Practice**

Where:

L stands for **Lecture** session consisting of classroom instruction.

T stands for **Tutorial** session consisting participatory discussion / self-study/ desk work/ brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes.

P stands for **Practice** session and it consists of Hands on Experience / Laboratory Experiments / Field Studies / Case Studies / Project Based Learning or Course end Project/Self Study/ Online courses from listed portals that equip students to acquire the much required skill component.

4.2 Classification of Courses

Courses offered are classified as: Core Courses, Open Elective Courses, Project work/Dissertation

4.2.1 **Core Course:** A course which should compulsorily be studied by a candidate choosing a particular program of study

4.2.2 **Foundation Course:** The foundation Course is a mandatory course which should be completed successfully as a part of graduate degree program irrespective of the program of study

4.2.3 **Hard Core Course (HC) simply core course:** The **Hard-Core Course** is a Core Course in the main branch of study and related branch(es) of study, if any, that the candidates have to complete compulsorily

4.2.4 **Soft Core Course (SC) (also known as Professional Elective Course)**

A Core course may be a **Soft Core** if there is a choice or an option for the candidate to choose a course from a pool of courses from the main branch of study or from a sister/related branch of study which supports the main branch of study

4.2.5 **Open Elective Course (OE):**

An elective course chosen generally from other discipline / subject, with an intention to seek exposure to the basics of subjects other than the main discipline the student is studying is called an **Open Elective Course**

4.2.6 **Project Work / Dissertation:**

Project work / Dissertation work is a special course involving application of knowledge in solving / analyzing /exploring a real-life situation / difficult problem to solve a multivariable or complex engineering problems. The project will be conducted in two phases, phase-I (7th Semester), Consists of literature survey, problem identification, formulation and methodology. In Phase-II (8th Semester) student should complete the project work by designing or creating an innovative process or development of product as an outcome. A project work carrying **TWO**, **FOUR or SIX** credits is called Minor Project work / Dissertation. A project work of **SIX, EIGHT, or TEN,** credits is called Major Project work / Dissertation. **A Minor Project work may be a hard core or a Soft Core as decided by the BOS / concerned. But the Major Project shall be Hard Core.**

4.2.7 **"Program"** means the academic program leading to a Degree, Post Graduate Degree, Post Graduate Diploma Degree or such other degrees instituted and introduced in REVA University.

5. Eligibility for Admission:

5.1. The eligibility criteria for admission to B Tech Program of 4 years (8 Semesters) is given below:

Sl. No.	Program	Duration	Eligibility
1	Bachelor of Technology (B Tech)	4 Years (8 Semesters)	Passed 10+2 examination with Physics and Mathematics as compulsory subjects, along with any one of the following subjects, namely, Chemistry, Bio-Technology, Computer Science, Biology, Electronics and Technical Vocational subject Obtained at least 45% marks (40% in case of candidate belonging to SC/ST category) in the above subjects taken together.
2	Bachelor of Technology (B Tech)	Lateral entry to second year	A. Passed Diploma examination from an AICTE approved Institution with at least 45% marks (40% in case of candidates belonging to SC/ST category) in appropriate branch of Engineering / Technology. B. Passed B. Sc Degree from a recognized University as defined by UGC, with at least 45% marks (40% in case of candidates belonging to SC/ST category) and passed XII standard with

			mathematics as a subject. C. Provided that in case of students belonging to B. Sc. Stream, shall clear the subjects of Engineering Graphics / Engineering Drawing and Engineering Mechanics of the first year Engineering program along with the second-year subjects. D. Provided further that, the students belonging to B. Sc. Stream shall be considered only after filling the seats in this category with students belonging to the Diploma stream. E. Provided further that student, who have passed Diploma in Engineering & Technology from an AICTE approved Institution or B. Sc., Degree from a recognized University as defined by UGC, shall also be eligible for admission to the first year Engineering Degree courses subject to vacancies in the first-year class in case the vacancies at lateral entry are exhausted. However, the admissions shall be based strictly on the eligibility criteria as mentioned in A, B, D, and E above.
3	Bachelor of Technology (B Tech)	Lateral entry to fourth year (final year)	Any candidate with genuine reason from any University / Institution in the country upon credit transfer could be considered for lateral admission to the respective semester in the concerned branch of study, provided he/she fulfils the University requirements.
4	B. Tech. in Bioelectronics		Pass in PUC / 10+2 examination with Physics and Mathematics as compulsory subjects along with one of the Chemistry / Biotechnology / Biology / Computer Science / Electronics / Technical Vocational subjects and obtained minimum 45% marks (40% in case of candidates belonging to SC / ST category) in the above subjects taken together of any board recognized by the respective State Government / Central Government / Union Territories or any other qualification recognized as equivalent there to.

5.2 Provided further that the eligibility criteria are subject to revision by the Government Statutory Bodies, such as AICTE, UGC from time to time.

6. Courses of Study and Credits

6.1 Each course of study is assigned with certain credit value

6.2 Each semester is for a total duration of 20 weeks out of which 16 weeks dedicated for teaching and learning and the remaining 4 weeks for final examination, evaluation and announcement of results

6.3 The credit hours defined as below:

In terms of credits, every one hour session of L amounts to 1 credit per Semester and a minimum of two hour session of T or P amounts to 1 credit per Semester or a three hour session of T / P amounts to 2 credits over a period of one Semester of 16 weeks for teaching-learning process.

1 credit = 13 credit hours spread over 16 weeks or spread over the semester

The total duration of a semester is 20 weeks inclusive of semester-end examination.

The following table describes credit pattern

Table-2: Credit Pattern

Lectures(L)	Tutorials(T)	Practice (P)	Credits (L: T: P)	Total Credits	Total Contact Hours
4	2	0	4:1:0	5	6
3	2	0	3:1:0	4	5
3	0	2	3:0:1	4	5
2	2	2	2:1:1	4	6
0	0	6	0:0:3	3	6
4	0	0	4:0:0	4	4
2	0	0	2:0:0	2	2

a. The concerned BoS will choose the convenient Credit Pattern for every course based on size and nature of the course

7. Different Courses of Study:

Different Courses of Study are labeled as follows:

a. Core Course (CC)
b. Foundation Course (FC)
c. Hard Core Course (HC)
d. Soft Core Course (SC)
e. Open Elective Course (OE)
f. Project Work / Dissertation:

g. A project work carrying **TWO, FOUR or SIX** credits is called Minor Project work / Dissertation. A project work of **EIGHT, TEN, TWELVE or SIXTEEN** credits is called Major Project work / Dissertation. A Project work may be a hard core or a Soft Core as decided by the BoS / concerned.

These are defined under Section 4 of these regulations.

8. Credits and Credit Distribution

8.1 A candidate has to earn 160 credits for successful completion of B Tech degree with the distribution of credits for different courses as given in table below:

Course Type	Credits (Range)
	For B Tech Degree (8 Semesters)
Foundation Core Course	A minimum of 06 but not exceeding 12

Hard Core Course	A minimum of 118 but not exceeding 121
Soft Core Course	A minimum of 15 but not exceeding 21
Open Elective	A minimum of 04 but not exceeding 12

8.2. The concerned BOS based on the credits distribution pattern given above shall prescribe the credits to various types of courses and shall assign title to every course including project work, practical work, field work, self-study elective, as **Foundation Course (FC), Hard Core (HC) or Soft Core (SC), Open Elective (OE).**

8.3. Every course including project work, practical work, field work, self-study elective should be entitled as **Foundation Course (FC), Hard Core (HC) or Soft Core (SC) or Open Elective (OE)** or **Core Course** (**CC**) by the BoS concerned. However, following shall be the **Foundation Courses** with credits mentioned against them, common to all branches of study.

Sl. No.	**Course Title**	**Number of Credits**
Foundation Courses		
1	English for Technical Communication / Communicative Skills	2-3
2	Environmental Studies / Environmental Sciences	2
3	Indian Constitution and Professional Ethics	2
4	MOOC / Internship /Soft Skill Training	6-15

8.4**.** The concerned BOS shall specify the desired Program Educational Objectives, Program Outcomes, Program Specific Outcomes and Course Outcomes while preparing the curriculum of a particular program.

8.5. A candidate can enrol for a maximum of 28 credits and a minimum of 19 credits per Semester. However he / she may not successfully earn a maximum of 28 credits per semester. This maximum of 28 credits does not include the credits of courses carried forward by a candidate.

8.6 **Only such full time candidates who register for a minimum prescribed number of credits in each semester from I semester to VIII semester and complete successfully 160 credits in 8 successive semesters shall be considered for declaration of Ranks, Medals, Prizes** and are eligible to apply for Student Fellowship, Scholarship, Free ships, and such other rewards / advantages which could be applicable for all full time students and for hostel facilities.

8.7 Add- on Proficiency Certification:

To acquire Add on Proficiency Certification a candidate can opt to complete a minimum of 4 extra credits either in the same discipline /subject or in different discipline / subject in excess to 160 credits for the B Tech Degree program**.**

8.7.1. Add on Proficiency Diploma / Minor degree/ Honor Degree:

To acquire Add on Proficiency Diploma/ Minor degree/ Honor Degree, A candidate can opt to complete a minimum of 18 extra credits either in the same discipline /subject or in different discipline / subject in excess to 160 credits for the B Tech Degree program.

The Add on Proficiency Certification / Diploma/ Minor degree/ Honor Degree: so, issued to the candidate contains the courses studied and grades earned.

9 Assessment and Evaluation

9.1 The Scheme of Assessment will have two parts, namely;

i. Internal Assessment (IA); and
ii. Semester End Examination (SEE)

9.2 Assessment and Evaluation of each Course shall be for 100 marks. The Internal Assessment (IA) and Semester End Examination (SEE) of UG Engineering programs shall carry 50:50 marks respectively (i.e., 50 marks internal assessment; 50 marks semester end examination).

9.3 The 50 marks of internal assessment shall comprise of:

Internal Test	30 marks
Assignments / Seminars / Model Making / Integrated Lab / Project Based Learning / Quizzes etc.	20 marks

9.4 There shall be **two Internal Tests** conducted as per the schedule announced below. **The Students shall attend both the Tests compulsorily.**

- 1st test is conducted for 15 marks during **6th week** of the Semester;
- 2nd test is conducted for 15 marks during **12th week** of the of the Semester;

9.5 The coverage of syllabus for the said tests shall be as under:

- Question paper of the **1st test should be based on first 40 %of the total syllabus**;
- Question paper of the **2nd test should be based on second 40 %of the total syllabus**;
- An assignment must be designed to cover the last **20% of the Syllabus**

9.6 There shall be one Assignment / Project Based Learning / Field Visit / Quiz test carrying 20 marks covering the last 20% of the Syllabus

9.7 The Semester End Examination for 50 marks shall be held in the 18th and 19th week of the beginning of the semester and the syllabus for the semester end examination shall be entire syllabus.

9.8 A test paper is set for a maximum of 30 marks to be answered in 1 hour duration. A test paper can have 4 main questions. Each main question is set for 10 marks. The main question can have 2-3 sub

questions all totalling 10 marks. Students are required to answer any three main questions. Each question is set using Bloom's verbs. The questions must be set to assess the student's outcomes described in the course document.

9.9 The question papers for internal test shall be set by the internal teachers who have taught the course. If the course is taught by more than one teacher all the teachers together shall devise a common question paper(s). However, these question papers shall be scrutinized by the Question Paper Scrutiny Committee to bring in the uniformity in the question paper pattern and as well to maintain the necessary standards.

9.10 The evaluation of the answer scripts shall be done by the internal teachers who have taught the course and set the test paper.

9.11 Assignment/seminar/Project based learning/simulation-based problem solving/field work should be set in such a way, students be able to apply the concepts learnt to a real-life situation and students should be able to do some amount self-study and creative thinking. While setting assignment care should be taken such that the students will not be able to plagiarise the answer from web or any other resources. An assignment / Quiz can be set for a maximum of 20. Course instructor at his/her discretion can design the questions as a small group exercise or individual exercise. This should encourage collaborative learning and team learning and also self-study.

9.12 Internal assessment marks must be decided well before the commencement of Semester End examinations

9.13 Semester End Examination: The Semester End Examination is for 50 marks shall be held in the 18th and 19th week of the semester and the entire course syllabus must be covered while setting the question paper.

9.14 Semester End Examination paper is set for a maximum of 100 marks to be answered in 3 hours duration. Each main question be set for a maximum of 25 marks, main questions can have a 3-4 sub questions. A total of 8 questions are set so that students will have a choice. Each question is set using Bloom's verbs. The questions must be set to assess the student's outcomes described in the course document. (Please note question papers have to be set to test the course outcomes)

9.15 There shall be three sets of question papers for the semester end examination of which one set along with scheme of examination shall be set by the external examiners and two sets along with scheme of examination shall be set by the internal examiners. All the three sets shall be scrutinized by the Board of Examiners. It shall be responsibility of the Board of Examiners particularly Chairman of the BOE to maintain the quality and standard of the question papers and as well the coverage of the entire syllabus of the course.

9.16 There shall be single evaluation by the internal teachers who have taught the subject. However, there shall be moderation by the external examiner. In such cases where sufficient number of external examiners are not available to serve as moderators internal senior faculty member shall be appointed as moderators.

9.17 Board of Examiners, question paper setters and any member of the staff connected with the examination are required to maintain integrity of the examination system and the quality of the question papers.

9.18 There shall also be an **Program Assessment Committee (PAC)** comprising at-least 3 faculty members having subject expertise who shall after completion of examination process and

declaration of results review the results sheets, assess the performance level of the students, measure the attainment of course outcomes, program outcomes and assess whether the program educational objectives are achieved and report to the Director of the Department. The Examination Review Committee shall also review the question papers of both Internal Tests as well Semester End Examinations and submit reports to the Director of the respective Department about the scope of the curriculum covered and quality of the questions.

9.19 The report provided by the Examination Review Committee shall be the input to the Board of Studies to review and revise the scheme of instruction and curriculum of respective program

9.20 During unforeseen situation like the Covid-19, the tests and examination schedules, pattern of question papers and weightage distribution may be designed as per the convenience and suggestions of the board of examiners in consultation with COE and VC

9.21 University may decide to use available modern technologies for writing the tests and SEE by the students instead of traditional pen and paper

9.22 Any deviations required to the above guidelines can be made with the written consent of the Vice Chancellor

9.23 Online courses may be offered as per UGC norms.
For online course assessment guidelines would be as follows:

1. If the assessment is done by the course provider, then the department can accept the marks awarded by the course provider and assign the grade as per REVA University norms.
2. If the assessment is not done by the course provider, then the assessment is organized by the concerned Department and the procedure explained in the regulation will apply
3. In case a student fails in an online course, s/he may be allowed to repeat the course and earn the required credits

IAs for online courses could be avoided and will remain at the discretion of the Department.

9.24 The online platforms identified could be SWAYAM, NPTEL, Coursera, Edx.org, Udemy, Udacity and any other internationally recognized platforms like MIT online, Harvard online etc.

9.25 Utilization of one or two credit online courses would be:

4-week online course – 1 credit

8-week online course / MOOC – 2 credits

12-week online course / MOOC – 3 credits

9.26 **Summary of Internal Assessment, Semester End Examination and Evaluation** Schedule is provided in the table given below.

Summary of Internal Assessment and Evaluation Schedule

Sl. No.	Type of Assessment	When	Syllabus Covered	Max Marks	Reduced to	Date by which the process must be completed
1	Test-1	During 6th week	First 40%	30	15	7th week
2	Test -2	During 12th	Second 40%	30	15	13th Week

		Week				
3	Assignment / Quiz	15th Week	Last 20%	20	20	16th Week
4	SEE	18/19th Week	100%	100	50	20th Week

10 Assessment of Students Performance in Practical Courses

The performance in the practice tasks / experiments shall be assessed on the basis of:
a) Knowledge of relevant processes;
b) Skills and operations involved;
c) Results / products including calculation and reporting.

10.1 The 50 marks meant for Internal Assessment (IA) of the performance in carrying out practical shall further be allocated as under:

i	Conduction of regular practical / experiments throughout the semester	20 marks
ii	Maintenance of lab records	10 marks
iii	Performance of mid-term test (to be conducted while conducting second test for theory courses); the performance assessments of the mid-term test include performance in the conduction of experiment and write up about the experiment.	20 marks
	Total	**50 marks**

10.2 The 50 marks meant for Semester End Examination (SEE), shall be allocated as under:

i	Conducting of semester end practical examination	30 marks
ii	Write up about the experiment / practical conducted	10 marks
iii	Viva Voce	10 marks
	Total	**50 marks**

10.3 The duration for semester-end practical examination shall be decided by the concerned Department Board.

For MOOC and Online Courses assessment shall be decided by the BOS of the Department.

For > 3 credit courses

i	IA-I	25 marks
ii	IA-2	25 marks
iii	Semester end examination by the concern Department board (demo, test, viva voice etc.)	50 marks
	Total	**100 marks**

For 1 & 2 credit courses

i	IA-I	15 marks
Ii	IA-2	15 marks
Iii	Semester end examination by the concern Department board (demo, test, viva voice etc.)	20 marks
	Total	**50 marks**

11. Evaluation of Minor Project / Major Project / Dissertation:

Right from the initial stage of defining the problem, the candidate has to submit the progress reports periodically and also present his/her progress in the form of seminars in addition to the regular discussion with the supervisor. At the end of the semester, the candidate has to submit final report of the project / dissertation, as the case may be, for final evaluation. The components of evaluation are as follows:

Component – I	Periodic Progress and Progress Reports (25%)
Component – II	Demonstration and Presentation of work (25%)
Component – III	Evaluation of Report (50%)

12. Requirements to Pass a Course:

A candidate's performance from IA and SEE will be in terms of scores, and the sum of IA and SEE scores will be for a maximum of 100 marks (IA = 50, SEE = 50) and have to secure a minimum of 40% to declare pass in the course. However, a candidate has to secure a minimum of 25% (13 marks) in Semester End Examination (SEE) which is compulsory.

The Grade and the Grade Point: The Grade and the Grade Point earned by the candidate in the subject will be as given below:

Marks, P	**Grade, G**	**Grade Point (GP=V x G)**	**Letter Grade**
90-100	10	v*10	O
80-89	9	v*9	A+
70-79	8	v*8	A
60-69	7	v*7	B+
55-59	6	v*6	B
50-54	5.5	v*5.5	C+
40-49	5	v*5	C
0-39	0	v*0	F
ABSENT			AB

O - Outstanding; A+-Excellent; A-Very Good; B+-Good; B-Above Average; C+-Average; C-Satisfactory; F – Unsatisfactory.

Here, P is the percentage of marks (P= [IA + SEE]) secured by a candidate in a course which is **rounded to nearest integer**. V is the credit value of course. G is the grade and GP is the grade point.

a. Computation of SGPA and CGPA

The Following procedure to compute the Semester Grade Point Average (SGPA).

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student in a given semester, i.e.: **SGPA (Si) = ∑ (Ci x Gi) / ∑ Ci where** Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course.

Illustration for Computation of SGPA and CGPA

Illustration No. 1

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit x Grade)
Course 1	3	A+	9	3X9=27
Course 2	3	A	8	3X8=24
Course 3	3	B+	7	3X7=21
Course 4	4	O	10	4X10=40
Course 5	1	C	5	1X5=5
Course 6	2	B	6	2X6=12
Course 7	3	O	10	3X10=30
	19			159

Thus, **SGPA = 159 ÷ 19 = 8.37**

Illustration No. 2

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade point)
Course 1	4	A	8	4X8=32
Course 2	4	B+	7	4X7=28
Course 3	3	A+	9	3X9=27
Course 4	3	B+	7	3X7=21
Course 5	3	B	6	3X6=18
Course 6	3	C	5	3X5=15
Course 7	2	B+	7	2X7=21
Course 8	2	O	10	2X10=20
	24			175

Thus, SGPA = 175 ÷ 24 = 7.29

Illustration No.3

Course	**Credit**	**Grade Letter**	**Grade Point**	**Credit Point (Credit x Grade point)**
Course 1	4	O	10	4 x 10 = 40
Course 2	4	A+	9	4 x 9 = 36
Course 3	3	B+	7	3 x 7 = 21
Course 4	3	B	6	3 x 6 = 18
Course 5	3	A+	9	3 x 9 = 27
Course 6	3	B+	7	3 x 7 = 21
Course 7	2	A+	9	2 x 9 = 18
Course 8	2	A+	9	2 x 9 = 18
	24			**199**

Thus**, SGPA = 199 ÷ 24 = 8.29**

b.Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (160) for B. Tech degree in Engineering & Technology is calculated taking into account all the courses undergone by a student over all the semesters of a program, i. e : **CGPA = ∑(Ci x Si) / ∑Ci**

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

Illustration:

CGPA after Final Semester

Semester (ith)	No. of Credits (Ci)	SGPA (Si)	Credits x SGPA (Ci X Si)
1	19	6.83	19 x 6.83 = 129.77
2	21	7.29	21 x 7.29 = 153.09
3	22	8.11	22 x 8.11 = 178.42
4	22	7.40	22 x 7.40 = 162.80
5	22	8.29	22 x 8.29 = 182.38
6	22	8.58	22 x 8.58 = 188.76
7	22	9.12	22 x 9.12 = 200.64
8	10	9.25	10 x 9.25 =92.50
Cumulative	**160**		**1288.36**

Thus, **CGPA** = $\frac{19x6.83+21x7.29+22x8.11+22x7.40+22x8.29+22x8.58+22x9.12+10x9.25}{160}$ = 8.05

c. Conversion of grades into percentage:

Conversion formula for the conversion of CGPA into Percentage is:

Percentage of marks scored = CGPA Earned x 10

Illustration: CGPA Earned 8.05 x 10=80.5

d. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

13. Classification of Results

The final grade point (FGP) to be awarded to the student is based on CGPA secured by the candidate and is given as follows.

CGPA	Grade (Numerical Index)	Letter Grade	Performance	FGP
	G			Qualitative Index
9 >= CGPA 10	10	O	Outstanding	Distinction
8 >= CGPA < 9	9	A+	Excellent	
7 >= CGPA < 8	8	A	Very Good	First Class
6 >= CGPA < 7	7	B+	Good	
5.5> = CGPA < 6	6	B	Above average	Second Class
>5 CGPA< 5.5	5.5	C+	Average	
>4 CGPA<5	5	C	Satisfactory	Pass
< 4 CGPA	0	F	Unsatisfactory	Unsuccessful

Overall percentage=10*CGPA

a. **Provisional Grade Card**: The tentative / provisional grade card will be issued by the Controller of Examinations at the end of every semester indicating the courses completed successfully. The provisional grade card provides **Semester Grade Point Average (SGPA).**

b. **Final Grade Card:** Upon successful completion of B Tech Degree a Final Grade card consisting of grades of all courses successfully completed by the candidate will be issued by the Controller of Examinations.

14. Attendance Requirement:

14.1 All students must attend every lecture, tutorial and practical classes.

14.2 In case a student is on approved leave of absence (e g:- representing the University in sports, games or athletics, placement activities, NCC, NSS activities and such others) and / or any other such contingencies like medical emergencies, the attendance requirement shall be minimum of 75% of the classes taught.

14.3 Any student with less than 75% of attendance in aggregate of all the courses including practical courses / field visits etc, during a semester shall not be permitted to appear to the end semester examination and such student shall seek re-admission

15. Re-Registration and Re-Admission:

15.1 In case a candidate's class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University, such a candidate is considered as dropped the semester and is not allowed to appear for semester end examination and he / she shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

15.2 In such case where in a candidate drops all the courses in a semester due to personal reasons, it is considered that the candidate has dropped the semester and he / she shall seek re-admission to such dropped semester.

16. Absence during Internal Test:

In case a student has been absent from an internal test due to the illness or other contingencies he / she may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Director of the Department, for conducting a separate internal test. The Director of the Department may consider such request depending on the merit of the case and after consultation with course instructor and class teacher, and arrange to conduct a special internal test for such candidate(s) well in advance before the Semester End Examination of that respective semester. Under no circumstances internal tests shall be held / assignments are accepted after Semester End Examination.

17. Provision for Appeal

If a candidate is not satisfied with the evaluation of Internal Assessment components (Internal Tests and Assignments), he/she can approach the Grievance Cell with the written submission together with all facts, the assignments, and test papers, which were evaluated. He/she can do so before the commencement of respective semester-end examination. The Grievance Cell is empowered to revise the marks if the case is genuine and is also empowered to levy penalty as prescribed by the University on the candidate if his/her submission is found to be baseless and unduly motivated. This Cell may recommend for taking disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the Grievance committee is final.

18. Grievance Committee:

In case of students having any grievances regarding the conduct of examination, evaluation and announcement of results, such students can approach Grievance Committee for redressal of grievances.

For every program there will be one grievance committee. The composition of the grievance committee is as follows: -

- The Controller of Examinations - Ex-officio Chairman / Convener
- One Senior Faculty Member (other than those concerned with the evaluation of the course concerned) drawn from the DEPARTMENT / Department/discipline and/or from the sister DEPARTMENTs / Departments/sister disciplines – Member.
- One Senior Faculty Members / Subject Experts drawn from outside the University DEPARTMENT / Department – Member.

19. Eligibility to Appear for Semester End Examination (SEE)

Only those students who fulfil a minimum of 75% attendance in aggregate of all the courses including practical courses / field visits etc., as part of the program shall be eligible to appear for Semester End Examination

20. Provision for Supplementary Examination

In case a candidate fails to secure a minimum of 25% (13 marks) in Semester End Examination (SEE) and a minimum of 40% marks together with IA and SEE to declare pass in the course, such candidate shall seek supplementary examination of only such course(s) wherein his / her performance is declared unsuccessful. The supplementary examinations are conducted after the announcement of even semester examination results. The candidate who is unsuccessful in a given

course(s) shall appear for supplementary examination of odd and even semester course(s) to seek for improvement of the performance.

21. Provision to Carry Forward the Failed Subjects / Courses:

The student who has failed in a maximum of 4 courses in odd and even semesters together shall move to next semester of succeeding year(s) of study till 8th semester. And he / she shall appear for Semester End examination of failed courses of previous semesters concurrently with odd semester end examinations and / or even semester end examinations of current year of study.

Case 1: A student who has failed in a maximum of 4 courses in 1st and 2nd semester together shall move to the 3rd semester of the succeeding year.

Case 2: A student who has failed in a maximum of 4 courses from semester 1 to 4 together shall move to the 5th semester of the succeeding year.

Case 3: A students who has failed in a maximum of 4 courses from semester 1 to 6 together shall move to the 7th semester of the succeeding year.

22. Challenge Valuation:

a. A student who desires to apply for challenge valuation shall obtain a photo copy of the answer script(s) of semester end examination by paying the prescribed fee within 10 days after the announcement of the results. He / She can challenge the grade awarded to him/her by surrendering the grade card and by submitting an application along with the prescribed fee to the Controller of Examinations within 10 days after the announcement of the results. This challenge valuation is only for semester end examination.

b. The answer scripts (in whatever form) for which challenge valuation is sought for shall be evaluated by the external examiner who has not involved in the first evaluation. The higher of two marks from first valuation and challenge valuation shall be the final.

23. With regard to any specific case of ambiguity and unsolved problem, the decision of the Vice-Chancellor shall be final.

24. All assessments must be done by the respective Departments as per the guidelines issued by the Controller of Examinations. However, the responsibility of announcing final examination results and issuing official transcripts to the students lies with the office of the Controller of Examinations.

REVA UNIVERSITY
Bengaluru, India

B. TECH IN ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Scheme of Instructions

(Effective from Academic Year 2021 - 22)

I SEMESTER (CYCLE-1)

Sl. No	Course Code	Title of the Course	HC/FC/SC/OE	Credit Pattern & Credit Value				Contact Hours/ Week
				L	T	P	Credits	
1	B21AS0105	Multivariable Calculus and Linear Algebra	HC	3	0	0	3	3
2	B21AS0106	Physics for Computer Science	HC	3	0	0	3	3
3	B21CS0101	Introduction to Data Science	FC	2	0	1	3	4
4	B21CS0102	Programming for Problem Solving	HC	3	0	1	4	5
TOTAL				11	0	2	13	15
	Practical /Term Work / Practice Sessions/Online /MOOC							
5	B21ME0104	Entrepreneurship	HC	1	0	0	1	1
6	B21EC0101	IoT Applications	FC	1	0	1	2	3
7	B21ME0101	Computer Aided Engineering Drawing	HC	2	0	1	3	4
TOTAL				4	0	2	06	8
TOTAL SEMESTER CREDITS							**19**	
TOTAL CUMULATIVE CREDITS							**19**	
TOTAL CONTACT HOURS							**23**	

II SEMESTER (CYCLE-2)

Sl. No	Course Code	Title of the Course	HC/FC/SC/ OE	Credit Pattern & Credit Value				Contact Hours/ Week
				L	T	P	Credits	
1	B21AS0204	Probability and Statistics	HC	4	0	0	4	4
2	B21AS0104	Engineering Chemistry	HC	3	0	0	3	3
3	B21CI0101	Introduction to Python Programming	FC	2	0	1	3	4
4	B21EE0101	Basics of Electrical and Electronics Engineering	HC	3	0	1	4	5
5	B21CE0201	Basics of Civil and Mechanical Engineering	HC	3	0	1	4	5
TOTAL				15	0	3	18	21
	Practical /Term Work / Practice Sessions/Online/MOOC							
6	B21AS0109	Biology for Engineers	FC	1	0	0	1	1
7	B21ME0102	Design Thinking	HC	1	0	1	2	3
TOTAL				**2**	**0**	**1**	3	4
TOTAL SEMESTER CREDITS							**21**	
TOTAL CUMULATIVE CREDITS							**40**	
TOTAL CONTACT HOURS							**25**	

III SEMESTER

Sl. No	Course Code	Title of the Course	HC/FC/SC/OE	Credit Pattern & Credit Value				Contact Hours/ Week
				L	T	P	Credits	
1	B21EF0301	Analog and Digital Electronics	HC	3	0	0	3	3
2	B21EF0302	Programming with JAVA	HC	3	0	0	3	3
3	B21EF0303	Data Structures	HC	3	0	0	3	3
4	B21AS0302	Discrete Mathematics and Graph Theory	HC	3	0	0	3	3
5	B21EF0304	Agile software development and DevOps	HC	3	0	0	3	3
TOTAL				**15**	**0**	**0**	**15**	**15**
	Practical /Term Work / Practice Sessions/Online/MOOC							
6	B21EF0305	Analog and Digital Electronics lab	HC	0	0	1	1	2
7	B21EF0306	Programming with JAVA lab	HC	0	0	1	1	2
8	B21EF0307	Data Structures lab	HC	0	0	1	1	2
9	B21AH0301	Communication Skills	FC	2	0	0	2	2
10	B21LS0301	Indian Constitution and Professional Ethics	FC	2	0	0	2	2
11	B21AHM301/ B21AHM302	Advanced Kannada/ Basics of Kannada	MC	0	0	0	0	2
TOTAL				**4**	**0**	**0**	**7**	**12**
TOTAL SEMESTER CREDITS							**22**	
TOTAL CUMULATIVE CREDITS							**62**	
TOTAL CONTACT HOURS							**27**	

IV SEMESTER

Sl. No	Course Code	Title of the Course	HC/FC/SC/OE	Credit Pattern & Credit Value				Contact Hours/ Week
				L	T	P	Credits	
1	B21EF0401	Design and Analysis of Algorithms	HC	3	0	0	3	3
2	B21EF0402	Unix Operating System	HC	3	0	0	3	3
3	B21EF0403	Database Management System	HC	3	0	0	3	3
4	B21EF0404	Computer Organization and Architecture	HC	3	0	0	3	3
5	B21AS0401	Numerical Methods and Optimization Techniques	HC	3	0	0	3	3
TOTAL				**15**	**0**	**0**	**15**	**15**
	Practical /Term Work / Practice Sessions/Online/MOOC							
6	B21EF0405	Unix Operating System lab	HC	0	0	1	1	2
7	B21EF0406	Database Management System lab	HC	0	0	1	1	2
8	B21EF0407	Computer Organization and Architecture lab	HC	0	0	1	1	2
9	B21MGM301	Management Science	FC	2	0	0	2	2
10	B21AS0303	Environmental Science	FC	2	0	0	2	2
11	B21AHM401	Universal Human Values	MC	0	0	0	0	2
TOTAL				**4**	**0**	**3**	**7**	**12**
TOTAL SEMESTER CREDITS							**22**	
TOTAL CUMULATIVE CREDITS							**84**	
TOTAL CONTACT HOUR							**27**	

V SEMESTER

Sl. No	Course Code	Title of the Course	HC/FC/SC/OE	Credit Pattern & Credit Value				Contact Hours/ Week
				L	T	P	Credits	
1	B21ET0501	Artificial Intelligence and Applications	HC	3	0	0	3	3
2	B21EF0503	Machine Learning	HC	3	0	0	3	3
3	B21ETS511-516	Professional Elective-I	SC	3	0	0	3	3
4	B21ETS517-522	Professional Elective-II	SC	3	0	0	3	3
5	B21XXO5XX	Open Elective-I	OE	3	0	0	3	3
TOTAL				**15**	**0**	**0**	**15**	**15**
	Practical /Term Work / Practice Sessions/Online/MOOC							
6	B21ET0502	Predictive Analytics and Data Visualization Tools	HC	2	0	0	2	2
7	B21ET0503	Artificial Intelligence and Applications lab	HC	0	0	1	1	2
8	B21ET0504	Predictive Analytics and Data Visualization Tools lab	HC	0	0	1	1	2
9	B21EF0507	Machine Learning lab	HC	0	0	1	1	2
10	B21PA0501	Indian Tradition and Culture	FC	1	0	0	1	1
11	B21ET0505	Skill Development-1	HC	0	0	0	2	4
TOTAL				**3**	**0**	**3**	**8**	**13**
TOTAL SEMESTER CREDITS							**23**	
TOTAL CUMULATIVE CREDITS							**107**	
TOTAL CONTACT HOURS							**28**	

VI SEMESTER

Sl. No	Course Code	Title of the Course	HC/FC/SC/OE	Credit Pattern & Credit Value				Contact Hours/ Week
				L	T	P	Credits	
1	B21EF0601	Theory of Computation	HC	3	0	0	3	3
2	B21ET0601	Natural Language Processing	HC	3	0	0	3	3
3	B21ET0602	Neural Networks and Deep Learning	HC	3	0	0	3	3
4	B21ETS611-614	Professional Elective-III	SC	3	0	0	3	3
5	B21ETS615-617	Professional Elective-IV	SC	3	0	0	3	3
6	B21XXO6XX	Open Elective-II	OE	3	0	0	3	3
TOTAL				**18**	**0**	**0**	**18**	**18**
Practical /Term Work / Practice Sessions/Online/MOOC								
7	B21ET0603	Research Based Mini Project	HC	0	0	2	2	4
8	B21EF0604	Mobile Application Development	HC	1	0	0	1	1
9	B21ET0604	Natural Language Processing lab	HC	0	0	1	1	2
10	B21ET0605	Neural Networks and Deep Learning lab	HC	0	0	1	1	2
11	B21EF0606	Mobile Application Development lab	HC	0	0	1	1	2
11	B21EF0607	Technical Documentation	FC	1	0	0	1	1
12	B21ET0606	Skill Development-2	HC	0	0	0	2	4
TOTAL				**2**	**0**	**5**	**9**	**16**
TOTAL SEMESTER CREDITS							**27**	
TOTAL CUMULATIVE CREDITS							**134**	
TOTAL CONTACT HOURS							**34**	

VII SEMESTER

Sl. No	Course Code	Title of the Course	HC/FC/SC/OE	Credit Pattern & Credit Value				Contact Hours/ Week
				L	T	P	Credits	
1	B21ETS711-713	Professional Elective-V	SC	3	0	0	3	3
2	B21XXO7XX	Open Elective-III	OE	3	0	0	3	3
TOTAL				**6**	**0**	**0**	**6**	**6**
Practical /Term Work / Practice Sessions/Online/MOOC								
3	B21ET0701	Capstone-Project Phase-1	HC	0	0	1	1	2
4	B21ET0702	Internship/Global Certification	HC	0	0	3	3	6
TOTAL				0	**0**	**4**	**4**	**8**
TOTAL SEMESTER CREDITS							**10**	
TOTAL CUMULATIVE CREDITS							**144**	
TOTAL CONTACT HOURS							**14**	

VIII Semester

Sl. No	Course Code	Title of the Course	HC/FC/SC/OE	Credit Pattern & Credit Value				Contact Hours/ Week
				L	T	P	Credits	
1	B21ET0801	Capstone-ProjectPhase-2	HC	0	0	7	7	14
2	B21ET0802	Internship/Global Certification	HC	0	0	3	3	6
3	B21ET0803	MOOC / Competitive Exam	SC	0	0	3	3	6
TOTAL				**0**	**0**	**13**	**13**	**26**
Practical /Term Work / Practice Sessions/Online/MOOC								
4	B21XXO8XX	Open Elective-IV	OE	3	0	0	3	3
TOTAL				**3**	**0**	**0**	**3**	**3**
TOTAL SEMESTER CREDITS							**16**	
TOTAL CUMULATIVE CREDITS							**160**	
TOTAL CONTACT HOURS							**29**	

	Professional Electives					
Semester /Soft-core		**Domain 1: System design and Networking**	**Course Code**	**Domain 2: Web Technologies**	**Course Code**	**Domain 3: Machine Learning and Data Science**
PE-I/V sem	B21ETS511	Web and Text Mining	B21ETS513	Security in IoT	B21ETS515	Object Oriented Concepts with C++
	B21ETS512	Pattern Recognition	B21ETS514	Advanced IOT and Applications	B21ETS516	Big Data and Cloud Computing
PE-II/V sem	B21ETS517	Cognitive Computing	B21ETS519	Industrial and Medical IoT	B21ETS521	Advanced Computer Architecture
	B21ETS518	Business Intelligence	B21ETS520	Cyber Physical Systems	B21ETS522	Parallel Computing and HighPerformance Computing
PE-III/VI sem	B21ETS611	Blockchain Technology	B21ETS612	Embedded Systems Design	B21ETS613	Advanced Web Technology
					B21ETS614	Digital Image Processing and Computer Vision
PE-IV/VI sem	B21ETS615	Advanced Machine Learning	B21ETS616	Communication Technologies For IoT	B21ETS617	Cloud Computing and DevOps
PE-V/VII sem	B21ETS711	Data Science Using R	B21ETS712	Virtual and Augmented Reality	B21ETS713	Cloud Security

OPEN ELECTIVES											
5TH SEM /OE-I			**6th SEM /OE-II**			**7th SEM /OE-III**			**8th SEM /OE-IV**		
Course code	Course Name	Teaching DEPARTMENT	Course code	Course Name	Teaching DEPARTMENT	Course code	Course Name	Teaching DEPARTMENT	Course code	Course Name	Teaching DEPARTMENT
B21CSO501	Database Management systems	CSE	B21CSO601	Data Structures	CSE	B21CSO701	Java Programming	CSE	B21CSO801	R Programming Language	CSE

List of Certification Programs:

Certification Programs		
EC Council: Certified Ethical Hacker	EC Council: CHFI Certified Hacking Forensics Investigator	Cisco: CCNP Security
CWNP: CWNS Certified Wireless Network Security Professional	ISACA: Certified Information Security Manager	Juniper: Juniper Network Certified Internet Professional
AWS: Certified Solutions Architect Professional	AWS: Certified Devops Engineer	AWS: Certified Security Speciality
Google: Certified Professional Cloud Architect	Google: Associate Cloud Engineer	Redhat: RHSCA in Redhat Open stack
Professional Cloud Developer	IBM: Certified System Administrator	IBM: Certified Database Administrator
PSC: Scrum Certification	Microsoft: Advanced MS Excel	PMI: PMP Certification
COBIT: IT Service Management Certification	VMWare: Advanced Certified Professional – Data Centre Virtualization	VMWare: Certified Professional Network Virtualization
IBM: Certified Application Developer	IBM: AI Certification	IBM: Data Science Professional Certificate
Wireshark: Certified Network Analyst	Cisco: CCNA Network Associate	Cisco: CCNP Enterprise
CWNP: WIFI administration	CWNP: Wireless Security Professional	Kubernettes and RedhatOpenstack /AWS
VMWare: Certified Professional Cloud Management and Automation	Oracle: Business Intelligence	Oracle: Enterprise Management
Oracle: Virtualization	Redhat: Microservices Certification	Block Chain Council: Blockchain Certification
DLA: Certified REST API Practitioner	Cloud Credential Council: IOT Certification	Microsoft : Devops Engineer
Microsoft: Azure Data Engineer	Microsoft: Azure Administrator	Microsoft: Azure AI Engineer

List of Skill Development Programs:

Skill Development Programs (by Clubs/Industries/Corporate-Trainers/ Department -Faculty)		
Github and Open-Source Technologies	Project Development Tools	Ethical Hacking
Cybersecurity and Forensics	Cyber Physical Systems	IOT and Cloud Convergence
Graphics with Open-Source Tools	AR and VR with **Unit**y Software	Robotic Process Automation
Data Analysis using Python	Python and ML	Data Analysis with R
MongoDB and NOSQL	Jango and Python	Full stack Development
Devops Tools	Linux System Administration	Cloud Administration
Network Administration	Software Testing with Scrum	Software Project Management
Bigdata using Spark/Hadoop	Excel and SQL for Data Analysis	AWS cloud and Devops
Azure Cloud and Devops	Google Cloud and Devops	Coding and Programming Skills
Android Application Development	IOS Application Development	NLP with Python
Social Media Analytics	Java script for Web Design	Micro Website Design Google web designer
Algorithms Thinking and Data Structures	UI Design	Storage System Management
Digital SEO/SEM Marketing	Web Services (Restful Services in Java, etc)	Digital Photography With Photoshop
Network Programming	WSN and IOT Programming	Image Processing using Python
5G and IOT	Sentiment Analysis	Machine Learning and IOT
System Integration Tools	Computational Biology using Python	C# and .Net
Kotlin Programming	Julia Programming	Objective C programming
Java script for Cybersecurity	C++ Programming for Automotive Applications	E-commerce site design
Banking and Insurance using Python	MATLAB for Scientific Computing	Network Simulator NS3

I Year
Detailed Syllabus

I Semester
Syllabus

Course Title	Multivariable Calculus and Linear Algebra				Course Type	Theory	
Course Code	B21AS0105	Credits	3		Class	I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	3	3	3			
	Practice	0	0	0	Theory	CIE	SEE
	-	-	-	-			
	Total	**3**	**3**	**3**	**48**	**30**	**70**

COURSE OVERVIEW:

The course Differential Calculus deals with the basic aspects of differential calculus. The students of Computer Science are equally benefited with this course as stepping stone to the broad areas of calculus. This course familiarizes students with important concepts coming under differential calculus and to develop strong foundations on these concepts. In Computer Science, Calculus is used for machine learning, data mining, scientific computing, image processing, and creating the graphics and 3D visuals for simulations. Calculus is also used in a wide array software program that require it. Linear algebra provides concepts that are crucial to many areas of computer science, including graphics, image processing, cryptography, machine learning, optimization, graph algorithms, information retrieval and web search.

COURSE OBJECTIVE (S):

1. Explain the scalar and vector point functions and their operations.
2. Illustrate how to find angle between polar curves with a suitable example.
3. Demonstrate the use of radius of curvature of the curves can be best suited for machine learning techniques with big data analytics.
4. Describe the concepts of Linear algebra and calculus theory.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO-1	Apply Taylor's and Maclaurin's series for finding series expansions of functions and approximating values.	1,2,3	1
CO-2	Identify the curve forms and can evaluate the radius of curvature of the given curve.	1,2,3	1
CO-3	Evaluate the limit using L' Hospital rule after identifying an indeterminate form.	1,2,3	1
CO-4	Solve the given system of equations by Gauss elimination and Gauss Jordon method, if the given system of equations is consistent.	1,2,3	1
CO-5	Determine the Eigen values, the corresponding Eigen vectors and diagonalize the given square matrix.	1,2,3	1
CO-6	Apply Rayleigh's Power method to find the largest Eigen value and the corresponding Eigen vector.	1,2,3	1

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO-1			√			
CO-2			√			
CO-3					√	
CO-4			√			
CO-5					√	
CO-6			√			

COURSE ARTICULATIONMATRIX

CO#/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO-1	3	3	1										1		
CO-2	3	3	2										1		
CO-3	3	2	1										1		
CO-4	3	3	1										1		
CO-5	3	3	1										1		
CO-6	3	2	1										1		

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT - 1

Introduction to Vector Differentiation: Introduction, Scalar and vector point functions, velocity, acceleration, Gradient, Divergence, Curl, Laplacian, Solenoidal and Irrotational vectors, Vector identities**.**

Differential Calculus-1: Successive differentiation- nth derivatives of standard functions (no proof) simple problems, Leibnitz Theorem (without proof) and problems, Taylors series and McLaurin's series expansion for function of one variable (only problems), Polar curves- Angle between the radius vector and the tangent, angle between two curves, Pedal equation for polar curves. Applications in computer science.

UNIT - 2

Differential Calculus-2: Derivative of arc length – concept and formulae (without proof), Radius of curvature- Cartesian, parametric, polar and pedal forms (with proof) problems.

Indeterminate forms and solution using L'Hospital's rule. Analysis of Randomized algorithms using Differential Calculus. Applications in computer science.

UNIT - 3

LinearAlgebra-1: Basic concepts, Echelon form, normal form of a matrix, Rank of Matrix, Gauss-Jordon method to find inverse of a matrix, consistency of linear system of equations, Gauss elimination and Gauss-Jordon method to solve system of equations. Linear Algebra for statistics. Applications in computer science.

UNIT- 4

Linear Algebra-2: Linear Transformations, orthogonal transformation, Eigen values and Eigen Vectors. Complex matrices, Similarity of Matrices, Diagonalization. Rayleigh power method to determiner largest Eigen value and the corresponding Eigen vector. Analysis of Randomized algorithms using Linear Algebra. Applications in computer science.

TEXT BOOKS:

1. Theodore Shifrin, "Multi-Variable Calculus and Linear Algebra with Applications", Wiley, 1st edition, Volume 2, 2018.
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43nd edition, 2015.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 9th edition,2013.
4. Ron Larson, "Multivariable Calculus, Cengage Learning", 10th Edition, 2013.

REFERENCE BOOKS:

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 19th Reprint edition, 2013.
2. R.K.Jain and S.R.K.Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, 4th edition, 2016.
3. Stanley I. Grossman, "Multivariable Calculus, Linear Algebra, and Differential Equations", 2nd edition, Academic Press 1986.

JOURNALS/MAGAZINE:

https://www.sciencedirect.com/journal/linear-algebra-and-its-applications

SWAYAM/NPTEL/MOOCs:

1.. https://nptel.ac.in/courses/111/107/111107108/

2. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ma07/

3. https://nptel.ac.in/courses/111/106/111106051/

4. https://nptel.ac.in/courses/111/104/111104092/

5. https://nptel.ac.in/courses/111/104/111104085/

SELF-LEARNINGEXERCISES:

1. Vectors in Space, Generalized Leibniz Rules, Mean Value of Derivatives, Powers of a matrix.
2. Testing of Linear Dependence and Independence and multivariate calculus. Introduction to differential equations.

Course Title	Physics for Computer Science				Course Type	Theory	
Course Code	B21AS0106	Credits	3		Class	I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	3	3	3			
	Practice	0	0	0	Theory	CIE	SEE
	-	-	-	-			
	Total	**3**	**3**	**3**	**39**	**50**	**50**

COURSE OVERVIEW:

This course introduces the basic concepts of Physics and its applications to Computer Science and Engineering courses by emphasizing the concepts underlying four units: Wave Mechanics, Lasers and optical fibers, EM wave and spectrum, Display Technology and Quantum computation. The subject has basic laws, expressions and theories which help to increase the scientific knowledge to analyze upcoming technologies.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Impart the knowledge about wave mechanics, electromagnetic waves, and its applications
2. Demonstrate the different applications of lasers, and optical fibers
3. Discuss different types of display technologies, touch screen techniques and its applications
4. Explain the importance of quantum computation as an emerging technology.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Apply knowledge of wave mechanics, its importance, and applications	1, 2, 3,	2
CO2	Solve and apply Schrodinger's time dependent and independent wave equations	1, 2, 3,	2
CO3	Analyse the working of LASERs and Classify EM waves based on the frequency range.	1,2,3	2
CO4	Classify optical fibres and derive expression for NA, number of Modes and attenuation.	1, 2, 3,	2
CO5	Summarize capacitive and resistive Display Technologies.	1, 2,3	2
CO6	Demonstrate the working of CRT and explain the application of quantum computation	1, 2,3	2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember(L1)	Understand(L2)	Apply(L3)	Analyze(L4)	Evaluate(L5)	Create(L6)
CO1			√			
CO2		√				
CO3		√				
CO4			√			
CO5		√				
CO6		√				

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1											1	
CO2	3	2	1											1	
CO3	3	2	1											1	
C04	3	2	1											1	
CO5	3	2	1											1	
CO6	3	2	1											1	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT
THEORY:

UNIT – 1

Wave mechanics: Introduction to Wave mechanics, De-Broglie hypothesis. Expression for de-Broglie wavelength of an electron in terms of accelerating potential. Phase velocity and group velocity, Relation between phase velocity and group velocity.

Quantum Physics: Wave function, properties of wave function and physical significance. Probability density and Normalization of wave function, Schrodinger time- dependent and independent wave equation, Eigen values and Eigen functions. Applications of Schrödinger wave equation – energy Eigen values of a free particle, Particle in one dimensional infinite potential well with numerical examples. Application-Quantum computation.

UNIT – 2

Lasers: Lasers Interaction between radiation and matter (induced absorption, spontaneous and stimulated emission). Expression for energy density at thermal equilibrium in terms of Einstein's coefficients. Characteristics of laser light, Conditions for laser operation (population inversion and Meta stable state). Requisites of laser system, semiconductor laser and its applications.

Electromagnetic Waves: Basic idea of displacement current, Electromagnetic waves, their characteristics, Electromagnetic spectrum (7 types of EM waves) including elementary facts. Uses of EM waves in communications.

UNIT – 3

Optical fibers: Construction and light propagation mechanism in optical fibers (total internal reflection and its importance), Acceptance angle, Numerical Aperture (NA), Expression for numerical aperture in terms of core and cladding refractive indices, Condition for wave propagation in optical fiber, V-number and Modes of propagation, Types of optical fibers, Attenuation and reasons for attenuation, Applications: Explanation of optical fiber communication using block diagram, Optical source (LED) and detector (Photodiode) and their applications. Advantages and limitations of optical communications.

UNIT – 4

Display technology: Touch screen technologies: Resistive and capacitive touch screen and Displays: CRT, Field emission display, Plasma display, LED display, OLED display, LCD display.

Quantum Computation: Quantum wires (one dimensional), Quantum dots (zero dimensional); the idea of "qubit" and examples of single qubit logic gates- Classical bits, Qubit as a two-level system.

TEXT BOOKS:

1. William T. Silfvast, "Laser Fundamentals", Cambridge University press, New York, 2004
2. 2.D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics",10th edition, John Wiley and Sons, New York, 2013
3. R. K. Gaur and S.L. Gupta, "Engineering Physics", Dhanpat Rai Publications (P) Ltd, New Delhi, 2014.
4. M.N. Avadhanulu and P.G. Kshirsagar, "A textbook of Engineering Physics", S. Chand and Company, New Delhi, 2014.
5. P. Lorrain and O. Corson, "EM Waves and Fields",3rd edition, CBS Publishers.

REFERENCE BOOKS:

1. Charls Kittel, "Introduction to Solid State Physics", 8thEdition Wiley, Delhi, ,2004
2. Arthur Beiser, "Concepts of modern Physics", 8th edition, Tata McGraw Hill publications, New Delhi, 2011
3. S. O. Pillai, "Solid State Physics", New Age International publishers, New Delhi, 2010
4. Janglin Chen, Wayne Cranton, Mark Fihn, "Handbook of Visual Display Technology", 2ndedition Springer Publication, 2012.

JOURNALS/MAGAZINE:

1. https://www.codemag.com/Magazine/ByCategory/Python
2. http://ijaerd.com/papers/special_papers/IT032.pdf
3. https://iopscience.iop.org/article/10.1088/176596/423/1/012027https://ieeexplore.ieee.org/document/4160250
4. Python for scientific computing

SWAYAM/NPTEL/MOOCs:

1. https://www.mooc.org/
2. https://www.coursera.org/

Course Title	Introduction to Data Science				Course Type		FC	
Course Code	B21CS0101	Credits	3		Class		I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	Tutorial	-	-	-				
	Total	**3**	**4**	**4**	**26**	**26**	**50**	**50**

COURSE OVERVIEW:

Data Science is an interdisciplinary, problem-solving oriented subject that is used to apply scientific techniques to practical problems. The course orients on preparation of datasets and programming of data analysis tasks. This course covers the topics: Set Theory, Probability theory, Tools for data science, ML algorithms and demonstration of experiments by using MS-Excel.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the fundamental concepts of Excel.
2. Illustrate the use of basic concepts of Data Science in the real-world applications.
3. Demonstrate the use of SQL commands in real world applications.
4. Discuss the functional components of Data Science for real world applications

COURSE OUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Make use of the basic concepts of Data Science in developing the real-world applications.	1 to 5, 8 to 10	1,2,3
CO2	Apply the SQL commands in developing the real-world applications.	1 to 5, 8 to 10	1,2,3
CO3	Build the data analytics solutions for real world problems, perform analysis, interpretation and reporting of data.	1 to 5, 8 to 10	1, 2, 3
CO4	Create the real-world AI based solutions using different machine learning algorithms	1 to 5, 8 to 10	1, 2, 3
CO5	Illustrate modeling Error in Linear Regression	1 to 5, 8 to 10	1, 2, 3
CO6	Demonstrate applications of Data Science	1 to 5, 8 to 10	1,2, 3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember(L1)	Understand(L2)	Apply(L3)	Analyze(L4)	Evaluate(L5)	Create(L6)
CO1			✓			
CO2			✓			
CO3			✓	✓		
CO4			✓	✓	✓	✓
CO5		✓				
CO6			✓			

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2			1	3	3			3	3	3
CO2	2	2	2	2	2			1	3	3			3	3	3
CO3	3	3	2	2	2			1	3	3			3	3	3
CO4	3	3	3	2	2			1	3	3			3	3	3
CO5	3	3	3	2	2			1	3	3			3	3	3
CO6	3	3	3	2	2			1	3	3			3	3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to Microsoft Excel:

Creating Excel tables, understand how to Add, Subtract, Multiply, Divide in Excel. Excel Data Validation, Filters, Grouping. Introduction to formulas and functions in Excel. Logical functions (operators) and conditions. Visualizing data using charts in Excel. Import XML Data into Excel How to Import CSV Data (Text) into Excel, How to Import MS Access Data into Excel, Working with Multiple Worksheets.

UNIT – 2

Introduction to Data Science:

What is Data Science? Probability theory, bayes theorem, bayes probability; Cartesian plane, equations of lines, graphs; exponents.

Introduction to SQL: creation, insertion, deletion, retrieval of Tables by experimental demonstrations. Import SQL Database Data into Excel

UNIT – 3

Data science components:

Tools for data science, definition of AI, types of machine learning (ML), list of ML algorithms for classification, clustering, and feature selection. Description of linear regression and Logistic Regression. Introducing the Gaussian, Introduction to Standardization, Standard Normal Probability Distribution in Excel, Calculating Probabilities from Z-scores, Central Limit Theorem, Algebra with Gaussians, Markowitz Portfolio Optimization, Standardizing x and y Coordinates for Linear Regression, Standardization Simplifies Linear Regression, Modeling Error in Linear Regression, Information Gain from Linear Regression.

UNIT – 4

Data visualization using scatter plots, charts, graphs, histograms and maps:

Statistical Analysis: Descriptive statistics- Mean, Standard Deviation for Continuous Data, Frequency, Percentage for Categorical Data

Applications of Data Science: Data science life cycle, Applications of data science with demonstration of experiments either by using Microsoft Excel.

PRACTICE:

<table>
<tr><th>sl.no</th><th>Title of the Experiment</th><th>Tools and Techniques</th><th>Expected Skill/Ability</th></tr>
<tr><td>1.</td><td>The height (in cm) of a group of fathers and sons are given below, Find the lines of regression and estimate the height of son when the height of father is 164 cm.
<table>
<tr><td>Plot the graph. Hgt of Fathers</td><td>158</td><td>166</td><td>163</td><td>165</td><td>167</td><td>170</td><td>167</td><td>172</td><td>177</td><td>181</td></tr>
<tr><td>Hgt of Sons</td><td>163</td><td>158</td><td>167</td><td>170</td><td>160</td><td>180</td><td>170</td><td>175</td><td>172</td><td>175</td></tr>
</table></td><td>MS Excel</td><td>Create and perform operations on Excel data set by applying Linear regression</td></tr>
</table>

<table>
<tr>
<td>2.</td>
<td>Using the data file DISPOSABLE INCOME AND VEHICLE SALES, perform the following:
i) Plot a scatter diagram.
ii) Determine the regression equation.
iii) Plot the regression line (hint: use MS Excel's Add Trendline feature).
iv) Compute the predicted vehicle sales for disposable income of $16,500 and of $17,900.
v) Compute the coefficient of determination and the coefficient of correlation</td>
<td>MS Excel</td>
<td>Perform prediction and visualization of data</td>
</tr>
<tr>
<td>3.</td>
<td>Managers model costs in order to make predictions. The cost data in the data file INDIRECT COSTS AND MACHINE HOURS show the indirect manufacturing costs of an ice-skate manufacturer. Indirect manufacturing costs include maintenance costs and setup costs. Indirect manufacturing costs depend on the number of hours the machines are used, called machine hours. Based on the data for January to December, perform the following operations.

i) Plot a scatter diagram.
ii) Determine the regression equation (hint: use MS Excel's Add Trendline feature).
iii) Compute the predicted indirect manufacturing costs for 300 machine hours and for 430 machine hours.
iv) Compute the coefficient of determination and the coefficient of correlation.</td>
<td>MS Excel</td>
<td>Perform prediction and visualization of data</td>
</tr>
<tr>
<td>4.</td>
<td>Apply multiple linear regression to predict the stock index price which is a dependent variable of a fictitious economy based on two independent / input variables interest rate and unemployment rate.

<table>
<tr><th>year</th><th>month</th><th>interest rate</th><th>unemployment rate</th><th>stock index price</th></tr>
<tr><td>2020</td><td>10</td><td>2.75</td><td>5.3</td><td>1464</td></tr>
</table>
</td>
<td>MS Excel</td>
<td>Perform prediction and visualization of data</td>
</tr>
<tr>
<td>5.</td>
<td>Calculate the total interest paid on a car loan which has been availed from HDFC bank. For example, Rs.10,00,000 has been borrowed from a bank with annual interest rate of 5.2% and the customer needs to pay every month as shown in table below. Calculate the total interest rate paid for a loan availed

<table>
<tr><th>Sl No.</th><th>A</th><th>B</th></tr>
<tr><td>1</td><td>Principal</td><td>Rs.10,00,000</td></tr>
<tr><td>2</td><td>Annual interest rate</td><td>5.20%</td></tr>
<tr><td>3</td><td>Year of the loan</td><td>3</td></tr>
<tr><td>4</td><td>Starting payment number</td><td>1</td></tr>
<tr><td>5</td><td>Ending payment number</td><td>36</td></tr>
<tr><td>6</td><td>total interest paid during period</td><td>?</td></tr>
</table>
of Rs.10,00,000 during 3 years.</td>
<td>MS Excel</td>
<td>Create Excel data and perform EMI estimator</td>
</tr>
</table>

<table>
<tr><td>6.</td><td>Create a supplier database of 10 records with SUPPLIER_ID as primary key, SUPPLIER_NAME, PRODUCTS, QUANTITY, ADDRESS, CITY, PHONE_NO and PINCODE, Where SUPPLIER_NAME, PRODUCTS, QUANTITY and PHONE_NO, should not be NULL.</td><td>SQL</td><td>Creating Tables</td></tr>
<tr><td>7.</td><td>Create the customer database of a big Market with CUSTOMER_ID as primary key, CUSTOMER_NAME, PHONE_NO, EMAIL_ID, ADDRESS, CITY and PIN_CODE. Store at least twenty customers details where CUSTOMER_NAME and PHONE_NO are mandatory and display the customer data in alphabetical order.</td><td>SQL</td><td>Creating and retrieving Tables</td></tr>
<tr><td>8.</td><td>Apply linear regression to find the weather (temperature) of a city with the amount of rain in centimeters. Create your own database with following details.<table><tr><td>CITY</td><td>Temperature in Centigrade</td><td>Rain in Centimeters</td></tr><tr><td></td><td></td><td></td></tr></table></td><td>MS Excel</td><td>Apply Linear regression</td></tr>
<tr><td>9.</td><td>Use the linear regression technique to compare the age of humans with the amount of sleep-in hours.<table><tr><td>Name</td><td>Age in Years</td><td>Sleep in hours</td></tr></table>Create your own database with above details.</td><td>MS Excel</td><td>Apply Linear regression</td></tr>
<tr><td>10.</td><td>Apply the linear regression, compare the average salaries of batsman depending on the run rate scored/ recorded in the matches. Assume your own database.</td><td>MS Excel</td><td>Apply Linear regression</td></tr>
<tr><td>11.</td><td>Design the ER diagram and create schema of the REVA library management system.</td><td>Entity Relationship</td><td>Entity Relationship diagrams</td></tr>
<tr><td>12.</td><td>Design the ER diagram and create schema for Hospital Management system.</td><td>Entity Relationship</td><td>Schema design</td></tr>
</table>

TEXT BOOKS:

1. B.S. Grewal, “Higher Engineering Mathematics”,43rd edition, Khanna Publishers, 2015.
2. Ramakrishnan and Gehrke , “Database Management systems”, 3rd Edition, Tata McGraw Hill Publications, 2003.
3. Mastering Data Analysis in Excel - https://www.coursera.org/learn/analytics-excel.
4. Kenneth N. Berk, Carey, “Data Analysis with Microsoft Excel”, S. Chand & Company,2004.

REFERENCE BOOKS:

1. B.V. Ramana, “Higher Engineering Mathematics”, 19th edition, Tata McGraw Hill Publications, 2013.
2. Erwin Kreyszig, “Advanced Engineering Mathematics”, 9th edition, Wiley Publications, 2013.
3. Seymour Lipschutz, John J. Schiller, “Schaum's Outline of Introduction to Probability and Statistics”, McGraw Hill Professional, 1998.

JOURNALS/MAGAZINES:

1. https://www.journals.elsevier.com/computational-statistics-and-data-analysis
2. https://www.springer.com/journal/41060International Journal on Data Science and Analytics
3. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=8254253 IEEE Magazine on Big data and Analytics

SWAYAM/NPTEL/MOOCs:

1. Excel Skills for Business: Essentials, Macquarie University (https://www.coursera.org/learn/excel-essentials)
2. SQL for Data Science, University of California, Davis (https://www.coursera.org/learn/sql-for-data-science)
3. Data Science Math Skills, Duke University (https://www.coursera.org/learn/datasciencemathskills)
4. https://www.edx.org/course/subject/data-science
5. https://onlinecourses.nptel.ac.in/noc19_cs60/preview

Course Title	**Programming for Problem Solving**				**Course Type**		**Integrated**	
Course Code	**B21CS0102**	**Credits**	**4**		**Class**		**I Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**4**	**5**	**5**	**39**	**26**	**50**	**50**

SELF-LEARNINGEXERCISES:

1. Relational database management system.
2. Advanced MS-Excel

COURSE OVERVIEW:

Algorithms and flowcharts are the fundamental tools for problem solving which can be used by the computers. The computer programs can be developed using algorithms and flowcharts to provide solutions to problems. C Language is a general-purpose, structured and procedure-oriented programming language. It is one of the most popular computer languages today because of its structure and higher-level abstraction C. This course introduces algorithms, flowcharts and various C Programming language constructs for the development of real-world applications.

COURSE OBJECTIVE(S):

1. Explain algorithms, flowcharts and different programming constructs of C to be used for development of applications.
2. Illustrate the use of iterative statements and conditional Statements for solving the real-world problems.
3. Demonstrate the use of functions with parameter passing mechanisms for solving the real-world problems.
4. Discuss the use of structures, unions, pointers and file operations for solving the real-world problems.

COURSE OUTCOMES (COs)

On successful completion of this course; the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Demonstrate knowledge on C programming constructs to develop programs.	1-5,9,10,12	1, 2

CO2	Apply functions and Arrays to enhance reusability and data manipulation.	1-5, 9,10,12	1,2
CO3	Use pointers to manage the memory effectively.	1-5, 9,10,12	1, 2
CO4	Demonstrate the use of command line arguments for a given problem.	1-5, 9,10,12	1,2
CO5	Apply Structures, Unions and File handling concepts to develop societal applications.	1-6, 9,10,12	1, 2
CO6	Design algorithms using problem-solving techniques for given problems.	1-5, 9,10,12	1, 2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	✓					
CO2			✓			
CO3		✓				
CO4		✓				
CO5			✓			
CO6				✓		

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3	1	2				3	3		3	3	2	
CO2	3	3	2	2	1				3	3		3	3	2	
CO3	3	2	2	3	1				3	3		3	3	2	
CO4	3	2	3	3	1				3	3		3	3	2	
CO5	3	1	1	1	2	3			3	3		3	3	2	
CO6	3	1	3	2	1				3	3		3	3	2	

Note:1-Low,2-Medium,3-High

COURSE CONTENTS
THEORY:

UNIT – 1

Algorithm: Definition, Purpose of writing an algorithm, Rules for writing an algorithm, Advantage of writing algorithm and examples.

Flowchart: Definition, Notations used to write a flow chart**,** Advantage and disadvantages of writing the flowchart and examples.

Introduction to "C": Introduction to GitHub, Structure of C program with example**, C** language & its features, C tokens, data types in C**,** variables, constants, input and output functions

Operators and Expressions: Unary operator, assignment operator, arithmetic operator, relational operators, logical operators &bitwise operator, conditional operator, increment and decrement operator, special operator.

Conditional Statements: if statement, if-else statement, nested if, switch statement.

UNIT – 2

Unconditional Statements: break and continue statement, goto statement, return statement

Iterative Statements (loops): while loop, do-while, for loop, differences between while, do-while and for loop.

Arrays: one dimensional array, two-dimensional array, Linear and binary search and bubble sorting.

UNIT – 3

Pointers: Introduction to pointers.

Strings: string operations with and without using inbuilt string functions.

Functions: Structure of a function, types of functions, parameter passing mechanisms, Command line arguments.

UNIT – 4

Structures & Union: Derived types- structures- declaration, definition and initialization of structures, accessing structures, nested structures, arrays of structures, union, typedef.

File Operations: Formatted Input & Output, Character Input and Output Functions, Direct Input and Output Functions, File Positioning Functions, Error Functions.

PRACTICE:

Part-A

Sl. No.	Name of the Experiment	Tools and Techniques	Expected Skill /Ability
1	a. Consider Loan applications in a bank consisting of various customer details such as Name, Organization, salary and loan amount applied. Segregate the loan applications based on income (low: <=5 lpa , medium: >5lpa <10 lpa, high:>10lpa) .	If then and else/ Switch case	Develop application program using if-else and switch
	b. Two files DATA1 and DATA2 contain sorted lists of integers. Write a C program to merge the contents of two files into a third file DATA i.e., the contents of the first file followed by those of the second are put in the third file. Display the contents of DATA.	Files, Merging	Develop application program using Files

2	a. Display the right angle, isosceles and equilateral triangles, comprising of alphabets from A to Z (upper case) in the following format	Nested Loops	Develop application program using Nested Loops
	b. Consider the details of Airline passengers such as Name, PAN-No., Mobile-no, Email-id, Source, Destination, Seat-No and Air-Fare. Develop a program to read the details of airline passengers, store them in the structure, "Airline" and List details of all the passengers who travelled from "Bengaluru to London".	structures, loop, search technique	Develop application program using Structure
3	a. Assume that Mr. Peterson shopped n items at big market and the Cart comprises of name of the item, cost of the item per unit and quantity. Read the details of shopping and store them in the structure, "Shop". Compute the total amount spent on shopping at Big Market and also find out the item with minimum and maximum cost.	Structure, Linear Search	Develop application program using Structure and Linear Search
	b. Write a C program to define a structure named Student with name and DOB, where DOB in turn is a structure with day, month and year. Read the details of student and store them in the structure, "Student". Display name and date of birth of students using the concept of nested structures.	Nested Structures	Develop application program using Nested Structures
4	a. Consider a set of n students with SRN, name, and marks scored in 8 subjects. Read the details of students and store them in the structure, "Student_Marks". Compute total marks and average marks of each student and display them with suitable headings.	Structure, Array, Loops	Develop application program using array of Structures.
	b. Create the structure, "Book" with book_id, title, author_name and price. Write a C program to pass a structure as a function argument and print the book details.	Structure, User-defined functions	Develop application program using array of Structures and functions,
5	a. Assume that Ms. Jassica shopped n items at Amazon and the Cart comprises of name of the item, cost of the item per unit and quantity. Arrange the items in the increasing order of cost of the item per unit.	Array of, Structures, loops, Bubble Sort	Develop application program to sort the contents of structure.
	b. Write a C program to compute the monthly pay of "N" employees using each employee's name, Basic_Pay, DA, HRA. The DA and HRA are 80% and 30% of the Basic_Pay respectively. Gross-salary is computed by adding DA and HRA to Basic_Pay. Store all the details in an array of structures and print the name and gross salary of each employee.	Structure, loops	Develop application program using structure
6	Consider the details of "N" Faculty members consisting of Name, EMP-ID,name of the DEPARTMENT, address and salary. Create a file to store the above details. Retrieve the contents of the file to perform following operations: isplay the details of the faculty based on salary range entered. (ii) Display the details of the faculty based on the EMP-ID entered.	File and looping concepts	Develop application program using Files.
	b.A character is entered through keyboard. Write a C program to determine whether the character entered is a capital letter, a small case letter, a digit or a special symbol using if else and switch case.	if statement	Develop application program using if-statement.

Part-B

Sl. No.	Name of the Experiment	Tools and Techniques	Expected Skill /Ability
1	Develop a project for Address Contact List with the following modules: 1. User a. Add User(Name, Address, Primary contact number, secondary contact number, E-mail ID) b. Delete User c. Search for User 2. Edit a. Find and replace the user name b. Edit the contact (Phone Number) details. c. Edit the Address of the user 3. Report a. List of users based on the starting letter of their names. b. List of users based on first 2 digits of their mobile number. c. List of users based on the domain name of their E-mail ID. **Title: Contact List / Address Book** **Problem Definition:** It is quite difficult to remember every person's address and mobile numbers. Hence, it is required to build an address book / contact list to store name, address, phone number and email_id. The contact book should provide the options for adding, deleting and editing the user's data. It should also have provision for searching the users data. **Solution:** **Develop a project to implement a contact list with the following modules:** 1. User a. Add member b. Delete member c. Search for member 2. Transaction a. Find and replace the user name b. Edit the contact (Phone Number) details. c. Edit the Address of the user 3. Report a. List of users based on the starting letter of their names. b. List of users based on first 2 digits of their mobile number. c. List of users based on the domain name of their E-mail ID. Implementation: Consider the following functions with data members for		

	developing the address book / contact list. 1. Structure: Contact a. Attributes: username, address, mobile, phone1, email_id b. Functions: add_member, delete_member, edit_member, search_member, find_member. 2. Report: Functions: List the users details based on name, mobile numbers, and email id.		
	List of Experiments:		
Sl.No	Name of the Experiment	Tools and Techniques	Expected Skill /Ability
1	Develop a program in C to create the structure, "Contact" with the fields, user_name, address, mobile, phone1 and email_id. Read the data into the structure "Contact" and store them in the file "Contact.txt".	Structure, arrays, &files	1. Develop the program using Structures and Files
2	Develop a program in C to open contact list from the file "Contact.txt" in read mode and delete contact details of the person based on name of the person by searching his/her details. Display the updated list.	Structure, arrays, &files	2. Develop the program using Structures and Files
3	Develop a program in C to input the string,"Str1"(which can be either a mobile no. or name of the user) and search for it in the file , "Contact.txt" and display the details if it is found else display an error.	Structure, arrays, &files	3. Develop the program using String and File
4	Develop a program in C to input the name of the user into the string, "Str1" , search for it in the file "Contact.txt" and replace the content of "Str1" with the new data if found.	Structure, arrays, &files	4. Develop the program using String and File
5	Develop a program in C to input the phone number of user into the string, "Str1", search for it in the file "Contact.txt" and edit it with new data if found and save the same.	Structure, arrays, &files	5. Develop the program using String, File and apply linear search
6	Develop a program in C to input the address of the user and search for the same in the file, "Contact.txt" and edit the address with new address and save the same.	Structure, arrays, &files	6. Develop the program using String, File and apply linear search
7	Develop a program in C to input a letter into "Letter", compare it with the details stored in "Contact.txt" and then display the list of the users whose name begin with "Letter ".	Structure, arrays, &files	. Develop the program using file
8	Develop a program in C to input first two digits of a mobile number into "Mobile", search for the same in "Contact.txt" and display the details of all the users whose mobile number begin with "Mobile".	Structure, arrays, &files	8. Develop the program using file
9	Develop a program in C to input a domain name of email-id and search for the same in the file, "contact.txt" and list the details of the users whose email-id matches with the given domain name.	Structure, arrays, &files	9. Develop the program using file

	Project: Calculator **1. Arithmetic Operations:** a. Addition b. Subtraction c. Multiplication d. Division **2. Relational Operations:** a. Less Than b. Greater Than c. Less Than or Equal to d. Greater than or equal to e. Equal to f. Not Equal to **3. Mathematical Operations:** a. Exponentiation b. Power c. Sine d. Cosine		
	Title: **Simple Scientific Calculator** **Problem Definition:** A calculator is a simple device which takes one or two inputs and performs the operations like arithmetic, logical, relational and Mathematical depending upon the operation chosen by the user. It is required to simulate the calculator to implement the above operations. **Solution:** **Develop a project to implement a simple scientific calculator with the following modules:** **1. Arithmetic Operations:** a. Addition b. Subtraction c. Multiplication d. Division **2. Relational Operations:** a. Less Than b. Greater Than c. Less Than or Equal to d. Greater than or equal to e. Equal to f. Not Equal to. **3. Mathematical Operations:** a. Exponentiation b. Power c. Sine d. Cosine **Implementation:**		

	Consider the working of a calculator. It should take in two input and an operation like +,- etc. Calculate the resultant with the input given. **Ex:** if the input is 2 + 3 then it should give an output 5.		
Sl.No	**Name of the Experiment**	**Tools and Techniques**	**Expected Skill /Ability**
1	Develop a program in C using if- else statement to perform the mathematical operations like like addition, subtraction, multiplication and division on any two operands and display the results of the same based on the choice entered by the user.	If else ladder	Develop the program using if-else to implement arithmetic calculator
2	Develop a program in C using switch statement to perform logical operations like Less Than, Greater Than, Less Than or Equal to, Greater than or equal to, Equal to, Not Equal to on any two operands get the result of the same based on the choice entered by the user.	Switch	
3	Develop a program in C using switch statement to perform mathematical functions like Exponentiation, Power, Sine, Cosine and get the result of the same based on the choice entered by the user.	if-else-ladder	

TEXT BOOKS:

1. B.W. Kernighan & D.M. Ritchie, "C Programming Language", 2nd Edition, PRENTICE HALL SOFTWARE SERIES,2005.
2. Herbert Schildt, "C: The Complete Reference", 4th edition, Tata Mc-GRAW Hill Publications,2000.
3. B.S. Anami, S.A. Angadi and S. S. Manvi, "Computer Concepts and C Programming: A Holistic Approach", 2nd edition, PHI,2008.

REFERENCE BOOKS:

1. Balaguruswamy, "Programming in ANSI C", 4th edition, Tata Mc-GRAW Hill Publications, 2008.
2. Donald Hearn, Pauline Baker, "Computer Graphics C Version", 2nd edition, Pearson Education, 2004.

JOURNALS/MAGAZINES:

1. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=6294(IEEE Journal/Magazine on IT Professional)
2. https://ieeexplore.ieee.org/document/1267572IEEE Computing in Science and Engineering)

SWAYAM/NPTEL/MOOCs:

1.https://onlinecourses.nptel.ac.in/noc20_cs06/preview(Problem Solving through Programming in C)

2.https://www.edx.org/course/c-programming-getting-started(C Programming Getting started)

3.https://www.coursera.org/specializations/c-programming(Introduction to C programming)

SELF-LEARNINGEXERCISES:

1.**Fundamentals of computer graphics**: output primitives–Line, Circle and Ellipse drawing algorithms-Attributes of output primitives.

2. **Inline Assembly Language Program:** Simple inline assembly, Extended Assembly Syntax Microsoft C Compiler.

Course Title	**Entrepreneurship**				**Course Type**	**Theory**	
Course Code	**B21ME0104**	**Credits**	**1**		**Class**	**I Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	1	1	1			
	Practice	-	-	-	Theory	CIE	SEE
	Tutorial	**-**	**-**	**-**			
	Total	**1**	**1**	**1**	**13**	**50**	**50**

COURSE OVERVIEW:

This introductory course is designed to introduce you to the foundational concepts of entrepreneurship, including the definition of entrepreneurship, the profile of the entrepreneur, the role of venture creation in society. The course also provides a bird's eye view on the steps to start a venture, financing, marketing as well as support by various institutions towards entrepreneurship.

COURSE OBJECTIVE(S):

1. To understand the basic terms, concepts in Entrepreneurship Development
2. To analyze and apply for the supporting schemes towards entrepreneurship

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Define the keywords and concepts used in entrepreneurship development	1	
CO2	Describe the characteristics and types of an entrepreneur	1,6	1,3
CO3	Explain the new generations of an entrepreneurship and skills of an entrepreneur	1,2,6,7,10,12	1,3
CO4	Differentiate between the industrial park and special economic zone	1,2,7	1,3
CO5	Classify the tender process and exemptions from income tax.	1,2,5,8,10-12	1,3

CO6	Choose the suitable government agencies to support his/her idea to become an entrepreneur	1-4,6-12	1,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√					
CO2	√					
CO3		√				
CO4		√				
CO5			√			
CO6			√			

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1														
CO2	1					1							2		2
CO3	1	1				2	1			1		2	2		2
CO4	1	1					2						2		2
CO5	2	2			1			3		3	3	1	2		2
CO6	1	3	3	1		3	3	3	1	3	3	2	2		2

Note:1-Low,2-Medium,3-High

COURSE CONTENTS

THEORY:

UNIT – 1

INTRODUCTION TO ENTREPRENEURSHIP: Evolution of term 'Entrepreneurship', Factors influencing entrepreneurship', Psychological factors, Social factors, Economic factors, Environmental factors. Characteristics of an entrepreneur, Difference between Entrepreneur and Entrepreneurship, Types of entrepreneurs. New generations of entrepreneurship viz. social entrepreneurship, Edupreneurship, Health entrepreneurship, Tourism entrepreneurship, Women entrepreneurship etc., Barriers to entrepreneurship, Creativity and entrepreneurship, Innovation and inventions, Skills of an entrepreneur, Decision making and Problem Solving

UNIT – 2

INSTITUTIONAL SUPPORT FOR ENTREPRENEURSHIP: Organization Assistance to an entrepreneur, New Ventures, Industrial Park (Meaning, features, & examples), Special Economic Zone (Meaning, features & examples), Financial assistance by different agencies, MSME Act Small Scale Industries, Carry on Business (COB) license, Environmental Clearance, National Small Industries Corporation (NSIC), e-tender process, Excise exemptions and concession, Exemption from income tax, The Small Industries Development Bank of India(SIDBI), Incentives for entrepreneurs

TEXTBOOKS:

1. K. Ramachandran," Entrepreneurship Development", Tata Mc. Graw Hill Publications, 2008
2. Sangeeta Sharma, "Entrepreneurship Development", PHI Publications, 2016

REFERENCE BOOKS:

1. Baringer and Ireland, "Entrepreneurship", 11th Edition, Pearson, 2020.
2. P. Narayana Reddy, "Entrepreneurship – Text and Cases", Cengage Learning India, I edition, 2010
3. Paul Burns, "Corporate Entrepreneurship: Building The Entrepreneurial Organization", Palgrave Macmillan.
4. Drucker F Peter,"Innovation and Entrepreneurship", 1985.Heinemann, London.
5. Doanld F Kuratko,"Entrepreneurship in the New Millennium", Cengage Learning India Pvt LTD.

JOURNALS/MAGAZINES:

1. International Small Business Journal: https://journals.sagepub.com/home/isb
2. Journal of Development Entrepreneurship: https://www.worldscientific.com/worldscinet/jde

SWAYAM/NPTEL/MOOCs:

1. Entrepreneurship: https://nptel.ac.in/courses/110/106/110106141/

SELF-LEARNINGEXERCISES:

1. Introverts participate. If you have a few vocal students asking questions and little participation from others, anonymous questions lower student anxiety, which makes it easier for everyone to participate.
2. You learn what students are thinking about. Anonymity provides cover for students to ask questions they may be too afraid to ask but are curious about.
3. Discussions start. Anonymity means you can invite students to pose "challenging" questions. If you encourage your students to question what they're learning, why it's important, or why they should have to do the work you're assigning, you spark discussions about how entrepreneurship is relevant, which can often be the key to increasing engagement.

Course Title	IoT and Applications				Course Type		Integrated	
Course Code	B21EC0101	Credits	2		Class		I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	Tutorial	-	-	-				
	Total	**2**	**3**	**3**	**13**	**26**	**50**	**50**

COURSE OVERVIEW:

The Internet of Things (*IoT)* expands access to the world-wide web from computers, smartphones, and other typical devices to create a vast network of appliances, toys, apparel, and other goods that are capable of connecting to the Internet. This introductory course focuses on IoT architecture, its domains and communication protocols. The course is supported with hands on sessions that incorporates different types sensors interfaced with IoT board to build IoT projects to solve real time problems. The case study of deployment of IoT in various applications are provided.

COURSE OBJECTIVE(S):

The objectives of this course are to:

1. Explain the architecture of Internet of Things.
2. Inculcate knowledge of IoT devices, Sensors and Communication Protocols in various application domains.
3. Gain expertise in interface of various sensors to IoT Boards.
4. Discuss the various applications of IoT.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Describe the architecture of IoT eco-system	1	1,2
CO2	Identify IoT devices, architecture, sensors and Communication protocols	1	1,2
CO3	Demonstrate the interface of sensors to IoT board	1,5, 12	1,2
CO4	Realize various Applications of IoT through case studies	1,5, 12	1,2
CO5	Develop simple IoT projects and modules	1,5,9, 12	1,2
CO6	Identify technologies used to develop IoT based applications	1, 5, 9,10,11,12	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√	√				
CO2		√				
CO3			√			
CO4				√	√	
CO5				√	√	√
CO6				√	√	√

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	
CO2	3												3	3	
CO3	3				3							3	2	2	
CO4	3				3							3	1	1	
CO5	3				3				2			3	3	3	
CO6	3				3				2	2	2	3	3	3	

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

IoT Basics: Introduction to IoT, How does Internet of Things Works, Features of IoT, Advantages and Disadvantages of IoT, Embedded Devices in IoT, IoT eco-system.

IoT Architecture and IoT Devices: Components of IoT architecture, Stages of IoT solution architecture, Smart Objects, IoT Devices.

UNIT – 2

IoT boards in Market: Arduino, Arduino UNO, ESP8266, Raspberry Pi

IoT Platform: Amazon Web Services (AWS) IoT platform, Microsoft Azure IoT platform, Google Cloud Platform IoT,IBM Watson IoT platform, ThingWork IoT platform

Technologies Used in IoT: Bluetooth, Wi-Fi, Li-Fi, RFID, Cellular, Z-Wave

PRACTICE:

Sl. No.	Titleof theExperiment	Tools and Techniques	ExpectedSkill /Ability
	Part-A		
1.	Introduction to IoT Board a. Arduino UNO b. Arduino Nano c. Node MCU d. Ethernet Shield	Hardware	• Identifications of various parts of Arduino and Node MCU boards • Study of Ethernet shield and connection to the board
2.	Working with Arduino IDE (Integrated Development Environment)	Open source Arduino IDE	• Dow nload specified software • Mod
3.	a) Demonstration of Multimeter usage b) Demonstration of Breadboard connection for Voltage, Ground, series and parallel connections c) Exercise to read the value of resistor using Colour code chart	Multimeter Breadboard Resistor packs	• Measurement of voltage at various points in IoT boards • Choose the value of Resistor for an application
4.	Reading photo resistor sensor value connected to Arduino Board	Arduino UNO Arduino IDE LDR , Multimeter, Resistor	• Interface of photo sensor to IoT board for light measurement applications
5.	Reading temperature sensor value connected to Arduino Board	Arduino UNO , Arduino IDE, Temperature sensor, Multimeter	• Interface of Temperature sensor to IoT board for temperature measurement application
6.	Reading motion detector sensor value connected to IoT board	Arduino UNO , Arduino IDE, pyro-dielectric sensor, Multimeter	• Interface of Motion detector sensor to IoT board for motion detection detection.
7	Reading distance measurement using Ultrasonic sensor Connected to IoT board	Arduino UNO , Arduino IDE, Ultrasonic sensor, Multimeter	• Interface of Motion detector sensor to IoT board for motion detection
8	Interface relay to IoT board	Arduino UNO , Arduino IDE, relay Multimeter	• Interface relay to IoT board for Switching applications
9	Connect Wifi-ESP8266 to Arduino UNO board, Send and receive data through smart phone.	Arduino UNO ESP8266, Arduino IDE Smart phone	• Connect IoT board to Wifi network

Part-B (Case Study projects)			
Automated lighting system, Intelligent Traffic system, Smart Parking, Smart water management ,Smart healthcare ,IoT for smart cities, IoT and Cloud Server Based Wearable Health Sensor's Monitoring System, IoT - Industrial Internet of Things Monitoring Of Sensor's Data on Android App, Remote Patient Monitoring ,E Agriculture Monitoring on Webpage Motor Controlling with Android App. Integrated Smart Health Care Monitoring System .,Air Pollution & Water Quality Monitoring System, A Smart System connecting E-Health Sensor's and the Cloud ,Smart E-Agriculture Monitoring Using Internet Of Things, IoT based Garbage Management System ,IoT projects | Smart Home Automation using IOT ,IoT based submersible motor pumps on/off ,IoT Based Electronic Door Opener, IoT Based Garbage Monitoring ,Monitoring of Highway Hybrid Parameter & Controlling Highway Light Through Iot Based Smart Agriculture Monitoring System, IoT Based Agriculture Crop - Field Monitoring System and Irrigation Automation ,An IoT Based Patient Monitoring System using Raspberry Pi ,Underground Cable Fault Detection Over Internet Of Things (Iot) Google Map ,IoT Air & Water Quality Monitoring System, IoT Based Automatic Vehicle Accident Detection and Rescue System ,Patient Health Status Observing Based On IoT and Email Alert ,IoT Based Vehicle Accident Detection and Tracking System on google map webpage ,Data Logger System for weather monitoring using WSN ,Smart intelligent security system for women ,Building Automation System Using GRPS IoT, Implementation of Industrial Data Acquisition, management and Guiding using IoT Distance based Accident Avoidance System using CAN protocol & Tracking through IoT ,Multiple Garbage Box Monitoring & Collection system, IoT Based Garbage Monitoring System ,Swachh Bharat Waste Collection Management System using IOT			
PART C (Mini Project)			
1	**Arduino Controlled Light intensity**: design and build a simple , effective circuit called Auto Intensity Control of Street Lights using Arduino	Arduino UNO,DS3231 RTC Module, LDR 16×2 LCD Display ,LED,10KΩ Potentiometer,10KΩ Resistor, Push Button, Connecting Wires, Breadboard	Design and Implementation of IoT project to solve Engineering Problems.
2	**Thermometer**: build an LCD thermometer with an Arduino UNO and a LM35/36 analog temperature sensor.	Arduino Uno, Temperature Sensor, LCD display, Breadboard and Connecting wires	Design and Implementation of IoT project for Engineering applications.
3	Motion activated light lamp: build an automated project that It switches on and off when there's motion.	Arduino Uno, PIR Motion sensor, breadboard, connecting wires, LED generic.	Design and Implementation of IoT project for Engineering applications
4	Touchless motion sensor trash can: build touchless motion sensor trash can	Arduino UNO, Ultra sonic sensor, Micro servo motor, Breadboard, Connecting wires	Design and Implementation of IoT project for Engineering applications

TEXTBOOKS:

1. Vijay Madisetti, Arshdeep Bahga,"Internet of Things: A Hands-On- Approach", VPT ,2014.

REFERENCEBOOKS:

1. Raj Kamal , ",Internet of Things: Architecture & design Principle", McGraw Hill Education,2017.

SWAYAM/NPTEL/MOOCS:

1. https://www.coursera.org/learn/iot
2. https://www.coursera.org/learn/interface-with-arduino

SELF-LEARNINGEXERCISES:

1. Create Arduino project hub

Course Title	Computer Aided Engineering Drawing				Course Type		Integrated	
Course Code	B21ME0101	Credits	3		Class		I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	0	-	-				
	Total	**3**	**4**	**4**	**26**	**26**	**50**	**50**

COURSE OVERVIEW:

Engineering Graphics or drawing is known as language of engineers. All phases of engineering process require the conversion of new ideas and design concepts into the basic line language of graphics. There are many areas such as civil, mechanical, electrical, architectural, computer, electronics and industrial applications where knowledge and skills of the drawing play major roles in the design and development of new products or construction. This course emphasizes on projection of point, line, surfaces and solids. It also provides knowledge about representing the object in terms of 3d view and also development of the object.

COURSE OBJECTIVE (S):

1. To introduce the students to various concepts like dimensioning, conventions and standards of engineering drawings in order to become professionally efficient
2. To enable students to learn about the software tool to prepare engineering drawings
3. To teach the students about the concepts and principles of orthographic projections, development of lateral surfaces and isometric projection of simple solids
4. To communicate the concept/idea with others through the language of technical drawing and sketching.

COURSE OUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Construct the simple 2D drawings manually and also by using CAD software	1,5,10	1
CO2	Draw orthographic projection of point, line, plane surfaces and simple solids	1,3,5, 10	1
CO3	Draw orthographic projection of simple solids	1,3,5, 10	1
CO4	Draw sectional views of a prisms, pyramids, cone and cylinder	1,3,5, 10	1

CO5	Develop the lateral surfaces of the solids	1,2, 3,5,10	1,2,3
CO6	Create isometric view of the solids	1,3,5,10	1,2,3

BLOOM'S LEVELOF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5				√		
CO6				√		

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				3					3			3		
CO2	3		2		3					3			3		
CO3	3		2		3					3			3		
CO4	3		2		3					3			3		
CO5	3	2	2		3					3			3	3	2
CO6	3		2		3					3			3	2	1

Note:1-Low,2-Medium,3-High

COURSE CONTENT
THEORY:

UNIT – 1

Introduction – Geometrical constructions, engineering drawing standards, Introduction to CAD Software. Orthographic projection of points in first and third Quadrant only. Orthographic projection of straight lines inclined to both horizontal and vertical planes. Orthographic projection of regular plane surfaces when the surface is inclined to both HP and VP.

UNIT – 2

Orthographic projection of regular solids like prisms, pyramids cone and cylinder when the axis is inclined to both HP and VP.

UNIT – 3

Sections of solids – Drawing sectional views and true shape of section, Development of surfaces- Parallel line method for prisms and cylinders, Radial line method for pyramids and cones.

UNIT – 4

Isometric projections of simple and combined solids.

PRACTICE:

No	Practice	Tools and Techniques	Expected Skill /Ability
1.	Use of solid edge software and familiarization of tools	Solid Edge Software	Use of commands to draw the drawings
2.	Draw the projection of point locating in first and third quadrant	Solid Edge Software	Analyzing and software skill
3.	Draw the projection of lines locating in first quadrant	Solid Edge Software	Draw the views of the line and software skill
4.	Draw the projection of rectangular and pentagonal lamina inclined to both HP and VP	Solid Edge Software	analyzing and software skill
5.	Draw the projection of hexagonal and circular lamina inclined to both HP and VP	Solid Edge Software	analyzing and software skill
6.	Draw the projection of prisms inclined to both HP and VP	Solid Edge Software	interpretation and software skill
7.	Draw the projection of pyramids inclined to both HP and VP	Solid Edge Software	interpretation and software skill
8.	Draw the projection of cone and cylinder inclined to both HP and VP	Solid Edge Software	interpretation and software skill
9	Draw the projection of section of solids in simple position	Solid Edge Software	analyzing and software skill
10	Develop the lateral surface of prisms and cylinder	Solid Edge Software	Creative and software skill
11	Develop the lateral surface of pyramids and cone	Solid Edge Software	Creative and software skill
12	Draw the isometric projection of simple plane surface and simple solids	Solid Edge Software	Analyzing and software skill
13	Draw the isometric projection of two co-axial solids	Solid Edge Software	Analyzing and software skill

TEXT BOOKS:

1. K. R. Gopalakrishna, “Engineering Graphics”, Subhas Publications, 2012.
2. Bhatt N.D., Panchal V.M. & Ingle P.R., “Engineering Drawing”, Charotar Publishing House,2014.

REFERENCE BOOKS:

1. Luzadder and Duff, “Fundamental of Engineering Drawing”, 11th Edition PHI, 2001.
2. Shah, M.B. & Rana B.C. ,” Engineering Drawing and Computer Graphics”, Pearson Education,2008.

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112/103/112103019/
2. https://www.udemy.com/course/ed/

II Semester
Syllabus

Course Title	Probability and Statistics				Course Type	Theory	
Course Code	B21AS0204	Credits	4		Class	II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	4	4	4			
	Practice	0	0	0	Theory	CIE	SEE
	-	0	-	-			
	Total	**4**	**4**	**4**	**48**	**30**	**70**

COURSE OVERVIEW:

The course Probability and Statistics for Computer Science treats the most common discrete and continuous distributions, showing how they find use in decision and estimation problems, and constructs computer algorithms for generating observations from the various distributions. Probability in the design and analysis of randomized algorithms. Common randomized algorithms are things like Quicksort and Quick select.Probabilistic method can also useful to prove various important results. Probabilistic methods used to prove some partition theorems that were then used to create efficient data structure.

COURSE OBJECTIVE (S):

1. Describe Curve fitting and regression in various problems in Computer Science and engineering fields.
2. Illustrate the applications of Probability and statistics in various computer science and engineering Fields like data mining, classification problems etc
3. Discuss Sampling theory concepts to solve various engineering problems like structured and unstructured data models
4. Demonstrate Stochastic problem as Markov model as a problem-solving method for systematic model buildings.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO-1	Solve the problems of Curve fitting and regression in various problems in Computer Science and Engineering fields.	1,2,3	1
CO-2	Apply the concepts of Probability and statistics in various computer science engineering fields like data mining, classification problems etc.	1,2,	1
CO-3	Develop a stochastic problem as Markov model as a problem solving methods for systematic model buildings.	1,2,3	1
CO-4	Make use of sampling theory concepts to solve various engineering problems like structured and unstructured data models.	2,3	1

CO-5	Use Discrete time Markov chain to model computer systems.	1,3	1
CO-6	Expose the basic characteristic features of a queuing system and acquire skills analyzing queuing models.	2,3	1

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	**Understand (L2)**	**Apply (L3)**	**Analyze (L4)**	**Evaluate (L5)**	**Create (L6)**
CO-1			√			
CO-2			√			
CO-3			√			
CO-4			√			
CO-5			√			
CO-6				√		

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO-1	3	3	2										3		
CO-2	3	3											3		
CO-3	3	3	2										2		
CO-4		3	2										1		
CO-5	2		2										1		
CO-6		3	1										2		

Note:1-**Low**,2-Medium,3-High

COURSE CONTENT
THEORY:

UNIT – 1

Curve Fitting:Curve fitting by the method of least squares and fitting of the curves of the form,

y = ax + b, y = ax2 + bx + c, y = aebx and y = axb

Statistical Methods: Measures of central tendency and dispersion. Correlation-Karl Pearson's coefficient of correlation-problems. Regression analysis- lines of regression, problems. Rank correlation. Applications in computer science

UNIT – 2

Probability distributions: Recap of probability theory (definition, addition rule, multiplication rule, conditional probability). Random variables, Discrete and continuous probability distributions. Binomial, Poisson, exponential and normal distributions (derivation of mean and variance for all distributions). Applications in computer science.

UNIT – 3

Joint Probability distribution: Joint Probability distribution for two discrete random variables (both discrete and continuous cases), expectation, covariance, correlation coefficient.

Stochastic processes- Stochastic processes, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability-simple problems. Applications in computer science.

UNIT – 4

Sampling theory: -Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student's t-distribution, Chi-square distribution as a test of goodness of fit. Applications in Computer Science.

Introduction to queuing systems: Single queuing nodes, service disciplines, M/M/1 Queuing system.

TEXTBOOKS:

1. B.S. Grewal, "Higher Engineering Mathematics",43nd edition Khanna Publishers, 2015.
2. ErwinKreyszig, "Advanced Engineering Mathematics",9thedition Wiley Publications, 2013.
3. Seymour Lipschutz, John J. Schiller., "Schaum's Outline of Introduction to Probability and Statistics", ,McGraw Hill Professional, 1998.

REFERENCEBOOKS:

1. B.V. Ramana, "Higher Engineering Mathematics", 19th Reprint edition, Tata McGraw Hill Publications, 2013.
2. R.K.Jain and S.R.K.Iyengar, "Advanced Engineering Mathematics",4th edition,Narosa Publishing House, 2016.
3. V.Sundarapandian, "Probability, Statistics and Queueing theory", PHI Learning, 2009
4. Dr. B. Krishna gandhi, Dr. T.K.V. Iyengar, Dr. M.V.S.S.N. Prasad&S. Ranganatham.,"Probability and Statistics" S. Chand Publishing, 2015.
5. J. K. Sharma "Operations Research theory and applications",5thedition, Macmillan publishers, 2013.

JOURNALS/MAGAZINES:

1. https://www.hindawi.com/journals/jps/
2. https://www.journals.elsevier.com/statistics-and-probability-letters
3. http://www.isoss.net/japs/

SWAYAM/NPTEL/MOOCs:

1. https://www.coursera.org/browse/data-science/probability-and-statistics
2. https://nptel.ac.in/courses/111/105/111105041/
3. https://onlinecourses.swayam2.ac.in/cec20_ma01/preview

SELF-LEARNINGEXERCISES:

1. Curve fitting for application problems, Regression analysis for a bivariate data.
2. Probability distribution- Geometric, gamma- distributions, Joint probability distribution of continuous random variables.
3. Sampling analysis of real time problems. Applications to computer science: Data mining, classification problems etc

Course Title	Engineering Chemistry				Course Type	Theory	
Course Code	B21AS0104	Credits	3		Class	II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	3	3	3			
	Practice				Theory	CIE	SEE
	Tutorial						
	Total	**3**	**3**	**3**	**39**	**50**	**50**

COURSE OVERVIEW:

Engineering chemistry covers very relevant topics compatible with ECE, EEE and CSE students and make them aware of importance of various aspects of basic science in engineering. The subject of Engineering chemistry covers area of light and matter interaction, clean energy storage and conversion devices, corrosion phenomenon and control which is widely an interdisciplinary subject of discussion. Further the course focus on the chemistry of engineering materials, and various applications. This area of science is very much interdisciplinary in its nature and gives a platform for students to strengthen their engineering knowledge to enlighten on the energy conversion and storage devices, which have become very attractive field of research in engineering stream. The subject deals with various engineering materials, their properties and applications in the field of engineering.

COURSE OBJECTIVE (S):

The Engineering chemistry course is designed to fulfil the following objective;

Engineering chemistry covers the very basic knowledge required for engineering students to understand its importance of science in technology.

1. It provides the basic knowledge on Interaction of light and matter to know the electronic transitions in materials and storage and conversion devices.
2. Corrosion and metal finishing, explains the phenomenon of corrosion and its prevention. It also covers the importance of metal finishing in various industries and fabrication of PCB
3. Polymers are all about the properties of various polymeric materials and their Commercial significance. The chapter reveals about technical and commercial Importance of composite materials.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Explain the phenomenon of light and matter interaction to study the materials	1,2,3	1
CO2	Illustrate the method of preparation of solar grade silicon and effect of dopant in photovoltaic devices.	1,2,3	1

CO3	Describe Corrosion phenomenon and precautions to be taken in the selection of materials in controlling corrosion. Methods of fabrication of printed circuit boards (PCB) and industrial applications.	1,2,3	1
CO4	Illustrate the properties of polymers, nano materials, composite materials and their applications in various fields.	1,2,3	1
CO5	Explore the light interaction with matter, modern materials and their composites for technological applications	1,2,3	1
CO6	Suggest the advanced materials for electrochemical energy storage, conversion, and environmental remedies.	1,2,3	1

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyse (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√		√		
CO3		√				
CO4		√				
CO5		√				
CO6		√				

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1										1		
CO2	2	1	2										1		
CO3	1	2	1										1		
CO4	2	3	3										1		
CO5	2	2	2										1		
CO6	1	2	1										1		

COURSE CONTENT

THEORY:

UNIT – 1

Light and Matter Interaction: Electro-magnetic spectrum-Applications in Engineering, Interaction of EM radiation with matter, work function of matter, Electrons in matter. Bonding theories: MOT, Band structure of matters HOMO-LUMO. Photochemical and thermal reactions: Laws of photochemistry, quantum yield, high and low quantum yield reactions. Jablonski diagram – photo physical and photochemical processes, photo-sensitization, photo-polymerization and commercial application of photochemistry.

UNIT – 2

Clean Energy Storage and Conversion Devices: Introduction to electrochemistry, basic concepts of Batteries and characteristics. Classification: Primary (Dry cell, Li-MnO2) and Secondary (Pb-acid, Li-ion) batteries. Super capacitors: classification, construction and applications in hybrid vehicles. Fuel cells: Alkaline fuel cells, Solid oxide fuel cells and phosphoric acid fuel cell. Photo-conversion devices: Photovoltaic cell, antireflective coating, panels and arrays. Production of single crystal semiconductor by Crystal pulling technique (Czochralski technique), zone refining process of Si.

Problems: Calculation of energy **and** power density, capacity of a Battery and capacitance of super capacitors for electric vehicle applications.

UNIT – 3

Corrosion and Metal Finishing: Electrochemical theory of corrosion, types of Corrosion- differential metal corrosion, differential aeration corrosion, boiler corrosion, and grain boundary corrosion, Corrosion studies on Al, Fe with pourbiax diagram, Factors affecting rate of corrosion-Primary, secondary. Corrosion control: Galvanizing & tinning, cathodic protection & Anodic Protection.

Metal Finishing: Theory of electroplating, Factors required to study electroplating Effect of plating variables in electroplating process, Electroplating of gold (acid, neutral and alkaline cyanide bath). Electro less plating of copper and PCB manufacture by Electro less plating of copper.

UNIT – 4

Chemistry of Engineering Materials

Polymer composites: Carbon fiber, Kevlar synthesis and applications, Conducting polymers: synthesis, electron transport mechanism and applications in poly acetylene and poly aniline. Liquid crystals: **Introduction** classification and applications in electronic display devices. Nano materials: Introduction, classification based on dimensionality, quantum confinement. Size dependent properties- surface area, magnetic properties (GMR phenomenon), and thermal properties. Synthesis, Properties and applications of Fullerenes, CNT and Graphene.

Sensors: Physical and chemical sensors, Biosensors for bio electronic applications.

TEXTBOOKS:

1. R.V.Gadag& Nithyanandashetty,"Engineering Chemistry", , Ik International Publishing house.
2. S.S. Dara," Text Book of Engineering Chemistry", S. Chand & Co.
3. S.S.Chawla, "Text Book of Engineering Chemistry ",Dhanpat Rai Pub.Co.

REFERENCE BOOKS:

1. P.W. Atkins, "Physical Chemistry", 5thedition, Oxford.
2. Callister W.D., "Materials Science and Engineering", John Wiley & Sons.
3. R.Gopalan, D.\/enkappaya, S.Nagarajan," Engineering Chemistry ", Vikas Publication.

JOURNALS/MAGAZINES:

1. https://www.sciencedirect.com/journal/water-science-and-technology

2. https://iwaponline.com/wst
3. https://www.scitechnol.com/nanomaterials-molecular-nanotechnology.php
4. https://www.journals.elsevier.com/journal-of-energy-storage

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/105/105/105105201/
2. https://nptel.ac.in/courses/112/108/112108150/

Course Title	Introduction to Python Programming				Course Type		Integrated	
Course Code	B21CI0101	Credits	3		Class		I/II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**4**	**4**	**26**	**26**	**50**	**50**

COURSE OVERVIEW:

Python is a Programming Language that can be treated in a procedural way, an object-orientated way or a functional way. It can be used on a server to create web applications, create workflows, connect to database systems, read and modify files, handle big data and perform complex mathematics. It can implement object oriented features and exception handling, It can parse the strings using regular expressions. It can be used for implementing the machine learning algorithms to develop solutions for interdisciplinary problems apart from any general problems leading to automation.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the fundamentals of python programming language constructs and their applications.
2. Inculcate knowledge of parsing of regular expressions and their usage in various application domains.
3. Gain expertise in Object oriented programming and NumPy package.
4. Discuss the files, Pandas and Data Virtualization concepts.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Make use of language constructs to solve real world problems using python programming.	1,2,3	1
CO2	Develop programs for text processing and other application domains by making use of regular expressions.	1,2,3	2
CO3	Apply features of object oriented and NumPy package to develop computationally intensive programming to analyze and interpret the data.	1,2,3,4	2,3
CO4	Create data science solutions with the help of files, Pandas and Data Visualization.	1,2,3,4,5	1,2,3

CO5	Develop sustainable solutions/projects for the needs of society, organizations and other sectors.	7,11	1,2,3
CO6	Recognize the need and engage in learning new libraries and tools in python.	12	3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√	√		
CO4			√	√	√	√
CO5						√
CO6		√				

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3										3		
CO2	3	2	3									1		3	
CO3	3	1	2	1										3	2
CO4	3	2	3	2	2								3	3	2
CO5							3				2		3	3	2
CO6												2			2

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to Computer **Fundamentals:** Computer Components, accessories, specifications of computers and external devices. Flowchart symbols and guidelines, types and advantages, Algorithm design.

Python Fundamentals: Introduction to Python: History, Applications, Your First Python Program, Constants, Variables, Naming conventions, simple data types, Type casting, Assignment statements, expressions, Boolean data type, Trigonometry functions, operators, precedence of operators, libraries, keywords, Python Collections, I/O statements, conditional statements, loops, functions, user defined functions. Introduction to GitHub and applications.

UNIT – 2

Strings: Unicode, Formatting Strings, Format Specifiers, other Common String Methods, Slicing a String.

Regular **Expressions:** Case Study: Street Addresses, Case Study: Roman Numerals, Checking for Thousands, Checking for Hundreds, Using the {n,m} Syntax, Checking for Tens and Ones.

UNIT – 3

Object Oriented Programming: Defining Classes, The init() Method, Instantiating Classes, OOP features: Abstraction. Encapsulation, Single Inheritance, Polymorphism.

Files: Reading from **Text** Files, Writing to text files, Reading and Writing the Binary Files.

UNIT – 4

Numpy: Introduction to numpy, creating arrays, Indexing Arrays, Array Transposition, Universal Array Function, Array Processing, Array Input and Output.

Pandas and Data Visualization**:** Introduction, Series and Data Frames in pandas and Data Visualization.

PRACTICE:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
Part-A			
1.	a). "LIST1" is a list that contains "N" different SRN of students read using a user defined function with the help of input() function. It is required to add SRN of "M" more students that are to be appended or inserted into "LIST1" at the appropriate place. The program must return the index of the SRN entered by user.	Windows/Linux OS, IDE, Jupyter	Create and perform operations on list.
	b)."TUPLE1" and "TUPLE2" are two tuples that contain "N" values of different data types read using the user defined function "READ" with the help of input() function. Elements of "TUPLE1" and "TUPLE2" are to be read one at a time and the "larger" value among them should be placed into "TUPLE3". Display all tuples.	Windows/Linux OS, IDE, Jupyter	Create and perform operations on Tuples.
2.	a).SET1 and SET2 are two sets that contain unique integers. SET3 is to be created by taking the union or intersection of SET1 and SET2 using the user defined function Operation(). Perform either union or intersection by reading choice from user. Do not use built in functions union() and intersection() and also the operators "|" and "&".	Windows/Linux OS, IDE, Jupyter	Create and perform Union and Intersection, Operations on Sets.
	b).The Dictionary "DICT1" contains N Elements and each element in dictionary has the operator as the KEY and operand's as VALUES. Perform the operations on operands using operators stored as keys. Display the results of all operations.		Create dictionary and perform operation using user defined function.
3.	a).A substring "Substr" between index1 and index2 is to be extracted from the given input string "Str1", which is read using input(). Display the substring "Substr" using a user defined function if available in string "Str1", otherwise display NULL.	Windows/Linux OS, IDE, Jupyter	String operations.

	b) A string containing multiple words is to be read from the user one at a time, after reading perform following operations. i) Convert all the strings to uppercase and display ii) Split the words of a string using space as the		
4.	a).Consider the text file, "Std.txt", with the details of students like SRN, NAME, SEMESTER, SECTION AND AVG_MARKS. Read the file, "Std.txt" and display the details of all the students of 4th Semester " A" Section who have scored more than 75%.	Windows/Linux OS, IDE, Jupyter	File Handling.
	b).Consider the text file "Emp.txt", with the details of Employees like EMP_CODE, EMP_NAME, BASIC_SALARY, DA, GROSS_SALARY, NET_SALARY, LIC, PF and TOTAL-DEDUCTIONS. Read EMP_CODE, EMP_NAME, BASIC_SALARY, DA, LIC and PF from the user using input() and compute the following: i) TOTAL_DEDUCTIONS= (LIC+PF) ii) GROSS_SALARY= BASIC_SALARY+ DA iii) NET_SALARY= GROSS_SALARY – TOTAL_DEDUCTIONS. Write the above data to file for each employee. Read the content of "Emp.txt" and display the details of each employee		File Handling.
5.	a). A "CAR" has the attributes COMPANY_NAME, MODEL, COLOR, MANUFACUTING_YEAR and PRICE. A Class is required to be created for "CAR" to store the above attributes and perform the following operations: i) Get the details of "CAR" object from user and store into Array of objects ii) Display the details of "CAR" object based on "COMPANY", "MODEL" and "PRICE".	Windows/Linux OS, IDE, Jupyter	Classes and objects usage.
	b). Airline Reservation System contains the attributes of passengers such as NAME, PAN_NO. MOBILE_NO, EMAIL_ID, SOURCE, DESTINATION, SEAT-NO, AIR-FARE and TRAVEL_DATE. A Class is required to be created for "Airlilne" with the above attributes and perform the following operations: i) Get the details of "Airline" object from user and store into Array of objects ii) List details of all the passengers who travelled From "Bengaluru to London". iii) List details of all the passengers who travelled From "Chicago to Beijing" on 10th of Feb, 2020.		
6.	iv) a). "Arr_1" is an integer array of size M x N. Size and content of the array is to be read using input() by using the user defined function READ_DATA(). It is required to display the i) Diagonal elements of "Arr_1" ii) Elements of mth row (row no should be entered by user) iii) Elements of nth column (column no should be entered by user)	Windows/Linux OS, IDE, Jupyter	NumPy arrays usability.

	b).The dictionary “DICT1” contains the pass percentage of each semester of B. Tech in CSE, where, ” Semester” acts as the key and “Pass Percentage” acts as the value. A Python Pandas dataframe is required to be created using the dictionary “DICT1” and display it using a user defined function.		Pandas Series usability.
	Part-B (Mini Project: Library Management System)		
1.	Develop a program to create the class “USER” with the attributes USER_NAME, USER_ID, DEPARTMENT_NAME, ADDRESS, PHONE_NO, EMAIL_ID, DOB and AGE. The functions add_user(), delete_user(), edit_user(), search_user() should be part of the class. Instantiate “User” class with 10 objects. Read the attributes of each “User” object using input() and store them in the file “User_File.txt”.	Windows/Linux OS, IDE, Jupyter	Create a class user to read the attributes of user and store them in a file.
2	Develop a program to get the name of the “User” object whose details are to be deleted. Read the “User_File.txt” and delete the “User” object if found. Display the contents of “User_File.txt” after deletion.	Windows/Linux OS, IDE, Jupyter	Create a class user to read the attributes and delete the object.
3	Develop a program to get the name of the “User” object whose details are to be edited (modified). Edit the details of the user object in the file “User_File.txt” and display the contents after modification.	Windows/Linux OS, IDE, Jupyter	To create a class and edit the file.
4	Develop a program to create the class “BOOK” with the attributes TITLE, AUTHOR, PUBLISHER, YEAR, PRICE, DEPARTMENT_NAME and the functions add_book(), delete_book(), edit_book() and search_book(). Instantiate “Book” class with 10 objects. Read the attributes of each “BOOK” object using input () and store them in the file “Book_File.txt”.	Windows/Linux OS, IDE, Jupyter	Create a class book to read the attributes of user and store them in a file.
5	Develop a program to get the name of the “BOOK” object whose details are to be deleted. Read the “Book_File.txt” and delete the “BOOK” object whose details match with the data entered. Display the contents of “Book_File.txt” after deletion.	Windows/Linux OS, IDE, Jupyter	Create a class book to read the attributes and delete the object.
6	Develop a program to get the name of the “BOOK” object whose details are to be edited (modified). Edit the details of the “Book” object in the file “Book_File.txt” and display the contents after modification.	Windows/Linux OS, IDE, Jupyter	To create a class and edit the file.
7	Develop a program to create the class “TRANSACTION” with the attributes USER_ID, USER_NAME, AUTHOR, TITLE, EDITION, ISSUE_DATE,DUE_DATE and RETURN_DATE and the functions issue_book(), return_book() and search_book(). Instantiate “Transaction” class with 10 objects. Read the attributes of each “Transaction” object using input() and store them in the file “TransactionFile.txt”. Develop a program to issue the book as requested by the user. Update the attributes in “Transaction _File” and display the contents of file.	Windows/Linux OS, IDE, Jupyter	Create class and perform string operations.

8	Develop a program to return the book. Edit the details of the user like USER_ID, USER_NAME, AUTHOR, TITLE, EDITION, ISSUE_DATE, DUE_DATE and RETURN_DATE in "TransactionFile.txt" and display the contents after modification. Compute the fine amount to be paid if return_date is not same as due_date. If both return_date and due_dateare same and put zero in fine_amount.	Windows/Linux OS, IDE, Jupyter	Create class and perform string operation.
9	Develop a program to search for a book using its "author". Display the message "available" if search is successful otherwise display the message "not available".	Windows/Linux OS, IDE, Jupyter	Create class and object, perform file operations and regular expressions.
10	Develop a program to get a list of users by referring to "User_File.txt" and "Transaction_File.txt".	Windows/Linux OS, IDE, Jupyter	Create class and object, perform file operations and regular expressions.
11	Develop a program to get List of Books in stock by referring to "Book_File.txt" and "Transaction_File.txt".	Windows/Linux OS, IDE, Jupyter	Create class and object, perform file operations and regular expressions.
12	Develop a program to get List of Books Issued by referring to "User_File", "Book_File" and "Transaction_File".	Windows/Linux OS, IDE, Jupyter	Create class and object, perform file operations and regular expressions.
13	Develop a project by integrating User, Books, Transaction and Reports Modules.	Windows/Linux OS, IDE, Jupyter	Module integration and project development.

TEXTBOOKS:

1.Mark Pilgrim, "Dive into Python 3",2nd edition,Apress special edition, 2015.
2.Travis E. Oliphant, "Guide to NumPy", Trelgol publishers,2006.

REFERENCEBOOKS:

1. A B Choudhary, "Flowchart and Algorithms Basics" Mercury Learning and Information,2020
2. Mark Lutz, "Learning Python", Oreilly. 2003.
3. .John M. Zelle, "PYTHON Programming: An Introduction to Computer Science", Franklin, Beedle& Associates. 2004.
4. Michael Dawson, "Python Programming for the Absolute Beginners",3rd Edition, CENAGE Learning.
5. Wesley J. Chun, "Core Python Programming", 2nd Edition, Prentice Hall.
6. Steve Holden and David Beazley, "Python Web Programming",2nd Edition New Riders, 2002. Springer,".
7. John V. Guttag, "Introduction to Computation and Programming using Python", MIT Press, 2016.
8. https://www.tutorialspoint.com/computer_fundamentals/computer_fundamentals_tutorial.pdf

JOURNALS/MAGAZINES:

1. https://www.codemag.com/Magazine/ByCategory/Python
2. http://ijaerd.com/papers/special_papers/IT032.pdf
3. https://iopscience.iop.org/article/10.1088/1742-6596/423/1/012027
4. https://ieeexplore.ieee.org/document/4160250
5. Python for scientific computing

SWAYAM/NPTEL/MOOCs:

1. Coursera – Python for everybody, University of Michigan
2. Coursera – Python Basics, University of Michigan

3. https://nptel.ac.in/courses/106/106/106106182/
4. https://www.edx.org/learn/python

Self-LearningExercises:

1. Explore PYTHON library for IOT programming
2. More exploration on GIThub
3. Data Visualization packages
4. C modules interface

Course Title	**Basic Electrical & Electronics Engineering**				**Course Type**		**Integrated**	
Course Code	**B21EE0101**	**Credits**	**4**		**Class**		**II Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	1	Theory Hours	Practical Hours	CIE	SEE
	-	0	-	-				
	Total	**4**	**5**	**4**	**39**	**26**	**50**	**50**

COURSEOVERVIEW:

Basic Electrical & Electronics Engineering covers basic concepts of electrical engineering and electromagnetism. This course introduces the student to the working AC and DC Machines. It also helps the student to understand the basics in digital electronics by applying the knowledge of logic gates and learning the applications of diodes in rectifiers, filter circuits. Further, it has a self-learning component on BJT's.

COURSE OBJECTIVE (S):

1. Explain the basics of electrical and electronics engineering terminologies.

2. Distinguish the single and three phase systems.

3. Illustrate the different building blocks in digital electronics using logic gates and explain simple logic functions using basic universal gates.

4. Discuss the applications of diode in rectifiers, filter circuits and wave shaping.

5. To build a broad concept for hands on experience in various types of electrical apparatus, tools and instrumentation with electrical safety norms.

6. Analyze the schematics for making electrical connection and to interpret experimental data for Various electrical appliances.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Summarize the basics of electrical engineering terminology and the usage.	1-6	1,2
CO2	Analyze the concepts and applications of DC & AC Machines.	1-5	1,2

CO3	Apply the concept of domestic wiring, importance of safety and sensing devices	1-5,10	1,2
CO4	Analyze the different building blocks in digital electronics using logic gates and applications of diode in rectifiers, filter circuits and wave shaping. .	1-5	1,2
CO5	Interpret, Identify and use appropriate electrical tools for electrical connections and to repair electrical equipment's.	1,4	1,2
CO6	Compare experimental results with theoretical analysis and the ability to critically evaluate the performance of electrical appliances.	1,5	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√	√				
CO2				√		
CO3			√			
CO4				√		
CO5			√			
CO6				√		

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	1	2	1							1	1	1
CO2	2	3	2	2	1								1	1	1
CO3	2	2	2	2	1					2			1	1	1
CO4	3	3	3	1	1								1	1	1
CO5	2	2	1	3	1	3	1		3	1			3	3	3
CO6	3	2	1	3	1	3	1		3	1			3	3	3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT
THEORY:

UNIT – 1

Electrical Circuits: Basic definitions, Types of elements, Ohm's Law, Kirchhoff's Laws, Resistive, Inductive, capacitive networks, Series, Parallel circuits and Star-delta and delta-star transformations, Network Theorems (Superposition, Thevenin's & Norton's) Generation of an alternating Emf–average and rms values of alternating quantity–representation of alternating quantities by phasors–single phase series and parallel circuits (simple problems), three phase systems and power calculations.

UNIT – 2

DC-Machines: Construction and Principle of operation of DC Machines–Emf & Speed equations-types–applications. AC-Machines: Principle of operation of single phase transformers–Emf equation–losses– efficiency and regulation-Construction and working principle of induction motors–Slip–torque characteristics–applications-Construction and Principle of operation of alternators applications.

UNIT – 3

Instruments: Basic Principle of indicating instruments–PMMC&MI instruments. Tariff, Protective Devices and Sensors: Tariff schemes, basic concepts of domestic wiring and types, Earthing, protective fuses, MCB, sensors: pressure sensors, strain gage, proximity sensors, displacement sensors, Rotatory encoder and ultrasonic sensors and civil engineering applications.

UNIT – 4

Diodes: Introduction, Physical operation of p-n junction diodes, Characteristics of p-n junction diodes, Zener diode, Rectifier circuits (half-wave, full-wave, bridge and peak rectifiers),Light emitting diodes.

Digital Electronic Principles: Introduction, Binary digits, Logic levels and Digital waveforms, Introduction to basic logic operation, Number system, Decimal numbers, Binary numbers, Decimal-to-Binary conversion, Simple binary arithmetic.

PRACTICE:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Electrical Safety Training. a) To Study the importance of Earthing during accidental shorting of line wire and the body of equipment.	Trainer kit Ohms Law Fall of resistance	Importance & applications of Earthing, Fuse & MCB
	b) To conduct experiment and to know the Importance and mechanism of FUSE		
	c) To study the Importance and mechanism of MCB.		
2.	Home Electrical Wiring Demonstration. a) To study & verify the connection procedure for fluorescent lamp wiring.	Fluorescent Lamp wiring Panel Fan with switch and regulator Kit	Connection & Trouble shooting of Fluorescent lamp wiring & Fan with switch and regulator
	b) To study the connection of Fan with switch and regulator.		
3.	Two-way switch/ staircase wiring. To study & verify the connection procedure for two-way switch or staircase wiring	Two-way switch or staircase wiring Kit	Connection, Working & application of Two-way switch
4.	Behaviour of current and voltage in series and parallel circuits. a)To study and verify the behaviour of current and voltage in series circuit.	Series and parallel circuits Kit	Connection & behaviour of current & voltage in series , parallel circuit
	b) To study and verify the behaviour of current and voltage in parallel circuit.		

5.	Polarity test on single phase transformer. a)To determine the additive polarity of a single-phase transformer. b) To determine the subtractive polarity of a single-phase transformer.	Transformer Kit	Polarities of single phase transformer
6.	Determination of VI characteristics of Zener Diode	VI characteristics of Zener Diode kit	VI characteristics of Zener Diode
7.	Determination of VI characteristics of Silicon Diode	VI characteristics of Silicon Diode kit	VI characteristics of Silicon Diode
8.	Analyze the Half Wave and Full Wave rectifiers using Diode with and without filter	Rectifier kit	Determine the efficiency, Voltage regulation, ripple factor of rectifiers
9.	Determine the Characteristics of BJT in Common Emitter Configuration	Characteristics of BJT in Common Emitter	Input & Output Characteristics of BJT
10.	Determine the Characteristics of JFET in Common Source Configuration	Characteristics of JFET in Common Source	Input & Output Characteristics of JFET
11.	Realization of Universal gates using basic logic gates.	Trainer kit	Universal gates will be realized using basic gates

TEXT BOOKS:

1. Nagrath I.J. and D. P. Kothari, "Basic Electrical Engineering", 3rd edition Tata McGraw Hill, 2009.
2. Hayt and Kimberly, "Engineering Circuit Analysis", 8thEdition, Tata McGraw Hill, 2013.
3. Kulshreshtha D.C., "Basic Electrical Engineering", Tata McGraw Hill, 2009.
4. Rajendra Prasad, "Fundamentals of Electrical Engineering", PHI, India, 2009.
5. Hughes, E., "Electrical Technology", Pearson, 2005.
6. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5thedition, 2008.
7. D.P. Kothari, I. J. Nagrath, "Basic Electronics", McGraw Hill Education (India) Private Limited, 2014.

REFERENCE BOOKS:

1. Theodore Wildi, "Electrical Machines, Drives, and Power, Systems",5th edition, Pearson 2007.
2. Hughes, "Electrical Technology", International Students 9thedition, Pearson, 2005.

JOURNALS/MAGAZINES:

1. International Journal of Electrical Power and Energy Systems (https://www.journals.elsevier.com/international-journal-of-electrical-power-and-energy-systems)
2. Journal of Electrical Engineering (https://link.springer.com/journal/202)

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/108/108/108108076/

SELF-LEARNING EXERCISES:

1. Build a electrical circuit using BJT as a switch
2. Identifying the practical application of Electromagnetic Induction

Course	Basics of Civil and Mechanical Engineering				Course Type		Integrated	
Course Code	B21CE0201	Credits	4		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	Tutorial	0	-	-				
	Total	**4**	**5**	**5**	**39**	**26**	**50**	**50**

COURSE OVERVIEW:

This course introduces the Mechanical and Civil Engineering concepts, underlying the fact that this knowledge is essential for all Engineers. The students are made to understand the concept of internal combustion engines and power transmission systems. The students are also exposed to the knowledge of mechanical machine tools with its operations on lathe, drilling, and CNC machines. The students are introduced to the domain of fabrication processes like Soldering, Welding and 3D printing technology. Along with this student are made to expose to scope of Civil engineering, role of civil engineers in different infrastructure & economic development of the country. Students will learn about basic concept of forces, friction, centroid and moment of inertia.

COURSE OBJECTIVE(S):

This course enables graduating students

1. To develop the basic knowledge of IC engines, refrigeration-air conditioning and power transmission systems.
2. To incorporate the concepts of manufacturing processes using different machine tools, welding techniques, CNC and 3D printing technology.
3. To understand a broad concept of engineering mechanics.
4. To develop the basics of composition of coplanar forces and fluid mechanics

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Describe the fundamentals of IC engines, refrigeration-air conditioning and power transmission systems.	1,2	3
CO2	Explain the manufacturing processes using lathe, drilling, welding, CNC machines and 3D printing technology	1,2	3
CO3	Calculate the speed ratio of belt drives and Gear Drives.	1,2,3	3
CO4	Describe the moment of force and couples and equivalent force-couple system.	1,2	3
C05	Solve numerical problems on composition of coplanar concurrent and non-concurrent force system.	1,2	3
CO6	Describe the basic terminology fluid mechanics	1,2	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2		✓				
CO3			✓			
CO4		✓				
C05			✓			
CO6		✓				

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2													1
CO2	3	2													1
CO3	3	2	3												1
CO4	3	2													1
C05	3	2													1
C06	3	2													1

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to Mechanical Engineering: Overview of Mechanical Engineering, Importance and applications of Mechanical Engineering in different fields.

Thermal Energy Systems: Introduction to IC Engines, Classification, parts of IC Engine, working of 4-stroke Petrol engine with PV-diagram. Simple numerical on calculation of IP, BP and Mechanical efficiency, Introduction to refrigeration system, working of vapour compression refrigeration and window spit air conditioning system. Applications of refrigeration systems

UNIT – 2

Power Transmission System: Introduction to drives, classification, belt drives (open and crossed-No derivations) and gear drives and types of gear, Numerical on gear drives.

Mechanical Machine Tools: Introduction- lathe, classification, major parts of engine lathe, operations, Drilling machine, classification working bench drilling machine and operations, CNC Machines-Block diagram and applications. Introduction to 3D Printing technology

Joining processes-Welding: Working of electric arc welding and soldering, Differences between welding and soldering, Applications and safety tools

UNIT – 3

Introduction to Civil Engineering: Scope of Civil Engineering, Types of Infrastructure, Effect of Infrastructure facilities, Role of Civil Engineers in the Infrastructure and Economic Development of Country.

Introduction to Engineering Mechanics: Basic concepts, Newton laws of Motion Elements of force, system of forces, principles of physical Independence, superposition and Transmissibility of forces. Moment of force –Couple, Moment of couple and its characteristics, Equivalent Force – Couple system. Resolution and composition of forces.

Coplanar Concurrent Force System: Parallelogram Law of forces, principle of resolved parts, composition of concurrent forces.

UNIT – 4

Coplanar Non – concurrent forces: Varignon's principle of Moments, Resultant of Non – Concurrent force systems, Equilibrium of Coplanar Concurrent Force System: Type's forces acting on the body, free body diagrams, Equations of Equilibrium, Lami's theorem, Equilibrium of Non – concurrent forces equilibrium equations

Friction: Frictional forces, Law of friction, Angle of friction, Angle of Repose and Cone of Friction (Theory only)

Centroid: Center of Gravity, Center of Gravity of Flat Plate, Centroid, difference between Center of gravity and Centroid, Uses of Axis Symmetry, simple problems

Moment of Inertia: Moment of Inertia of Plane Figure, Polar Moment of Inertia and Moment of Inertia of Standard sections (Derivations not included). Simple problems.

Fluid Mechanics: Introduction, methods of describing fluid motion, definitions of types of fluid flow, streamline, path line, stream tube. General Continuity equation (problems).

PRACTICE:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Dismantling and Assembly of 2-Wheeler (2–stroke) Engine	2-Stroke Engine (TVS Bike)	Hands on Experience
2	Study of Fitting tools and preparation of fitting model (1 Model)	Fitting tools	Hands on experience
3.	Study of sheet metal tools and development of Cylinder (1 Model)	Sheet metal tools and soldering tools	Hands on experience
4.	Study of sheet metal tools and development of Pen stand and funnel (2-Models)	Sheet metal tools and soldering tools	Creative Thinking
5.	Hands on training on basic welding joint (Butt Joint-1 Model)	Welding tools	Hands on experience

6.	To study the carpentry tools with one model (Half Joint-Model)	Carpentry Tools (Marking, Sawing, Planning and Chiseling	Comprehend the different handling carpentry tools
7.	To study the carpentry tools with one model (Dovetail-Model)	Carpentry Tools (Marking, Sawing, Planning and Chiseling	Comprehend the different handling carpentry tools
8.	To study the carpentry tools with one model (T-Joint - Model)	Carpentry Tools (Marking, Sawing, Planning and Chiseling	Comprehend the different handling carpentry tools
9.	To Study the plumbing tools and to make threads on pipe and pipe fittings using plumbing tools	Plumbing Tools	Comprehend the different handling plumbing tools
10.	To Study the plumbing tools used for valves and sanitary fitting	Plumbing Tools	Comprehend the different handling plumbing tools

TEXT BOOKS:

1. K.R. Gopal krishna," Elements of Mechanical Engineering", 12thEdition, Subhash Publishers, Bengaluru,2012.
2. Roy & Choudhury, "Elements of Mechanical Engineering", Media Promoters & Publishers Pvt. Ltd, Mumbai, 2000.
3. Mikell P Groover," Automation, Production Systems, and Computer Integrated Manufacturing ",4th edition, Pearson India, 2007.

REFERENCE BOOKS:

1. SKH Chowdhary, AKH Chowdhary, NirjharRoy (2001), "The Elements of Workshop Technology - Vol I & II, 11th edition, Media Promotors and publisher.
2. Avikshit Saras, "3D Printing-Made Simple", BPB Publications.

JOURNALS/MAGAZINES:

1. International Journal of Machine Tools and Manufacture
2. International Journal of Refrigeration.

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112/103/112103262/#
2. https://www.my-mooc.com/en/mooc/fundamentals-manufacturing-processes-mitx-2-008x/
3. https://www.coursera.org/learn/3d-printing-applications

Course Title	Biology For Engineers			Course Type	Theory
Course Code	B21AS0109	Credits	1	Class	II Semester

Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	1	1	1			
	Practice	-	-	-	Theory	CIE	SEE
	Tutorial	-	-	-			
	Total	**1**	**1**	**1**	**13**	**50**	**50**

COURSE OVERVIEW:

Understanding biological systems, principles and concepts in order to create usable, tangible, economically viable product or process has become need of the hour. Hence irrespective of the parent engineering discipline, knowledge and expertise from pure and applied sciences is necessary to create product or process related to healthcare, agriculture, environmental issues and many more. Any engineer will have a high probability of using biology related skills and concepts to create products and processes beneficial to the mankind and as well for the sustainable environmental friendly approach. For example, the knowledge can be used to create medical devices, diagnostic equipment's, bioreactor designing, agriculture related equipment/instruments or anything related to surface science, fluid mechanism and polymer science. This course is designed to lay foundation in the field of Cell biology, Molecular biology and Genetics, so that anyone who is interested can design better product/process to enhance the overall quality of life.

COURSE OBJECTIVE(S):

1.To inculcate the basic concepts of biology from engineering perspective among students

2. To understand the interplay between biology and engineering disciplines

3.To conceptualize the engineering design/process/product for life science challenges

COURSE OUTCOMES (COs):

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Understand and explain the concepts regarding origin and evolution of life.	1	
CO2	Demonstrate the structure and functions of various biomolecules in living	1	
CO3	Comprehend the organization of cell structure in prokaryotes and	1	
CO4	Describe the process of cell division involving mitosis and meiosis	1	
CO5	Predict the inheritance pattern of genes from parents to offspring	1	
CO6	Apply the principles of Biology either for the process/product development from the engineering perspective.	1	

BLOOM'S LEVEL OF THE COURSE OUTCOMES

	Bloom's Level

CO#	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	✓	✓				
CO2	✓	✓				
CO3	✓	✓				
CO4	✓	✓				
CO5	✓	✓				
CO6	✓	✓	✓			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2													
CO2	2													
CO3	2													
CO4	2													
CO5	2													
CO6	2													

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to Biology, Evolution and Origin of Life, Biomolecules-Lipids, Biomolecules: Carbohydrates, Water Biomolecules: Amino acids, Proteins, Biomolecules: Enzymes.

UNIT – 2

Biomolecules: Nucleotides, Cell structure and function – Prokaryotes, Cell structure and function – Eukaryotes

Cell cycle-Mitosis and Meiosis, Mendelian genetics: Mendelian inheritance, Genetic diseases and Mendelian inheritance, Central Dogma – Replication, Transcription and Translation

TEXT BOOKS:

1. G.K. Suraish kumar, “Biology for Engineers”, Oxford University Press, 2019.
2. “Biology for Engineers: As per AICTE curriculum”, Wiley publication.
3. Dr Sohini Singh, Dr.Tanu Allen ,”Biology for Engineers” , Vayu Education of India.

REFERENCE BOOKS:

1. P.S.Verma and V.K. Agarwal,"Cell Biology, Genetics, Molecular Biology, Evolution and Ecology ",S. Chand Publishing,2018.
2. Sambamurthy,"Handbook of Genetics", Friends Publisher, 2010

JOURNALS/MAGAZINES:

1. Current Sciences
2. SWAYAM/NPTEL/MOOCs:
3. https://onlinecourses.nptel.ac.in/noc19_ge31/preview
4. Coursera: Biology everywhere

SELF-LEARNING EXERCISES:

Case Study: Computational biology in agriculture and Health Care Artificial Intelligence in health care Image processing for medical applications

Course Title	Design Thinking				Course Type		Integrated	
Course Code	B21ME0102	Credits	2		Class		I/II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Practice	1	2	2				
	-	-	-	-	Theory	Practical	CIE	SEE
	Total	**2**	**3**	**3**	**13**	**26**	**50**	**50**

COURSE OVERVIEW:

Today, innovation is everyone's business. At every level, in every kind of organization, design thinking provides the tools that one needs to become an innovative thinker and uncover creative opportunities. For example, companies like Procter, Gamble and GE have incorporated Design Thinking into their strategy and marketing. The course draws on methods from engineering and design, and combines them with ideas from the arts, tools from the social sciences, and insights from the business world.

In this course, students start in the field, where they discover the needs of the target audience. They then iterate ideas on teams to develop a range of promising possible solutions, create rough prototypes to take back out into the field, and learn to test with real people in the target audience.

COURSE OBJECTIVE(S):

1. To impart knowledge on design thinking process for understanding designs.
2. To provide design skills to analyze design thinking issues and apply the tools and techniques of design.
3. To inculcate attitude to solve societal problems using design thinking tools.

COURSE OUTCOMES (CO's)

On successful completion of this course; the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Identify the problems that fall under the purview of human centered design process for creative problem solving.	1,2, 9,10,12	1,2
CO2	Develop empathy maps to visualize user needs and to get insights of the problem.	1,2,9,10,12	2
CO3	Define the problem from user's perception.	1,2,9,10,12	1,2
CO4	Apply Ideation techniques to ideate innovative ideas for the problem	1,2,9,10,12	1,2
CO5	Develop simple prototypes for problems using feasible idea.	1,3, 5,9,10,12	1,2
CO6	Improve prototype by testing it with a specific set of users for making it sustainable by following ethics.	1,4,8,9,10,12	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	✓					
CO2			✓			
CO3	✓					
CO4			✓			
CO5						✓
CO6					✓	

COURSE ARTICULATION MATRIX

CO#/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2							2	2		2	3	2	
CO2	1	3							2	3		2		2	
CO3	1	2							3	2		3	1	2	
CO4	1	2							3	2		2	1	2	
CO5	2		3		2				3	3		2	2	3	
CO6	2			2				1	3	2		2	2	3	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENTS

THEORY:

UNIT – 1

Design Thinking Process: Types of the thinking process, Design thinking: Definition, Origin of design thinking, Importance of design thinking, Design vs Design thinking. Problem Exploration, Case Studies from Embrace-Stanford Innovation Challenge, IDEO, GE Healthcare, The Good Kitchen- Denmark Program etc, identifying the target users for the problem selected, Survey on existing solutions for the problem identified.

Empathizing: Powerful Visualizing tool – a method to connect to the user, Creating Empathy maps – Case studies.

UNIT – 2

Defining the problems: POV statements from User perspective. Idea generation: Methods to spark the innovative ideas – Brainstorming, Mind map, Story board, Provocation etc

What is a prototype? - Prototyping as a mindset, prototype examples, prototyping for products; Why we prototype? Fidelity for prototypes, Process of prototyping- Minimum Viable prototype

Prototyping for digital products: What's unique for digital, Preparation; Prototyping for physical products: What's unique for physical products, Preparation; Testing prototypes with users.

PRACTICE:

Sl.No	Name of the Practice Session	Tools and Techniques	Expected Skill /Ability
1	Identifying the problem that can be solved using Design Thinking approach	Observation and survey	Develop identifying human centered problems
2	Build the empathy maps for simple problems like single user	Visualization	Develop ability to understand other's emotions
3	Build the detailed empathy maps for problem identified in the teams formed	Visualization	Develop ability to understand other's emotions
4	Presentation by student teams	PPT	Develop ability to express their views
5	Obtain the insights into user's problems and make PoV statement	Understanding	Develop making problem statements from user perception
6	Presentation by student teams	PPT	Develop ability to express their views
7	Carry out Brain storming between the groups and generate as many as ideas possible	Ideation tools	Develop innovative mind set
8	Prototype for best 3 ideas selected	Sketching, simple model making etc	Develop prototyping techniques
9	Presentation by student teams	PPT	Develop ability to express their plan
10	Test the developed prototype with set of identified users	Google forms , cold calls, social media etc.	Develop understanding of various testing methods
11	Pitching final solution	PPT	Develop ability to express their views

TEXT BOOKS:

1. Gavin Ambrose, Paul Harris, “Basics Design-Design Thinking”, AVA Publishing, 2010
2. Kathryn McElroy, “Prototyping for Designers: Developing the best Digital and Physical Products”, O’Reilly,2017.

REFERENCE BOOKS:

1. Michael G. Luchs, Scott Swan , Abbie Griffin,”Design Thinking – New Product Essentials from PDMA”, Wiley, 2015.
2. Vijay Kumar, “101 Design Methods: A Structured Approach for Driving Innovation in Your Organization”, 2012.

JOURNALS/MAGAZINES:

1. Leonard, D., and Rayport, J. F. 1997. Spark Innovation through Empathic Design. In Harvard Business Review, November-December 1997,102-113.
2. https://www.ideo.com
3. https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking- process
4. https://www.ibm.com/design/thinking/page/toolkit
5. https://www.interaction-design.org/literature/article/define-and-frame-your-design-challenge-by- creating-your-point-of-view-and-ask-how-might-we
6. https://www.culturepartnership.eu/en/article/ten-tools-for-design-thinking
7. https://youtu.be/M66ZU2PCIcM
8. https://thisisdesignthinking.net/2017/07/innogy_energy_ecarsharing/

SWAYAM/NPTEL/MOOCS:

1. https://nptel.ac.in/courses/109/104/109104109/
2. https://nptel.ac.in/courses/110106124/

2nd Year Detailed Syllabus

III sem syllabus

Course Title	Analog and Digital Electronics				Course Type		HC	
Course Code	B21EF0301	Credits	3		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-							
	Total	**3**	**3**	**3**	**39**	**-**	**50**	**50**

COURSE OVERVIEW:

This course covers basic concepts of Electrical Engineering. The course introduces the working of analog components and helps in understanding basics in digital electronics by applying the knowledge of logic gates and learning the applications of diodes and OP Amps. The course provides foundation on designing and implementation of logic circuits. Analog circuits are simulated using ORCAD tool and digital circuits using XILINX tool which helps in gaining experience in creating and testing of circuits.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Discuss the applications of diode in rectifiers, filter circuits and wave shaping.
2. Describe the foundation on designing, building and testing of common combinational and sequential Digital logic circuits.
3. Explain the procedure required for simulation of digital logic circuits.
4. Demonstrate the use of general electronic instruments in design and testing of digital logic circuits.

COURSE OUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Analyze the use of diodes in rectifiers, filter circuits and wave shaping	1 to 4, 7,8,9,10,12	1
CO2	Apply the basic knowledge used in solid state electronics including diodes, and operational amplifiers for specific engineering applications.	1 to 3, 5 7,8,9,10,12	1
CO3	Identify the different families of digital integrated circuits build, and troubleshoot combinatorial circuits using digital integrated circuits	1 to 5 7,8,9,10,12	2
CO4	Develop the ability to analyze and design analog electronic circuits using discrete components	1,4,5 7,8,9,10,12	3
CO5	Model the schematics of some electronic circuits to interpret its working.	1,3,5 7,8,9,10,12	3
CO6	Solve the implementation of logic circuit using programming.	1,2,4 7,8,9,10,12	3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1				√		
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2			2	2	3	3		2	3		
CO2	3	2	3		2		2	2	3	3		2	3		
CO3	3	1	2	1	2		1	2	3	3		2		3	
CO4	3			2	2		1	2	3	3		1			3
CO5	3		2		2		1	2	3	3		1			3
CO6	3	3		2			1	2	3	3		1			3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Limiters and Oscillators: Clipping and clamping circuits using diodes, Oscillator operation, Phase shift Oscillator, Wien bridge Oscillator, Tuned Oscillator circuits, Crystal Oscillator. (BJT Version Only) Simple design methods of Oscillators.

UNIT- 2

Operational Amplifiers: Ideal Opamp versus Practical Opamp, Performance Parameters, Some Applications: Peak Detector Circuit, Absolute Value Circuit, Comparator, Active Filters-First order LPF and HPF, Phase Shifters, Instrumentation Amplifier, Non-Linear Amplifier-Log and antilog amplifier.

UNIT – 3

Principle and Minimization Techniques of combinational Circuits: Introduction to combinational logic, Minimization Techniques: Minterm, Maxterm, Sum of Products (SOP), Product of Sums (POS), 3 and 4 Variable Karnaugh map.

UNIT – 4

Analysis of Combinational and sequential Circuits: Half adder, full Adder, Half Subtractor, full Subtractor, multiplexers and Demultiplexers.

Introduction to Sequential circuits: flip-flops: SR, JK, D, T Characteristic tables and equations; Application of Shift register (Ring Counter and Johnson counter) .

TEXTBOOKS:

1. Anil K Maini, Varsha Agarwal, "Electronic Devices and Circuits", Wiley, 2009.
2. Jacob Millman, Christos Halkias, Chetan D Parikh, 'Millman's Integrated Electronics – Analog and Digital Circuits and Systems", 2nd Edition, Tata McGraw Hill, 2010.
3. Donald P Leach, Albert Paul Malvino & GoutamSaha , "Digital Principles and Applications", 7th Edition, Tata McGraw Hill, 2010.

REFERENCEBOOKS:

1. Stephen Brown, ZvonkoVranesic," Fundamentals of Digital Logic Design with VHDL", 2nd Edition, Tata McGrawHill, 2005.
2. R D Sudhaker Samuel, "Illustrative Approach to Logic Design", Sanguine-Pearson, 2010.
3. Charles H. Roth," Fundamentals of Logic Design", Jr., 5th Edition, Cengage Learning, 2004.
4. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss," Digital Systems Principles and Applications", 10th Edition, Pearson Education, 2007.
5. M Morris Mano," Digital Logic and Computer Design", 10th Edition, Pearson Education, 2008.
6. Jacob Millman, Christos Halkias, " Analog and Digital Circuits and Systems", 2nd Edition, Tata McGraw Hill, 2010
7. R. D. Sudhaker Samuel," Electronic Circuits", Sanguine-Pearson, 2010

JOURNALS/MAGAZINES:

1. https://ieeexplore.ieee.org/document/1085417
2. https://www.academia.edu/Documents/in/Digital_Electronics
3. https://www.mdpi.com/journal/electronics/special_issues/circuit_machine_learning

SWAYAM/NPTEL/MOOCs:

1. https://technobyte.org/digital-electronics-logic-design-course-engineering/
2. https://www.udemy.com/course/digital-electronics-logic-design/
3. https://www.javatpoint.com/digital-electronics/.

Course Title	Programming with JAVA				Course Type		HC	
Course Code	B21EF0302	Credits	3		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**-**	**50**	**50**

COURSE OVERVIEW:

Java's unique architecture enables programmers to develop a single application that can run across multiple platforms seamlessly and reliably. In this course, students gain extensive experience with Java, object-oriented features and advance Java programming skills. Students learn to create robust object-oriented applications with Java.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the basic data types and control structures of the Java language.
2. Illustrate the creation of classes and objects in Java.
3. Demonstrate the extending a class (inheritance) and use proper program anomaly handling structures.
4. Discuss the use of Java generics and collections.

COURSE OUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Make use of array concepts in java to solve real world problems.	1 to 5,9,10,12	1,3
CO2	Apply the features of OOPS in java to solve the real-world problems.	1 to 5,9,10,12	1,3
CO3	Develop program for stack implementation using Exception Handling in java.	1 to 5,9,10,12	2, 3
CO4	Identify suitable data structures to solve real world applications.	1 to 5,9,10,12	2
CO5	Apply the garbage collection for saving the resources automatically in real world problem.	1 to 5,9,10,12	1,3
CO6	Develop java web applications using JDBC in real world problem.	1 to 5,9,10,12	1,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1				3	3		2	3		3
CO2	3	3	2	2	1				3	3		2	3		3
CO3	3	3	1	1	1				3	3		2		3	3
CO4	3	3	3	1	2				3	3		2		3	
CO5	3	1	2	1	3				3	3		2	3		3
CO6	3	1	2	1	3				3	3		2	3		3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Fundamental Programming Structures: Dissecting the "Hello, World" Program; Compiling and Running a Java Program; Primitive Types; Variables; Arithmetic Operations; Strings; Input and Output; Control Flow; Arrays; Functional Decomposition.

UNIT – 2

Object-Oriented Programming: Working with Objects; Implementing Classes; Object Construction; Static Variables and Methods, Packages; Nested Classes; Documentation Comments; Interfaces; Static, Default and Private Methods in interface; Lambda Expressions; Method and Constructor References; Local and Anonymous Classes.

UNIT – 3

Inheritance and Exceptions: Extending a Class; Object: The Cosmic Superclass; Enumerations; Runtime Type Information and Resources; Exception Handling: Throwing Exceptions; The Exception Hierarchy; Declaring Checked Exceptions; Catching Exceptions; the Try-with-Resources Statement; The finally Clause; Rethrowing and Chaining Exceptions; Uncaught Exceptions and the Stack Trace.

UNIT – 4

Generic Programming and Collections: Generic Classes; Generic Methods; Type Bounds; Type Variance and Wildcards; Restrictions on Generics; an Overview of the Collections Framework; Iterators; Sets; Maps.The Concept of JDBC; JDBC Driver Types; JDBC Packages; A Brief Overview of the JDBC process; Database Connection; Associating the JDBC/ODBC Bridge with the Database.

TEXTBOOKS:

1. Cay S. Horstmann, ”Core Java® SE 9 for the Impatient”, Addison Wesley, Second Edition, 2018.
2. HerbertSchild, ”Java™:TheCompleteReference”,McGraw-Hill,TenthEdition,2018.
3. David Gallardo, Ed Burnette, Robert Mcgovern”, Eclipse in Action a guide for java developers”, Manning Publications,2003.
4. Ed Burnette, ” Eclipse IDE Pocket Guide : Using the Full-Featured IDE”, O'Reilly Media, Inc, USA,2005.

REFERENCEBOOKS:

1. Cay S. Horstmann, ”Core Java™ Volume I—Fundamentals”, Prentice Hall, Tenth Edition, 2015
2. Joshua Bloch, ”Effective Java”,Addison-WesleyProfessional,ThirdEdition,2017
3. Ken Kousen, ” Modern Java Recipes”, O'Reilly Media, Inc.,2017
4. Oracle Java Documentation. (https://docs.oracle.com/javase/tutorial/)

JOURNALS/MAGAZINES:

1. https://ieeexplore.ieee.org/document/5464387
2. https://files.eric.ed.gov/fulltext/EJ1075126.pdf
3. https://www.sciencedirect.com/science/article/pii/S0167642304000590
4. https://www.informingscience.org/Publications/4322?Source=%2FJournals%2FJITEIIP%2FArticles%3FVolume%3D0-0
5. https://www.javadevjournal.com/
6. https://blogs.oracle.com/javamagazine/

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc19_cs84/preview
2. https://www.classcentral.com/course/swayam-programming-in-java-12930
3. https://swayam.gov.in/explorer?searchText=java

SELF-LEARNINGEXERCISES:

1. The Eclipse-IDE
2. Streams
3. Concurrent Programming
4. Swing and JavaFX
5. Networking- JDBC, Database Access

Course Title	Data Structures				Course Type		HC	
Course Code	B21EF0303	Credits	3		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	3	3	3	**39**	**-**	**50**	**50**

COURSE OVERVIEW:

This course covers basic data structures techniques and their implementation in Java. Familiarize the concept of Abstract Data Types (ADT), stacks, Queues and Trees. The course also introduces applications of these data structures in solving problems. Students are expected to use these data structure concepts to write simple programs.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1.Explain the basic Concepts of java and Data Structures

2. Illustrate the creation and use of singly and doubly Linked list in Java.

3. Demonstrate the use of Stacks and Queues in real world applications.

4. Discuss the concept and applications of Binary trees.

COURSE OUTCOMES(COs)

After the completion of the course, the student will be ablet o:

CO#	Course Outcomes	POs	PSOs
CO1	Make use of Java Arrays to solve real world problems.	1 to 5,9,10,12	1
CO2	Develop a java program for implementing the linked list.	1 to 5,9,10,12	1,2
CO3	Build a real world application in Java using stacks and queues.	1 to 5,9,10,12	1,2
CO4	Apply the concepts of trees for solving real world problems.	1 to 5,9,10,12	1,2
CO5	Identify the most suitable data structure for real world application.	1 to 5,9,10,12	1,2,3
CO6	Experiment with all data structures in a high-level language for problem solving.	1 to 5,9,10,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	2				3	3		3	3		
CO2	3	2	3	3	2				3	3		3	3	3	
CO3	3	1	2	3	1				3	3		3	3	3	
CO4	3	1	3	3	2				3	3		3	3	3	
CO5	3	3	3	3	1				3	3		3	3	3	3
CO6	3	3	3	3	2				3	3		3	3	3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to Data Structures: Introduction to data structures, classification of data structures, operations on data structures, abstract data type, algorithms; Arrays-Sorting an Array (Insertion Sort), java.util Methods for Arrays, Cryptography with character arrays; Two-dimensional Arrays and positional games.

UNIT – 2

Linked list: Singly Linked List, Implementing a Singly linked list class; Circularly Linked List, Round-Robin Scheduling, Designing and implementing a circularly linked list; Doubly linked List, Implementing a Doubly linked list class.

UNIT – 3

Stacks: Introduction, The Stack Abstract Data type, A Simple Array-based Stack implementation,

Implementing a Stack with a Singly Linked List.

Queue: Introduction, The Queue Abstract Data type, Array-based Queue implementation, implementing a Queue with a Singly Linked List.

UNIT – 4

Trees: General Trees-Tree definitions and properties, The Tree Abstract data type, computing depth and height; Binary Trees: The Binary Tree abstract data type, properties of Binary Trees; Implementing Trees- Linked structure for Binary Trees; Tree Traversal Algorithms- Preorder, Postorder Traversals of General Tree, Inorder Traversal of a Binary Tree, Implementing Tree Traversal.

TEXTBOOKS:

1. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in JAVA ", Wiley, 6th Edition, 20l4
2. Herbert Schildt, "The Complete reference Java", 7th edition, 2007

REFERENCEBOOKS:

1. Richard Gilberg, Behrouz Forouzan, "DataStructures: A Pseudocode Approach with C", Cengage Learning,2004.
2. DebasisSamanta, "Classic DataStructures", second edition, PHI Learning Private Limited,2011.

JOURNALS/MAGAZINES:

1. https://www.imedpub.com/scholarly/data-structure-journals-articles-ppts-list.php
2. https://www.mdpi.com/journal/algorithms/special_issues/Efficient_Data_Structures
3. https://ieeexplore.ieee.org/document/4055607
4. https://ieeexplore.ieee.org/abstract/document/6312216
5. https://www.sciencedirect.com/science/article/pii/0022000083900065
6. https://www.sciencedirect.com/journal/journal-of-algorithms

SWAYAM/NPTEL/MOOCs:

1. Coursera – Data Structures and Algorithms Specialization
2. Coursera – Data Structures, University of California San Diego
3. Data Structures and Algorithms, National Research University Higher DEPARTMENT of Economics
4. https://nptel.ac.in/courses/106/102/106102064/
5. https://nptel.ac.in/courses/106/106/106106127/
6. https://nptel.ac.in/courses/106/103/106103069/

SELF-LEARNINGEXERCISES:

1. Storing game entities in a array
2. Pseudo-random number generators
3. Reversing an array using a stack
4. Matching parentheses and HTML tags
5. Double ended queue
6. Application of tree traversals.

Course Title	Discrete Mathematics and Graph Theory				Course Type		HC	
Course Code	B21AS0302	Credits	3		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**-**	**50**	**50**

COURSE OVERVIEW:

Discrete Mathematics is the study of discrete objects. Discrete Mathematics is used to develop our ability to understand and create mathematical arguments and also used to provide the mathematical foundation for advanced mathematics and computer science courses.

Graphs (abstract networks) are among the simplest mathematical structures, which are used in most of the areas of Computer Science to solve the complex problems.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain mathematical arguments using logical connectives and quantifiers.
2. Illustrate the operation on discrete structures such as sets, relations and functions.
3. Describe the theory and application of graphs, fundamental theorems and their proofs.
4. Demonstrate the use of graphs to model many types of relations and processes in physical, biological. Social and information system.

COURSE OUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Construct mathematical arguments using logical connectives and quantifiers	1 ,2,3	2
CO2	Explain basic concepts and prove basic facts about ordinals and well-ordered sets.	1 ,2,3	2
CO3	Apply the operations like union and intersection on discrete structures such as sets, relations and functions	1 ,2,3	2
CO4	Demonstrate the ability to write and evaluate the proof or outline the basic structure of and give example of each proof technique described.	1 ,2,3	2
CO5	Illustrate the concept of isomorphic graphs and isomorphism invariant properties of graphs	1 ,2,3	2
CO6	Develop a model using advanced concepts of graph for real world applications	1 ,2,3	2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4		√				
CO5		√				
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1											3	
CO2	3	2	3											3	
CO3	3	1	2											3	
CO4	3	2	3											3	
CO5	3	2	2											3	
CO6	3	2	2											3	

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Set Theory and Logic: Fundamentals of Sets, Sub sets, Venn diagram, Operations on sets, Laws of set theory, Countable and Uncountable sets, Addition Principle, Extended Addition Principle, Propositions, Logical Connectives and truth tables (Illustrative Examples), Logical equivalence, Laws of logic, Duality, NAND and NOR connectives (Circuits), Converse, Inverse and Contrapositive, Rules of Inference, Open statements, Quantifier, Logical implication involving quantifiers, Statement with more than one variable. Methods of Proofs and Disproof.

UNIT – 2

Relations and Functions: Cartesian product of sets (Illustrative Examples), Matrices and Digraph of the relations, Properties of relations, Equivalence relations, Partial ordered relations, Posets, Hasse diagrams, Extremal elements in

posets, Types of Functions, properties of Functions, The pigeon hole principle, composite functions, invertible functions, Floor and ceiling functions, Sterling number of second kind.

UNIT – 3

Introduction to graph theory: Konigsberg's bridge problems, Utilities problem, Seating Problem, Graphs, Representation of Graphs. Directed graphs, Incidence, Adjacency, Degree, In degree, Out degree, Regular graphs, Complete graphs, Null Graph, Bipartite Graphs, Isomorphism, Directed Graphs, Sub graphs, Walk, Trail, Path, Circuit, Cycle, Connected and disconnected graphs, Components, Weakley connected and Strongly connected Components, Complement of graphs, Partition and Decompositions.

UNIT – 4

Euler and Hamiltonian graphs and Graph coloring: Operation on graphs, Definition of Euler Trail, Euler Graphs, Hamiltonian path, Hamiltonian Cycle, Hamiltonian Graphs, Standard Theorems on Euler and Hamiltonian graphs, planar graph, detection of Planarity, Dual of planar graphs, Euler formula for planar graph, Graph coloring, Chromatic polynomial, Map coloring, Four Color Theorem, Five Color Theorem, Matching, Network flow, and its applications, Cut set, Cut vertex, Chord, Properties of Cut Sets, Max Flow Min Cut Theorem.

TEXT BOOKS:

1. Ralph P Grimaldi, "Discrete and Combinatorial Mathematics", Pearson Education, 5th Edition, 2014.
2. Nasingh Deo, "Graph Theory with Applications to Engineering Computer Science", Prentice-Hall, 2014.

REFERENCE BOOKS:

1. Keneth H Rosen, "Discrete Mathematics and its applications", Tata McGraw Hill,5th Edition, 2014.
2. C L Liu, "Elements of Discrete Mathematics", Tata MacGraw Hill, 4th edition, 2014.
3. Thomas Khoshy, "Discrete Mathematics with applications", Elsvier, 2012.
4. Ralph P Grimaldi, "Discrete and Combinatorial Mathematics", Pearson Education, Asia, 2015.
5. Frank Harary, "Graph Theory", Norosa, 2013.
6. J. A. Bondy and V. S. R. Murthy,"Graph Theory with Applications", Macmillan, London, 2013.

JOURNALS/MAGAZINES:

1. https://www.journals.elsevier.com/discrete-mathematics
2. http://www.math.iit.edu/~kaul/Journals.html
3. https://www.siam.org/publications/journals/siam-journal-on-discrete-mathematics-sidma
4. https://onlinelibrary.wiley.com/journal/10970118
5. https://iopscience.iop.org/article/10.1088/1742-6596/1175/1/012069/meta
6. https://iopscience.iop.org/article/10.1088/1742-6596/1188/1/012065/meta
7. https://www.worldscientific.com/worldscinet/jml
8. https://www.scimagojr.com/journalsearch.php?q=12000154480&tip=sid

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/111/107/111107058/
2. https://nptel.ac.in/courses/106/103/106103205/
3. https://onlinecourses.swayam2.ac.in/cec20_ma02/preview

4. https://onlinecourses.nptel.ac.in/noc20_ma05/preview
5. https://onlinecourses.swayam2.ac.in/cec20_ma03/preview
6. https://www.coursera.org/learn/graphs

Course Title	Agile software development and DevOps				Course Type		HC	
Course Code	B21EF0304	Credits	3		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

The course provides students with knowledge on the basic principles of software development life cycle, activities involved in software requirements engineering, software development, testing, evolution and maintenance. It introduces concepts such as software processes and agile methods, and essential software development activities.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1.Discuss the importance of the software development process.

2.Demonstrate the workflow of Automating process.

3.Explain the development of a software using Agile method

4.Illustrate with case study, the importance of DevOps.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Apply software development process to solve complex problems of engineering.	1,2	2
CO2	Make use of Agile principle for rapid software development	1,3	3
CO3	Summerize the manifesto and basic principles of agile approach to software development.	1,3,5	1
CO4	Apply the concepts of process modeling and automation in real world applications.	1,3,5	2,3
CO5	Distinguish between the traditional SDLC and agile ALM model for efficient and effective product delivery.	1,3,4	1
CO6	Develop the real world applications using DevOps tools.	1,3,4,5,9	2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3		√				
CO4			√			
CO5				√		
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3												3	
CO2	3		3												3
CO3	3		3		3								3		
CO4	3		3		3									3	3
CO5	3		3	3									3		
CO6	3		3	3										3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Requirements and Development process: Software Processes: Models, Process iteration, Process activities. Software Requirements: Functional and Non-functional requirements, User requirements, System requirements, Interface specification, the software requirements document. Requirements Engineering Processes: Feasibility studies, Requirements elicitation and analysis, Requirements validation, Requirements management. Development: Rapid Software Development: Agile methods, Extreme programming and Rapid application development. Software Evolution: Program evolution dynamics, Software maintenance.

UNIT – 2

Agile Application Life Cycle Management: Goals of Agile Application Life cycle Management, Why Is Agile ALM Important? Where Do I Start? Understanding the Paradigm Shift, Rapid Iterative Development, Remember RAD?,

Focuson12 Agile Principles, Agile Manifesto, Fixed Time box Sprints, Customer Collaboration, Requirements and Documentation.

UNIT – 3

Automating the Agile ALM: Goals of Automating the Agile ALM, Why Automating the ALMIs Important, Where Do I Start? Tools, Do Tools Matter? Process over Tools, Understanding Tools in the Scope of ALM, Staying Tools Agnostic, Commercial versus Open Source, What Do I Do Today?, Automating the Workflow, Process Modeling Automation, Managing the Lifecycle with ALM, Broad Scope of ALM Tools ,Achieving Seamless Integration ,Managing Requirements of the ALM, Creating Epics and Stories, Systems and Driven Development, Environment Management, Gold Copies, Supporting the CMDB, Driving DevOps ,Supporting Operations ,Help Desk ,Service Desk ,Incident Management , Problem Escalation ,Project Management, Planning the PMO ,Planning for Implementation, Evaluating and Selecting the Right Tools, Defining the Use Case, Training Is Essential, Vendor Relationships, Keeping Tools Current.

UNIT – 4

DevOps: Goals of DevOps, Why Is DevOps Important? Where Do I Start? How Do I Implement DevOps? Developers and Operations Conflicts, Developers and Operations Collaboration, Need for Rapid Change, Knowledge Management, the Cross-Functional Team, Is DevOps Agile? The DevOps Ecosystem, Moving the Process Upstream, Left-Shift, Right-Shift, DevOps inDev, DevOps as Development, Deployment Pipeline, Dependency Control, Configuration Control, Configuration Audits, QA and DevOps, Information Security, Infrastructure as Code, Taming Complexity, Automate Everything, Disaster Recovery and Business Continuity, Continuous Process Improvement.

TEXTBOOKS:

1. Ian Summerville, ”Software Engineering”, 8th Edition, Pearson Education,2007.
2. BobAiello and LeslieSachs, “Agile Application Life cycle Management Using DevOps to Drive Process Improvement”, Addison Wesly, First printing, 2016.

REFERENCE BOOKS:

1. Roger S, “Software Engineering-A Practitioner’s Approach”, seventh edition, Pressman, 2010.
2. Roger Pressman, Ian sommerville, “Software Engineering”, Pearson,9th edition,2010.
3. HansVanVliet, “Software Engineering: Principles and Practices”, Wiley,2008.
4. Richard Fairley, “Software Engineering Concepts”, McGraw-Hill ,2008
5. ACM Transactions on Software Engineering and Methodology (TOSEM).
6. IEEE Transactions on Software Engineering.

JOURNALS/MAGAZINES:

1. Journal of Software Engineering Research and Development
2. International Journal of Agile and Extreme Software Development
3. A decade of agile methodologies: Towards explaining agile software development
4. Journal of Systems and Software

SWAYAM/NPTEL/MOOCs:

1. https://www.udemy.com/course/devops-core-fundamentals
2. https://www.scaledagile.com/certification/courses/safe-devops/
3. https://www.coursera.org/learn/devops-culture-and-mindset
4. https://www.coursera.org/learn/uva-darden-continous-delivery-devops

SELF-LEARNING EXERCISES:

1. Case study on Critical system
2. Case study on ATM using agile method

Course Title	Analog and Digital Electronics Lab				Course Type		HC	
Course Code	B21EF0305	Credits	1		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	-	-	-				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**1**	**2**	**2**	**-**	**26**	**25**	**25**

COURSE OVERVIEW:

Analog Electronics offers a very elegant design with many components and would effectively act as an impetus to the digital world. In this course, students gain extensive experience with Verilog / VHDL code to design equations / methods for the electronic circuit. Students learn analog techniques, processes and subsystems, modern digital systems.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Examine clipper and clamper circuit, rectangular waveform generator, Schmitt trigger, wein bridge oscillator, CE amplifier using simulation tool.
2. Design and Implement Half/Full adder and Half/Full Subtractors.
3. Understand the working of sequential, combinational logic circuits using simulation tools.
4. Simulation, synthesis and implementation of Verilog / VHDL code.

COURSE OUTCOMES (COs)

After the completion of the course ,the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Use appropriate design equations / methods to design the given circuit.	1 to 5,9,12	1,2,3
CO2	Examine and verify the design of both analog and digital circuits using simulators.	1 to 5,9,12	1,2,3
CO3	Make use of electronic components, ICs, instruments and tools for design and testing of circuits for the given the appropriate inputs.	1 to 5,9,12	1,2, 3
CO4	Design digital systems through Verilog / VHDL code.	1 to 5,9,12	1,2,3
CO5	Design and implement sequential, combinational logic circuits using necessary electronics components.	1 to 5,9,12	1,2,3
CO6	Evaluate working of multiplexer and switched tail counter using Xilinx.	1 to 6,9,10,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2				√		
CO3			√			
CO4					√	
CO5						√
CO6						√

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2				3	3		2	3	1	1
CO2	3	3	3	3	2				3	3		2	3	1	1
CO3	3	3	3	3	2				3	3		2	3	3	1
CO4	3	3	3	3	2				3	3		2	3	3	3
CO5	3	3	3	2	2				3	3		2	3	3	3
CO6	3	3	2	2	2				3	3	3	3	3	3	3

Note:1-Low,2-Medium,3-High

PRACTICE:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	Part-A		
1	To simulate a positive clipper, double ended clipper & positive clamper circuits using diodes	Orcad	Simulation of clipper and clamper electronic
2	To simulate a rectangular wave form generator (Op-amp relaxation oscillator) and compare the frequency and duty cycle with the design specifications	Orcad	Simulation of rectangular waveform generator
3.	To simulate a Schmitt trigger using Op-amp and compare the UTP andLTP values with the given specification	Orcad	Simulation of Schmitt trigger
4.	To simulate a Wien bridge Oscillator	Orcad	Simulation of wein bridge oscillator

5.	To determine the working of a power supply and observe the waveforms	Orcad	Simulation of power supply
6.	To build and simulate CE amplifier (RC coupled amplifier) for its frequency response and measure the bandwidth.	Orcad	Simulation of RC coupled amplifier and determining the frequency response
7.	Realization of Half/Full adder and Half/Full Subtractors using logic gates	ICs, Trainer kit and patch cords Create and perform the adder and subtractor circuits	ICs, Trainer kit and patch cords Create and perform the adder and subtractor circuits
8.	Design and develop VHDL code to realize Full adder and Full Subtractors	Xilinx	Simulation knowledge of the mentioned adders an
9.	Given a 4-variable logic expression, simplify it using Entered Variable Map and realize the simplified logic expression using 8:1 multiplexer IC	ICs, Trainer kit and patch cords	Realization of a multiplexer
10.	Design and develop the VHDL code for an 8:1 multiplexer. Simulate and verify it's working	Xilinx	Simulation knowledge of combinational logic circuit
11.	Design and implement a ring counter using 4-bit shift register and demonstrate its working	ICs, Trainer kit and patch cords	Realization of shift register and ring counter
12.	Design and develop the Verilog / VHDL code for switched tail counter.	Xilinx	Simulation of ring counter

TEXTBOOKS:

1. Anil K Maini, Varsha Agarwal, "Electronic Devices and Circuits", Wiley, 2009.
2. Jacob Millman, Christos Halkias, Chetan D Parikh,"Millman's Integrated Electronics – Analog and Digital Circuits and Systems", 2nd Edition, Tata McGraw Hill, 2010.
3. Donald P Leach, Albert Paul Malvino&GoutamSaha ,"Digital Principles and Applications", 7th Edition, Tata McGraw Hill, 2010.

Course Title	Programming with JAVA lab				Course Type		HC	
Course Code	B21EF0306	Credits	1		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	-	-	-				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**1**	**2**	**2**	**-**	**26**	**25**	**25**

COURSE OVERVIEW:

This course is intended to provide a basic knowledge of core java programming. It offers students to have the proficiency on OOPs concepts and develop the skills to design interdisciplinary applications through java programming.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Learn fundamentals of object-oriented programming in Java using hands-on.
2. Familiarize Java environment to create, debug and run simple Java programs.
3. Demonstrate java compiler and learn how to use IDE to create Java Application.
4. Develop an application to address real time issues.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Apply basic syntactic concepts of JAVA to solve logic-based problems.	1 to 3,5,9,12	1
CO2	Solve problems using Object Oriented Programming concept like class, object, polymorphism, inheritance etc.	1 to 5, 9,12	1,3
CO3	Develop solutions using the concepts of interfaces, packages.	1 to 6, 9,12	1,2, 3
CO4	Interpret the concepts of Exception Handling, Collection framework and Multithreading.	1 to 6, 9,12	1,2, 3
CO5	Design Java applications to access database through Java programs, using Java Database Connectivity.	1 to 6, 9,12	1,2, 3
CO6	Design and develop solution to address real time applications.	1 to 6, 9,10,12	1,2, 3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2					√	
CO3						√
CO4					√	
CO5						√
CO6						√

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2		1				1	2		2	2		
CO2	1	2	2	2	1				2	2		2	2		3
CO3	1	2	1	1	1				2	2		2	2	3	3
CO4	1	2	3	1	2				2	2		2	3	3	3
CO5	1	2	2	1	3	2			3	2		2	3	3	3
CO6	1	2	2	1	3	2			3	2		3	3	3	3

Note:1-Low,2-Medium,3-High

PRACTICE:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	Part-A		
1.	The sieve of Eratosthenes is one of the most efficient ways to find all primes smaller than n when n is smaller than 10 million. Given a number n, use JAVA to print all primes smaller than or equal to n.	Windows/Linux OS, IDE	Understanding conditional operators and statements

2.	The Gauss-Jordan method is also known as Gauss-Jordan elimination method is very useful in solving a linear system of equations. It is a technique in which a system of linear equations is resolved by the means of matrices. Develop a JAVA program to solve a given set of linear equations.	Windows/Linux OS, IDE	Creating an array and performing some operations on array.
3.	To compute a square root of any positive number a, start with an initial guess x=x1 for √a; then calculate successive approximations x2,x3...,√a using the formula: $x_i = \frac{x_{i-1} + (a/x_{i-1})}{2}, i = 2, 3, \ldots$ Develop a JAVA application that implements the above SQRT function to compute the square root of any positive	Windows/Linux OS, IDE	Understanding conditional statements (if, if..else, etc)
4.	Model a lamp as a Java object. Make a Lamp class. This will contain atleast one instance variable which will be of type Boolean and will hold the state of the lamp: i.e., whether it is on or off. In addition, add methods to do the following things: switch the light on and off, and check its current state, i.e., whether it is on or off. Maintain proper encapsulation mechanism. Next, write a launcher class with a main() method to carry out the following tasks: • create a lamp object; • turn it on and off; • print the lamp's on/off status to the console.	Windows/Linux OS, IDE	Object and class creation and its usage

5.	Given the following functional interface:
	interface MathOperation {
	int operation(int a, int b);
	}
	Develop an application that would implement the above interface using lambda expressions as to perform the addition, subtraction, multiplication and division operations.
		Windows/Linux OS, IDE	Creation of interfaces and its usage.

6.	The String class in JAVA has a static method compare To Ignore Case, which compares two strings and the Arrays class has a static sort method. Build a JAVA program that creates an array of strings, use the sort function from Arrays class to sort the strings by passing the compare To Ignore Case function as a parameter to the sort function using method reference. Print the sorted array.	Windows/Linux OS, IDE	Creation of string class and its usage
7	XYZ technologies is firm that has 5employees with 1manager, and 4 technicians. XYZ wants to digitize its payroll system, the following requirements: Dearness Allowance is 70% of basic for all employees. House Rent Allowance is 30% of basic for all employees. Income Tax is 40% of gross salary for all employees. The annual increments to the employees are to be given of the following criteria: -Manager 10% of the basic salary, and Technicians 15% of basic. Develop the pay roll for XYZ. Implement a class hierarchy using inheritance, where Employee is an abstract class and Manager and Technician are derived from Employee. Demonstrate a polymorphic behavior for giving the annual increments.	Windows/Linux OS, IDE	Creation multiple inheritance and its usage
8	Define a new Exception class named Odd Exception. Create a new class named Even Odd. Write a method called halfOf(), which takes an int as parameter and throws an Odd Exception if the int is odd or zero, otherwise returns (int / 2). Write a main method that calls halfOf() three times (once each with an even int, an odd int, and zero), with three try/catch blocks, and prints either the output of halfOf() or the caught Odd Exception.	Windows/Linux OS, IDE	Creation of exception class and its usage
9	Implement a class named Fraction that represents fractions with numerator and denominator always stored reduced to lowest terms. If fraction is negative, the numerator will always be negative, and all operations leave results stored in lowest terms. Implement the addition, subtraction, multiplication and division operation for the Fraction class and also handle divide by zero using java exception handling mechanism.	Windows/Linux OS, IDE	Creation of exception class and its usage

10	Create a class Student that has instance variables as Name, Age, Address and access transmutation methods to access the instance variables along with display method to print the details of student. Next write a main() function that will create a collection of 10students and reverse the list. Print the details before and after reversing the collection.	Windows/Linux OS, IDE	Object and class creation and its usage
11	Use generics to build a class Sort. Implement the bubble sort algorithm to sort an array of any type.	Windows/Linux OS, IDE	Creation of generics class and its usage
12	Write a generic method to count the number of elements in a collection that have a specific property (for example, odd integers, prime numbers, palindromes).	Windows/Linux OS, IDE	Creation of generics class and its usage

Sl. No.	Part B Mini Project
1	Develop a project for Airline reservation system List with the following modules: 1. PASSENGER a) Add member b) Delete member c) Search for member d) Edit member 2. FLIGHT a. Add Flight b. Delete Flight c. Search Flight d. Display Flights 3. RESERVATION a. Book b. Cancel Title: Airline Reservation system Problem Definition: *Airline Reservation System*" main aim is to provide the online ticket & seat reservation of National and International Flights and give the information about flight departures. Solution: Develop a project to implement an Airline reservation system with the following modules: 1. PASSENGER a. Add member

	b. Delete member c. Search for member d. Edit member 2. FLIGHT a. Add Flight b. Delete Flight c. Search Flight d. Display Flights 3. RESERVATION a. Book b. Cancel
List of Experiments:	
Sl.No	Name of the Experiment
1	Create a passenger class with the attributes Adhar_number, Passenger_name, Email_id, Phone, Address, DOB and the methods to facilitate Addition, Deletion, Search and Modify the passenger data. Store the details of the 10 passenger objects in "Passenger.txt" and Display. a. void Add_passenger() b. Display_details() c. void Delete_Passenger(Adhar_number) d. void Search_Passenger(Adhar_number) e. void Modify_Passenger(Adhar_number)
2	It is required to delete an existing passenger data based on the request from the passenger. Read adhar card number of the passenger to be deleted and delete the record from "passenger.txt" if found. Otherwise display an error message saying that "record does not exist". Develop a program to implement the above task.
3	It is required to modify an existing passenger data based on the request from the passenger. Read aadhar card number of the passenger to be modified and modify the record from "passenger .txt" if found. Otherwise display an error message saying that "Record does not exist". Develop a program to implement the above task.
4	It is required to Search an existing passenger data based on the request from the passenger. Read Adhaar card number of the passenger to be searched for, search the record from "passenger .txt" and display the details of passenger if found. Otherwise display the error

	message “Record does not exist”. Develop a program to implement the above task.
5	Create a Flight class with attributes Flight_number, Flight_name, Source, Destination, Departure_Timing and the methods Add_Flight(), Delete_Flight(), Search_Flight() and Display_Flight(). Store the details of any 5 Flights in a file called “Flights.txt” and display the same. Develop a program to achieve the above task.
6	It is required to delete the details a flight stored in “Flights.txt”. Read the Flight_no and search for the same in “Flights.txt”. If found, it should be deleted from “Flights.txt”. Otherwise display the error message “Flight Does Not Exist”. Develop a program to achieve the above task.
7	It is required to delete the search for a flight stored in “Flights.txt”. Read the Flight_no and search for the same in “Flights.txt”. If found, Display the details of Fllight, otherwise display the error message “Flight Does Not Exist”. Develop a program to achieve the above task.
8	It is required to display the details of all the flights running from Source1 to Destination1. Read the name of source1 and destination1 and fetch from “Flights.txt” the details of all the flights running between Source1 and desitnation1 and display the same. Develop a program to achieve the above task.
9	Create a reservation class that facilitates booking and cancellation of domestic and international flights using the following methods and parameters. Develop a program to store the details of 10 bookings in “**Reservations.txt”** and display the same. a. Book_Ticket(Flight_Number, Flight_Name, Ticket_Number,Source, Destination, Adhar_number, Passport_number,Date, Departure_time, Class, Type_of_Travel(Domestic , International), Fare, Status) b. Cancel_Ticket(Ticket_Number)
10	A passenger would like to cancel the ticket due to a genuine reason. Read the ticket_no and search for the record in “Reservation.txt”. Cancel the Ticket based on the request from passenger and update the status.

TEXTBOOKS:

a. Cay S. Horstmann, “Core Java® SE 9 for the Impatient”, Addison Wesley, Second Edition, 2018.
b. HerbertSchild, “Java™:TheCompleteReference”,McGraw-Hill, TenthEdition,2018.
c. David Gallardo, Ed Burnette, Robert Mcgovern,“Eclipse in Action a guide for java developers”, Manning Publications,2003.
d. Ed Burnette, “Eclipse IDE Pocket Guide: Using the Full-Featured IDE”, O'Reilly Media, Inc, USA,2005.

<table>
<tr><td>Course Title</td><td colspan="4">Data Structures Lab</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
<tr><td>Course Code</td><td>B21EF0307</td><td>Credits</td><td colspan="2">1</td><td colspan="2">Class</td><td colspan="2">III Semester</td></tr>
<tr><td rowspan="8">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="4">Total Number of Classes Per Semester</td><td colspan="2" rowspan="4">Assessment in Weightage</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Theory</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td>Theory</td><td>Practical</td><td>CIE</td><td>SEE</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>1</td><td>2</td><td>2</td><td>-</td><td>26</td><td>25</td><td>25</td></tr>
</table>

COURSE OVERVIEW:

The course is designed to develop skills to design and analyze simple linear and non linear data structures. It strengthen the ability to the students to identify and apply the suitable data structure for the given real world problem. It enables them to gain knowledge in practical applications of data structures using java. Java is a widely used object-oriented programming language and software platform that runs on billions of devices, including notebook computers, mobile devices, gaming consoles, medical devices and many others.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Understand various data representation techniques in the real world.
2. Implement linear and non linear data structures.
3. Implement matrix, abstract data type using java.
4. Analyze various algorithms based on queue, stack, stack applications using java.
5. Implement binary search tree, tree traversal, array, linked lists using java programs.
6. Develop real time applications using suitable data structure and to solve various computing problems.

.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Understand to choose appropriate data structures to represent data items in real world problems.	1 to 5,9,10,12	1,2
CO2	Implement linear and non linear data structures using java.	1 to 5,9,10,12	1,2
CO3	Make use of algorithms based on queue, stack, stack applications using java.	1 to 5,9,10,12	1,2
CO4	Apply to design programs using a variety of data structures such as stacks, queues, stack applications.	1 to 5,9,10,12	1,2
CO5	Implement ADTs such as lists, search trees in java to solve problems	1 to 5,9,10,12	1,2
CO6	Analyze the real time applications with suitable data structure.	1 to 5,9,10,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6				√		

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1				2	1		2	3	2	
CO2	3	2	2	1	1				2	1		2	3	2	
CO3	3	3	2	2	1				2	2		2	3	2	
CO4	3	3	3	3	2				3	2		3	3	2	
CO5	3	3	2	2	1				2	2		2	3	2	
CO6	3	3	2	3	2				3	2		3	3	1	2

Note:1-Low,2-Medium,3-High

PRACTICE:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	Part-A		
1.	Matrix multiplication is thus a basic tool of linear algebra, and as such has numerous applications in many areas of mathematics, as well as in applied mathematics, statistics, physics, economics,and engineering. Co mputing matrix products is a central operation in all computational applications of linear algebra. Write a Java program using the data structure arrays to multiply two given matrices of same order.	Windows/Lin ux OS, IDE	Creating an array and performing some operations on array

2.	A Sparse matrix is a matrix with the majority of its elements equal to zero. Develop a program in java to read a sparse matrix of integer values in the 2D array format and convert the sparse matrix to <row, column, value> format and search for an element specified by the user. Print the result of the search appropriately.	Windows/Linux OS, IDE	Creating an array and performing some operations on array.
3.	The abstract datatype (ADT) is special kind of datatype, whose behavior is defined by a set of values and set of operations. Stack is a linear data structure which follows a particular order in which the operations are performed. The order may be LIFO(Last In First Out) or FILO(First In Last Out). Write Java programs to implement the STACK ADT using an array.	Windows/Linux OS, IDE	Creating a stack data structure and performing some operations on it.
4.	Whenever we need to manage any group of objects in an order in which the first one coming in, also gets out first while the others wait for their turn, like in the scenarios of Serving requests on a single shared resource, like a printer, CPU task scheduling etc., we need a Queue Data Structure. Write Java programs to implement the QUEUE ADT using an array.	Windows/Linux OS, IDE	Creating a queue data structure and performing some operations on it.
5.	Infix expressions are readable and solvable by humans. We can easily distinguish the order of operators, and also can use the parenthesis to solve that part first during solving mathematical expressions. The computer cannot differentiate the operators and parenthesis easily, hence postfix conversion is needed. Select an appropriate data structure and develop a program to convert an infix expression into postfix using stack.	Windows/Linux OS, IDE	Understanding Expression conversions by using stack data structure
6	These are few operations or functions of the Stack ADT. isFull() used to check whether stack is full or not, isEmpry() used to check whether stack is empty or not, push(x) used to push x into the stack, pop() used to delete one element from top of the stack, peek() used to get the top most element of the stack, size() is used to get number of elements present into the stack Write Java programs to implement the STACK ADT using a singly linked list.	Windows/Linux OS, IDE	Creating a stack data structure and performing some operations on it.
7	Evaluation of postfix expressions is done by compilers during the compilation process. Design and Develop a program to evaluate a postfix expression using stack.	Windows/Linux OS, IDE	Understanding Expression conversions by using stack data structure
8	The queue operations are given as Queue() creates a new queue that is empty. enqueue(item) adds a new item to the rear of the queue. dequeue() removes the front item from the queue. isEmpty() tests to see whether the queue is empty. size() returns the number of items in the queue. Write Java programs to implement the QUEUE ADT using a singly linked list.	Windows/Linux OS, IDE	Creating a queue data structure and performing some operations on it.
9	Consider a compiler, Matching parentheses ('(' and ')'), brackets ('[' and ']'), and braces ('{' and '}') delimit various parts of the source code. In order for these parts to be interpreted correctly, the compiler must be able to determine how these different kinds of parentheses match up with each other. Write a java program that determines whether parenthetic symbols ( ), { } and [ ] are nested correctly in a string of characters (use stack ADT).	Windows/Linux OS, IDE	Creating a stack data structure and performing some operations on it.
10	The researches about biological sequence compression algorithms use palindrome. Write a java program that uses both stack and queue to test whether the given string is a palindrome (Use Java Utility).	Windows/Linux OS, IDE	Usage of stack and Queue data structure

11	Files are stored in memory in tree structure directory. Design and develop a program to create a directory having files with unique file-id in the hard disk and display the files in all three traversal orders using Binary Search Tree (BST).	Windows/Linux OS, IDE	Creating a tree data structure and performing some operations on it.
12	Consider a class having 100 students where, the details of each student like name, roll number and marks of 3 subjects is to be stored. Design and develop a program to construct a singly linked list to enter records of different students in list, display the list and calculate the percentage of each student. Also count the number of students passed (scored >40 in all the subjects).	Windows/Linux OS, IDE	Creating a linked list data structure and performing some operations on it.
	Part-B (Mini Project: Text Editor Design)		
	A text editor is a program that allows the user to open, view, and edits plain text files (files containing only text). They are essential to the world today as lots of people often try to open a text file and view the content. Most of us have interacted or heard of text editors such as Notepad, Vim, gedit, and so on. Text editors have evolved over time to become faster and provide more features than their competitors. Text editors deal with manipulating text and provide features to enhance the experience. The major functionalities of text editors are: inserting, deleting, and viewing text. Additional features that are practically required to even compete with other text editors are: find and replace, copy/cut and paste, text formatting, sentence highlighting, and etc. In this context, create a text editor(without GUI) using various data structures in JAVA language that allow user to create/edit/save text files and allow user to perform the following operations using various suitable data structures.		
	File Module		
1	It is required to store the brief profile of the 10 students permanently in the file “Student.txt”. Develop a program to implement the above task.	File, loop	Able to create the text file
2	It is required to append the "Student.txt” with details of some more students. Develop a program to achieve the above goal.	File, String,	Able to write into text file
3	It is required to open the "Student.txt” and display the contents. Develop a program to achieve the above goal.	File	Able to open and view contents of the text file
4	Search for a file It is required to search a file name "Student.txt” among all the existing files, if file exists, display the contents of the file. If file does not exist, display the message “file not found”. Develop a program to achieve the above goal using file system.	Binary search tree	Able to search and view contents of the text file
	Edit Module		
5	It is required to open the file "Student.txt” and display the contents. Further, a portion of text is to be selected and removed. Develop a program to i) Prompt the user to specify the position (start location and end location). ii) Remove the text from specified position, store it in the Stack “Stack1” (implement using structure) and write the remaining part of "Student.txt” into another file “Student2.txt”. iii) Rename “Student2.txt” as "Student.txt” and display the contents of "Student.txt”.	stack, File, structure	Able to cut contents of the text file

6	It is required to open the file "Student.txt" and display the contents. Further, a portion of text is to be selected for copying. Develop a program to i) Prompt the user to specify the position (start location and end location). ii) Copy the text from specified position and write the selected text into "Stack2" (implement using linked list).	stack, File, linked list, structure	Able to copy contents of the text file
7	It is required to open the file "Student.txt" and display the contents. Further, a portion of text which was cut or copy is to be pasted at specified location in "Student.txt". Develop a program to i) Prompt the user to specify the start position and paste the text stored in Stack1 (cut) or Stack2 (copy) from start position. ii) Display the contents of "Student.txt".	File, linked list, structure, Stack	Able to paste contents into text file
8	It is required to open the file "Student.txt" and display the contents. Further, when user selects "Undo" operation, the text which was removed most recently is to be pasted **at the same position from where it was removed.** i) Develop a program to Paste the portion of text which was cut or copy most recently at the specified location in "Student.txt".	File ,Structure and stack	Able to undo operations on file
9	It is required to open the file "Student.txt" and display the contents for "Redo" operation. Further, a portion of text is to be selected and removed. Develop a program to i) Prompt the user to specify the position (start location and end location). ii) Remove the text from specified position, store it in the Stack "Stack1" (implement using structure) and write the remaining part of "Student.txt" into another file "Student2.txt". iii) Rename "Student2.txt" as "Student.txt" and display the contents of "Student.txt".	stack, File, structure, stack	Able to redo operations on file
10	It is required to open the file "Student.txt" and display the contents. Develop a program to i) Prompt the user to specify the word/character to search for ii) Display the search results.	File, string	Able to find any string/character in the text file
11	It is required to open the file "Student.txt" and display the contents. Develop a program to i) Prompt the user to specify the word/character to search for ii) Prompt the user to specify the new word/character to replace iii) Replace the searched word with the new word and Display the results.	Arrays ,string	Able to find any word/string/character in the text file and replace with the new word.

TEXTBOOKS:

1. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in JAVA ", Wiley, 6th Edition, 20l4
2. Herbert Schildt, "The Complete reference Java", 7th edition, 2007

Course Title	Communication Skills				Course Type		FC	
Course Code	B21AH0301	Credits	2		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**2**	**2**	**2**	**26**	**0**	**50**	**50**

COURSE OVERVIEW:

This course is aimed to develop basic communication skills in English in the learners, to prioritize listening and reading skills among learners, to simplify writing skills needed for academic as well as workplace context, to examine that the learners use the electronic media such as internet and supplement the learning materials used in the classroom.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Develop basic communication skills in English.
2. EmphasizeonthedevelopmentofspeakingskillsamongstlearnersofEngineeringandTechnology
3. Impart the knowledge about use of electronic media such as internet and supplement the learning materials used in the classroom.
4. Inculcate the habit of reading and writing leading to effective and efficient communication.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Demonstrate speaking ability with clarity, confidence and comprehension and communicate with one or many listeners using appropriate communicative strategies (SpeakingSkills).	9,10	
CO2	Build inferences from the text.	10	
CO3	Make use of accurate writing skills using different components of academic writing.	9,10	
CO4	Develop the ability to write cohesively, coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic	9,10	
CO5	Make use of reading different genres of texts adopting various reading strategies (Reading Skills).	10	
CO6	Apply appropriate vocabulary and grammar in written and spoken context.	9,10	

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3			√			
CO4						√
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1									2	3					
CO2										3					
CO3									1	3					
CO4									2	3					
CO5										2					
CO6									2	2					

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Functional English: Grammar: Prepositions; Modal Auxiliaries, Reading Comprehension, Active and passive voice, Giving Instructions.

UNIT – 2

Interpersonal Skills: Grammar: Tenses; Wh-questions, Compound words; Phrasal verbs, Recommendations

UNIT – 3

Multitasking Skills Grammar: Conditional Sentences, Homonyms; homophones, Subject-verb agreement.

UNIT – 4

Communication Skills Grammar: Direct and indirect speech, Interpreting visual materials (line graphs, pie charts etc.), Single word substitutes.

TEXTBOOKS:

1. Green,David, “Contemporary English Grammar Structures and Composition”,NewDelhi: MacMillan Publishers,2010.
2. Thorpe, Edgar and Showick Thorpe, “Basic Vocabulary”, Pearson Education India, 2012.
3. Leech, “GeoffreyandJanSvartvik: A Communicative Grammar of English”,Longman, 2003.

REFERENCE BOOKS:

1. Murphy, Raymond,“Murphy’s English Grammar with CD”, Cambridge University Press, 2004.
2. Rizvi, M. Ashraf, “Effective Technical Communication”, New Delhi, Tata McGraw-Hill, 2005.
3. Riordan, Daniel, “Technical Communication”, New Delhi, Cengage Publications, 2011.
4. Sen et al., “Communication and Language Skills”, Cambridge University Press, 2015.

Course Title	Indian Constitution and Professional Ethics				Course Type		FC	
Course Code	B21LS0301	Credits	2		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**2**	**2**	**2**	**26**	**0**	**50**	**50**

COURSE OVERVIEW:

The Constitution of India lays down in defining fundamental political principles, establishes the structure, procedures, powers and duties of government institutions and sets out fundamental rights, directive principles and duties of citizen. It helps to know and understand the human rights and human values. It also helps to know the meaning of ethics and need of ethics in personal and professional life.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain basic knowledge required to understand Constitution of India.
2. Describe the Fundamental Rights, Duties and other Rights.
3. Discuss different types of ethics.
4. Explore ethical standards followed by different companies.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Analyze the Fundamental Rights, Duties and other Rights protected under Indian Constitution.	6,7,8,9, 12	
CO2	Demonstrate the practicality of Constitution perspective and make them to face the world as a bonafide citizen.	8 ,12	
CO3	Illustrate the professional ethics and human values.	6,8,12	
CO4	Summarize ethical standards followed by different companies.	7,8,12	
CO5	Demonstrate the Knowledge of Ethics to protect environment as an Engineer	6, 7, 8, 12	
CO6	Apply the principles of Ethics as an employee employer in the professional life	6, 8, 9, 12	

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1				√		
CO2		√				
CO3			√			
CO4			√			
CO5		√				
CO6		√				

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						2	2	3	2			1			
CO2								3				1			
CO3						2		3				1			
CO4							2	3				1			
CO5						2	2	3				1			
CO6						2		3	1			1			

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Indian constitution: Sailent features, fundamental rights and duties (Directive principle and statepolicy), Legislature (Loka Sabha &Rajya Sabha), Executive (President& Governor) and Judiciary (Supreme court & high court), Composition and function of parliament, Council of ministers, prime minister, Speaker, Passing of bills.

UNIT – 2

Human Rights: Nature and Scope of human rights, Universal protection of human rights (UDHR),Regional protection of human rights, National level protection of human rights, Human rights and vulnerable groups (children, women & old-age).

Human values: Truth, Honesty, Loyalty, Love, Peace with examples, Difference between ethics, beliefs and morals.

UNIT – 3

Ethics: Meaning, Definition, Evolution, Need of ethics, Aristotlean Ethics, Utilitarianism, Katianism, human values(Good conduct, respect for elders), ethical human conduct (Gender equality), Professional Ethics, Personal Ethics and Business Ethics, Ethical Standards, Duties of Employers and Employees.

UNIT – 4

Engineering Ethics: Definition Scope and needs, Ethics in Consumer Protection, Due Care theory, Environmental Ethics, Ethical Code of Conduct in ethics. Best Ethical Companies in India and Abroad; Corporate Social Responsibilities, Code of Conduct and Ethical Excellence

TEXT BOOKS:

1.Kapoor, S.K., "Human rights under International Law and Indian Law", Prentice Hall of India, New Delhi, 2002.

2. Basu, D.D., "Indian Constitution", Oxford University Press, New Delhi, 2002.

3. Chakraborty, S.K., "Values and ethics for Organizations and Theory Practice", Oxford University Press, New Delhi, 2001.

REFERENCE BOOKS:

1. Meron Theodor, "Human Rights and International Law Legal Policy Issues", Vol. 1 and 2, Oxford University, Press, New Delhi, 2000.

2. M V Pylee, "An Introduction to Constitution of India", S Chand & Company, 5th Edition

3. Durga Das Basu, "Introduction to constitution of India", LexisNexis, 23rdEdition.

SELF-LEARNINGEXERCISES:

Abuse of Technologies: Hacking and other crimes, addiction to mobile phone usage, video games and social networking websites

Course Title	Advanced Kannada/Basics of Kannada				Course Type	MC	
Course Code	B21AHM301/ B21AHM302	Credits	0		Class	III Semester	
Course Structure			Contact	Work	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	0	2	2			
	Practice	-	-	-	Theory	CIE	SEE
	Tutorial	**-**	**-**	**-**			
	Total	**0**	**2**	**2**	**26**	**0**	**0**

ಕನ್ನಡಿಗರಿಗೆ ಇಂಜಿನಿಯರಿಂಗ್ ಪ್ರಥಮ ಪದವಿ ಪಠ್ಯ

ಪರಿವಿಡಿ

ಘಟಕ – 1: ಕವಿತೆಗಳು
1. ಬೆಳಗು – ದ ರಾ ಬೇಂದ್ರೆ
2. ಕಲ್ಕಿ – ಕುವೆಂಪು

ಘಟಕ – 2: ಕಥೆಗಳು
3. ಗಾಂಧಿ – ಬೆಸಗರಹಳ್ಳಿ ರಾಮಣ್ಣ
4. ಸೆರೆ – ಯಶವಂತ ಚಿತ್ತಾಲ

ಘಟಕ – 3: ವಿಜ್ಞಾನ ಲೇಖನಗಳು
5. ಆನೆಹಳ್ಳದಲ್ಲಿ ಹುಡುಗಿಯರು – ಬಿ ಜಿ ಎಲ್ ಸ್ವಾಮಿ
6. ವೃತ್ತಿಶಿಕ್ಷಣದಲ್ಲಿ ಕನ್ನಡ ಮಾಧ್ಯಮ – ಎಸ್ ಸುಂದರ್

ಘಟಕ – 4: ಪರಿಸರ ಲೇಖನಗಳು
7. ಚೀಂಕ್ರ ಮೇಸ್ತ್ರಿ ಮತ್ತು ಅರಿಸ್ಟಾಟಲ್ – ಕೆ ಪಿ ಪೂರ್ಣಚಂದ್ರ ತೇಜಸ್ವಿ
8. ಗುಬ್ಬಚ್ಚಿಯ ಗೂಡು – ಪಿ ಲಂಕೇಶ್

- ಬಿ ಐಂ ಐಸ್ ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು ಕನ್ನಡಿಗರಿಗೆ **'ಕನ್ನಡ ಕಲಿ'** ಪಠ್ಯಪುಸ್ತಕ
- ಕರ್ನಾಟಕ ತಾಂತ್ರಿಕ ಶಿಕ್ಷಣ ವಿಭಾಗ ಕನ್ನಡಿಗರಿಗೆ **'ಸಾಹಿತ್ಯ ಸಿಂಚನ'** ಪಠ್ಯಪುಸ್ತಕ
- ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಳಗಾವಿ ಕನ್ನಡಿಗರಿಗೆ **'ಬಳಕೆ ಕನ್ನಡ'** ಪಠ್ಯಪುಸ್ತಕ

ಹಲವಾರು ಪಠ್ಯಪುಸ್ತಕಗಳು ಇಂಜಿನಿಯರಿಂಗ್ ವಿಭಾಗದಲ್ಲಿ ಕನ್ನಡ ಬೋಧನೆಗೆ ಬಳಕೆಯಲ್ಲಿದ್ದು ಜೊತೆಗೆ ಬಿಎಡ್ ಕನ್ನಡ ಕಲಿಕೆಯ ಪಠ್ಯಪು ಸ್ತಕಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು ರೇವಾ ವಿಶ್ವವಿದ್ಯಾಲಯದ ತಾಂತ್ರಿಕ ವಿಭಾಗದ ಕನ್ನಡಿಗರು ಮತ್ತು ಕನ್ನಡೇತರ ವಿದ್ಯಾರ್ಥಿಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಇಷ್ಟವಾಗುವ ಮತ್ತು ಪ್ರಯೋಜನಕಾರಿಯಾಗುವ ಪಠ್ಯಪುಸ್ತಕವನ್ನು ತರಗತಿಗಳು ಪ್ರಾರಂ ಭವಾಗುವುದರ ಒಳಗೆ ಸಿದ್ಧಪಡಿಸಲಾಗುವುದು.

ಕನ್ನಡೇತರರಿಗೆ ಇಂಜಿನಿಯರಿಂಗ್ ಪ್ರಥಮ ಪದವಿ ಪಠ್ಯ

<u>ಭಾಷಾ ಕೌಶಲ್ಯಗಳು</u>

ಘಟಕ – 1

1. ಆಲಿ ಸುವುದು
   - ಆಲಿಸುವ ಕೌಶಲ್ಯ
   - ಆಲಿಸುವಿಕೆಯಲ್ಲಿನ ದೋಷಗಳು
   - ಉತ್ತಮ ಆಲಿಸುವಿಕೆ

ಘಟಕ – 2

2. ಮಾತನಾಡುವುದು
   - ಸಂಭಾಷಣೆ
   - ವ್ಯವಹಾರಿಕ ಸಂಭಾಷಣೆ
   - ದೋಷಗಳು ಮತ್ತು ಪರಿಹಾರಗಳು

ಘಟಕ – 3

3. ಓದುವುದು
   - ಓದು ಕಲಿಸುವಾಗ ಗಮನಿಸಬೇಕಾದ ಅಂಶಗಳು
   - ಧ್ವನ್ಯಾಂಗಗಳ ಪರಿಚಯ
   - ಓದಿನ ವಿಧಗಳು

ಘಟಕ – 4

4. ಬರೆಯುವುದು
   - ವರ್ಣಮಾಲೆಯ ಸ್ವರೂಪ
   - ಕಾಗುಣಿತ ಸ್ವರೂಪ
   - ಕನ್ನಡ ಸಂಖ್ಯೆಗಳು

- ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಳಗಾವಿ ಕನ್ನಡೇತರರಿಗೆ **<u>'ಬಳಕೆ ಕನ್ನಡ'</u>** ಪಠ್ಯಪುಸ್ತಕ.
- ಬಿ ಎಂ ಎಸ್ ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು ಕನ್ನಡೇತರರಿಗೆ **<u>'ಕನ್ನಡ ಮನಸ್ಸು'</u>** ಪಠ್ಯ ಪುಸ್ತಕ.
- ಕರ್ನಾಟಕ ತಾಂತ್ರಿಕ ಶಿಕ್ಷಣ ವಿಭಾಗ ಇವರು **<u>'ಬಳಕೆ ಕನ್ನಡ'</u>** ಪಠ್ಯಪುಸ್ತಕ ತಂದಿದ್ದಾರೆ.

ಹಲವಾರು ಪಠ್ಯಪುಸ್ತಕಗಳು ಇಂಜಿನಿಯರಿಂಗ್ ವಿಭಾಗದಲ್ಲಿ ಕನ್ನಡ ಬೋಧನೆಗೆ ಬಳಕೆಯಲ್ಲಿದ್ದು ಜೊತೆಗೆ ಬಿಎಡ್ ಕನ್ನಡ ಕಲಿಕೆಯ ಪಠ್ಯಪು ಸ್ತಕಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು ರೇವಾ ವಿಶ್ವವಿದ್ಯಾಲಯದ ತಾಂತ್ರಿಕ ವಿಭಾಗದ ಕನ್ನಡಿಗರು ಮತ್ತು ಕನ್ನಡೇತರ ವಿದ್ಯಾರ್ಥಿಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಇಷ್ಟವಾಗುವ ಮತ್ತು ಪ್ರಯೋಜನಕಾರಿಯಾಗುವ ಪಠ್ಯಪುಸ್ತಕವನ್ನು ತರಗತಿಗಳು ಪ್ರಾರಂಭವಾಗುವುದರ ಒಳಗೆ ಸಿದ್ಧಪಡಿಸಲಾಗುವುದು.

IV SEMESTER

Course Title	Design and Analysis of Algorithm				Course Type		HC	
Course Code	B21EF0401	Credits	3		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

In this course the study of fundamental algorithms to solve a variety of problems, including sorting, searching and graph algorithms are discussed. Techniques for analyzing time and space complexity of algorithms are discussed and hence evaluation of tradeoffs between different algorithms is done.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the mathematical foundation for the analysis of algorithms.

2.Illustrate the algorithms using brute force and divide and conquer design technique.

3.Make use of greedy and dynamic algorithmic design techniques for a given problem.

4.Discuss the problems based on backtracking and branch and bound techniques.

COURSE OUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Apply the knowledge of mathematical foundation for the analysis of algorithms.	1 to 5, 12	1,2
CO2	Develop a program to solve the given real world problems using brute force and divide and conquer design paradigm.	1 to 5,12	1,2
CO3	Make use of greedy and dynamic programming techniques for solving the given real world problem.	1 to 5,12	1,2,3
CO4	Utilize backtracking and branch and bound techniques to solve real world problems.	1,to 5,12	1,2,3
CO5	Compare and contrast different algorithm design techniques, and identify the most suitable algorithm design technique for any application.	1 to 5	1,2,3
CO6	Construct any real-world software using existing or creating new algorithm design technique.	1 to 5	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5		√				
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	3	1							1	3	3	
CO2	2	2	1	2	2							2	3	3	
CO3	2	2	1	3	2							2	3	3	3
CO4	2	1	1	3	2							1	3	3	3
CO5	3	3	3	3	1								3	3	3
CO6	3	3	3	3	2								3	3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction-Notion of an Algorithm; Fundamentals of Algorithmic Problem Solving; Fundamentals of the Analysis of Algorithm Efficiency- The Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non-recursive Algorithms, Mathematical Analysis of Recursive Algorithms.

UNIT – 2

Brute Force: Bubble Sort, Selection Sort, Sequential Search and Brute-Force String Matching, Exhaustive Search, Divide-and-Conquer: Merge sort, Quick sort, Multiplication of Large Integers.Decrease-and-Conquer- Insertion Sort, Depth-First Search and Breadth-First Search ,Topological Sorting.

UNIT – 3

Greedy Technique-Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm Dynamic Programming- Fibonacci numbers, Binomial coefficient, The Knapsack Problem and Memory Functions, Warshall's and Floyd's Algorithms.

UNIT – 4

Space and Time Trade-Offs- Sorting by Counting, Input Enhancement in String Matching,, Coping with the Limitations of Algorithm Power- Backtracking-n-Queens Problem, Subset-Sum Problem, Branch-and-Bound, Assignment Problem, Travelling Salesman Problem

TEXTBOOKS:

1.Anany Levitin," Introduction to the Design and Analysis of Algorithms", Pearson, 3rd Edition, 2012.

2.Ellis Horowitz, SatrajSahni and Rajasekaran,"Computer Algorithms/C++", Universities Press, 2nd Edition, 2014.

3.Kleinberg, "Algorithm Design", Pearson Education, 1st Edition, 2013.

4.Michael Goodrich, Roberto Tamassia, "Algorithm Design and Applications", Wiley Publishers, 1st Edition, 2014.

REFERENCEBOOKS:

1.Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein, "Introduction to Algorithms", PHI, 3rd Edition,

2. ACM Transactions on Algorithms.

3.ACM Journal of Algorithms and Computational Technology.

JOURNALS/MAGAZINES:

1. https://www.mdpi.com/journal/algorithms
2. https://ieeexplore.ieee.org
3. https://www.springer.com/journal/453
4. https://ieeexplore.ieee.org/document/7990553

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.swayam2.ac.in/cec20_cs03/preview
2. https://iiiier.org/NPTEL-Local-Chapter
3. https://www.edx.org/course/algorithm-design-and-analysis

SELF-LEARNINGEXERCISES:

1. More exploration on GIThub

Course Title	Unix Operating System				Course Type		HC	
Course Code	B21EF0402	Credits	3		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	3	3	3	**39**	**--**	**50**	**50**

COURSE OVERVIEW:

UNIX operating system provides a practical case of operating systems for the user to understand and master deeply and tangibly the theory and algorithms in operating systems. It gives deeper insights into the hierarchical structure, principles, applications, shells, development, and management of the UNIX operation system multi-dimensionally, systematically and from the elementary to the profound. It makes the user to understand about how UNIX operating system functions.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the history, basics and structure of UNIX Operating System
2. Describe UNIX process concepts and scheduling techniques
3. Illustrate the use of different memory management techniques of UNIX.
4. Describe UNIX kernel, data structures and internal representation of files in UNIX operating system

COURSE OUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Outline the history of Operating System and UNIX environment.	1,2,5,9,10,12	1,3
CO2	Develop the programs to implement the different process states, attributes and control the process in foreground and background.	1,4,5, 9,10,12	1,3
CO3	Compare and analyze the performance of different memory management techniques.	1,4,5, 9,10,12	2,3
CO4	Make use of UNIX file types, file structure and file system implementation.	1,2,4, 5, 9,10,12	1,3
CO5	Summarize the issues of Inter-process Communication.	1,2,4,5, 9,10,12	1,3
CO6	Make use of system calls for managing processes, memory and the file system.	1,4,5, 9,10,12	1,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3				√		
CO4			√			
CO5		√				
CO6			√			

COURSE ARTICULATION MATRIX

CO#/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3			1				3	3		2	3		3
CO2	3			3	3				3	3		2	3		3
CO3	3			3	3				3	3		2		3	3
CO4	3	3		3	2				3	3		2	3		3
CO5	3	3		2	3				3	3		2	3		3
CO6	3			3	3				3	3		2	3		3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Basic of Operating Systems: Introduction of Operating System, Evolution of Operating Systems, Types of Operating System and operations, Operating System Services, Operating System structure.

Background of UNIX Operating System: Types of UNIX, History of UNIX, UNIX Software Architecture: System Call Interface, Standard Libraries and Language Libraries, UNIX Shell, Applications, UNIX Environment, Character User Interface Versus Graphical User Interface, UNIX Command Lines.

UNIT – 2

UNIX Process Management: Multiple Processes Running Concurrently: Fundamental Concept for Scheduler and Scheduling Algorithm, UNIX Scheduling Algorithm and Context Switch, Process States, Process Image and Attributes,

Process Control: Running Command in Foreground or in Background, More Concepts about Process Concurrently, Execution in UNIX, UNIX Inter-Process Communication, UNIX Signals, Termination of Processes, Daemons UNIX Background "Guardian Spirits", UNIX System Boot and Init Process.

UNIT – 3

UNIX Memory Management: Outline of Memory Management: Memory Allocation Algorithms in Swapping, virtual memory, Page Replacement Algorithms in Demand Paging, Process Swapping in UNIX: Swapped Content, Timing of Swapping, Allocation Algorithm, Selection Principle of Swapped Processes, Swapper, Swapping Effect. Demand Paging in UNIX: Demand Paging, Page Replacement.

UNIT – 4

UNIX File System: UNIX File System Structure: File System Organization, Home and Working Directories, Absolute and Relative Pathnames, UNIX Inodes and Data Structures for File System, UNIX File Concept and Types of Files, Managing Files and Directories : Displaying Pathname for Home Directory and Changing Directories, Viewing Directories and File Attributes, Creating Directories and Files, Displaying Type of a File, File and Directory Wildcards, UNIX File Storage and File System Implementation.

TEXTBOOKS:

1. Yukun Liu, Yong Yue,Liwei Guo, “UNIX Operating System: The Development Tutorial via UNIX Kernel Services”, Springer, Higher Education Press, 2011.
2. Maurice J. Bach, “The Design of the UNIX Operating System; Pearson Education”, Prentice Hall of India, 2004.

REFERENCEBOOKS:

1. William Stallings,” Operating Systems: Internals and Design Principles”, Prentice Hall of India, seventh edition 2011.
2. D. M. Dhamdhere,” Operating Systems: A Concept-Based Approach”,Tata McGraw-Hill,2002.
3. Gary J. Nutt,”Operating Systems: A Modern Perspective”, Addison-Wesley, 2011.

JOURNALS/MAGAZINES:

1. https://link.springer.com/chapter/10.1007/978-3-030-02619-6_53
2. https://link.springer.com/chapter/10.1007/978-3-642-88049-0_25
3. https://link.springer.com/chapter/10.1007/978-3-642-20432-6_1

SWAYAM/NPTEL/MOOCs:

1. Coursera – The UNIX Workbench
2. Coursera – Practical Introduction to the Command line
3. https://www.edx.org/course/linux-basics-the-command-line-interface
4. https://www.edx.org/course/introduction-to-linux

SELF-LEARNINGEXERCISES:

1. Basic Shell commands

2. Usage of vi and gedit text editors
3. UNIX I/O system and redirection
4. C modules interface

Course Title	Database Management System				Course Type		HC	
Course Code	B21EF0403	Credits	3		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	3	3	3	**39**	**-**	**50**	**50**

COURSE OVERVIEW:

This course introduces topics such as conceptual data modelling, relational data model, relational query languages, and relational database design. It helps the students to gain fundamental concepts, techniques and applications in database.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the basics of Database Management System.
2. Demonstrate the use of Relational model and Relational algebra.
3. Illustrate the use of different SQL statements.
4. Discuss the topics such asDatabase Design and Normalization.

COURSE OUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Design conceptual entity relationship diagrams for the real world applications.	1 to 5,9 10,12	1,2
CO2	Make use of the concepts of relational algebra to solve queries over database.	1 to 5,9.10,12	1,2
CO3	Construct the database for given real world application and solve queries over it using SQL commands.	1 to 5,9,10,12	1,2,3
CO4	Develop an optimized database using design guidelines and normalization technique.	1to 5,9,10,12	1,2
CO5	Construct the physical and logical database designs, database modeling, relational, hierarchical, and network models.	1to 5,9,10,12	1,3
CO6	Relate conceptual model to relational model and formulate relational algebra queries.	1to 5,9,10,12	2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6		√				

COURSE ARTICULATION MATRIX

CO#/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2				3	3		1	3	3	
CO2	3	3	2	3	1				3	3		1	3	3	
CO3	3	3	2	3	3				3	3		1	3	3	3
CO4	3	3	2	3	1				3	3		1	3	3	
CO5	3	2	3	3	3				3	3		1	3		3
CO6	3	3	2	3	3				3	3		1		3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to databases and Conceptual Modelling :Introduction to database, characteristics of the database approach, data models, schemas, instances, database languages and interfaces, Using high-level conceptual data models for database design, a sample database application, entity types, attributes, keys, relationship types, weak entity types, ER diagrams, naming conventions, design issues. Introduction to various database tools and framework (commercial and open source)

UNIT – 2

Relational Data Model and Relational algebra: Relational model concepts, relational model constraints and relational database schemas, update operations, transactions, dealing with constraint violations, unary relational operations, select and project, relational algebra operations from set theory, binary relational operations, join and division, additional relational operations, examples of queries in relational algebra.

UNIT – 3

SQL:SQL data definition and data types, specifying constraints in SQL, basic retrieval queries in SQL, insert, delete, update statements in SQL, additional features of SQL, schema change statements in SQL, Retrieving data using the SQL Select Statement, Restricting and sorting data, Using Single row functions, Joins, More complex SQL retrieval queries, views in SQL.

UNIT – 4

Database Design Theory and Normalization: Informal design guidelines for relation schemas, Functional dependencies, and Normal forms based on primary keys, General definitions of second and third normal forms, Other Normal forms.

TEXTBOOKS:

1. Elmasri and Navathe, "Fundamentals of Database Systems", Pearson Education, 5th Edition, 2007.
2. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems", McGraw-Hill, 3rd Edition, 2003.
3. Phill Pratt, "Concepts of Database Management, Cengage Learning", 8th Edition, 2014
4. Jeffrey A Hoffer, "Modern Database Management, Pearson", 12th Edition, 2015

REFERENCEBOOKS:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan: "Database System Concepts", 6th Edition, McGraw Hill, 2010.
2. C J Date, "Database Design and Relational Theory: Normal Forms and All that Jazz", O 'Reilly, April 2012.
3. James Martin, "Principles of Database Management Systems", 1985, Prentice Hall of India, New Delhi
4. IEEE Transactions on Knowledge and Data Engineering
5. Elsevier Data and Knowledge Engineering
6. ACM Transactions on Database Systems

JOURNALS/MAGAZINES:

1. http://www.ijstr.org/final-print/june2019/Database-Management-System.pdf
2. https://www.dbjournal.ro/

SWAYAM/NPTEL/MOOCs:

1. https://www.coursera.org/courses?query=database%20management
2. https://onlinecourses.swayam2.ac.in/cec19_cs05/preview
3. https://www.edx.org/learn/databases
4. https://www.classcentral.com/course/swayam-data-base-management-system-9914

SELF-LEARNINGEXERCISES:

1. MONGODB
2. Transaction and concurrency control
3. UML

Course Title	Computer Organization and Architecture				Course Type		HC	
Course Code	B21EF0404	Credits	3		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	3	3	3	**39**	**-**	**50**	**50**

COURSE OVERVIEW:

Computer organization and architecture is the science and art of selecting and interconnecting hardware components to create a computer that meets functional, performance, and cost goals. Computer organization defines the constituent parts of the system, how they are interconnected, and how they interoperate in order to implement the architectural specification. In this course, student will learn the basics of hardware components from basic arithmetic units to memory and I/O devices, instruction set architectures and assembly language, and designs to improve performance.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain architecture of ARM processor and write simple assembly programs.
2. Demonstrate the translation of assembly instructions into their binary representation.
3. Describe and understand the processor memory hierarchy.
4. Discuss basic understanding of interrupts, I/O devices, and I/O protocols

COURSE OUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Make use of ARM processor instruction set for developing simple assembly programs.	1,2,5,9,10,12	1
CO2	Interpret the functional architecture of computing systems.	1,2,5,9,10,12	1
CO3	Identify the issue related to instruction set architecture, memory unit and control unit and I/O functions.	1,2,5,9,10,12	1
CO4	Develop a real world application using parallel processing concepts.	1,2,4,9,10,12	1,2,3
CO5	Summarize the common components and organization of memory unit and I/O functions.	1,2,4,9,10,12	1
CO6	Experiment with the multitasking of different programs.	1,2,4,9,10,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2		√				
CO3			√			
CO4			√			
CO5		√				
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3			3				3	3		2	3		
CO2	3	3			2				3	3		2	3		
CO3	3	3			2				3	3		2	3		
CO4	3	3		2					3	3		2	3	3	3
CO5	3	3		2					3	3		2	3		
CO6	3	3		2					3	3		2	3	3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to ARM processor: Introduction to the architecture of Microprocessor, Microcontroller, Microcomputer and Internet of Things (IoT). ARM characteristics, Register structure, Addressing modes, Instructions, Assembly language, Operating Modes and Exceptions, Conditional execution of Instructions.

UNIT – 2

Arithmetic unit: Addition and Subtraction of Signed Numbers**,** Multiplication of unsigned numbers, Multiplication of signed numbers, Fast multiplication, Integer division, Floating point numbers and operations, Arithmetic operations on floating point numbers.

UNIT – 3

Memory System: Basic concepts, Synchronous RAM memories, Read-only memories, Direct Memory Access, Memory Hierarchy, Cache memories, Virtual memory.

UNIT – 4

Input/output Organization: Bus structure, Bus operation, Arbitration, Interface circuits, Intercommunication standards.

Parallel processing: Hardware multithreading, Vector (SIMD) processing and Shared Memory multiprocessors.

TEXTBOOKS:

1. Carl Hamacher, ZvonkoVranesic, SafwatZaky, NaraigManjikian, "Computer Organization and Embedded Systems", Mc-graw Hill, 6th Edition.

REFERENCEBOOKS:

1. Linda Null, Julia Labor, "The Essentials of Computer Organization and Architecture", Viva Publishers, 4th Edition, 2015.
2. William Stallings. "Computer organization and architecture: designing for performance", Pearson Education India, 2000.
3. David A. Patterson, John L. Hennessy. "Computer organization and design: the Hardware/software interface". Elsevier, 2011.
4. Peter Knaggs, "ARM Assembly Language Programming", April 2016.

JOURNALS/MAGAZINES:

1. https://engineering.lehigh.edu/cse/academics/course-index/cse-202-computer-organization-and-architecture-3
2. https://www.computer.org/csdl/magazine/co/1977/12/01646340/13rRUwInvnA
3. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=10208

SWAYAM/NPTEL/MOOCs:

1. https://www.classcentral.com/course/swayam-computer-organization-and-architecture-a-pedagogical-aspect-9824
2. https://onlinecourses.nptel.ac.in/noc20_cs25/preview
3. https://www.edx.org/course/computation-structures-2-computer-architecture-2

SELF-LEARNINGEXERCISES:

1. Intel IA-32 architecture, Instruction Set Architecture of IA-32, Basic Input/Output, Basic processing unit and Pipelining.

Course Title	Numerical Methods and Optimization Techniques				Course Type		HC	
Course Code	B21AS0401	Credits	3		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

Numerical Methods and Optimization Techniques emphasizes on the development of numerical algorithms to provide solutions to common problems formulated in science and engineering. The primary objective of the course is to develop the basic understanding of the construction of numerical algorithms, and perhaps more importantly, the applicability and limits of their appropriate use. The emphasis of the course will be the thorough study of numerical algorithms to understand the guaranteed accuracy that various methods provide, the efficiency and scalability for large scale systems. and issues of stability. Optimization Techniques provide ability to solve real-world problems by finding the optimal solutions to the models subject to constraints.

COURSE OBJECTIVE (S):

The objectives of this course are to:

i) Explain numerical methods to obtain approximate solutions to mathematical problems.

ii) Examine numerical methods for various mathematical operations and tasks, such as interpolation and integration.

iii) Illustrate the notation of vector spaces, sub spaces, linear independence, coordinate and change of coordinate.

iv) Solve linear programming problems considering Transportation and Assignment Problems.

COURSE OUTCOMES(COs)

After thecompletion of the course, the student will be able to :

CO#	Course Outcomes	POs	PSOs
CO1	Apply numerical methods to obtain approximate solutions for mathematical problems.	1 to 3, 12	1
CO2	Determine suitable interpolation formula and quadrature formulae to find the solution for the given data.	1 to 4 ,12	2
CO3	Solve the matrix associated with liner transformation with respect to the given base and understand the relationship between the operation and linear transformations and their corresponding matrices.	1 to 5,12	3
CO4	Develop mathematical equations with simplex method and Transportation-Assignment problem for linear programming	1 to 5,12	1,2,3
CO5	Apply various mathematical equations with simplex method for linear programming	1 to 5,12	1,2,3
CO6	Develop mathematical equations for Transportation-Assignment problem.	1 to 5,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2					√	
CO3			√			
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3									1	3		
CO2	3	3	3	3								1		3	
CO3	3	3	3	3	3							1			3
CO4	3	3	3	3	3							1	3	3	3
CO5	3	3	3	3	3							1	3	3	3
CO6	3	3	3	3	3							1	3	3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Numerical Methods: Errors in Numerical Calculations Types of Errors-Significant Digits-Programming Errors-Numerical Solution of Non-Linear Equations-Bisection Method-Regula Falsi Method-Newton Raphson Method –Fixed Point Method of Iteration – Rates of Convergence of These Methods. Solutions of Algebraic Equations, Relaxation Method and Gauss Seidel Iteration Method.

UNIT – 2

Numerical Analysis: Finite Differences-Operators (Δ, ∇ and E), Interpolation, Newton-Gregory Forward Interpolation Formula, Central Difference, Stirling And Bessel's Interpolation Formulae, Lagrange's Interpolation Formula, Inverse Interpolation Formula, Divided Difference Formula, and Newton's Divided Differences Formula**.** Numerical integration**:** Newton-Cotes quadrature formulae: Trapezoidal, Simpson's rules and Weddle's rule.

UNIT – 3

Vector Spaces and Linear transformations: Bases, Echelon forms, Rank, and determinants. Gauss elimination and its complexity, Inner products, Gram-Schmidt orthogonalization. Linear transformations.

UNIT – 4

Linear Programming: Introduction, Canonical and Standard Form of LPP-Simplex Method-Big M Method- Two Phase Method-Principle of duality-Dual Simplex Method. Transportation Problem and Assignment problem.

TEXTBOOKS:

1. Sastry S.S., "Numerical Analysis", Prentice-Hall India (module I), 4th edition
2. K. Hoffman and R. Kunze," Linear Algebra", Prentice-Hall India, 1971.
3. R Panneerselvam," Operations research", 2nd edition, PHI

REFERENCES BOOKS:

1. KanthiSwarup, P.K. Gupta, Man Mohan, "Operations research", Sultan Chand & Sons. (module II), 5th edition.
2. Froberg, "Introduction to Numerical Analysis",Second Edition, Addition Wesley
3. Gerald and Wheatley, "Applied Numerical Analysis", Pearson Education Asia, Sixth Edition
4. S.S Rao, "Optimization Theory and Applications", Wiley Eastern
5. Grawin W. W, "Introduction of Linear Programming", McGraw Hill.
6. M. K. Jain, S. R. K. Iyengar and R. K. Jain, "Numerical Methods for Scientific and Engineering Computation", New Age International Publishers, 6th edition, 2012.

JOURNALS/MAGAZINES:

1. https://onlinelibrary.wiley.com/journal/10970207
2. https://www.springer.com/journal/245
3. https://ijnao.um.ac.ir/
4. https://www.scimagojr.com/journalrank.php?category=2612

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/106/108/106108056/
2. https://www.coursera.org/learn/intro-to-numerical-analysis
3. https://nptel.ac.in/courses/122/102/122102009/
4. https://nptel.ac.in/courses/122/106/122106033/
5. https://www.edx.org/course/convex-optimization

SELF-LEARNINGEXERCISES:

1. Optimization Methods for Business Analytics
2. Numerical Methods and Optimization in Finance

Course Title	Unix Operating System Lab				Course Type		HC	
Course Code	B21EF0405	Credits	1		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	-	-	-				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**1**	**2**	**2**	**-**	**26**	**25**	**25**

COURSE OVERVIEW:

A study of the UNIX operating system including multi-user concepts, terminal emulation, use of system editor, basic UNIX commands, and writing script files. Topics The Linux Operating System Laboratory, Linux OS Lab is a course that will teach students about principles of operating systems using a constructivist approach and problem-oriented learning.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Understand the concepts, design, and structure of the UNIX operating system.
2. Understand and appreciate the principles in the design and implementation of java programs in UNIX operating system.
3. Use java program for basic UNIX Utilities.
4. Demonstrate the fundamental UNIX commands, system calls and its applications.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Understand the fundamental Linux OS.	1 to 5,9,10,12	1
CO2	Apply the scheduling algorithms for the given problem.	1 to 5,9,10,12	1,2
CO3	Make use of system calls to execute the java programs in UNIX.	1 to 5,9,12	1,3
CO4	Illustrate the hardlink and softlink using java programs in Linux.	1 to 5,9,12	1,3
CO5	Use interprocess communication, single handler function using java programs in linux platform.	1 to 5,9,10,12	1,3
CO6	Analyze the application using linux OS.	1 to 5,9,10,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6				√		

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	1				1	2		1	3		
CO2	3	3	2	1	1				2	1		2	3	3	
CO3	3	1	3	1	1				1			1	3		1
CO4	3	1	2	1	1				1			1	3		2
CO5	3	1	2	1	1				1	1		1	3		2
CO6	3	2	2	1	2				2	2		2	3	1	2

Note:1-Low,2-Medium,3-High

PRACTICE:

No	Title of the Experiment	Tools and Techniqu	Expected Skill /Ability
	Part-A		
1.	a) Execute at least ten UNIX shell commands on the terminal and the use of the shell commands.	Linux OS	shell commands.
	b) Write a C/Java program to display the output of any UNIX shell command.	Linux OS	
2.	a) Write a C/Java program to create a sub process by printing its pid and the main process pid value.	Linux OS	Process Control.
	b) Write a C/Java program to show the process is an orphan process and print its parent pid value.		

3.	a) Write a C/Java program that creates a zombie and then calls system to execute the ps command to verify that the process is zombie.	Linux OS	Zombie Process.
	b) Write a C/Java program to avoid zombie process by forking twice.		
4.	a) Write a C/Java program that outputs the contents of its Environment list.	Linux OS	Process Control.
	b) Write a C/Java program to illustrate the race condition.		
5.	a) Write a C/Java to create hard link and soft link and display the hard link count with other attributes of the created file within the sample code.	Linux OS	File Types and File attributes
	b) Consider the last 100 bytes as a region. Write a C/Java program to check whether the region is locked or not. If the region is locked, print pid of the process which has locked. If the region is not locked, lock the region		
6.	a) Write a C/Java program which demonstrates Inter process communication between a reader process and a writer process of a FIFO file by using the corresponding	Linux OS	Inter Process Communication.
	b) Write a C/Java program which demonstrates the signal handler function to handle the signal sent by the process.		UNIX signals.
	Part-B (Mini Project: Bank Management System)		
	Bank System is based on the concept of recording customer's account details. The system contains only the admin section. Here the admin can perform all the tasks like creating an account, deposit and withdraw amount, check balance, view all account holder. It contains the following modules of account creation. 1. Customer Module 2. Transaction Module	Linux OS	Modules of Bank Management System
1	Write a C/Java program to create account of a customer of Bank Management System and display the contents.	Linux OS	Create a class bank to create account and display the contents.
2	Write a C/Java program to close or delete an account of a created customer accounts of Bank Management	Linux OS	To close an existing account.
3	Write a C/Java program to display all account holders of a created customer accounts of Bank Management	Linux OS	To display all account holders.
4	Write a C/Java program to modify an account of a created customer accounts of Bank Management	Linux OS	To modify account and display the contents.

5	Write a C/Java program to deposit amount of a created customer account of bank Management System and display the contents	Linux OS	To deposit amount and display the contents.
6	Write a C/Java program to deposit and withdraw amount of a created customer account of bank	Linux OS	To withdraw amount and display the contents.
7	Write a C/Java program to check the balance amount of a created customer account of bank Management System and display the contents.	Linux OS	To check balance and display the contents.
8	Write a C/Java program to integrate the above modules scenario and display each module contents.	Linux OS	Complete knowledge of the project.

TEXTBOOKS:

1. Yukun Liu, Yong Yue,Liwei Guo, "UNIX Operating System: The Development Tutorial via UNIX Kernel Services", Springer, Higher Education Press, 2011.
2. Maurice J. Bach, "The Design of the UNIX Operating System; Pearson Education", Prentice Hall of India, 2004.

Course Title	Database Management System Lab				Course Type		HC	
Course Code	B21EF0406	Credits	1		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	-	-	-				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**1**	**2**	**2**	**-**	**26**	**25**	**25**

COURSE OVERVIEW:

This course introduces the core principles and techniques required in the design and implementation of database systems. This introductory application-oriented course covers the relational database systems RDBMS - the predominant system for business scientific and engineering applications at present. It includes Entity-Relational model, Normalization, Relational model, Relational algebra, and data access queries as well as an introduction to SQL. It also covers essential DBMS concepts such as: Transaction Processing, Concurrency Control and Recovery. It also provides students with theoretical knowledge and practical skills in the use of databases and database management systems in information technology applications.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. To explain basic database concepts, applications, data models, schemas and instances.
2. To demonstrate the use of constraints and relational algebra operations.
3. Describe the basics of SQL and construct queries using SQL.
4. To emphasize the importance of normalization in databases.
5. To facilitate students in Database design.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Understand the basic concepts of Database Systems and Applications.	1 to 5	1
CO2	Apply the basics of SQL and construct queries using SQL in database creation and interaction.	1 to 5,9,10,12	1,3
CO3	Make use of commercial relational database system by writing SQL using the system.	1 to 5,9,10,12	1,2,3
CO4	Illustrate the storage techniques of database system.	1 to 5,9,10,12	1,3
CO5	Acquire skills in using SQL commands for a given application.	1 to 5,9,10,12	1,2,3
CO6	Analyze solutions for database applications using SQL.	1 to 5,9,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6				√		

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1								3		
CO2	3	1	2	1	2				2	2		2	3		2
CO3	3	2	2	1	2				2	2		2	3	1	2
CO4	3	1	2	1	1				2	1		2	3		2
CO5	3	2	2	2	2				2	1		2	3	1	2
CO6	3	3	3	2	2				3			3	3	2	3

Note:1-Low,2-Medium,3-High

PRACTICE:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	Part-A		
1	Consider the following schema for Order Database: SALESMAN (Salesman_id, Name, City, Commission) CUSTOMER (Customer_id, Cust_Name, City, Grade, Salesman_id) ORDERS (Ord_No, Purchase_Amt, Ord_Date, Customer_id, Salesman_id) Write SQL queries to 1. Count the customers with grades above Bangalore's average. 2. Find the name and numbers of all salesmen who had more than one customer. 3. List all salesmen and indicate those who have and don't have customers in their cities (Use UNION operation.) 4. Create a view that finds the salesman who has the customer with the highest order of a day. 5. Demonstrate the DELETE operation by removing salesman with id 1000. All his orders must also be deleted	SQL PLUS	Solving queries using SQL
2	Specify the following queries on the Flight relational database schema using SQL Flights(*flno:* integer, *from:* string, *to:* string, *distance:* integer, *departs:* time, *arrives:* time) Aircraft(*aid:* integer, *aname:* string, *cruisingrange:* integer) Certified(*eid:* integer, *aid:* integer) Employees(*eid:* integer, *ename:* string, *salary:* integer) 1.Find the eids of pilots certified for some Boeing aircraft. 2. Find the names of pilots certified for some Boeing aircraft. 3. Find the aids of all aircraft that can be used on non-stop flights from Bonn to Madras. 4. Identify the flights that can be piloted by every pilot whose salary is more than $100,000. 5. Find the names of pilots who can operate planes with a range greater than 3,000 miles but are not certified on any Boeing aircraft. 6. Find the eids of employees who make the highest salary. 7. Find the eids of employees who make the second highest salary. 8. Find the eids of employees who are certified for the largest number of aircraft. 9. Find the eids of employees who are certified for exactly three aircraft. 10. Find the total amount paid to employees as salaries	SQL PLUS	Solving queries using SQL

3	Solve the below queries by using SQL Student(snum, sname, major, level, age) Class(cname, meets at, room, fid) Enrolled(snum, cname) Faculty(fid, fname, deptid) The meaning of these relations is straightforward; for example, Enrolled has one record per student-class pair such that the student is enrolled in the class. Queries 1. Find the names of all juniors (Level = JR) who are enrolled in a class taught by I. Teacher. 2. Find the age of the oldest student who is either a History major or is enrolled in a course taught by I. Teacher. 3. Find the names of all classes that either meet in room R128 or have five or more students enrolled. 4. Find the names of all students who are enrolled in two classes that meet at the same time. 5. Find the names of faculty members who teach in every room in which some class is taught. 6. Find the names of faculty members for whom the combined enrollment of the courses that they teach is less than five. 7. Print the Level and the average age of students for that Level, for each Level. 8. Print the Level and the average age of students for that Level, for all Levels except JR. 9. Find the names of students who are enrolled in the maximum number of classes. 10. Find the names of students who are not enrolled in any class.	SQL PLUS	Solving queries using SQL

4	Solve the below queries by using SQL branch (branch-name, branch-city, assets) customer (customer-name, customer-street, customer-city) account (account-number, branch-name, balance) loan (loan-number, branch-name, amount) depositor (customer-name, account-number) borrower (customer-name, loan-number) employee (employee-name, branch-name, salary) 1. Find the names of all customers. 2. Find the names of all branches in the loan relation, don't display duplicates. 3. Display the entire Branch table. 4. Find the account number for all accounts where the balance is greater than $700. 5. Find the account number and balance for all accounts from Brighton where the balance is greater than $800. 6. Display the branch name and assets from all branches in thousands of dollars and rename the assets column to 'assets in thousands'. 7. Find the name of all branches with assets between one and four million dollars. 8. Find the name, account number, and balance of all customers who have an account. 9. Find the name, account number, and balance of all customers who have an account with a balance of $400 or less.	SQL PLUS	Solving queries using SQL
5	Consider the following schema for a Library Database: BOOK (Book_id, Title, Publisher_Name, Pub_Year) BOOK_AUTHORS (Book_id, Author_Name) PUBLISHER (Name, Address, Phone) BOOK_COPIES (Book_id, Branch_id, No-of_Copies) BOOK_LENDING (Book_id, Branch_id, Card_No, Date_Out, Due_Date) LIBRARY_BRANCH (Branch_id, Branch_Name, Address) Write SQL queries to 1. Retrieve details of all books in the library – id, title, name of publisher, authors, number of copies in each branch, etc. 2. Get the particulars of borrowers who have borrowed more than 3 books, but from Jan 2017 to Jun 2017 3. Delete a book in BOOK table. Update the contents of other tables to reflect this data manipulation operation. 4. Partition the BOOK table based on year of publication. Demonstrate its working with a simple query. 5. Create a view of all books and its number of copies that are currently available in the Library.	SQL PLUS	Solving queries using SQL

TEXTBOOKS:

1. Elmasri and Navathe,"Fundamentals of Database Systems", Pearson Education, 5th Edition, 2007.
2. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems", McGraw-Hill, 3rd Edition, 2003.
3. Phill Pratt, "Concepts of Database Management, Cengage Learning", 8th Edition, 2014
4. Jeffrey A Hoffer, "Modern Database Management, Pearson", 12th Edition, 2015

Course Title	Computer Organization and Architecture lab				Course Type		HC	
Course Code	B21EF0407	Credits	1		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	-	-	-				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**1**	**2**	**2**	**-**	**26**	**25**	**25**

COURSE OVERVIEW:

The goal of this course is to have students understand and apply the principles of computing hardware and how it interfaces to software. It would provide the students with an understanding of Assembly language and provide a high-level understanding of the role played by the ARM tool kit and Keil software. It also expose the students to the various key aspects of Computer Organization and architecture.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Sketch simple assembly language program.
2. Illustrate working of MC Board.
3. Execute program on ARM Tool kit and keil software.
4. Design a simulation environment.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Implement assembly language programs and display result on LCD	1,3,5,9,10,12	1,3
CO2	Perform motor control using MC Board	1,3,5,9,10,12	1,3
CO3	Illustrate the working of temperature sensor using MC Board	1,3,5,9,10,12	1,3
CO4	Execute keypad interface with the microcontroller.	1,3,5,9,10,12	1,3
CO5	Structure a fewreal worlds scenario using keypad and LCD	1,3,5,9,10,12	1,3
CO6	Create simulation environment using assembly language program.	1 to5,9,10,12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			✓			
CO2			✓			
CO3				✓		
CO4			✓			
CO5				✓		
CO6						✓

COURSE ARTICULATION MATRIX

CO#/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2		1		2				2	1		2	3		2
CO2	2		1		2				2	1		2	3		2
CO3	2		1		2				2	1		2	3		2
CO4	2		1		2				2	1		2	3		2
CO5	2		1		2				2	1		2	3		2
CO6	3	2	2	2	3				2	2		2	3	2	2

Note: 1-Low, 2-Medium, 3-High

Practice:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1	Write a program to display the text "REVA UNIVERSITY" on a LCD Display.	MC board	Learn about sensors
2	Develop a program to demonstrate the up/down counter from 00 to 99.	MC board	Learn about sensors
3	Design a program to interface and control the stepper motor to rotate in the specified direction.	MC board	Learn about sensors

4	Write a program to interface 4X4 keypad with the microcontroller.	MC board	Learn about sensors
5	Control the on/off status of LED using switches.	MC board	Learn about sensors
6	Determine the rise in temperature using Temperature sensor.	MC board	Learn about sensors
7	Determine the leakage of gas.	MC board	Learn about sensors

Part-B Mini Project

S. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1	Create a lift operation sequence using LED interface. The lift should move from floor 0 to floor 10. During movement of the lift, requests from intermediate floors should be considered. The LED should display the current floor number of the lift based on its movement.	Arm Tool kit, Keil software,	Assembly Language programming
2	Create a phone booth monitor. The LCD device should display the time used and the cost involved in the call. The keypad should tell the number that you want to dial.	Arm Tool kit, Keil software,	Assembly Language programming
3	Create an attendance system using keypad, LCD / 7 segment display screen. The user should type in the employee id and get his attendance marked for the morning session and later one more punch with employee id for closing the attendance.	Arm Tool kit, Keil software,	Assembly Language programming
4	Implement an automatic door opening system using keypad, LCD device.	Arm Tool kit, Keil software,	Assembly Language programming
5	Create a traffic light simulation environment.	Arm Tool kit, Keil software,	Assembly Language programming

TEXTBOOKS:

1. Carl Hamacher,ZvonkoVranesic, SafwatZaky, NaraigManjikian, “Computer Organization and Embedded Systems”, Mc-graw Hill, 6th Edition.

Course Title	Management Science				Course Type		FC	
Course Code	B21MGM301	Credits	2		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**2**	**2**	**2**	**26**	**0**	**50**	**50**

COURSE OVERVIEW:

The course intends to familiarise students to understand the management principles and applications, which lays a strong foundation for managers and leaders in critical thinking and decisions making process. The course emphasises on giving an overview of the functional area of management.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1.To help the students gain understanding of the functions and responsibilities of managers.

2. To provide them tools and techniques to be used in the performance of the managerial job.

3. To enable them to analyze and understand the environment of the organization.

4. To help the students to develop cognizance of the importance of management principles.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Make use of Plan organizational structure for a given context in the organisation carry out production operations through Work-study.	1-5	1,2
CO2	Analyse production operations through Work-study.	1-5	1,2
CO3	Understand the markets, customers and competition better and price the given products Appropriately.	1-5	1,2
CO4	Summarize the HR function better.	1-5	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3				√		
CO4			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3								2	2	
CO2	1	1	3	3	3								2	2	
CO3	1	3	2	3	1								2	2	
CO4	1	1	3	2	5								2	2	

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to Management and Organisation: Concepts of Management and organization- nature, importance and Functions of Management. Systems Approach to Management - Taylor's Scientific Management Theory- Taylor's Principles of Management, Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's Theory X and Theory- Hertzberg Two Factor Theory of Motivation - Leadership Styles, Social responsibilities of Management. Designing Organisational Structures: Basic concepts related to OrganisationDepart mentation and Decentralisation.

UNIT – 2

Operations and Marketing Management: Principles and Types of Plant Layout-Methods of Production(Job, batch and Mass Production), Work Study --Basic procedure involved in Method Study and Work Measurement - Business Process Reengineering(BPR) Statistical

Quality Control: control charts for Variables and Attributes (simple Problems) and Acceptance Sampling, TQM, Six Sigma, Deming's contribution to quality. Objectives of Inventory control, EOQ, ABC Analysis. Purchase Procedure, Stores Management and Store Records - JIT System, Supply Chain Management, Functions of Marketing, Marketing Mix. And Marketing Strategies based on Product Life Cycle. Channels of distribution.

UNIT – 3

Human Resources Management (HRM): Concepts of HRM. HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR.. Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development. Placement, Wage and Salary Administration, Promotion. Transfer, Separation, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating -Capability Maturity Model (CMM) Levels - Performance Management System.

UNIT – 4

Strategic Management and Contemporary strategic Issues: Mission, Goals, Objectives, Policy, Strategy. Programmes, Elements of Corporate Planning Process, Environmental Scanning. Value Chain Analysis, SWOT Analysis. Steps in Strategy Formulation and implementation, Generic. Strategy alternatives. Bench Marking and Balanced Score and as Contemporary Business Strategies.

TEXTBOOKS:

I. Kotler Philip and Keller Kevin Lane, "Marketing Management", Pearson, New York, 15th Edition, 2012.

2. Koontz and Weihrich,"Essentials of management", McGraw Hill, New Delhi, 11th Edition, 2012.

REFERENCEBOOKS:

1. Thomas N. Duening and John M. Ivancevich, "Management - Principles and Guidelines", Dreamtech Press; 1stEdition, 2012.

2. Samuel C. Certo, "Modern Management", Prentice Hall, New York, 9th Edition, 2012.

3. Schermerhorn, Capling, Poole and Wiesner, "Management", Wiley, New York, 6th Edition, 2012.

4. John A. Parnell, "Strategic Management – Theory and Practice", Cengage Publications, 2018.

5. Lawrence R Jauch, R. Gupta and William F. Glucek,"Business Policy and Strategic Management Science", McGraw Hill, New York, 5th Edition, 2012.

Course Title	Environmental Science				Course Type	FC	
Course Code	B21AS0303	Credits	2		Class	IV Semester	
Course Structure			Contact	Work	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	2	2	2			
	Practice	-	-	-	Theory	CIE	SEE
	Tutorial	**-**	**-**	**-**			
	Total	**2**	**2**	**2**	**26**	**50**	**50**

COURSE OVERVIEW:

This introductory course is designed to introduce you to the foundational concepts of environmental engineering, types of resources, biodiversity, threats and methods of conservation, sources and control measures of environmental pollution and ways to protect the environment.

COURSE OBJECTIVE(S):

1. Graduates will be familiar with current and emerging environmental engineering and global issues, and have an understanding of ethical and societal responsibilities.
2. Graduates will have the ability to obtain the knowledge, and will recognize the need for engaging in life-long learning.
3. Will find the need of various types of energy (conventional & non-conventional) resources and natural resources.
4. Acquire knowledge with respect to biodiversity, threats, conservation and appreciate the concept of ecosystem.
5. Acquire knowledge about sources, effects and control measures of environmental pollution, degradation and waste management.
6. Explore the ways for protecting the environment.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Understand, analyse and execute favourable environmental conditions and the role of individual, government and NGO in environmental protection.	2,7,8,12	
CO2	List the causes, effects & remedial measures and find ways to overcome them by suggesting the pollution-controlled products	2,7,8,12	
CO3	Classify different wastes, sources of waste and their effect on population	2,7,8,12	
CO4	Get motivation to find new renewable energy resources with high efficiency through active research and innovation.	2,7,8,9,10,12	
CO5	Critically analyse the ecological imbalances and provide recommendations to protect the environment.	2,7,8,9,10,12	

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√				
CO3	√					
CO4		√				
CO5		√				

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		1					3	1				2			
CO2		1					3	1				2			
CO3		1					3	1				2			
CO4		1					3	1	1	1		2			
CO5		1					3	1	1	1		2			

Note:1-Low,2-Medium,3-High

COURSE CONTENTS
THEORY:

UNIT – 1

ENVIRONMENT & ENVIRONMENTAL PROTECTION:

Basics of environment: Introduction & definition to Environment, objectives and guiding principles of environmental education, Components of environment, Structure of atmosphere, Sustainable environment/Development, Impact of technology on the environment in terms of modern agricultural practices and industrialization, Environmental Impact Assessment. **Environmental protection:** Role of Government - Assignments of MOEF, Functions of central and state boards, Institutions in Environment and People in Environment, Environmental Legislations, Initiative and Role of Non-government organizations in India and world.

UNIT-2

ENVIRONMENTAL POLLUTION, DEGRADATION & WASTE MANAGEMENT:

Environmental Pollution: Definition, sources and types, Pollutant-Definition & classification, Concepts of air pollution, water pollution, Soil pollution, Automobile Pollution-Causes, Effects & control measures.

Environmental degradation: Introduction, Global warming and greenhouse effect, Acid rain-formation & effects, Ozone depletion in stratosphere and its effect.

Waste management: Municipal solid waste, Biomedical waste and Electronic waste (E-Waste).

UNIT-3

ENERGY & NATURAL RESOURCES:

Energy: Definition, classification of energy resources, electromagnetic radiation-features and applications, Conventional/Non-renewable sources – Fossil fuels based (Coal, petroleum & natural gas), nuclear energy, Non-conventional/renewable sources – Solar, wind, hydro, biogas, biomass, geothermal, ocean thermal energy, Hydrogen as an alternative as a future source of energy.

Natural resources:

Water resource - Global water resource distribution, Water conservation methods, Water quality parameters, Uses of water and its importance. Mineral resources - Types of minerals, Methods of mining & impacts of mining activities. Forest wealth - Importance, Deforestation-Causes, effects and controlling measures

UNIT-4

ECOLOGY, ECOSYSTEM & FIELD WORK:

Ecology-Definition, branches, objectives and classification, Concept of an ecosystem – Structure and functions, Characteristics of an Ecosystem - Ecosystem Resilience, Ecological succession and productivity, Balanced ecosystem, Components of ecosystem-abiotic and biotic, biological diversity. Biogeochemical cycles and its environmental significance – Carbon and nitrogen cycle, Energy flow in ecosystem, food chains –types, food web & Ecological Pyramids.

TEXT BOOKS:

1. R.J. Ranjit Daniels and Jagadish Krishnaswamy, "Environmental Studies", Wiley India Private Ltd., New Delhi, Co-authored &Customised by Dr.MS Reddy & Chandrashekar, REVA University, 1st Edition, 2017.
2. R.J. Ranjit Daniels and Jagadish Krishnaswamy, "Environmental Studies", Wiley India Private Ltd., New Delhi, 2nd Edition, 2014.
3. Benny Joseph, "Environmental Studies", Tata McGraw – Hill Publishing Company Limited, New Delhi, 2nd Edition, 2008.

REFERENCE BOOKS:

1. Dr.S.M.Prakash, "Environmental Studies", Elite Publishers, Mangalore, 2nd Edition, 2009.
2. Rajagopalan R, "Environmental Studies – from Crisis to cure", Oxford University Press, New Delhi, 3rd Edition, 2016
3. Anil Kumar Dey and Arnab Kumar Dey, "Environmental Studies", New age international private limited publishers, New Delhi, 2nd Edition, 2007.
4. Michael Allaby, "Basics of environmental Science", Routledge-Tayler &Francis e-library, New York, 2nd Edition, 2002.
5. Dr.Y.K Singh, "Environmental Science", New age international private limited publishers, New Delhi, 1st Edition, 2006

JOURNALS/MAGAZINES:

1. International Journal of Environmental Science and Technology, https://www.springer.com/journal/13762/
2. Journal of Environmental Sciences, https://www.journals.elsevier.com/journal-of-environmental-sciences

SWAYAM/NPTEL/MOOCs:

1. Environmental Studies: https://onlinecourses.swayam2.ac.in/cec19_bt03/preview
2. Environmental Studies: https://nptel.ac.in/courses/120/108/120108004/

SELF-LEARNING EXERCISES:

1. Discussion on the need for public awareness on the environment, Gaia Hypothesis

2. Case studies of London smog, Bhopal gas tragedy, marine pollutions and study of different waste water treatment processes, Disaster management, early warning systems-bio indicators for Tsunami and other natural disasters.

3. Hydrology & modern methods adopted for mining activities, Remote sensing and its applications, Chernobyl (USSR) nuclear disaster and Fukushima (Japan) nuclear disaster.

4. Discussion on the need for balanced ecosystem and restoration of degraded ecosystems.

Course Title	Universal Human Values				Course Type	MC	
Course Code	B21AHM401	Credits	0		Class	IV Semester	
Course Structure			Contact	Work	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	0	2	2			
	Practice	-	-	-	Theory	CIE	SEE
	Tutorial	**-**	**-**	**-**			
	Total	**0**	**2**	**2**	**26**	**0**	**0**

COURSE OVERVIEW:

Basic human values refer to those values which are at the core of being human. The values which are considered basic inherent values in humans include truth, honesty, loyalty, love, peace, etc. because they bring out the fundamental goodness of human beings and society at large. This subject focuses on developing holistic perspective and harmony on self-exploration among individuals, family and society.

COURSE OBJECTIVE(S):

1. Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act

COURSEOUTCOMES(COs):

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Understand the significance of value inputs in a classroom and start applying them in their life and profession.	3,6,7,8, 9,10	
CO2	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.	3,6,7,8, 9,10	
CO3	Understand the role of a human being in ensuring harmony in society and nature.	3,6,7,8	
CO4	Demonstrate the role of human being in the abetment of pollution.	3,6,7,9	
CO5	Describe appropriate technologies for the safety and security of the society as responsible human being.	9,10,11, 12	
CO6	Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.	9,10,11, 12	

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√	√			
CO2	√	√			√	
CO3		√				
CO4			√		√	
CO5		√				√
CO6				√	√	

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			1			3	3	3	3	3					
CO2			1			3	3	3	3	3					
CO3			1			3	3	3							
CO4			1			3	3		3						
CO5									3	3	3	2			
CO6									2	3	3	2			

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT- 1

Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship, basic requirements for fulfilment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly, Method to fulfil human aspirations: understanding and living in harmony at various levels, Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. Understanding the Body as an instrument of 'I' (I being the doer, seeker and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.

UNIT- 2

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence. Understanding the meaning of

Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family

UNIT- 3

Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT- 4

Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers b) At the level of society: as mutually enriching institutions and organizations

TEXT BOOKS:

1. R R Gaur, R Sangal, G P Bagaria, "Human Values and Professional Ethics", Excel Books, New Delhi, 2010

2. A.N Tripathy, "Human Values" , New Age Intl. Publishers, New Delhi, 2004.

3. R.R. Gaur, R. Sangal and G.P. Bagaria, "A Foundation Course in Human Values and Professional Ethics", Excel Books, New Delhi, 2010

4.Bertrand Russell, "Human Society in Ethics & Politics" , Routledge Publishers, London, 1992

REFERENCE BOOKS:

1.Corliss Lamont, "Philosophy of Humanism", Humanist Press, London, 1997

2. I.C. Sharma, "Ethical Philosophy of India", Nagin & co Julundhar, 1970

3. Mohandas Karamchand Gandhi, "The Story of My Experiments with Truth" ,NavajivanMudranalaya, Ahmadabad, 1993

4. William Lilly, "Introduction to Ethics", Allied Publisher, London, 1955

JOURNALS/MAGAZINES:

1. Value Education websites, http://uhv.ac.in, http://www.uptu.ac.in

2. Story of Stuff, http://www.storyofstuff.com

3. Al Gore, An Inconvenient Truth, Paramount Classics, USA

4. Charlie Chaplin, Modern Times, United Artists, USA

5. IIT Delhi, Modern Technology – the Untold Story

6. Gandhi A., Right Here Right Now, Cyclewala Production

SELF-LEARNING EXERCISES:

1. Observe that each one of us has Natural Acceptance, based on which one can verify right or not right for him. Verify this in case of

i) What is Naturally Acceptable to you in relationship- Feeling of respect or disrespect?

ii) What is Naturally Acceptable to you – to nurture or to exploit others? Is our living the same as your natural acceptance or different?

2. Out of the three basic requirements for fulfilment of your aspirations- right understanding,relationship and physical facilities, observe how the problems in your family are related to each. Also observe how much time & effort you devote for each in your daily routine.

3. Choose any two current problems of different kind in the society and suggest how they can be solved on the basis of natural acceptance of human values. Suggest steps you will take in present conditions.

3rd Year Syllabus

V SEMESTER

Course Title	Artificial Intelligence and Applications				Course Type		HC	
Course Code	B21ET0501	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

This course introduces the basics of Artificial Intelligence (AI), AI problems and search strategies. The students can explore knowledge representation issues and methods. This course provides planning methods /algorithms for, problem solving and controlling the knowledge and also demonstrates various learning methods for constructing knowledge and taking decisions.

COURSE OBJECTIVE (S):

1. Discuss the basics of Artificial Intelligence (AI).
2. Illustrate knowledge representation issues and methods
3. Explain planning methods/algorithms in problem solving
4. Describe the concepts of intelligent agent in a specific environment.

COURSE OUTCOMES (COs)

On successful completion of this course; the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Utilize the AI search strategies and production system.	1 to 5,9,10,12	3
CO2	Apply the logic and apply reasoning methods for given real world problem.	1 to 5,9,10,12	3
CO3	Make use of planning and probability to solve uncertainty problems.	1 to 5,9,10,12	3
CO4	Develop an intelligent agent in a specific environmentto solve real world problems.	1 to 5,9,10,12	2,3
CO5	Classify the techniques which involves perception, reasoning and learning in real world applications.	1 to 5,9,10,12	1
CO6	Analyze real world problems to understand the dynamic behavior of a system.	1 to 5,9,10,12	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5		√				
CO6				√		

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	2				3	3		1			3
CO2	2	2	2	2	1				3	3		1			3
CO3	3	2	3	2	3				3	3		1			3
CO4	1	2	3	1	3				3	3		1		3	3
CO5	3	3	2	3	3				3	3		1	3		
CO6	3	3	3	3	3				3	3		1	3	3	

Note: 1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Problems and search: What is AI, AI Problems; AI Techniques; Problem Space and Problem Search techniques; Defining the problem as a state space search, production systems; Problem characteristics, production system characteristics, Issues in the design of search programs; Heuristic search techniques, generate-and-test; Hill climbing, BFS, DFS; Problem reduction; Constraint satisfaction

UNIT – 2

Knowledge Representation: Knowledge representation Issues, representations and mappings; Approaches to knowledge representation; Issues in knowledge representation; Using Predicate logic: Representing simple facts in logic; Representing Instance and ISA relationships; Computable functions and predicates; Representing Knowledge using Rules; Procedural versus declarative knowledge; Resolution Forward versus backward reasoning; Matching

UNIT – 3

Planning: A simple planning agent; Representations for planning; A partial-order planning example; A partial-order planning algorithm; Planning with partially Instantiated operators; Knowledge Engineering for planning; Uncertainty: Sources of Uncertainty; Probability Theory, Issues with Probability; Advantages & Disadvantages of Bayesian Network.

UNIT – 4

Intelligent Agents: Introduction, How Agent should Act, Structure of Intelligent Agents, Agents and environments, Rationality, PEAS (Performance measure, Environment, Actuators, Sensors), Environment types , Agent types. Environments.

TEXTBOOKS:

1. Russell &Norvig,"Artificial Intelligence: A Modern Approach", Third Edition, Prentice-Hall, 2010.
2. Elaine Rich, Kevin Knight,"Artificial Intelligence", 3rdedition, TataMcgraw Hill, 2009.

REFERENCEBOOKS:

1. Nils J.Nilsson, "Principles of Artificial Intelligence", Elsevier, 1980.
2. Krishan Mehrotra, Chilkuri K. Mohan, Sanjay Ranka, "Artificial Neural Networks", Penram International Publishing, 1997.
3. B.Yegananarayana,"Artificial Neural Networks", PHI, 2001.
4. ACM, ACM transaction on Multi-Agent System.
5. IEEE, IEEE transaction for computational Intelligence.
6. Springer, Springer transaction for security based intelligent systems.

JOURNALS/MAGAZINES:

1. https://opensky.ucar.edu/islandora/object/articles:21155
2. https://cs.cit.ie/contentfiles/PDFs/MScFlyers/MScAI_FT.pdf
3. https://www.enterrasolutions.com/news/trends-predictions-2017-digital-transformation-2/
4. https://www.wsj.com/articles/readers-beware-ai-has-learned-to-create-fake-news-stories-11571018640

SWAYAM/NPTEL/MOOCs:

1. https://medium.com/javarevisited/10-best-udemy-and-coursera-courses-to-learn-artificial-intelligence-in-2020-ec77ad13bdc1
2. https://medium.com/javarevisited/10-best-udemy-and-coursera-courses-to-learn-artificial-intelligence-in-2020-ec77ad13bdc1
3. https://javarevisited.blogspot.com/2020/08/top-10-coursera-courses-and-certification-for-artificial-intelligence-and-machine-learning.html#axzz6jQ05pXOG

SELF-LEARNING EXERCISES:

1.Prolog programming language for artificial intelligence.

2. Multi-Agent Systems and Agent Communication for distributed problem solving which is performed by agents working together towards a solution of a common problem.

Course Title	Machine Learning				Course Type		HC	
Course Code	B21EF0503	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	3	3	3	**39**	**-**	**50**	**50**

COURSE OVERVIEW:

The course introduces the fundamental concepts of machine learning, data exploration, information-based learning, similarity based learning, probability based learning, and error based learning. It also discusses the art of machine learning for predictive data analytics and Descriptive Statistics & Data Visualization for Machine Learning.

COURSE OBJECTIVE (S):

The main objectives of this course are:

1. Explain the characteristics of datasets and compare the trivial data and big data for various applications.
2. Illustrate implement machine learning techniques and computing environment that are suitable for the applications under consideration.
3. Describe various ways for implementation of selecting suitable model parameters for different machine learning techniques.
4. Discuss machine learning libraries and mathematical and statistical tools with modern technologies like Hadoop and MapReduce.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Make use of predictive data analytics tools to analysethe characteristics of datasets.	1 to 6 ,9,10, 12	3
CO2	Choose machine learning technique and computing environment suitable for the given application.	1 to 6 , 9,10, 12	1
CO3	Apply a linear regression model for the given real world application.	1 to 6 , 9,10, 12	3
CO4	Develop an application to make use of decision trees to solve the real world problem.	1 to 6 , 9,10, 12	2,3
CO5	Make use ofunsupervised learning concepts and dimensionality reduction techniques in real world applications.	1 to 6 , 9,10,12	1,3
CO6	Apply Machine Learning algorithms in real-world applications using Python programming.	1 to 6 , 9,10,12	2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3	2	2			3	3		1			3
CO2	2	3	3	3	2	1			3	3		1	3		
CO3	3	3	2	3	2	1			3	3		1			3
CO4	3	3	3	3	3	1			3	3		1		3	3
CO5	3	2	3	3	2	3			3	3		1	3		3
CO6	3	3	3	3	2	3			3	3		1		3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

The Art of Machine Learning for Predictive Data Analytics: Different Perspectives on Prediction Models, Choosing a Machine Learning Approach, Matching Machine Learning Approaches to Projects Matching Machine Learning Approaches to Data and Your Next Steps.

Descriptive Statistics & Data Visualization for Machine Learning: Descriptive Statistics for Continuous Features, Central Tendency, Variation, Descriptive Statistics for Categorical Features, Populations & Samples

UNIT – 2

Machine Learning for Predictive Data Analytics: What is Predictive Data Analytics?, What is Machine Learning?, How does Machine Learning Work?, What can go wrong with Machine Learning?, The Predictive Data Analytics Project Life Cycle: CRISP-DM and Predictive Data Analytics Tools.

Data to Insights to Decisions: Converting Business Problems into Analytics Solutions, Assessing Feasibility, Designing the Analytics Base Table and Designing & Implementing Features.

Data Exploration: The Data Quality Report, Getting to Know the Data, Identifying Data Quality Issues, Handling Data Quality Issues, Advanced Data Exploration and Data Preparation.

UNIT – 3

Probability-based Learning: Bayes' Theorem, Bayesian Prediction, Conditional Independence &Factorization, Standard Approach: The Naive Bayes Model, A Worked Example, Smoothing, Handling Continuous Features: Probability Density Functions, Handling Continuous Features: Binning Bayesian Networks.

Error-based Learning: Simple Linear Regression, Measuring Error, Error Surfaces, Standard

Approach: Multivariable Linear Regression with Gradient Descent, Multivariable Linear Regression, Gradient Descent, Choosing Learning Rates & Initial Weights, A Worked Example, Interpreting Multivariable Linear Regression Models, Setting the Learning Rate Using Weight Decay, Handling Categorical Descriptive Features, Handling Categorical Target Features: Logistic Regression, Modelling Non-linear Relationships, Multinomial Logistic Regression and Support Vector Machines.

UNIT – 4

Information-based Learning: Decision Trees, Shannon's Entropy Model, Information Gain, Standard Approach: The ID3 Algorithm, A Worked Example: Predicting Vegetation Distributions, Alternative Feature Selection & Impurity Metrics, Handling Continuous Descriptive Features, Predicting Continuous Targets, Tree Pruning and Model Ensembles.

Similarity-based Learning: Feature Space, Measuring Similarity Using Distance Metrics, Standard

Approach: The Nearest Neighbor Algorithm, Handling Noisy Data, Efficient Memory Search

Data Normalization, Predicting Continuous Targets, Other Measures of Similarity Feature Selection.

TEXTBOOKS:

1. John D Kelleher, Brian Mac Namee, Aoife D'Arcy, "Fundamentals of Machine Learning for Predictive Data Analytics-Algorithms, Worked Examples and case studies", MIT Press, 2015.

REFERENCEBOOKS:

1. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (INDIAN EDITION), 2013.
2. EthemAlpaydin," Introduction to Machine Learning", 2nd Ed., PHI Learning Pvt. Ltd, 2013.
3. T. Hastie, R. Tibshirani, J. H. Friedman, "The Elements of Statistical Learning", Springer; 1stedition, 2001.

JOURNALS/MAGAZINES:

1. Springer Journal of Machine Learning.
2. International Journal of Machine Learning and Computing.

SWAYAM/NPTEL/MOOCs:

1. Coursera – Machine Learning
2. Coursera – Deep Learning
3. https://onlinecourses.nptel.ac.in/noc19_cs53/preview
4. https://www.edx.org/learn/machine-learning

SELF-LEARNINGEXERCISES:

1. Data Visualization
2. Bar Plots
3. Histograms
4. Box Plots

Course Title	Web and Text Mining				Course Type		SC	
Course Code	B21ETS511	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-			Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

This course will cover the major techniques for mining and analyzing text data to discover interesting patterns, extract useful knowledge, and support decision making, with an emphasis on statistical approaches that can be generally applied to arbitrary text data in any natural language with no or minimum human effort. Detailed analysis of text data requires understanding of natural language text, which is known to be a difficult task for computers. This course focuses on extracting knowledge from the web by applying Machine Learning techniques for classification and clustering of hypertext documents. Basic approaches from the area of Information Retrieval and text analysis are also discussed. The students use recent Machine Learning and Data Mining software to implement practical applications for web document retrieval, classification and clustering.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Discuss various data mining techniques for different applications.
2. Describe different clustering techniques for text data.
3. Demonstrate the classification techniques for text data.
4. Illustrate web data retrieval techniques.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Choose the Data mining techniques to extract data from given dataset.	1 to 5	1
CO2	Apply appropriate classification algorithm to analyze the given data.	1 to 5	2
CO3	Identify suitable Web Mining technique to perform social network analysis.	1 to 5	1,2
CO4	Design web crawlers for information retrieval from web.	1 to 5	2,3
CO5	Apply relevant machine learning models for analyzing textual data and correctly interpreting the results	1 to 5	1,3
CO6	Make use of basic methods for information extraction and retrieval of textual data	1 to 5	2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	3	2								3		
CO2	3	3	3	3	2									3	
CO3	2	3	3	2	2								3	3	
CO4	3	2	3	2	2									3	3
CO5	2	3	3	2	3								3		3
CO6	3	2	3	2	3									3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT- 1

Introduction to Data Mining Techniques: Text Extraction and Document Clustering. Introduction to data mining, Classification, Clustering, Association Analysis, Introduction to key extraction methods, Rapid automatic keyword extraction, Benchmark evaluation, Stop list generation, Evaluation on news articles, Algebraic techniques for multilingual document clustering: Introduction, Experimental setup, Multilingual LSA.

UNIT -2

Text Data Classification: Content-based spam email classification using machine-learning algorithms: Introduction, Naive Bayes, Logit Boost, Support vector machines, Augmented latent semantic indexing spaces, Radial basis function networks, Data pre-processing, Feature selection, Message representation,

Evaluation of email classification, utilizing nonnegative matrix factorization for email classification problems: Introduction, Nonnegative matrix factorization.

UNIT- 3

Web Mining - I: Information Retrieval and Web Search: Basic Concepts of Information Retrieval, Information Retrieval Models, Relevance Feedback, Evaluation Measures, Text and Web Page Pre-Processing, Link Analysis: Social Network Analysis, Co-Citation and Bibliographic Coupling.

UNIT- 4

Web Mining - II: Web Crawling: A Basic Crawler Algorithm: Breadth-First Crawlers, Preferential Crawlers, Implementation Issues: Fetching, Parsing, Stop word Removal and Stemming Link Extraction and Canonicalization, Spider Traps, Page Repository, Concurrency, Universal Crawlers: Scalability, Coverage vs Freshness vs Importance, Focused Crawlers, Topical Crawlers: Topical Locality and Cues.

TEXTBOOKS:

1. Michael W. Berry and Jacob Kogan, "Text Mining: Applications and Theory", Wiley, 2010
2. Bing Liu, "Web Data Mining: Exploring Hyperlinks, Contents and Usage Data", Springer, 2007.

REFERENCEBOOKS:

1. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", Elsevier, 2011.

JOURNALS/MAGAZINES:

1. ACM Transactions on Knowledge Discovery from Data (TKDD)
2. IEEE Transactions on Knowledge and Data Engineering

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/110/107/110107129/
2. https://onlinecourses.nptel.ac.in/noc19_mg47/preview
3. https://onlinecourses.swayam2.ac.in/cec20_cs12/preview

SELF-LEARNINGEXERCISES:

1. https://www.linguamatics.com/what-text-mining-text-analytics-and-natural-language-processing
2. https://www.coursera.org/learn/text-mining
3. https://www.ibm.com/cloud/learn/text-mining

Course Title	Pattern Recognition				Course Type		SC	
Course Code	B21ETS512	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

Pattern recognition techniques are concerned with the theory and algorithms of putting abstract objects, e.g., measurements made on physical objects, into categories. Typically the categories are assumed to be known in advance, although there are techniques to learn the categories (clustering). Methods of pattern recognition are useful in many applications such as information retrieval, data mining, document image analysis and recognition, computational linguistics, forensics, biometrics and bioinformatics.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Understand Fundamentals and definitions of variety of pattern classification, structural pattern recognition, and pattern classifier combination techniques.
2. Explore, compare and contrast the pattern recognition area verbally and in writing.
3. Understand the performance evaluation methods for pattern recognition, and critique comparisons of techniques made in the research literature.
4. Explore the pattern recognition techniques to real-world problems such as document analysis and recognition.
5. Understand the design and implementation of simple pattern classifiers, classifier combinations, and structural pattern recognizers.
6. Develop and evaluate any pattern recognition model for any real world problem

COURSE OUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Outline the variety of pattern classification, structural pattern recognition, and pattern classifier combination techniques.	1,2	1,2
CO2	Analyze and relate research perspectives in the pattern recognition area verbally and in writing.	1,2,3,4	1,2,3
CO3	Apply performance evaluation methods for pattern recognition, and critique comparisons of techniques made in the research literature.	1-5	1,2,3
CO4	Apply pattern recognition techniques to real-world problems such as document analysis and recognition.	1-5	1,2,3
CO5	Develop simple pattern classifiers, classifier combinations, and structural pattern recognizers in the real world applications.	1-5	1,2,3
CO6	Evaluate various pattern recognition model for any real world problem.	1-5	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√				
CO3			√			
CO4						√
CO5			√			
CO6						√

COURSE ARTICULATION MATRIX

CO#/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											3	3	
CO2	3	3	3	3									3	3	3
CO3	1	1	3	3	3								3	3	3
CO4	1	1	3	3	3								3	3	3
CO5	1	1	3	3	3								3	3	3
CO6	1	1	3	3	3								3	3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT-1

Fundamentals and definitions: Goals of pattern recognition, Structure of a pattern recognition system,Abstract view of pattern recognition, Design of a pattern recognition system.**Features**: Types of features and their traits, Feature space inspection, Transformations of the feature space, Measurement of distances in the feature space,Normalization.Selection and construction of features, Dimensionality reduction of the feature space.

UNIT-2

Bayesian decision theory: General considerations, The maximum a posteriori classifier, Bayesian classification. **Parameter estimation:** Maximum likelihood estimation, Bayesian estimation of the class-specific distributions, Bayesian parameter estimation, Additional remarks on Bayesian classification**. Parameter free methods:** The Parzen window method, The k-nearest neighbor method, k-nearest neighbor classification.

UNIT-3

General considerations: Dimensionality of the feature space, Overfitting.**Special classifiers:** Linear discriminants, The perceptron, Linear regression, Artificial neural networks,Autoencoders, Deep learning, Support vector machines, Matched filters, Classification of sequences.

UNIT-4

Classification with nominal features: Decision trees, Random forests, String matching, Grammars.**Classifier-independent concepts:** Learning theory, Empirical evaluation of classifier performance, Boosting, Rejection.

TEXTBOOKS:

1. Beyerer, Jürgen, Matthias Richter, and Matthias Nagel,"Pattern recognition: introduction, features, classifiers and principles", Walter de Gruyter GmbH & Co KG, 2017.

REFERENCEBOOKS:

1. Fukunaga, Keinosuke,"Introduction to statistical pattern recognition", Elsevier, 2013.
2. Theodoridis, Sergios, et al,"Introduction to pattern recognition: a matlab approach", Academic Press, 2010.
3. Bishop, Christopher M,"Pattern recognition and machine learning", springer, 2006.

JOURNALS/MAGAZINES:

1. IEEE Pattern recognition and machine learning
2. ACM International Journal of Pattern Recognition and Artificial Intelligence
3. Elesevier Pattern Recognition

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/117/108/117108048/
2. https://www.coursera.org/learn/data-patterns
3. https://www.classcentral.com/course/swayam-pattern-recognition-and-application-14228

SELF-LEARNINGEXERCISES:

1. Context Dependent Classification
2. Clustering: Sequential Algorithms, Hierarchical

Course Title	Security in IoT				Course Type		SC	
Course Code	B21ETS513	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

In general, IoT is a network of devices every object is connected through internet or some non-internet oriented connections like Bluetooth, ZigBee, etc. It features an IP address for Internet connectivity, and the communication occurs between these objects and other Internet-enabled devices and systems. The course covers IoT security and vulnerability threats. Different IoT protocols and their security measures, differentIoT types of attacks

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Understand the Security requirements in IoT.

2. Understand the cryptographic fundamentals for IoT

3. Illustrate the authentication credentials and access control

4. Compare the various types Trust models and Cloud Security

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Identify the general authentication and security challenges in IoT	1 to 5	1,3
CO2	Compare the different IoT protocols and their security measures in real world applications.	1 to 5	1,3
CO3	Apply various cryptographic primitives to IoT based applications	1 to 5	1,3
CO4	Analyze different security attacks in IoT environment.	1 to 5	1,3
CO5	Apply the access management solutions to IoT applications.	1 to 5	
CO6	Develop privacy based IoT applications.	1 to 5	

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√				
CO3			√			
CO4				√		
CO5				√		
CO6			√			

COURSE ARTICULATION MATRIX

CO#/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	3	3								3		3
CO2	2	3	3	3	3								3		3
CO3	2	3	3	3	2								3		3
CO4	2	3	2	3	2								3		3
CO5	2	3	3	3	2								3		3
CO6	2	3	2	3	2								2	3	2

Note:1-Low,2-Medium,3-High

COURSE CONTENT

UNIT-1

INTRODUCTION: SECURING THE INTERNET OF THINGS: Security Requirements in IoT Architecture - Security in Enabling Technologies - Security Concerns in IoT Applications. Security Architecture in the Internet of Things - Security Requirements in IoT - Insufficient Authentication/Authorization - Insecure Access Control - Threats to Access Control, Privacy, and Availability - Attacks Specific to IoT. Vulnerabilities – Secrecy and Secret-Key Capacity - Authentication/Authorization for Smart Devices - Transport Encryption – Attack & Fault trees

UNIT-2

CRYPTOGRAPHIC FUNDAMENTALS FOR IOT : Cryptographic primitives and its role in IoT – Encryption and Decryption – Hashes – Digital Signatures – Random number generation – Cipher suites – key management fundamentals – cryptographic controls built into IoT messaging and communication protocols – IoT Node Authentication

UNIT-3

IDENTITY & ACCESS MANAGEMENT SOLUTIONS FOR IOT : Identity lifecycle – authentication credentials – IoT IAM infrastructure – Authorization with Publish / Subscribe schemes – access control

UNIT-4

PRIVACY PRESERVATION AND TRUST MODELS FOR IOT : Concerns in data dissemination – Lightweight and robust schemes for Privacy protection – Trust and Trust models for IoT – self-organizing Things - Preventing unauthorized access

TEXT BOOKS:

1. Brian Russell, Drew Van Duren, "Practical Internet of Things Security", 2nd Edition, PacktPublication.
2. "Securing the Internet of Things" Elsevier
3. Fei Hu, "Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations", 1st Edition, CRC Press, 2016.

REFERENCE BOOKS:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Pearson Education (Cisco Press Indian Reprint).
2. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.

JOURNALS/MAGAZINES:

1. IEEE Wireless Communications
2. IEEE Sensors Journal
3. IEEE Communications Surveys and Tutorials
4. IEEE Intelligent Systems
5. IEEE Transactions on Wireless Communications
6. Proceedings of the IEEE
7. IEEE Transactions on Computers
8. ICT Express

SWAYAM/NPTEL/MOOCs:

1. Introduction to internet of things, Indian Institute of Technology, Kharagpur and NPTEL via Swayam
2. Introduction and Programming with IoT Boards (Coursera)
3. Software Architecture for the Internet of Things (Coursera)
4. Cybersecurity and the Internet of Things (Coursera)
5. MicroMasters® Program in Internet of Things (IoT)

SELF-LEARNINGEXERCISES:

1. Installation and working on the IDEs required for executing projects using Arduino and Raspberry.

Course Title	Advanced IOT and Applications				Course Type		SC	
Course Code	B21ETS514	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

In general, IoT is a network of devices every object is connected through internet or some non-internet oriented connections like Bluetooth, ZigBee, etc. It features an IP address for Internet connectivity, and the communication occurs between these objects and other Internet-enabled devices and systems. The course covers the IoT Impact, Convergence of IT and IoT, and IoT Challenges. It also explains an Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics. The usage of various microcontroller boards such as Arduino, Raspberry and Adafruit are covered.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Examine the genesis and impact of IoT applications, architectures in real world.
2. Illustrate diverse methods of deploying smart objects and connect them to network.
3. Compare different Application protocols for IoT.
4. Discuss sensor technologies used for sensing real world entities.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Interpret the impact and challenges posed by IoT networks leading to new architectural models.	1 to 5	1,3
CO2	Compare and contrast the deployment of smart objects and the technologies to connect them to network.	1 to 5	1,3
CO3	Identify the need for Data Analytics and Security in IoT.	1 to 5	1,3
CO4	Outline the role of IoT protocols for efficient network communication.	1 to 5	1,3
CO5	Identify different concepts of advanced of IoT in real time applications.	1 to 5	2,3
CO6	Analyze the data received through sensors in IOT.	1 to 5	2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√				
CO3			√			
CO4		√				
CO5			√			
CO6				√		

COURSE ARTICULATION MATRIX

CO#/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	3	3								3		3
CO2	2	3	3	3	3								3		3
CO3	2	3	3	3	2								3		3
CO4	2	3	2	3	2								3		3
CO5	3	3	2	3	3									3	3
CO6	3	2	3	3	3									3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Network Architectures: Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack. Smart Objects, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies.

UNIT – 2

Layers in IoT Systems: IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods.

UNIT – 3

Data and Analytics for IoT: An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of IOT Security, Common Challenges in OT Security, How IT and IOT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment.

UNIT – 4

Hardware in IoT Systems: IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino Programming. IoT Physical Devices and Endpoints - RaspberryPi: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi with Python, Wireless Temperature Monitoring System Using Pi, DS18B20 Temperature Sensor, Connecting Raspberry Pi via SSH, Accessing Temperature from DS18B20 sensors, Remote access to RaspberryPi, Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture, 10 Hours Smart City Security Architecture, Smart City Use-Case Examples.

TEXT BOOKS:

1. Raj Kamal, “Internet of Things: Architecture and Design Principles”, 1st Edition, McGraw Hill Education, 2017.
2. Srinivasa K G, “Internet of Things”, CENGAGE Leaning India, 2017.

REFERENCE BOOKS:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, 1st Edition, Pearson Education (Cisco Press Indian Reprint).
2. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014.

JOURNALS/MAGAZINES:

1. IEEE Wireless Communications
2. IEEE Sensors Journal
3. IEEE Communications Surveys and Tutorials
4. IEEE Intelligent Systems

5. IEEE Transactions on Wireless Communications
6. Proceedings of the IEEE
7. IEEE Transactions on Computers
8. ICT Express

SWAYAM/NPTEL/MOOCs:

1. Introduction to internet of things, Indian Institute of Technology, Kharagpur and NPTEL via Swayam
2. Introduction and Programming with IoT Boards (Coursera)
3. Software Architecture for the Internet of Things (Coursera)
4. Cybersecurity and the Internet of Things (Coursera)
5. MicroMasters® Program in Internet of Things (IoT)

SELF-LEARNINGEXERCISES:

1.Installation and working on the IDEs required

Course Title	Object Oriented Concepts with C++				Course Type		SC	
Course Code	B21ETS515	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

This course introduces the basic concepts of object oriented programming. Familiarizes with object creation and accessing members of object. OOP concepts such as data abstraction, information hiding(Encapsulation),overloadingoperations,inheritancemechanisms,virtual functions and friend functions are discussed. File I/O operations, Templates and exception handling mechanisms are also introduced.

COURSE OBJECTIVE (S):

1. Explain the basic concepts of objects and classes for a real world application.
2. Illustratetheuseofoperatoroverloading/functionoverloadingforgiven applications.
3. Demonstrate the use of inheritance in real world applications.
4. Describe I/O streams and Templates and Exception Handling.

COURSE OUTCOMES(COs)

On successful completion of this course; the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Apply the basic concepts of objects and classes for a real world application.	1 to 5, 9 , 10	1
CO2	Utilize operator overloading / function overloading in given real world applications.	1 to 5,9,10	2
CO3	Develop programs using Inheritance feature of object oriented programming.	1 to 5, 9, 10,11	1,2
CO4	Solve programs using I/O streams, Templates and Exception Handling.	1 to 5,9,10,11	1,3
CO5	Classify inheritance based on early and late binding, exception handling and generic programming in real world application.	1 to 5, 9, 10	2,3
CO6	Explain the concept of data security using access specifiers in building real world application.	1 to 5, 9 , 10	2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5		√				
CO6		√				

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	3	2				2	2			3		
CO2	2	2	2	2	1				2	2				3	
CO3	3	2	3	3	1				2	2	2		3	3	
CO4	3	2	3	3	1				2	2	2		3		3
CO5	3	2	3	3	1				2	2				3	3
CO6	2	2	3	2	1				2	2				3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction: Introduction to object oriented concepts: Encapsulation, Abstraction, Inheritance, Polymorphism, Overview of OOP, Introduction to object oriented modelling, Introduction to variables in C++, I/O operators, Function overloading, Inline function, Recursive function.

Classes & Objects: Introduction to Classes, Member Functions and Member data, Constructors and Destructors, Static Class members.

UNIT – 2

Operator over loading: Introduction to Objects, Array of Objects, Dynamic Objects, Pointers to objects, Friend Function, Access specifiers. The scope resolution operator, Generic functions and classes, Operator overloading using Friend function: Unary operator '+' & binary operator, Copy constructor.

UNIT – 3

Inheritance: Base Class, Inheritance and Protected members, inheriting multiple base classes, Constructors, Destructors and Inheritance, Virtual base classes. Virtual functions and Polymorphism: Virtual functions, pure virtual functions, Early and late binding.

UNIT – 4

Templates and Exception handling: Template Functions, Template Classes, Fundamentals of Exception handling, handling derived class exceptions.

TEXT BOOKS:

1.HerbertSchildt,"The Complete Reference C++",4thEdition,TataMcGrawHill,2003.

2.SanleyB.Lippmann,JoseeLajore,"C++Primer",4th Edition, Pearson Education,2005.

REFERENCE BOOKS:

1. PaulJDeitel, HarveyMDeitel, "C++ for Programmers", Pearson Education,2009.

2.KRVenugopal, Rajkumar Buyya,TRaviShankar,"Mastering C++",TataMcGrawHill, 1999.

3. ACM, ACM Transactionson Programming Languages and Systems(TOPLAS).

4.ACM Journal on Object-Oriented Programming

JOURNALS/MAGAZINES:

1. https://www.geeksforgeeks.org/introduction-of-object-oriented-programming/
2. https://www.geeksforgeeks.org/best-practices-of-object-oriented-programming-oop/
3. https://www.britannica.com/technology/object-oriented-programming
4. https://www.codeproject.com/Articles/22769/Introduction-to-Object-Oriented-Programming-Concepts

SWAYAM/NPTEL/MOOCs:

1. https://www.coursera.org/specializations/object-oriented-programming
2. https://www.coursera.org/lecture/writing-running-fixing-code/introduction-to-the-programming-environment-sXizU
3. https://www.coursera.org/learn/object-oriented-design

SELF-LEARNING EXERCISES:

1. I/O System Basics,
2. File I/O: C++ stream classes,
3. Formatted I/O,
4. <fstream> and File classes.

Course Title	Big data and Cloud Computing				Course Type		SC	
Course Code	B21ETS516	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

The system architecture, software environment, supporting technologies, and innovative applications of Cloud and Big Data systems are all covered in depth in this course. Students are provided a strong foundation and hands-on experience in order to make engineering decisions for commercial and science applications. The essential principles and important themes of Cloud and Big Data Systems are introduced in this course, including Cloud Computing models and platforms, virtualization, distributed file systems, , and Big Data processing frameworks (Apache Hadoop and Spark). This course will also cover contemporary technology developments and research in cloud computing and big data, with an emphasis on bridging the gap between data analytics and data-driven platforms.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Describe the basics of Cloud Computing and Big Data.
2. Demonstrate the use of Cloud Technologies for Big Data.
3. Illustrate the use of different Cloud-based services for Big Data handling.
4. Demonstrate the use of Spark Big Data platform for Big Data.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Understand the foundation of Big Data enabling Technologies used for the real world applications.	1 to 5,9 10,12	1,2
CO2	Make use of the concepts of Machine Learning to deal with Big Data applications.	1 to 5,9.10,12	1,2
CO3	Build various types of cloud infrastructures corresponding to the real world applications demanding the cloud services.	1 to 5,9,10,12	1,2,3
CO4	Compare and contrast Smart Clouds, Virtualization and Mashup Services in cloud computing.	1to 5,9,10,12	1,2
CO5	Understand the Distributed Functional Programming Model such as Spark to deal with Big Data applications.	1to 5,9,10,12	1,3
CO6	Build scalable applications based on Spark programming model to tackle real world big data problems.	1to 5,9,10,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3			√			
CO4		√				
CO5		√				
CO6			√			

COURSE ARTICULATION MATRIX

CO#/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2				3	3		1	3	3	
CO2	3	3	2	3	1				3	3		1	3	3	
CO3	3	3	2	3	3				3	3		1	3	3	3
CO4	3	3	2	3	1				3	3		1	3	3	
CO5	3	2	3	3	3				3	3		1	3		3
CO6	3	3	2	3	3				3	3		1		3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

Unit-1:

Big Data Science and Machine Intelligence: Enabling Technologies for Big Data Computing, Social-Media, Mobile Networks and Cloud Computing, Big Data Acquisition and Analytics Evolution, Machine Intelligence and Big Data Applications.

Unit-2:

Smart Clouds, Virtualization and Mashup Services: Cloud Computing Models and Services, Creation of Virtual Machines and Docker Containers, Cloud Architectures and Resources Management, Case Studies of IaaS, PaaS and SaaS Clouds, Mobile Clouds and Inter-Cloud Mashup Services.

Unit-3:

Introducing Big Data, Hadoop, and Spark: Introduction to Big Data, Distributed Computing, and Hadoop; Introduction to Apache Spark, Functional Programming Using Python.

Understanding the Spark Cluster Architecture: Anatomy of a Spark Application, Spark Applications Using the Standalone Scheduler, Deployment Modes for Spark Applications Running on YARN.

Unit-4:

Learning Spark Programming Basics: Introduction to RDDs, Loading Data into RDDs, Operations on RDDs. **Advanced Programming Using the Spark Core API:** Shared Variables in Spark, Partitioning Data in Spark, RDD Storage Options, Processing RDDs with External Programs, Data Sampling with Spark,
Understanding Spark Application and Cluster Configuration.

TEXT BOOKS

1. Hwang, Kai, and Min Chen. Big-data analytics for cloud, IoT and cognitive computing. John Wiley & Sons, 2017.
2. Aven, Jeffrey. Data Analytics with Spark Using Python. Addison-Wesley Professional, 2018.

REFERENCE BOOKS:

3. Kshetri, Nir, TorbjörnTorbjörnFredriksson, and Diana Carolina Rojas Torres. Big data and cloud computing for development: Lessons from key industries and economies in the global south. Routledge, 2017.
4. Kane, Frank. Frank Kane's Taming Big Data with Apache Spark and Python. Packt Publishing Ltd, 2017.
5. Luu, Hien. Beginning Apache Spark 2: with resilient distributed datasets, Spark SQL, structured streaming and Spark machine learning library. Apress, 2018.
6. Karau, Holden, et al. Learning spark: lightning-fast big data analysis. " O'Reilly Media, Inc.", 2015.

Sample Assignments for Internal Assessment:

Use Java Programming Language to complete the assignment.

Assignment	Description	Concepts
	Manufacturing	
Predictive maintenance	Big data can help predict equipment failure. Potential issues can be discovered by analyzing both structured data (equipment year, make, and model) and multi-structured data (log entries, sensor data, error messages, engine temperature, and other factors). With this data, manufacturers can maximize parts and equipment uptime and deploy maintenance more cost effectively. This data can be used to predict more than just equipment failure. For many manufacturing processes, it's also important to predict the remaining optimal life of systems and components to ensure that they perform within specifications. Falling out of tolerance—even if nothing is broken—can be as bad as failure. For example: in drug manufacturing a faulty, but still functional, component could introduce too much or too little of the active ingredient. **Challenges**: Companies must integrate data coming from different formats and identify the signals that will lead to optimizing maintenance.	Big Data and Cloud Computing

Operational efficiency	Operational efficiency is one of the areas in which big data can have the most impact on profitability. With big data, you can analyze and assess production processes, proactively respond to customer feedback, and anticipate future demands. **Challenges**: Data teams must balance the data volume with the growing number of sources, users, and applications.	Big Data and Cloud Computing
Production optimization	Optimizing production lines can decrease costs and increase revenue. Big data can help manufacturers understand the flow of items through their production lines and see which areas can benefit. Data analysis will reveal which steps lead to increased production time and which areas are causing delays. **Challenges**: Optimizing production requires manufacturers to analyze their production equipment data, material use, and other factors. Combining the different kinds of data can pose a challenge.	Big Data and Cloud Computing
Retail		
Product development	Big data can help you anticipate customer demand. By classifying key attributes of past and current products and then modeling the relationship between those attributes and the commercial success of the offerings, you can build predictive models for new products and services. Dig deeper by using the data and analytics from focus groups, social media, test markets, and early store rollouts to plan, produce, and launch new products. **Challenges**: Companies will have to analyze what can be a high volume of data coming in varying formats, and then create segments according to customer behavior. They will also have to identify sophisticated use patterns and behavior and map them to potential new offerings..	Big Data and Cloud Computing
Customer experience	The race for customers is on. Big data provides retailers with a clearer view of the customer experience that they can use to fine-tune their operations. By gathering data from social media, web visits, call logs and other company interactions, and other data sources, companies can improve customer interactions and maximize the value delivered. Big data analytics can be used to deliver personalized offers, reduce customer churn, and proactively handle issues. **Challenges**: Integrating a high volume of data from various sources can be difficult. Once the data is integrated, path analysis can be used to identify experience paths and correlate them with various sets of behavior.	Big Data and Cloud Computing

Healthcare		
Genomic research	Big data can play in a significant role in genomic research. Using big data, researchers can identify disease genes and biomarkers to help patient's pinpoint health issues they may face in the future. The results can even allow healthcare organizations to design personalized treatments. **Challenges**: The volume of genome data is enormous, and running complex algorithms on the data is complicated and can require long processing times.	Big Data and Cloud Computing
Patient experience and outcomes	Healthcare organizations seek to provide better treatment and improved quality of care—without increasing costs. Big data helps them improve the patient experience in the most cost-efficient manner. With big data, healthcare organizations can create a 360-degree view of patient care as the patient moves through various treatments and departments. **Challenges**: Improving the patient experience requires a large volume of patient data, some of which could be multi-structured data, such as doctor notes or images. Additionally, to analyze patient journeys, path and graph analyses are often needed.	Big Data and Cloud Computing
Healthcare billing analytics	Big data can improve the bottom line. By analyzing billing and claims data, organizations can discover lost revenue opportunities and places where payment cash flows can be improved. This use case requires integrating billing data from various payers, analyzing a large volume of that data, and then identifying activity patterns in the billing data. **Challenges**: Sifting through large volumes of data can be complicated, especially when it comes to integrating different data sources.	Big Data and Cloud Computing

Course Title	Cognitive Computing				Course Type		SC	
Course Code	B21ETS517	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

It represents self-learning systems that utilize Machine Learning models to mimic the way brain works. Eventually, this technology will facilitate the creation of automated IT models which are capable of solving problems without human assistance

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Identify how Artificial Intelligence, Machine Learning and Cognitive Computing are related together and are used for application development.
2. Identify, design and assess Cognitive Computing and Artificial Intelligence Applications use and requirements.
3. Prepare and formulate data collection, sampling, preprocessing for such systems

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Demonstrate a broad knowledge and clear understanding of critical concepts, practices and issues in Cognitive Computing and Artificial Intelligence Applications.	1 to 6	1,2
CO2	Explore the technical and managerial issues in developing and using applications based on cognitive computing and Artificial Intelligence Applications techniques.	1 to 6	1,2
CO3	Apply and assess Cognitive Computing and Artificial Intelligence Applications in an organizational setting	1 to 6	1,2
CO4	Understanding on different Perception and sensing data	1 to 6	1,2
CO-5	Design a Real-Time information Based Evacuation Decision support system for emergency Management	1 to 6	1,2
CO-6	Understand Current Trends and Research Issues and applications of Cognitive computing	1 to 6	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO-1		√	√			
CO-2			√	√		
CO-3			√			
CO-4		√	√			
CO-5			√			
CO-6		√				

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	1							3	3	
CO2	3	3	3	3	3	1							3	3	
CO3	3	3	2	2	2	1							3	3	
C04	2	3	2	2	3	1							3	3	
CO5	3	3	2	2	3	1							3	3	
CO6	2	3	2	3	3	1							3	3	

Note:1-**Low**,2-Medium,3-High

COURSE CONTENTS

THEORY:

UNIT-1

Cognitive Computing: Concepts, Architectures, Systems and Applications, Introduction, Interdisciplinary Nature of Cognitive science, Cognitive Computing Systems, Representation for Information and Knowledge, Cognitive Computing Architectures and Approaches, Cognitive Computing systems and Applications.

UNIT-2

Cognitive Computing and Neural Networks: Reverse Engineering the Brain: Introduction, Brain Scalability, Neocortical Brain Organization, Abstractions of Cortical Basic Circuits, Large-scale cortical simulations, Hardware Support for Brain Simulation, Deep Learning Networks.

UNIT-3

Complex Analytics and Machine Learning: Visual Analytics to Cognitive Computing, Time-Evolving Graphs, Visual Analytics Sandbox, Architecture, Case Study: Emerging Event Detection for Social Media, Real-Time information Based Evacuation Decision support system for emergency management, Forecasting Influenza

UNIT-4

Cognitive Analytics: Introduction, Evolution of Analytics and Core Themes, Types of Learning, Machine Learning Algorithms, Cognitive Analytics Applications, Current Trends and Research Issues.

TEXTBOOK:

1. Raghavan, Vijay V., Venkat N. Gudivada, Venu Govindaraju, and Calyampudi Radhakrishna Rao, "Cognitive computing: Theory and applications", Elsevier, 2016.
2. Vernon D, "Artificial cognitive systems: A primer", MIT Press; 2014 Oct 17.

REFERENCE BOOKS:

1. Ward T, Beech AR, "Aggressive offenders' cognition: Theory, research and practice", Gannon TA, Fisher D, editors. John Wiley & Sons; 2008 Feb 28.
2. Revlin R, "Cognition: Theory and practice", Macmillan; 2012 Feb 24.
3. Lassiter C, "Cognition Beyond the Brain: Computation, Interactivity, and Human Artifice", 2013.
4. Stork DG, Hennecke ME, "Speechreading by humans and machines: models, systems, and applications", Springer Science & Business Media; 2013 Nov 11.

JOURNAL/ MAGAZINES:

1. Cognitive computing: https://www.springer.com/journal/12559/

2. International Journal of Cognitive Computing in Engineering,

http://www.keaipublishing.com/en/journals/international-journal-of-cognitive-computing-in-engineering/

3. IEEE Transactions on Cognitive and Developmental Systems,

https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=7274989

SWAYAM/NPTEL/MOOC:

1. Swayam : Course Name : Fundamentals Of Artificial Intelligence, By Prof. Shyamanta M Hazarika, IIT Guwahati.
2. NPTEL: Course Name : Human Computer Interaction (HCI), unded by -MHRD, Govt. of India National Mission on Education Through Information and Communication Technology.
3. Coursera: Mind and Machine Specialization (https://www.coursera.org/specializations/mind-machine)

SELF-LEARNINGEXERCISES:

1. Cognitive function measurement tools and software.
2. Selected topics from research papers.

Course Title	Business Intelligence				Course Type		SC	
Course Code	B21ETS518	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

This course provides a useful insight to introduction to the concepts of business intelligence (BI) being as modules and functionality of data systems. It delves into how business challenges can be solved effectively by using operational data to establish data warehouses, and then utilizing data mining tools and analytics to achieve new perceptions into structural procedures. Exhaustive discussion of the analysis, design, and implementation of systems for BI, including the differences between types of reporting and analytics, enterprise data warehousing, data management systems, decision support systems, knowledge management systems, big data, and data/text mining. Case studies are used to study the use of application software, web tools, success, and limitations of BI as well as technical and social issues.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the turbulent business environment and describe how organizations survive.
2. Comprehend the need for computerized support of managerial decision making.
3. Describe the business intelligence methodology and concepts.
4. Discuss the various types of analytics.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Outline modern concepts, theories, and research in the field of Business Intelligence (BI).	1 to 4, 8, 9 , 12	1,2,3
CO2	Identify the different visualization techniques used to represent the real time data.	1 to 3, 5,9,12	1
CO3	Apply modern BI practices, including knowledge integration, sourcing, and managing BI solutions real time problems.	1 to 5, 9, 12	1,2,3
CO4	Make use of BI enabling technologies in organizational settings.	1,4,5,9,12	1
CO5	Categorize and assess consumer behavior and its influence on business decisions.	1 to 5	1,3
CO6	Apply big data technologies in business intelligence.	1 to 5	2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3			√			
CO4			√			
CO5				√		
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	3				2	2	2		1	3	3	3
CO2	2	2	2		3				3			1	3		
CO3	3	1	3	3	3				2			3	3	3	3
CO4	3			3	3				3			3	3		
CO5	2	3	3	3	3								3		3
CO6	3	3	3	2	3									3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

An overview of Business Intelligence, Analytics, and Decision Support: Changing Business environments and computerized Decision support, A framework for BI, Intelligence creation, Use, and BI Governance, Successful BI implementation, Analytics overview, Brief Introduction to Big Data Analytics.

Data Warehousing: Data Warehousing definitions and concepts, Data Warehousing process overview, Data Warehousing architectures, Data Warehousing development, Data integration and the extraction, transformation, and load process.

UNIT – 2

Business Reporting, Visual Analytics, and Business performance Management: Business Reporting definitions and concepts, Data and Information Visualization, Different types of Charts and Graphs, Performance Dashboards, Business Performance Management, Performance measurement, Balanced scoreboards, Six sigma as a Performance measurement system.

UNIT – 3

Text and Web Analytics: Text analytics and text mining overview, Natural language processing, Text Mining applications, Text mining process, Sentiment analysis, Search engines, Web Usage mining, Social Analytics.

Big Data Analytics: Big Data definition and technologies, Big data and data warehousing, Big data and stream analytics, Applications of stream analytics.

UNIT – 4

Business Analytics: Emerging Trends and Future Impacts: Location- based analytics for organizations, Analytics applications for consumers, The web 2.0 revolution and online social networking, Cloud computing and BI, **Impacts of analytics in organizations:** an overview, Issues of legality, privacy and ethics, An overview of the analytical ecosystem.

TEXTBOOKS:

1. Ramesh Sharda, Dursun Delen, Efraim Turban, "Business Intelligence: A Managerial Perspective on Analytics", Pearson Publications, 2018
2. Ramesh Sharda, Dursun Delen, Efraim Turban," Decision Support and Business Intelligence Systems", Pearson Publications, 2016

REFERENCEBOOKS:

1. GalitShmueli, Nitin R Patel, Peter C Bruce, "Data Mining for Business Intelligence", Wiley Publications, 2016
2. Carlo Vercellis, "Business Intelligence: Data Mining and Optimization for Decision Making", Wiley Publications, 2015
3. David Loshin Morgan, Kaufman, "Business Intelligence: The Savvy Manager‟s Guide", Second Edition, 2012.
4. Cindi Howson, "Successful Business Intelligence: Secrets to Making BI a Killer App", McGraw-Hill, 2007.
5. Ralph Kimball ,Margy Ross , Warren Thornthwaite, Joy Mundy, Bob Becker, "The Data Warehouse Lifecycle Toolkit", Wiley Publication Inc.,2007.
6. Larissa T. Moss, S. Atre, "Business Intelligence Roadmap: The Complete Project Lifecycle of Decision Making", Addison Wesley, 2003.

JOURNALS/MAGAZINES:

1. http://www.businessintelligence-book.com
2. https://ebooks.lpude.in/computer_application/mca/term_6/DCAP606_BUSINESS_INTELLIGENCE.pdf
3. https://www.researchgate.net/publication/226752489_Business_Intelligence/link/54ada0d70cf2828b29fcb06f/download
4. http://www.redbooks.ibm.com/pubs/pdfs/redbooks/sg245747.pdf
5. https://ppcexpo.com/Content/lecture02.pdf
6. http://www.biomedicahelp.altervista.org/Magistrale/Clinics/BIC_PrimoAnno/IdentificazioneModelliDataMining/Business%20Intelligence%20-%20Carlo%20Vercellis.pdf

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc20_mg24/preview
2. https://www.mooc-list.com/tags/business-analytics
3. https://www.my-mooc.com/en/categorie/business-intelligence
4. https://www.coursera.org/learn/business-intelligence-tools

SELF-LEARNINGEXERCISES:

1. Explore Decision Support for BI
2. More exploration on Data Mining and Optimization using BI
3. Data Visualization packages

Course Title	Industrial and Medical IoT				Course Type		SC	
Course Code	B21ETS519	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact	WorkLoad	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	Tutorial	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

The objective of the course is to introduce the industrial internet of things (IIoT) that refers to interconnected sensors, instruments, and other devices networked together with computers' industrial applications, including manufacturing and energy management. This connectivity allows for data collection, exchange, and analysis, potentially facilitating improvements in productivity and efficiency as well as other economic benefits. The IIoT is an evolution of a distributed control system (DCS) that allows for a higher degree of automation by using cloud computing to refine and optimize the process controls. Also, the IoT is described as a network of physical devices that uses connectivity to enable the exchange of data. IoT in healthcare facilitates mundane albeit important tasks to improve patient outcomes, and also takes some of the burden off health practitioners.

COURSE OBJECTIVE (S):

1. Assess the genesis and impact of IoT applications, architectures in real world.
2. Illustrate diverse methods of deploying smart objects and connect them to network.
3. Compare different Application protocols for IoT.
4. Infer the role of Data Analytics and Security in IoT.
5. Identify sensor technologies for sensing real world entities and understand the role of IoT in various domains of Industry.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Describe the architecture and applications of IoT System in real world	1,3,5	1,2
CO2	Outline the diverse methods of deploying smart objects and connect them to Industrial IoT.	4,5,6	2
CO3	Identify the various wearable sensors used in healthcare field.	3,5,9	2,3
CO4	Design an IoT system for healthcare monitoring forRemote Patient.	2,4,6	1,2,3
CO5	Identify various security threats and challenges in real world applications and obtain their potential solutions.	3,5,9	2,3
CO6	Identify various wireless routing protocols to transfer data from sensors.	3,5,9	2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember(L1)	Understand(L2)	Apply(L3)	Analyze(L4)	Evaluate(L5)	Create(L6)
CO1		✓				✓
CO2		✓	✓			✓
CO3		✓	✓			✓
CO4		✓	✓			✓
CO5			✓		✓	
CO6			✓		✓	

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		3		2								3	3	
CO2				3	3	3								3	
CO3			3		2				3					3	3
C04		3		3		3							3	3	3
3CO5				3		3								3	3
CO6			3		3				3					3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT-1

Introduction to the Industrial Internet: What Is the Industrial Internet? - Key IIoT Technologies - Why Industrial Internet and Why Now? - Adequately Skilled and Trained Staff - Innovation and the IIoT - Intelligent Devices - Key Opportunities and Benefits - The Digital and Human Workforce – Industrial Internet Use-Cases – Healthcare - Oil and Gas Industry - DDS data bus - Smart Office - Logistics and the Industrial Internet – Retail - IOT Innovations in Retail

UNIT-2

IIoT Reference Architecture: The IIC Industrial Internet Reference Architecture - Stakeholder PoV - Industrial Internet Viewpoints - Functional domains - Operational Domain - Operations to control domain - Information Domain - Application Domain - Business Domain - Architectural Topology - Three-tier architecture – Connectivity - OSI communication layers - Key System Characteristics - Data Management – Query - Advanced Data Analytics - Types and methods of analytics

Designing Industrial Internet Systems: Concept of the IIoT - Proximity Network - WSN Network Protocols - Low-Power Technologies - Designing Low-Power Device Networks - OSI table - Web 2.0 layers - Legacy Industrial Protocols - Field

Bus Technologies - Modern Communication Protocols - Wireless Communication Technologies – RFID - Proximity Network Communication Protocols

UNIT-3

Internet of Medical Things: Security Threats, Security Challenges, and Potential Solutions - Intelligent Transit Healthcare Schema Using Internet of Medical Things (IoMT) Technology for Remote Patient Monitoring. - Smart Assistance of Elderly Individuals in Emergency Situations at Home.

UNIT-4

Wearable Smart Devices: Wearable Sensors - Wearable Smart Devices for Remote Healthcare Monitoring to Detect Cardiac Diseases - Smart Wearable Devices for Remote Patient Monitoring in Healthcare 4.0.

TEXT BOOK:

1. Alasdair Gilchrist, “Industry 4.0 - The Industrial Internet of Things”, Apress, 2016.
2. Hemanth, D. Jude, Anitha, J., Tsihrintzis, George A. (Eds.), “Internet of Medical Things - Remote Healthcare Systems and Applications”, Springer International Publishing, 1st Edition, 2021.

REFERENCE BOOK:

1. Catarina I. Reis, Marisa da Silva Maximiano, “Internet of Things and Advanced Application in Healthcare Hardcover”, 2016.
2. Krishna Singh Mohamed Elhoseny Akansha Singh Ahmed Elngar, “Machine Learning and the Internet of Medical Things in Healthcare” ,Academic Press , 1st Edition.
3. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, 1 st Edition, Pearson Education (Cisco Press Indian Reprint).
4. Srinivasa K G, “Internet of Things”,CENGAGE Leaning India, 2017
5. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1 st Edition, VPT, 2014.
6. Raj Kamal, “Internet of Things: Architecture and Design Principles”, 1st Edition, McGraw Hill Education, 2017.

JOURNALS/MAGAZINES:

1. International Journal of Distributed Sensor Networks

2. IEEE Transaction on Artificial Intelligence and Internet of Things

3. International Journal of Information Communication Technologies and Human

SWAYAM/NPTEL/MOOCS:

1. Hands-on Internet of Things, Coursera
2. An Introduction to Programming the Internet of Things (IOT), Coursera

SELF LEARNING EXERCISES:

Case studies for implanted medical devices, powering wireless SHM sensor nodes

Course Title	Cyber Physical Systems				Course Type		SC	
Course Code	B21ETS520	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact	Work Load	Total Number of Classes		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	Tutorial	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

The objective of the course is to introduce students to the emerging domain of cyber physical systems, Principles of Automated Control Design, CPS Performance Analysis, security and application of CPS.

COURSE OBJECTIVE (S):

1. Explain the basic principles and hardware platforms of CPS
2. Illustrate the controller design techniques of CPS
3. Discuss the performance analysis of CPS
4. Demonstrate the security mechanism and applications of CPS

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Summarize the basic principles and hardware platforms of Cyber Physical System.	1,3,5	1,2
CO2	Illustrate the controller design techniques of Cyber Physical System.	4,5	2,3
CO3	Identify the performance analysis of Cyber Physical System.	3,5	2,3
CO4	Outline the security mechanism and applications of Cyber Physical System.	2,4	2,3
CO5	Identify the Formal Methods for Safety Assurance of Cyber Physical System.	1,3,4,6	1,2
CO6	Analyze the stability of Cyber Physical System in various real world scenarios.	1,3,5	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember(L1)	Understand(L2)	Apply(L3)	Analyze(L4)	Evaluate(L5)	Create(L6)
CO1		✓				
CO2		✓				
CO3		✓	✓			
CO4		✓				
CO5			✓			
CO6				✓		

COURSE ARTICULATIONMATRIX

CO#/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		3		2								3	3	
CO2				3	3									3	3
CO3			3		2									3	3
C04		3		3										3	3
CO5	3		3	2		3							3	3	
CO6	3		2		3								3	3	

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT-1

Introduction to Cyber-Physical Systems: Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, CPS HW platforms: Processors, Sensors, Actuators, CPS Network, CPS SW stack RTOS, Scheduling Real Time control tasks.

UNIT-2

Principles of Automated Control Design: Dynamical Systems and Stability, Controller Design Techniques. Stability Analysis: CLFs, MLFs, stability under slow switching, Performance under Packet drop and Noise, CPS: From features to software components, Mapping software components to ECUs.

UNIT-3

CPS Performance Analysis: Effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, Formal Methods for Safety Assurance of Cyber-Physical Systems, Formal Analysis: Flow pipe construction, reachability analysis, Analysis of CPS Software: Weakest Pre-conditions, Bounded Model checking.

UNIT-4

Applications and Security: CPS SW Verification: Frama-C, CBMC Secure Deployment of CPS: Attack models, Secure Task mapping and Partitioning, State estimation for attack detection, Automotive Case study: Vehicle ABS hacking, Power Distribution Case study: Attacks on Smart Grids

TEXT BOOKS:

1. Raj Rajkumar, Dionisio De Niz and Mark Klein, "Cyber-Physical Systems", Addison-Wesley Professional, 2016
2. Rajeev Alur, "Principles of Cyber-Physical Systems," MIT Press, 2015.
3. E. A. Lee and S. A. Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", 2011.
4. Walid M. Taha, Abd-Elhamid M. Taha and Johan Thunberg, "Cyber-Physical Systems: A Model-Based Approach", Springer 2020
5. Andre Platzer, "Logical foundations of Cyber-Physical System", Springer 2018

REFERENCE BOOKS:

1. Andre Platzer, "Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics", Springer, 2010
2. Jean J. Labrosse, "Embedded Systems Building Blocks", CRC press 2011.
3. T. D. Lewis "Network Science: Theory and Applications", Wiley, 2009.
4. P. Tabuada, "Verification and control of hybrid systems: a symbolic approach", Springer-Verlag 2009.
5. C. Cassandras, S. Lafortune, "Introduction to Discrete Event Systems", Springer 2007.
6. Constance Heitmeyer and Dino Mandrioli, "Formal methods for real-time computing", Wiley publisher, 1996.

SWAYAM/NPTEL/MOOCS:

1. Cyber-Physical Systems: Modeling and Simulation, Coursera

JOURNALS/MAGAZINES:

1. Hiroshi Fuketa; Kunio Uchiyama ,Edge Artificial Intelligence Chips for the Cyberphysical Systems Era , 13 January 2021 ,IEEE, DOI: 10.1109/MC.2020.3034951
2. Teng Liu; ,Cyber-Physical-Social System for Parallel Driving: From Concept to Application, 21 September 2020,IEEE, DOI: 10.1109/MITS.2020.3014079

SELF LEARNING EXERCISES:

Machine Learning in Cyber-Physical Systems

Course Title	Advanced Computer Architecture				Course Type		SC	
Course Code	B21ETS521	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weight age	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

The course provides an elaborate idea about the Parallelism concepts in Programming, different memory systems and buses, advanced processor architectures, importance of multiprocessor and multi computers and data flow computer architectures

COURSE OBJECTIVE (S):

The objectives of the course are to;

1. Make students know about the Parallelism concepts in Programming
2. Give the students an elaborate idea about the different memory systems and buses.
3. vIntroduce the advanced processor architectures to the students.
4. Make the students know about the importance of multiprocessor and multi computers.
5. Study about data flow computer architectures

COURSE OUTCOMES (COs)

On successful completion of this course; the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Demonstrate concepts of parallelism in hardware/software.	1 to 5	1,2
CO2	Illustrate memory organization and mapping techniques.	1 to 5	1,2
CO3	Identify architectural features of advanced processors.	1 to 5	1,2
CO4	Compare the performance of pipelining and non pipelining environment in a processor	1 to 5	1,2
CO5	Outlinethe concepts of pipelining, instruction set architectures and memory addressing.	1 to 5	1,2
CO6	Summarize different message passing mechanisms in multi processing architectures.	1 to 5	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√				
CO3			√			
CO4		√				
CO5		√				
CO6		√				

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	1								3	3	
CO2	3	2	3	1	1								3	3	
CO3	2	3	2	1	2								3	3	
CO4	3	2	3	2	1								3	3	
CO5	3	3	2	1	3								3	3	
CO6	3	2	2	1	3								3	3	

Note:1-Low,2-Medium,3-High

UNIT – 1

PARALLEL COMPUTER MODELS: Evolution of Computer architecture, system attributes to performance, Multi processors and multi computers, Multi-vector and SIMD computers, PRAM and VLSI models-Parallelism in Programming, conditions for Parallelism-Program Partitioning and Scheduling-program flow Mechanisms-Speed up performance laws-Amdahl's law, Gustafson's law-Memory bounded speedup Model.

UNIT – 2

MEMORY SYSTEMS AND BUSES: Memory hierarchy-cache and shared memory concepts-Cache memory organization-cache addressing models, Aliasing problem in cache, cache memory mapping techniques-Shared memory organization-Interleaved memory organization, Lower order interleaving, Higher order interleaving. Back plane bus systems-Bus addressing, arbitration and transaction.

UNIT – 3

ADVANCED PROCESSORS: Instruction set architectures-CISC and RISC scalar processors-Super scalar processors-VLIW Architecture- Multi vector and SIMD computers-Vector processing principles-Cray Y-MP 816system-Inter processor communication

UNIT – 4

MULTI PROCESSOR AND MULTI COMPUTERS: Multiprocessor system interconnects- Cross bar switch, Multiport memory-Hot spot problem, Message passing mechanisms-Pipelined processors-Linear pipeline, on linear pipeline-Instruction pipeline design-Arithmetic pipeline design.

TEXTBOOKS:

1. Kai Hwang, Advanced Computer architecture Parallelism , scalability ,Programmability ‖ Mc Graw Hill, N.Y, 2003
2. Kai Hwang and F.A.Briggs, Computer architecture and parallel processor, Mc Graw Hill, N.Y, 1999

REFERENCEBOOKS:

1. David A. Paerson and John L. Hennessey, —Computer organization and design Elsevier, Fifth edition, 2014.
2. www.sci.tamucc.edu/~sking/Courses/COSC5351/syllabus.php

JOURNALS/MAGAZINES:

1. https://engineering.lehigh.edu/cse/academics/course-index/cse-202-computer-organization-and architecture-3
2. https://www.computer.org/csdl/magazine/co/1977/12/01646340/13rRUwInvnA
3. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=10208

SWAYAM/NPTEL/MOOCs:

1. https://www.classcentral.com/course/swayam-computer-organization-and-architecture-a-pedagogical-aspect-9824
2. https://onlinecourses.nptel.ac.in/noc20_cs25/preview
3. https://www.edx.org/course/computation-structures-2-computer-architecture-2

SELF-LEARNING EXERCISES:

1. Data flow computer architectures-Static
2. Dynamic-VLSI Computing Structures-Systolic array architecture
3. Mapping algorithms into systolic arrays

Course Title	Parallel Computing and High Performance Computing				Course Type		SC	
Course Code	B21ETS522	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

This course provides foundations for developing parallel algorithms. It focuses on types of parallelism and Flynn's classification of Computer Architectures. It provides a practical feeling of how algorithms map to and behave on real systems and supplement algorithmic theory with hands-on exercises on modern HPC systems, such as CUDA for graphics co-processors (Graphics Processing Unit).

COURSE OBJECTIVE (S):

The objectives of this course are to

1. Explain the basic concepts related to HPC architecture and parallel computing.
2. Illustrate the use of CUDA concepts in real world applications.
3. Describe the concepts of NVIDIA SLI.
4. Discuss different Parallel algorithms and their applications in real world examples.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Outline the basic concepts related to HPC architecture and parallel computing.	1 to 4, 8, 9 , 12	1
CO2	Illustrate the concepts of CUDA for scientific computations.	1 to 3, 5,9,12	1
CO3	Make use of concepts of NVIDIA SLI in real world applications.	1 to 5, 9, 12	2
CO4	Analyse performance of different parallel algorithms.	1,4,5,9,12	1
CO5	Develop and test parallel computing solutions to real world programming problems.	1,5,9,12	1
CO6	Demonstrate the architectural features in the GPU hardware accelarators.	1,5,8,9,12	1

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√				
CO3			√			
CO4				√		
CO5			√			
CO6		√				

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1	3		
CO3	3	1	2	1	2				1			1		3	
CO4	3			2	2				1			1	3		
CO5	3				2				1			1	3		
CO6	3				2			1	1			1	3		

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT-1

Parallel Processing Concepts: Levels of parallelism –Bit, instruction; Data, transaction; task; thread; memory; function; Flynn's Classification of Computer Architectures: SISD, SIMD, MISD, MIMD. Dataflow Models, Demand-driven Computation, Introduction to superscalar architectures; multi-core; multi-threaded.

UNIT-2

Parallel Programming with CUDA: Processor Architecture; Interconnect; Communication; Memory Organization; and Programming Models in high performance computing architecture Memory hierarchy and transaction specific memory design ; Thread Organization. Heterogeneous Computing; Blocks; Threads; Indexing Shared memory sync threads (); Asynchronous operation; Handling errors; Managing devices.

UNIT-3

NVIDIA SLI: What is SLI? , Choosing SLI Modes, Avoid CPU Bottlenecks, Disable VSync by Default, DirectX SLI Performance Tips, OpenGL SLI Performance Tips. **Multi-GPU Performance:** Moving to Multiple GPUs, Subdividing

Computation across Multiple GPUs, Peer-to-Peer Communication on Multiple GPUs, Finite Difference on Multi-GPU, Scaling Applications across GPU Clusters

UNIT 4

Parallel Algorithms and Applications: Numerical Algorithms: Dense Matrix Algorithms -Matrix-Vector Multiplication, Matrix-Matrix Multiplication, Solving a System of Linear Equations; Non-numerical algorithms: Sorting: Bubble Sort and its Variants and Quicksort

TEXTBOOKS:

1. Nielsen, Frank, "Introduction to HPC with MPI for Data Science" , Springer, 2nd Edition, 2016
2. Ananth Grama, Anshul Gupta, George Karypis, and VipinKumar, "Introduction to Parallel Computing", 2nd edition, Addison-Welsey, 2003.
3. Grama, A. Gupta, G. Karypis, V. Kumar, "An Introduction to Parallel Computing, Design and Analysis of Algorithms" Addison-Wesley, 2nd Edition, 2003.
4. NVIDIA GPU Programming Guide Version 2.5.0, by NVIDIA Corporation, 2006.
5. John Cheng, Max Grossman ,Ty McKercher, "PROFESSIONAL CUDA C Programming" , John Wiley & Sons, Inc,.2014
6. Kai Hwang , "Advanced Computer Architecture: Parallelism, Scalability, Programmability", McGraw Hill 1993

REFERENCEBOOKS:

1. J. Dongarra, I. Foster, G. Fox, W. Gropp, K. Kennedy, L. Torczon, A. White, "The Sourcebook of Parallel Computing", Morgan Kaufmann, 1st Edition, 2002.
2. G.S. Almasi and A. Gottlieb, "Highly Parallel Computing", 2ndEdition, Addison-Wesley, 1994.
3. Wilkinson and M. Allen, "Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers", Prentice Hall,2nd Edition, 2005.
4. M.J. Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw-Hill, 2004.
5. G.E. Karniadakis, R.M. Kirby II, "Parallel Scientific Computing in C++ and MPI: A Seamless Approach to Parallel Algorithms and their Implementation", Cambridge University Press, 2003

JOURNALS/MAGAZINES:

1. Elsevier Journal on high performance computing for Big data.
2. Elsevier Journal on Parallel Computing

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/106/102/106102114/
2. https://onlinecourses.nptel.ac.in/noc19_cs45/preview

SELF-LEARNINGEXERCISES:

Open-MP, Open MPI, Quantum computing.

Open elective-I:

Course Title	Database Management System				Course Type		OE	
Course Code	B21CSO501	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**-**	**50**	**50**

COURSE OVERVIEW:

This course introduces topics such as conceptual data modelling, relational data model, relational query languages, and relational database design. It helps the students to gain fundamental concepts, techniques and applications in database.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the basics of Database Management System.
2. Demonstrate the use of Relational model and Relational algebra.
3. Illustrate the use of different SQL statements.
4. Discuss the topics such as Database Design and Normalization.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSO
CO1	Design conceptual entity relationship diagrams for the real world applications.	1 to 5, 10,12	1,2
CO2	Make use of the concepts of relational algebra to solve queries over database.	1 to 5,12	1,2
CO3	Construct the database for given real world application and solve queries over it using SQL commands.	1 to 5,12	1,2, 3
CO4	Develop an optimized database using design guidelines and normalization technique.	1,to 5,12	1,2
CO5	Construct the physical and logical database designs, database modeling, relational, hierarchical, and network models.	1to 5,12	1,3
CO6	Relate conceptual model to relational model and formulate relational algebra	1to 5,12	2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6		√				

COURSE ARTICULATION MATRIX

CO#/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2					1		1	3	3	
CO2	3	3	2	3	1							1	3	3	
CO3	3	3	2	3	3							1	3	3	3
CO4	3	3	2	3	1							1	3	3	
CO5	3	2	3	3	3							1	3		3
CO6	3	3	2	3	3							1		3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to databases and Conceptual Modelling: Introduction to database, characteristics of the database approach, data models, schemas, instances, database languages and interfaces, Using high-level conceptual data models for database design, a sample database application, entity types, attributes, keys, relationship types, weak entity types, ER diagrams, naming conventions, design issues. Introduction to various database tools and framework (commercial and open source)

UNIT – 2

Relational Data Model and Relational algebra: Relational model concepts, relational model constraints and relational database schemas, update operations, transactions, dealing with constraint violations, unary relational operations, select and project, relational algebra operations from set theory, binary relational operations, join and division, additional relational operations, examples of queries in relational algebra.

UNIT – 3

SQL:SQL data definition and data types, specifying constraints in SQL, basic retrieval queries in SQL, insert, delete, update statements in SQL, additional features of SQL, schema change statements in SQL, Retrieving data using the SQL Select Statement, Restricting and sorting data, Using Single row functions, Joins, More complex SQL retrieval queries, views in SQL.

UNIT – 4

Database Design Theory and Normalization: Informal design guidelines for relation schemas, Functional dependencies, and Normal forms based on primary keys, General definitions of second and third normal forms, Other Normal forms.

TEXTBOOKS:

1. Elmasri and Navathe,"Fundamentals of Database Systems", Pearson Education, 5th Edition, 2007.
2. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems", McGraw-Hill, 3rd Edition, 2003.
3. Phill Pratt, "Concepts of Database Management, Cengage Learning", 8th Edition, 2014
4. Jeffrey A Hoffer, "Modern Database Management, Pearson", 12th Edition, 2015

REFERENCEBOOKS:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan: "Database System Concepts", 6th Edition, McGraw Hill, 2010.
2. C J Date, "Database Design and Relational Theory: Normal Forms and All that Jazz", O 'Reilly, April 2012.
3. James Martin, "Principles of Database Management Systems", 1985, Prentice Hall of India, New Delhi
4. IEEE Transactions on Knowledge and Data Engineering
5. Elsevier Data and Knowledge Engineering
6. ACM Transactions on Database Systems

JOURNALS/MAGAZINES:

1. http://www.ijstr.org/final-print/june2019/Database-Management-System.pdf
2. https://www.dbjournal.ro/

SWAYAM/NPTEL/MOOCs:

1. https://www.coursera.org/courses?query=database%20management
2. https://onlinecourses.swayam2.ac.in/cec19_cs05/preview
3. https://www.edx.org/learn/databases
4. https://www.classcentral.com/course/swayam-data-base-management-system-9914

SELF-LEARNINGEXERCISES:

1. MONGODB
2. Transaction and concurrency control
3. UML

Course Title	Predictive Analytics and Data Visualization Tools				Course Type		HC	
Course Code	B21ET0502	Credits	2		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	2	2	2	**26**	**-**	**50**	**50**

COURSE OVERVIEW:

This course aims to build computational abilities, inferential thinking, and practical skills for tackling core data scientific challenges. It explores foundational concepts in data management, processing, statistical computing, and dynamic visualization using modern programming tools and agile web-services. After completion of the course student will be able to apply specific statistical and regression analysis methods applicable to predictive analytics and identify new trends and patterns, uncover relationships, create forecasts, predict likelihoods, and test predictive hypotheses.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. To extend student's knowledge in the area of Data Science with emphasis on Predictions utilizing associated statistical methods and software tools.
2. Gain understanding of the computational foundations in Big Data Science.
3. Develop critical inferential thinking.
4. Gather a tool chest of R libraries for managing and interrogating raw and derived, observed, experimental, and simulated big healthcare datasets.
5. Possess practical skills for handling complex datasets.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Make use of the concepts of visualisation in real world applications	1 to 5	1
CO2	Apply specific statistical and regression analysis methods applicable to predictive analytics	1 to 5	1,2
CO3	Identify various regression models for a given application.	1 to 5	3
CO4	Develop various quantitative and classification predictive models based on various regression and decision tree methods	1 to 5	3
CO5	Evaluate exploratory data analysis using visualization	1 to 5	1,3
CO6	Apply data transformations such as aggregation and filtering for visualization.	1 to 5	2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5					√	
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	1	2	2				3	3			3		
CO2	2	2	3	2	2				3	3			3	3	
CO3	3	1	2	1	2				3	3					3
CO4	3	2	2	2	2				3	3					3
CO5	2	2	3	2	2				3	3			3	3	
CO6	3	2	2	2	2				3	3				3	

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT-1

Introduction to Data Acquisition – Applications –Process- Data Extraction- Data Cleaning and Annotation- Data Integration -Data Reduction- Data Transformation –Visualization-Introduction - Terminology- Basic Charts and Plots- Multivariate Data Visualization- Data Visualization Techniques– Pixel-Oriented Visualization Techniques- Geometric Projection Visualization Techniques- Icon-Based Visualization Techniques- Hierarchical Visualization Techniques Visualizing Complex Data and Relations

UNIT-2

Data Visualization Tools– Rank Analysis Tools- Trend Analysis Tools- Multivariate Analysis Tools- Distribution Analysis Tools- Correlation Analysis Tools- Geographical Analysis Tools.

UNIT-3

Regression model building framework: Problem definition, Data pre-processing; Model building; Diagnostics and validation Simple Linear Regression: Coefficient of determination, Significance tests, Residual analysis, confidence and Prediction intervals.

UNIT-4

Multiple Linear Regression: Coefficient of multiple coefficient of determination, Interpretation of regression coefficients, Categorical variables, Heteroscedasticity, Multi-collinearity, outliers, Auto regression and transformation of variables, Regression model building.

TEXTBOOKS:

1. Andy Kirk, "Data Visualization A Handbook for Data Driven Design" , Sage Publications, 2016

2. Philipp K. Janert, "Gnuplot in Action, Understanding Data with Graphs", Manning Publications, 2010.

REFERENCEBOOKS:

1. Alberto Cordoba, "Understanding the Predictive Analytics Lifecycle", Wiley, 2014.

2. Eric Siegel, Thomas H. Davenport, "Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die", Wiley, 2013.

3. James R Evans, "Business Analytics – Methods, Models and Decisions", Pearson 2013.

4. R. N. Prasad, Seema Acharya, "Fundamentals of Business Analytics", Wiley, 2015.

JOURNALS/MAGAZINES:

1. Data Science, Machine Learning and AI programme (upgrad.com)
2. IEEE, IEEE Transactions on Knowledge and Data Engineering.
3. Elsevier, Elsevier Data and Knowledge Engineering

SWAYAM/NPTEL/MOOCs:

1. https://www.coursera.org/courses?query=predictive%20analytics
2. https://www.coursera.org/learn/data-analyze-visualize

SELF-LEARNINGEXERCISES:

Defining data visualization; Visualization workflow: describing data visualization workflow, process in practice; Data Representation.

Course Title	Artificial Intelligence and Applications lab				Course Type		HC	
Course Code	B21ET0503	Credits	1		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	-	-	-				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**1**	**2**	**2**	**-**	**26**	**25**	**25**

COURSE OVERVIEW:

Artificial intelligence and applications is broad and fast growing sub-field of computer science concerned with the intelligence demonstrated by machines, in contrast to the intelligence displayed by humans. This course covers all the foundation skills necessary to start the Artificial Intelligence and applications with implementation in Python. Python is a open-source language with a simple syntax, and a powerful set of libraries. It is an interpreted language, with a rich programming environment. It is widely used in many scientific areas for data exploration, traversal method, artificial intelligence gaming applications, NLP, string concepts.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. To learn the basic programming concepts in python.
2. To practice various operations like list operations, lists methods, set operations, matrix etc.
3. To understand the traversal approaches using python.
4. To acquire artificial intelligence and application skills in python.
5. To implement gaming applications using python.
6. To use string and NLP concepts using python.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Understand and execute simple python programs.	1 to 5	1,2
CO2	Implement list, set, matrix programs using python.	1 to 5	1,2,3
CO3	Apply python programs for traversal approach.	1 to 5,9,10,12	1,2,3
CO4	Make Use of artificial intelligence applications using python.	1 to 5,9,10,12	1,2,3
CO5	Illustrate appropriate skill for the development of gaming problems using python.	1 to 5,9,10,12	1,2,3
CO6	Analyze the application of Natural Language Processing.	1 to 5,9,10,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6				√		

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	2								3		2
CO2	3	3	3	1	3								3	1	3
CO3	3	3	3	1	3				2	1		2	3	2	3
CO4	3	2	3	1	3				2	1		2	3	2	3
CO5	3	3	3	2	3				3	2		3	3	3	3
CO6	3	1	1	1	2				2	1		2	3	1	2

Note:1-Low,2-Medium,3-High

PRACTICE:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	(a). Write a python program to print the multiplication table for the given number? (b). Write a python program to check whether the given number is prime or not? (c) Write a python program to find factorial of the given number?	Windows/Linux OS, IDE, Jupyter	Get acquainted with Python Basics
2.	Write a python program to implement simple Chatbot?	Windows/Linux OS, IDE, Jupyter	Create a chatbot
3.	(a) Write a python program to implement List operations (Nested List, Length, Concatenation, Membership, Iteration, Indexing and Slicing)? (b) Write a python program to implement List methods (Add, Append, Extend & Delete).	Windows/Linux OS, IDE, Jupyter	Create and perform operations on list.

4.	(a). Write a python program to Illustrate Different Set Operations? (b). Write a python program to generate Calendar for the given month and year? (c). Write a python program to implement Simple Calculator program?	Windows/Linux OS, IDE, Jupyter	Create and perform operations on list.
5.	(a). Write a python program to Add Two Matrices. (b). Write a python program to Transpose a Matrix.	Windows/Linux OS, IDE, Jupyter	Create and perform operations on list.
6.	Write a python program to implement Breadth First Search Traversal?	Windows/Linux OS, IDE, Jupyter	Create and perform operations on
7	Write a python program to implement Water Jug Problem?	Windows/Linux OS, IDE, Jupyter	Create and perform operations on list.
8	(a) Write a python program to remove punctuations from the given string? (b) Write a python program to sort the sentence in alphabetical order?	Windows/Linux OS, IDE, Jupyter	Create and perform operations on strings
9	Write a program to implement Hangman game using python.	Windows/Linux OS, IDE, Jupyter	Implement a gaming application
10	Write a program to implement Tic-Tac-Toe game using python.	Windows/Linux OS, IDE, Jupyter	Implement a gaming application
11	(a) Write a python program to remove stop words for a given passage from a text file using NLTK? (b) Write a python program to implement stemming for a given sentence using NLTK? (c) Write a python program to POS (Parts of Speech) tagging for the give sentence using	Windows/Linux OS, IDE, Jupyter	Implement an NLP application
12	(a) Write a python program to implement Lemmatization using NLTK? (b) Write a python program to for Text Classification for the give sentence using NLTK?	Windows/Linux OS, IDE, Jupyter	Implement an NLP application

TEXTBOOKS:

1. Russell &Norvig, “Artificial Intelligence: A Modern Approach”, Third Edition, Prentice-Hall, 2010.

2. Elaine Rich, Kevin Knight, ”Artificial Intelligence”, 3rdedition, Tata Mcgraw Hill, 2009.

Course Title	Predictive Analytics and Data Visualization Tools Lab				Course Type		HC	
Course Code	B21ET0504	Credits	1		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	-	-	-				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**1**	**2**	**2**	**-**	**26**	**25**	**25**

COURSE OVERVIEW:

This course aims to build computational abilities, inferential thinking, and practical skills for tackling core data scientific challenges. It explores foundational concepts in data management, processing, statistical computing, and dynamic visualization using modern programming tools and agile web-services. After completion of the course student will be able to apply specific statistical and regression analysis methods applicable to predictive analytics and identify new trends and patterns, uncover relationships, create forecasts, predict likelihoods, and test predictive hypotheses.

COURSE OBJECTIVE (S):

The objectives of this course are to:

6. Extend student's knowledge in the area of Data Science with emphasis on Predictions utilizing associated statistical methods and software tools.
7. Learn theories, techniques, strategies and tools for constructing information visually.
8. Develop critical inferential thinking.
9. Develop an iterative approach to evolve and test visualization methods.
10. To analyze data analytics using decision tree, cluster.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Understand the scatter plot for processing in data analytics.	1 to 5	1
CO2	Apply data visualization and visual presentation of data for effective communications.	1 to 5,9,10,12	1,2,3
CO3	Illustrate the knowledge of plotting in visualization analytics.	1 to 5	1,2,3
CO4	Identify the dot plotting methods in data visualization.	1 to 5	1,2,3
CO5	Evaluate Box and whisker method in data visualization.	1 to 5	1,2,3
CO6	Analyze opportunity for application of decision tree, cluster, different types of charts, multidimensional, graphs in data visualization techniques	1 to 5,9,10,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6				√		

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	2								2		
CO2	3	2	2	1	2				1	1		1	1	1	2
CO3	3	2	3	1	2								1	2	3
CO4	3	2	3	1	2								1	2	3
CO5	3	2	3	1	3								1	1	2
CO6	3	3	3	2	3				3	2		3	3	3	3

Note:1-Low,2-Medium,3-High

PRACTICE:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	Part-A		
1.	a. Create a scatter plot of *y* vs. *x* with varying marker size and/or color.	Windows/Linux OS, IDE, Jupyter	Scatter plot
2.	a).Create a data representation using categorical and hierarchical chart type for a table containing employee details	Windows/Linux OS, IDE, Jupyter	Chart types in data visualization and analytics

<table>
<tr><td>3.</td><td>Demonstrate 3D plotting
A survey was carried out among women aged 30 to 80 from 10 different cities. The aim of this survey was to find out how many of these women were married, widowed, or divorced. The table below is the result of this
surv
<table><tr><th>Cities</th><th>Married</th><th>Divorced</th><th>Widowed</th></tr><tr><td>Los Angeles</td><td>893</td><td>191</td><td>175</td></tr><tr><td>Chicago</td><td>902</td><td>419</td><td>134</td></tr><tr><td>Houston</td><td>252</td><td>448</td><td>124</td></tr><tr><td>Phoenix</td><td>407</td><td>231</td><td>150</td></tr><tr><td>Philadelphia</td><td>927</td><td>153</td><td>123</td></tr><tr><td>San Antonio</td><td>763</td><td>464</td><td>104</td></tr><tr><td>San Diego</td><td>669</td><td>487</td><td>127</td></tr><tr><td>Texas</td><td>282</td><td>270</td><td>168</td></tr><tr><td>California</td><td>163</td><td>294</td><td>174</td></tr><tr><td>Florida</td><td>471</td><td>108</td><td>139</td></tr></table></td><td>Windows/Linux OS, IDE, Jupyter</td><td>Plotting in in data visualization and analytics</td></tr>
<tr><td>4.</td><td>The table below describes the average number and types of pizzas ordered from a pizza store in a week. Draw a dot plot for the table.
<table><tr><th>Day</th><th>Bacon</th><th>Cheese</th><th>Pepperoni</th></tr><tr><td>Monday</td><td>478</td><td>112</td><td>148</td></tr><tr><td>Tuesday</td><td>492</td><td>199</td><td>141</td></tr><tr><td>Wednesday</td><td>180</td><td>485</td><td>102</td></tr><tr><td>Thursday</td><td>246</td><td>407</td><td>172</td></tr><tr><td>Friday</td><td>777</td><td>112</td><td>102</td></tr><tr><td>Saturday</td><td>498</td><td>305</td><td>173</td></tr><tr><td>Sunday</td><td>300</td><td>376</td><td>182</td></tr></table></td><td></td><td>Dot plotting in data visualization</td></tr>
<tr><td>5.</td><td>David and Bryan are both sales attendants at a Phone shop. At the end of each month, they record the number of phones sold. By the end of the year, they both submitted their sales record, and they made the following number of sales.

David: 51, 17, 25, 39, 7, 49, 62, 41, 20, 6, 43, 13.

Bryan: 30, 56, 23, 65, 42, 61, 54, 17, 21, 34, 3, 16.

1. Arrange the monthly sales made by David and Bryan in a tabular form.
2. Give a five-number summary of David and Bryan’s sales.
3. Make a box and whisker plots describing the sales made by David and Bryan.</td><td></td><td>Box and whisker method in data visualization.</td></tr>
<tr><td></td><td colspan="3">Part-B</td></tr>
<tr><td>1.</td><td>Consider a table showing students’ average test scores for each subject offered. Plot a filled radar chart for the test scores and use the graph to determine the class with the highest score in each of the subjects.</td><td>Windows/ Linux OS, IDE, Jupyter</td><td>Radar char</td></tr>
</table>

<table>
<tr><td>2</td><td>Perform prediction using decision tree algorithm</td><td>Windows /Linux OS, IDE, Jupyter</td><td>Decision tree based prediction</td></tr>
<tr><td>3</td><td>Prediction using Unsupervised Machine Learning to predict the optimum number of clusters and visualize it graphically.</td><td>Windows /Linux OS, IDE, Jupyter</td><td>Cluster prediction</td></tr>
<tr><td>4</td><td>b.Develop a scatter plot of y vs. x with varying marker size and/or color.
The plot function will be faster for scatterplots where markers don't vary in size or color.
Any or all of x, y, s, and c may be masked arrays, in which case all masks will be combined and only unmasked points will be plotted.
Fundamentally, scatter works with 1D arrays; x, y, s, and c may be input as N-D arrays, but within scatter they will be flattened. The exception is c, which will be flattened only if its size matches the size of x and y.</td><td>Windows /Linux OS, IDE, Jupyter</td><td>Scatter plot.</td></tr>
<tr><td>5</td><td>Create a 2 dimentional data representation using bar charts, Clustered bar charts,<table><tr><th>Day</th><th>Bacon</th><th>Cheese</th><th>Pepperoni</th></tr><tr><td>Monday</td><td>478</td><td>112</td><td>148</td></tr><tr><td>Tuesday</td><td>492</td><td>199</td><td>141</td></tr><tr><td>Wednesday</td><td>180</td><td>485</td><td>102</td></tr><tr><td>Thursday</td><td>246</td><td>407</td><td>172</td></tr><tr><td>Friday</td><td>777</td><td>112</td><td>102</td></tr><tr><td>Saturday</td><td>498</td><td>305</td><td>173</td></tr><tr><td>Sunday</td><td>300</td><td>376</td><td>182</td></tr></table></td><td>Windows /Linux OS, IDE, Jupyter</td><td>Bar charts for data visualization</td></tr>
<tr><td>6</td><td>Create pictograms, proportional shape charts for any dataset.</td><td>Windows /Linux OS, IDE, Jupyter</td><td>Shape charts</td></tr>
<tr><td>7</td><td>Create relational and temporal chart for a table containing student details</td><td>Windows /Linux OS, IDE, Jupyter</td><td>Relational and temporal charts</td></tr>
</table>

<table>
<tr><td>8</td><td>Create stacked bar chart for the following table
<table><tr><th>Day</th><th>Bacon</th><th>Cheese</th><th>Pepperoni</th></tr><tr><td>Monday</td><td>478</td><td>112</td><td>148</td></tr><tr><td>Tuesday</td><td>492</td><td>199</td><td>141</td></tr><tr><td>Wednesday</td><td>180</td><td>485</td><td>102</td></tr><tr><td>Thursday</td><td>246</td><td>407</td><td>172</td></tr><tr><td>Friday</td><td>777</td><td>112</td><td>102</td></tr><tr><td>Saturday</td><td>498</td><td>305</td><td>173</td></tr><tr><td>Sunday</td><td>300</td><td>376</td><td>182</td></tr></table></td><td>Windows /Linux OS, IDE, Jupyter</td><td>Stacked bar chart</td></tr>
<tr><td>9</td><td>Create back –to-back bar chart for
<table><tr><th>Cities</th><th>Married</th><th>Divorced</th><th>Widowed</th></tr><tr><td>Los Angeles</td><td>893</td><td>191</td><td>175</td></tr><tr><td>Chicago</td><td>902</td><td>419</td><td>134</td></tr><tr><td>Houston</td><td>252</td><td>448</td><td>124</td></tr><tr><td>Phoenix</td><td>407</td><td>231</td><td>150</td></tr><tr><td>Philadelphia</td><td>927</td><td>153</td><td>123</td></tr><tr><td>San Antonio</td><td>763</td><td>464</td><td>104</td></tr><tr><td>San Diego</td><td>669</td><td>487</td><td>127</td></tr><tr><td>Texas</td><td>282</td><td>270</td><td>168</td></tr><tr><td>California</td><td>163</td><td>294</td><td>174</td></tr><tr><td>Florida</td><td>471</td><td>108</td><td>139</td></tr></table></td><td>Windows /Linux OS, IDE, Jupyter</td><td>Back to back bar chart</td></tr>
<tr><td>10</td><td>Apply pm3d coloring to any sample dataset</td><td>Windows /Linux OS, IDE, Jupyter,</td><td>pm3d coloring</td></tr>
<tr><td>11</td><td>Apply multi-dimensional data visualization technique to any sample dataset</td><td>Windows /Linux OS, IDE, Jupyter,</td><td>multi-dimensional data visualization</td></tr>
<tr><td>12</td><td>Apply graph data visualization technique to any sample dataset</td><td>Windows /Linux OS, IDE, Jupyter,</td><td>graph data visualization technique</td></tr>
</table>

TEXTBOOKS:

1. Andy Kirk, “Data Visualization A Handbook for Data Driven Design” , Sage Publications, 2016

2. Philipp K. Janert, “Gnuplot in Action, Understanding Data with Graphs”, Manning Publications, 2010.

Course Title	Machine Learning lab				Course Type		HC	
Course Code	B20EF0507	Credits	2		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	-	-	-				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**1**	**2**	**2**	**-**	**26**	**25**	**25**

COURSE OVERVIEW:

This course gives an overview of many machine learning concepts, techniques and algorithms beginning with topics such as classification and linear regression and ending up with more recent topics such support vector machines. Also, students will learn to analyze the data and predict the results.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Apply the mathematical and statistical prospective of machine learning algorithms throughpython programming.
2. Analyze machine learning algorithms to predict individual income, medical data & more
3. Execute Python program to design and implement classifiers for machine learning applications.
4. Analyze model generated from various dataset.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Implement various data processing operations and evaluate prediction results.	1,3,4,5,8,9,1012	1,2,3
CO2	Execute K-mean clustering to perform segmentation.	1,3,4,5,8,9,1012	1,2,3
CO3	Evaluate supervised machine learning algorithm to predict classes	1 to 5,8,9,10,12	1,2,3
CO4	Assess regression algorithms for predicting continuous values.	1 to 5,8,9,10,12	1,2,3
CO5	Examine efficiency of linear classifier on aforesaid data set	1 to 5,8,9,10,12	1,2,3
CO6	Create a mini project to address data optimization techniques in retail industry	1 to 5,9,10,11,12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			✓			
CO2			✓			
CO3					✓	
CO4					✓	
CO5			✓			
CO6						✓

COURSE ARTICULATION MATRIX

CO# / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2		1	2	2			1	2	2		2	3	2	2
CO2	2		1	1	2			1	2	2		2	3	2	2
CO3	3	2	2	2	2			1	2	2		2	3	2	2
CO4	3	2	2	2	2			1	2	2		2	3	3	2
CO5	3	2	2	2	2			1	2	2		2	3	2	2
CO6	3	3	3	3	3			1	3	2	3	3	3	3	3

Note: 1-Low, 2-Medium, 3-High

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	Part-A		
1.	Write a python program to predict income levels of adult individuals using a linear regression model. The process includes training, testing and evaluating the model on the Adult dataset. In this sample experiment you need to train a classifier on the Adult dataset, to predict whether an individual's income is greater or less than $50,000. The students are expected to demonstrate how you can perform basic data processing operations, split the dataset into training and test sets, train the model, score the test dataset, and evaluate the predictions. Refer the following link to download the Adult Income Dataset: https://raw.githubusercontent.com/jbrownlee/Datasets/master/adult-all.csv	Anaconda, PyCharm	Python Programming skills
2.	Write a python code to cluster similar companies into same group given their Wikipedia articles and can be used to assign cluster to new company. The students are expected to demonstrate how to use the K-Means clustering algorithm to perform segmentation on companies from the Standard & Poor (S&P) 500 index, based on the text of Wikipedia articles about each company. Refer the following link (S&P) 500 index: https://en.wikipedia.org/wiki/List_of_S%26P_500_companies	Anaconda, PyCharm	Python Programming skills
3.	Write a python program to classify the medical dataset using Multilayer Perceptron Classifier. The students are expected to demonstrate how you can perform basic data processing operations, split the dataset into training and test sets, train the model, score the test dataset, and evaluate the predictions. Refer the following link to download the Medical Data set: https://lionbridge.ai/datasets/18-free-life-sciences-medical-datasets-for-machine-learning/	Anaconda, PyCharm	Python Programming skills
4.	Write a python program to perform the prediction of retail sales. The students are expected to demonstrate how you can perform basic data processing operations, split the dataset into training and test sets, train the model, score the test dataset, and evaluate the predictions. Refer the following link to download the Retail Sale Data set: https://data.world/datasets/retail	Anaconda, PyCharm	Python Programming skills

5.	Write a python code to predict the real estate sales price of a house based upon various quantitative features about the house and sale. The students are expected to demonstrate how you can perform basic data processing operations, split the dataset into training and test sets, train the model, score the test dataset, and evaluate the predictions. Refer the following link to download the real estate sales price of a house Data set: https://data.world/datasets/real-estate	Anaconda, PyCharm	Python Programming skills
6.	Write a python program to predict income levels of adult individuals using Decision Tree Regression Model. The process includes training, testing and evaluating the model on the Adult dataset. In this sample experiment you need to train a classifier on the Adult dataset, to predict whether an individual's income is greater or less than $50,000. The students are expected to demonstrate how you can perform basic data processing operations, split the dataset into training and test sets, train the model, score the test dataset, and evaluate the predictions. Refer the following link to download the Adult Income Dataset: https://raw.githubusercontent.com/jbrownlee/Datasets/master/adult-all.csv	Anaconda, PyCharm	Python Programming skills
7.	Write a python program to predict income levels of adult individuals using Support Vector Machine Regression Model. The process includes training, testing and evaluating the model on the Adult dataset. In this sample experiment you need to train a classifier on the Adult dataset, to predict whether an individual's income is greater or less than $50,000. The students are expected to demonstrate how you can perform basic data processing operations, split the dataset into training and test sets, train the model, score the test dataset, and evaluate the predictions. Refer the following link to download the Adult Income Dataset: https://raw.githubusercontent.com/jbrownlee/Datasets/master/adult-all.csv	Anaconda, PyCharm	Python Programming skills

8.	Write a python program to classify the medical dataset using Multilayer Perceptron Classifier. The students are expected to demonstrate how you can perform basic data processing operations, split the dataset into training and test sets, train the model, score the test dataset, and evaluate the predictions. Refer the following link to download the Medical Data set: https://lionbridge.ai/datasets/18-free-life-sciences-medical-datasets-for-machine-learning/	Anaconda, PyCharm	Python Programming skills
9.	Write a python program to classify the medical dataset using Gaussian Naïve Bayes Classifier. The students are expected to demonstrate how you can perform basic data processing operations, split the dataset into training and test sets, train the model, score the test dataset, and evaluate the predictions. Refer the following link to download the Medical Data set: https://lionbridge.ai/datasets/18-free-life-sciences-medical-datasets-for-machine-learning/	Anaconda, PyCharm	Python Programming skills
10.	Compare the performances of the classification models that you implemented to classify the medical dataset. The students are expected to demonstrate how you can perform basic data processing operations, split the dataset into training and test sets, train the model, score the test dataset, and evaluate the predictions. Refer the following link to download the Medical Data set: https://lionbridge.ai/datasets/18-free-life-sciences-medical-datasets-for-machine-learning/	Anaconda, PyCharm	Python Programming skills
11.	Consider the publicly available banknote authentication Data Set on the UCI machine learning repository. Implement and compare the efficiency of linear classifiers to classify the aforesaid data set. Refer the following link to download the Medical Data set: https://archive.ics.uci.edu/ml/datasets/banknote+authentication	Anaconda, PyCharm	Python Programming skills
12.	Consider the publicly available banknote authentication Data Set on the UCI machine learning repository. Implement the deep learning classifier to classify the aforesaid data set. Refer the following link to download the Medical Data set: https://archive.ics.uci.edu/ml/datasets/banknote+authentication	Anaconda, PyCharm	Python Programming skills
	Part - B		
	Mini Project **Retail Price Optimization using Machine Learning**		

1	In this machine learning pricing project, implement a retail price optimization algorithm using regression trees. This is one of the first steps to building a dynamic pricing model. Pricing a product is a crucial aspect in any business. A lot of thought process is put into it. There are different strategies to price different kinds of products. There are products whose sales are quite sensitive to their prices and as such a small change in their price can lead to noticeable change in their sales. While there are products whose sales are not much affected by their price - these tend to be either luxury items or necessities (like certain medicines). This machine learning retail price optimization project will focus on the former type of products. Price elasticity of demand (Epd), or elasticity, is the degree to which the effective desire for something changes as its price changes. In general, people desire things less as those things become more expensive. However, for some products, the customers desire could drop sharply even with a little price increase, and for other products, it could stay almost the same even with a big price increase. Economists use the term elasticity to denote this sensitivity to price increases. More precisely, price elasticity gives the percentage change in quantity demanded when there is a one percent increase in price, holding everything else constant.	To implement a retail price optimization algorithm using regression trees	Python Programming skills

	In this machine learning pricing optimization case study, we will take the data of a cafe and based on their past sales, identify the optimal prices for their items based on the price elasticity of the items. For each item, first the price elasticity will be calculated and then the optimal price will be figured. While this is taking a particular cafe data, this work can be extended to price any product. Briefly, price optimization uses data analysis techniques to pursue **two main objectives**: Understanding how customers will react to different pricing strategies for products and services, i.e., understanding the elasticity of the demand. Finding the best prices for a given company, considering its goals. Pricing systems have evolved since the early 1970s until now, from applying very simple strategies, such as a standard markup to base cost, to being capable of predicting the demand of products or services and finding the best price to achieve the set KPI. Price optimization techniques can help retailers **evaluate the potential impact of sales promotions** or **estimate the right price** for each product if they want to **sell it in a certain period of time**. **Modules:** Competition Weather Season Special events / holidays Macroeconomic variables Operating costs Warehouse information To **determine**: The initial price The best price The discount price The promotional price		

TEXTBOOKS:

1. John D Kelleher, Brian Mac Namee, Aoife D'Arcy, "Fundamentals of Machine Learning for Predictive Data Analytics- Algorithms, Worked Examples and case studies", MIT Press, 2015

Course Title	INDIAN TRADITION AND CULTURE				Course Type	FC	
Course Code	B21PA0501	Credits	1		Class	V Semester	
Course Structure	TLP	Credits	Contact	WorkLoad	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	1	1	1			
	Practice	0	0	0	Theory	CIE	SEE
	Tutorial	-	-	-			
	Total	**1**	**1**	**1**	**13**	**50**	**50**

COURSE OVERVIEW:

This course offers the students with various aspects of culture and heritage of India..This course also enable the students to understand the contribution of our ancestors in the areas of science, medicine, arts, language and literature.

COURSE OBJECTIVE (S):

1. To provide conceptual knowledge of Indian culture and traditions
2. To introduce students to the science and technological advancements related to Indian culture
3. To help students understand the Indian spiritual aspects of Indian culture
4. To help learners understand the factors which unite the diverse cultures of India

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Gain conceptual understanding of Indian culture and traditions.	2,3,4,6,8,12	
CO2	Describe various ancient theories in treatment of any disease.	10,11	
CO3	Appreciate the science and technological advancements in ancient India.	11	
CO4	Comprehend the Indian spiritual aspects of Indian culture like yoga, meditation and nirvana.	11,12	
CO5	Demonstrate the theory behind celebrating Hindu festivals and concept of making varieties of food	2-6,10,11	
CO6	Understand India as a land united by cultural diversity	2-6,10,11	

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom'sLevel					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√	√			
CO3		√				
CO4		√				
CO4			√			
CO5		√				

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		2	1	2		2		3				3			
CO2										2	2				
CO3											2				
CO4											2	2			
CO5		2	2	2	2	2				2	2				
CO6		2	2	2	2	2				2	2				

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Indian Tradition: Culture – Indus Valley Civilization and early cultural practices, The Vedic culture, Influence of Buddhism and Jainism on Indian Culture, Influence of Islam and Christianity, Indian Cultural Renaissance of the 19th Century Religion – Pre-vedic and Vedic religion, Jainism, Buddhism, Hinduism, Religious Reform Movements, Advent of Christianity Art – Introduction to Natyashastra, classical and contemporary art forms (dance and music), regional art forms (dance and music), Folk art, puppetry Architecture – Engineering and Architecture in Ancient India; Evolution of Hindu Temple Structures, Sculptures, Coins and Pottery from Ancient India Literature-Vedas, Upanishads, Ramayana, Mahabharata & Bhagavat Gita.

UNIT – 2

Contribution of ancient India to Science and Maths: Development of Science in Ancient India- Astronomy, Mathematics, Medicine, Metallurgy. Scientists of Ancient India: Mathematics and Astronomy- Baudhayan, Aryabhata, Brahmagupta, Bhaskaracharya, Mahaviracharya Science- Kanad, Varahamihira, Nagarjuna Medical Sciences (Ayurveda and Yoga)- Susruta, Charaka, Yoga and Patanjali Science and Scientists in Medieval India- Mathematics, Biology, Chemistry, Astronomy, Medicine, Agriculture. Scientists in Modern India- Srinivas Ramanujan, Chandrasekhara V Raman, Jagadish Chandra Bose, Homi Jehangir Bhabha, Dr, Vikram Ambalal Sarabhai, ,Dr. APJ Abdul Kalam.

UNIT – 3

Indian Spiritual Aspects: Hindu Spirituality based on shruti and smriti- Hinduism in General, Basic notions of Vedas, Upanishads, Ramayana, Mahabharata & Bhagavat Gita. Hata Yoga and Pranayama- Main Features, Basics of Yoga –Different kinds of Yoga; Raja Yoga (Ashtanga yoga); Karma yoga; Bhakti Yoga – yoga of Loving Devotion; Jnana yoga – Yoga of Knowledge; Hatha Yoga (Asana/ Pranayamas); Kundalini Yoga; Nada Yoga; Sannyasa Yoga Buddhist, Jaina Spiritualities- Main Doctrines of Buddhism: Four Noble Truths (Arya Satya), Concept of Nirvana - Ashtanga Marga.

UNIT – 4

Unity in Diversity: Commensality and the Significance of Food – Eating Together as Family and as a Society, Food at Rituals; annaprasan, marriage and funeral, Kitchen as Shared Space for Women, Food and Nationalist Response of Indian Community, Visibility of Indian Cuisine in the World. Celebrating Diverse Festivals – Festival Types: Religious and Seasonal, Religious - Holi, Diwali, Ganesh Chaturthi, Janmashtami, Mahavir Jayanthi, Ramadan, Christmas, Buddha Purnima; Seasonal (harvest festivals) - Baisakhi, Pongal, Sankranti Attire - Indus Valley Civilization, Vedic period, Modern India

TEXT BOOKS:

1. Sundararajan K.R., “Hindu Spirituality - Vedas through Vedanta” , Cross Road Publications, New York, 1997.

2. Griffiths Bede, Yoga and the Jesus Prayer Tradition, Asian Trading Corporation, Bangalore, 1992

REFERENCES BOOKS:

1. Ansh Mishra, “Science in Ancient India” , Indian Corporation, New Delhi, 1998
2. Sen Taylor, Collen,“Feasts and Fasts: A History of Food in India”,Reaktion Books, New Delhi, 2014.
3. Thapar, Romila, “Readings in Early Indian History”, Oxford University Press. New Delhi, 2018

JOURNALS/MAGAZINES:

1. Arts and Humanities (miscellaneous)
2. History
3. Language and Linguistics
4. History and Philosophy of Science
5. Literature and Literary Theory

SWAYAM/NPTEL/MOOCs:

1.https://nptel.ac.in/courses/109/104/109104102/
2.https://nptel.ac.in/courses/109/103/109103018/

Course Title	Skill development-1				Course Type	HC	
Course Code	B21ET0505	Credits	2		Class	V Semester	
Course Structure	TLP	Credits	Contact	Work Load	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	2	4	-			
	Practice	-	-	-	Theory	CIE	SEE
	Tutorial	**-**	**-**	**-**			
	Total	**2**	**4**	**-**	**-**	**-**	**-**

COURSE OUTCOMES (CO'S):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Demonstrate in-depth knowledge on the project topic	1	1,2,3
CO2	Identify, analyze and formulate complex problem chosen for project work to attain substantiated conclusions.	2	1,2,3
CO3	Design solutions to the chosen project problem.	3	1,2,3
CO4	Undertake investigation of project problem to provide valid conclusions.	4	1,2,3
CO5	Use the appropriate techniques, resources, and modern engineering tools necessary for project work.	5	1,2,3
CO6	Apply project results for sustainable development of the society.	6	1,2,3
CO7	Understand the impact of project results in the context of environmental sustainability.	7	1,2,3
CO8	Understand professional and ethical responsibilities while executing the project work.	8	1,2,3
CO9	Function effectively as individual and a member in the project team.	9	1,2,3
CO10	Develop communication skills, both oral and written for preparing and presenting project report.	10	1,2,3
CO11	Demonstrate knowledge and understanding of cost and time analysis required for carrying out the project.	11	1,2,3
CO12	Engage in lifelong learning to improve knowledge and competence in the chosen area of the project.	12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3						√
CO4				√		
CO5			√			
C06			√			
CO7		√				
CO8		√				
CO9	√			√		
CO10			√			√
CO11		√		√		
CO12			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	3
CO2		3											3	3	3
CO3			3										3	3	3
CO4				3									3	3	3
CO5					3								3	3	3
C06						3							3	3	3
CO7							3						3	3	3
CO8								3					3	3	3
CO9									3				3	3	3
CO10										3			3	3	3

CO11											3		3	3	3
CO12												3	3	3	3

Note: 1-Low, 2-Medium, 3-High

The students are informed to follow the following instructions to complete the Skill development-1:

Students will be offered training and certifications on the trending technologies from the industry experts.

The students are evaluated and certified after the training programs.

VI SEMESTER

Course Title	Theory of Computation				Course Type		HC	
Course Code	B21EF0601	Credits	3		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

The course introduces some fundamental concepts in automata theory and formal languages including finite automaton, regular expression, formal language, grammar, pushdown automation, and Turing machine which form basic models of computation also the foundation of many branches of computer science.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Compare the concepts of Deterministic and Non-Deterministic Finite Automata.
2. Demonstrate the use of regular expressions for constructing DFA and NFA.
3. Illustrate the construction of context free grammar for a given language.
4. Explain computing Machine including PDA and Turing Machine.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Construct the Finite State Machine by applying the concepts of DFA and NFA.	1 to 5, 12	1
CO2	Make use of regular expressions for constructing DFA and NFA.	1 to 5,12	2
CO3	Identify ambiguity in grammar and Construct CFG for the given language in Normal Forms.	1 to 5,12	3
CO4	Apply the concepts of Push down Automata and Turing machine for a given Language.	1 to 5,12	2
CO5	Outline the notions of computation, such as algorithm, computability,decidability, reducibility, and complexity, through problem solving.	1 to 5,12	1,2
CO6	Choose mathematical foundations, algorithmic principles and computer science theory to model and design of computer based systems.	1 to 5,12	2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5		√				
CO6	√					

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	1							1	3		
CO2	2	2	1	1	1							1		3	
CO3	2	2	1	1	1							1			3
CO4	2	2	1	1	1							1		3	
CO5	3	2	3	3	2								3		3
CO6	3	3	2	3	3									3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to finite automata: Alphabets; Languages; strings; Deterministic and non-deterministic finite automata (with and without epsilon transitions) and their applications; Equivalence of finite automata; Minimization of Finite Automata

UNIT - 2

Regular Expressions, regular languages and their properties: Regular Expressions; Finite Automata and Regular Expressions; Equivalence of finite automata and regular expressions; Pumping lemma for regular languages;

UNIT- 3

Context free Grammars and Normal forms: Context Free Grammars; Parse Trees; Ambiguity in Grammars and languages; Normal forms-CNF and GNF.

UNIT- 4

Push Down Automata and Turing Machine: Push down automata (PDA); Languages of a PDA**;** Deterministic PDA; Turing Machine.

TEXT BOOKS:

1. John E Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, "Introduction to Automata Theory, Languages and Computation", 3rd Edition, Pearson Education, 2009.
2. Peter Linz, "An Introduction to formal Languages and Automata", 4/ E, Jones and Bartlett Publishers, 2006.

REFERENCE BOOKS:

1. Kamala Krithivasan, Rama R, "Introduction to Formal Languages, Automata Theory and Computation", Pearson, 2009.
2. B N Srinivasa Murthy, "Formal Languages and Automata Theory", Sanguine Publishers, 2006.

JOURNALS/MAGAZINES:

1. https://theoryofcomputing.org/
2. https://www.journals.elsevier.com/theoretical-computer-science
3. https://www.springer.com/journal/224

SWAYAM/NPTEL/MOOCs:

1. https://www.edx.org/course/automata-theory
2. https://nptel.ac.in/courses/106/104/106104028/
3. https://ocw.mit.edu/courses/mathematics/18-404j-theory-of-computation-fall-2006/syllabus/

SELF-LEARNING EXERCISES:

Applications of Finite Automata and Applications of Regular Expressions.

Course Title	Natural Language Processing				Course Type		HC	
Course Code	B21ET0601	Credits	3		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	3	3	3	**39**	**-**	**50**	**50**

COURSE OVERVIEW:

The intent of the course is to give introduction to Natural Language Processing (NLP, a.k.a. computational linguistics), the study of computing systems that can process, understand, or communicate in human language. The primary focus of the course will be on understanding various NLP tasks as listed in the course syllabus, algorithms for effectively solving these problems, and methods for evaluating their performance. There will be a focus on statistical algorithms to acquire the knowledge needed to perform language processing.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the fundamentals of natural language processing and python.
2. Discuss how to access the text corpora and Lexical Resources.
3. Demonstrate the writing the structured programs to process the raw text.
4. Describe role of Classifiers in Text processing.

COURSE OUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Apply the concepts of Python using NLTK tool to solve a given real world problem.	1 to 5,9,10,12	1,3
CO2	Develop an algorithm to access the text corpora and Lexical Resources to process the raw text.	1 to 5,9,10,12	3
CO3	Make use of Categorizing and Tagging concepts to solve the given real-world problems.	1 to 5,9,10,12	2,3
CO4	Analyze the performance of different classifiers in Text processing and Modelling Linguistic.	1 to 5,9,10,12	1
CO5	Make use of Automatic Tagging to find the category of a word.	1 to 5,9,10,12	1,3
CO6	Apply different classification algorithm to solve real world problems.	1 to 5,9,10,12	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4				√		
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3	2				3	3		3	3		3
CO2	2	3	2	3	3				3	3		3			3
CO3	2	3	2	3	2				3	3		3		3	3
CO4	3	3	1	3	2				3	3		3	3		
CO5	2	3	3	2	3				3	3		3	3		3
CO6	2	2	2	2	3				3	3		3	3	3	

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT-1

Language Processing and python, Accessing Text corpora and Lexical Analysis: Computing with language- Texts and words**,** a closer look at python: texts as list of words, **computing with language**: simple statistics, Automatic natural language understanding; Accessing Text Corpora, Conditional Frequency Distributions, Lexical Resources, WordNet, Introduction to NLTK Tool.

UNIT-2

Processing Raw Text: Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode, Regular Expressions for Detecting Word Patterns, Useful Applications of Regular

Expressions, Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation, Formatting: From Lists to Strings.

UNIT-3

Categorizing and Tagging words: Using a Tagger, using a Tagger, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, N-Gram Tagging, Transformation-Based Tagging, How to Determine the Category of a Word.

UNIT-4

Classifying Text: Supervised Classification: Examples, Evaluation; Decision Trees, Naive Bayes Classifiers, Maximum Entropy Classifiers, Modelling Linguistic Patterns.

TEXTBOOKS:

1.Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python", First Edition, OReilly Media, 2009.

2.Yuxi (Hayden) Liu,"Python Machine Learning by Example," First edition, Packt publisher, 2017.

REFERENCEBOOKS:

1. James Allen, "Natural Language Understanding", Benjamin-Cummings Publishing Co., Inc. Redwood City, CA, USA,1995.
2. Christopher D. Manning and HinrichSchutze," Foundations of Statistical Natural Language Processing", The MIT Press, 1999.
3. Randolf Quirk, Sidney Greenbaum, Geoffrey Leech, Jan Svartvik, "A Comprehensive Grammar of English Language", Cambridge University Press,1987.

JOURNALS/MAGAZINES:

2. ACM Transactions on Language Processing
3. Elsevier Journal of cognitive systems research

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/106/105/106105158/
2. https://nptel.ac.in/courses/106/106/106106211/

SELF-LEARNINGEXERCISES:

Extracting information from Text, Exploring the 20 Newsgroups with Text Analysis Algorithms, Stock Price prediction with Regression Algorithms,

Best Practices:

i) Data preparation stage

ii) Training sets generation stage

iii) Model training, evaluation and selection stage

Course Title	Neural Networks and Deep Learning				Course Type		HC	
Course Code	B21ET0602	Credits	3		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	3	3	3	**39**	**-**	**50**	**50**

COURSE OVERVIEW:

This course is an introduction to neural networks and deep learning, a branch of machine earning concerned with the development and application of modern neural networks. In this course the students will be able to get a knowledge on practical implementation of deep learning using Tensor Flow. This course covers topics like Introduction to TensorFlow, Computational Graph, Key highlights, Creating a Graph, Regression example, Gradient Descent.Deep learning is behind many recent advances in AI, including Siri's speech recognition, Face book's tag suggestions and self-driving cars.

COURSE OBJECTIVE(S):

The objectives of this course are to:

1. Understand complexity of Deep Learning algorithms and their limitations
2. Illustrate modern notions in data analysis-oriented computing;
3. Applying common Deep Learning algorithms in practice and implementing their own;
4. Demonstrate distributed computations and experiments in Deep Learning using real-world data.

COURSE OUTCOMES (CO'S):

On successful completion of this course; the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Identify the concepts of TensorFlow, its main functions, operations and the execution pipeline in any given problem.	1 to 5,9,10,12	1
CO2	Apply the concepts of deep learning, its functions and operations to deep learning models.	1 to 5, 9, 10, 12	3
CO3	Develop deep learning models in tensorflow and interpret the results.	1 to 5,9,10,12	2,3
CO4	Evaluate various deep learning models for any given project.	1 to 5,9,10,12	2,3
CO5	Build and train full connected deep neural networks	1 to 5,9,10,12	2,3
CO6	Apply convolutional networks in visual detection and recognition tasks.	1 to 5, 9, 10, 12	2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓	✓			
CO2			✓			
CO3			✓			
CO4						✓
CO5			✓			
CO6			✓			

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	3	1	2	1			3	3		2	3		
CO2	1	3	2	2	1				3	3		2			3
CO3	2	2	2	2	1				3	3		2		3	3
CO4	3	3	3	1	1				3	3		2		3	3
CO5	2	2	2	2	1				3	3		2		3	3
CO6	3	3	3	1	1				3	3		2		3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENTS
THEORY:

UNIT 1

Introduction to TensorFlow : Computational Graph, Key highlights, Creating a Graph, Regression example, Gradient Descent, Tensor Board, Modularity, Sharing Variables,Keras Perceptrons: What is a Perceptron, XOR Gate

UNIT 2

Activation Functions: Sigmoid,ReLU, Hyperbolic Fns, Softmax Artificial Neural Networks : Introduction, Perceptron Training Rule, Gradient Descent Rule

UNIT 3

Gradient Descent and Backpropagation: Gradient Descent, Stochastic Gradient Descent, Backpropagation, Some problems in ANN Optimization and Regularization: Overfitting and Capacity, Cross Validation, Feature Selection, Regularization, Hyperparameters

UNIT 4

Introduction to Convolutional Neural Networks: Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple Filters, CNN applications Introduction to Recurrent Neural Networks: Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, LSTM, RNN application

TEXT BOOKS:

1. Goodfellow, I., Bengio,Y., and Courville, A., "Deep Learning", MIT Press, 2016. References
2. Bishop, C. ,M., "Pattern Recognition and Machine Learning" , Springer, 2006.

REFERENCE BOOKS:

1. Yegnanarayana, B., "Artificial Neural Networks", PHI Learning Pvt. Ltd, 2009.

2.Golub, G.,H., and Van Loan,C.,F., "Matrix Computations" , JHU Press,2013.

3.Satish Kumar, "Neural Networks: A Classroom Approach" , Tata McGraw-Hill Education, 2004

JOURNALS/MAGAZINES:

1. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=6294(IEEE Journal/Magazine on IT Professional)

2.https://ieeexplore.ieee.org/document/1267572IEEE Computing in Science and Engineering)

SWAYAM/NPTEL/MOOCs:

1.https://www.coursera.org/learn/neural-networks-deep-learning

2.https://www.coursera.org/learn/introduction-to-deep-learning-with-keras

3.https://www.classcentral.com/course/neural-networks-deep-learning-9058

SELF-LEARNINGEXERCISES:

1.Illustrate a typical structure of a machine learning algorithm in Tensorflow

2.Expand the Tensorflow implementation of logistic regression in a way to enable simple creation of configurable fully connected classification models.

Course Title	Block chain Technology				Course Type		SC	
Course Code	B21ETS611	Credits	3		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0				
	-	-	-	-	Theory	Practical	CIE	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

This course introduces the concept of digital cryptocurrencies using Blockchain, which is fundamentally public digital ledger to share information in a trustworthy and secure way. The course also discuss the concept and applications Block chain that have now spread from cryptocurrencies to various other domains, including business process management, smart contracts, IoT and so on. This includes the fundamental design and architectural primitives of Blockchain, the system and the security aspects, along with various use cases from different application domains.

COURSE OBJECTIVES:

The objective of the course is to:

1.Explain the underlying technology of transactions, blocks, proof-of-work, and consensus building

2.Discuss Hyperledger to build applications on blockchain

3.Describe the architecture of bit coins and to give the working of the bitcoin

4.Illustrate the design and implementation of new ways of using block chain technology

COURSE OUTCOMES:

On successful completion of this course; the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Compare the performance of POW and POS mining consensus algorithm with respect to given real world application	1 to 5	1,2
CO2	Make use of Hyperledger to build applications on blockchain	1 to 5	1,2,3
CO3	Summerize design principles of Bitcoin and Ethereum	1 to 5	1,2,3
CO4	Make use of blockchain technologies in real world applications.	1 to 5	1,2
CO5	Develop distributed applications based on blockchain concept.	1 to 5,7,8,10,12	1,2
CO6	Analyse security, privacy, and efficiency of a given blockchain system	1 to 5	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3		√				
CO4			√			
CO5			√			
CO6				√		

COURSE ARTICULATION MATRIX

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	3	2								3	3	
CO2	1	3	3	2	2								3	3	3
CO3	3	2	1	3	3								3	3	3
CO4	3	1	2	3	3								3	3	
CO5	3	2	3	3	1		2	2		3		1	3	3	
CO6	3	1	3	3	1								3	3	

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT-1

Introduction to Blockchain: History: Digital Money to Distributed Ledgers; Design Primitives: Protocols, Security, Consensus, Permissions, Privacy; Blockchain Architecture and Design: Basic crypto primitives: Hash, Signature; Hash chain to Blockchain; Basics on sensus mechanisms; Consensus: Requirements for the consensus protocols, Proof of Work(PoW), Scalability aspects of Blockchain Consensus, consensus protocols.

UNIT-2

Permissioned Blockchains: Design goals, Consensus protocols for Permissioned Blockchains Hyperledger Fabric I: Decomposing the consensus process, Hyperledger fabric components, Chaincode Design and Implementation; Hyperledger Fabric II: Beyond Chaincode: Fabric SDK and Front End Hyperledger composer tool.

UNIT-3

Use case I: Blockchain in Financial Software and Systems (FSS): Settlements, KYC, Capital markets, Insurance; Use case II: Blockchain in trade supply chain: Provenance of goods, visibility, trade supply

chain finance, invoice management discounting, etc Use case III: Blockchain for Government: Digital identity, land records and other kinds of record keeping between government entities, public distribution system, social welfare systems.

UNIT-4

Blockchain Cryptography, Privacy and Security on Blockchain; Research aspects I: Scalability of Blockchain consensus protocols, Case Study of various recent works on scalability; Research aspects II: Secure cryptographic protocols on Blockchain; Case Study of Secured Multi-party Computation, Blockchain for science: making better use of the data-mining network; Case Studies: Comparing Ecosystems - Bitcoin, Hyperledger, Ethereum and more.

TEXT BOOKS:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies", Princeton University Press,2016
2. Andreas Antonopoulos, "Mastering Bitcoin", O'Reilly Media, 1st Edition, 2014
3. https://github.com/bitcoinbook/bitcoinbook

REFERENCE BOOKS:

1. Hyperledger Fabric - https://www.hyperledger.org/projects/fabric
2. Bob Dill, David Smits , "Zero to Blockchain - An IBM Redbooks course"
3. https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html
4. http://cs251crypto.stanford.edu/18au-cs251/syllabus.html

JOURNALS/MAGAZINES:

1. Elsevier Jounal on Block Chain : Research and Applications

SWAYAM/NPTEL/MOOCS:

1. https://onlinecourses.nptel.ac.in/noc20_cs01/preview
2. https://onlinecourses.nptel.ac.in/noc19_cs63/review
3. https://nptel.ac.in/courses/106/105/106105184/
4. https://www.classcentral.com/course/swayam-introduction-to-blockchain-technology-and-applications-17656
5. https://www.my-mooc.com/en/categorie/blockchain-and-cryptocurrency
6. https://www.coursera.org/specializations/blockchain
7. https://www.coursera.org/courses?query=blockchain

SELF-LEARNINGEXERCISES:

1. Explore the architecture and design of Ethereum

Course Title	Embedded Systems Design				Course Type		SC	
Course Code	B21ETS612	Credits	3		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

Embedded systems have become the next inevitable wave of technology, finding application in diverse fields of engineering. Microprocessors, together with sensors and actuators, have become embeddable in almost everything. The purpose of the course is to provide the students with the basic information about embedded systems which can be defined as a control system or computer system designed to perform a specific task.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1.Demonstrate the optimal composition and characteristics of an embedded system.

2.Provide an understanding of the A/D conversion process.

3.Demonstrate the protocols and software tools employed In embedded system design.

4.DiscussHardware/Software co-design techniques for micro controller-based embedded systems

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Identify the optimal composition and characteristics of an embedded system	1 to 4, 8, 9 , 12	1
CO2	Analyze and discover the motives and caused of using sensors and actuators	1 to 3, 5,9,12	1
CO3	Examine the protocols and software tools employed in embedded system design.	1 to 5, 9, 12	2
CO4	Compare the knowledge of Hardware/Software co-design techniques for microcontroller- based embedded systems.	1,4,5,9,12	1
CO5	Outline the internal architecture and interfacing of different peripheral devices with Microcontrollers.	1 to 5, 9, 12	2
CO6	Identify the requirements of programming Embedded Systems, related software architectures and tools for designing an Embedded Systems.	1 to 5, 9, 12	2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3				√		
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1	3		
CO3	3	1	2	1	2				1			1		3	
CO4	3			2	2				1			1	3		
CO5	3	2	2	1	2				1			1		3	
CO6	3	3	1	2	2				1			1		3	

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to Embedded Systems and Computer Systems Terminology. Modular approach to Embedded System Design using Six-Box model: Input devices, output devices, embedded computer, communication block, host and storage elements and power supply.

Microcontroller Based Embedded System Design. Salient Features of Modern Microcontrollers. Elements of Microcontroller Ecosystem and their significance.

Design of Power Supply for Embedded Systems. Linear Regulator Topologies. Switching Power Supply Topologies. Power Supply Design Considerations for Embedded Systems.

UNIT – 2

Introduction to MSP430 Microcontroller. MSP430 CPU Architecture. Programming Methods for MSP430. Introduction to Lunchbox Platform.

Fundamentals of Physical Interfacing. Connecting Input Devices:Switches, Keyboard and Output devices: LEDs, Seven Segment Displays(SSD). Assignment: MCQ/MSQ

Advanced Physical Interfacing: Driving load - high side, low side and H-bridge. Multiplexing displays including Charlieplexing. Shaft encoder.

UNIT – 3

Programming the MSP430. Basics of version control system - Git. Installing and using Code Composer Studio(CCS). Introduction to Embedded C. Interfacing LEDs and Switches with MSP430 using Digital Input and Output.

MSP430 Clock and Reset System. MSP430 Clock sources and distribution. Types of Reset sources. Handling Interrupts in MSP430. Writing efficient Interrupt Service Routine (ISR).

Interfacing Seven Segment Displays and Liquid Crystal Displays with MSP430. Low Power Modes in MSP430. Introduction to MSP430 Timer Module and it's Modes of Operation.

UNIT – 4

Generating Pulse Width Modulation (PWM) using Timer Capture Mode. ADC operation in MSP430. Interfacing analog inputs. Generating random numbers using LFSR and other methods. Adding DAC to MSP430. Custom Waveform generation using MSP430.

Timer Capture Modes. Measuring frequency and time period of external signals and events. Serial Communication Protocols: UART, SPI, I2C. Interfacing Universal Serial Communication Interface (USCI) Module of the MSP430 for UART Communication. Advanced Coding Exercises based on Interrupt driven Programming. Building an Electronics Project.

Circuit Prototyping techniques. Designing Single Purpose Computers using Finite State Machine with Datapath (FSMD) approach. MSP430 Based Project Design and Implementation. Recap of Course Coverage.

TEXTBOOKS:

1. John Catsoulis, "Designing Embedded Hardware", O'Reilly Media, Inc.,2nd Edition, 2005
2. Tony Givargis and Frank Vahid,"Embedded System Design: A Unified Hardware / Software Introduction". Wiley, 2002
3. John H. Davies, "MSP430 Microcontroller Basics", Elsevier, 1st Edition, 2008.
4. Micheal Barr, "Programming Embedded Systems in C and C++", O'Reilly Media, Inc., 1999

REFERENCE BOOKS:

1. JonathanW.Valvano, "EmbeddedMicrocomputerSystems",3rd Edition,CengageLearning, 2011.
2. David E. Simon, "An Embedded Software Primer", Pearson Ed.,2005.
3. Raj Kamal, "Introduction to Embedded Systems", TMH,2002.
4. SriRamVIyer,PankajGupta, "EmbeddedRealTimeSystemsProgramming",TMH,2004.
5. International Journal of Embedded Systems-InderSciencePublishers.

JOURNALS/MAGAZINES:

1. International Journal of Embedded Systems
2. A Journal of Embedded System and Applications
3. IEEE embedded System Letters

SWAYAM/NPTEL/MOOCs:

1. Coursera – Embedded System Course, University of Michigan
2. https://onlinecourses.nptel.ac.in/noc20_ee98/preview

SELF-LEARNINGEXERCISES:

1. Real Time Projects on Embedded Systems

Course Title	Web Technologies				Course Type		HC	
Course Code	B20EF0501	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**-**	**50**	**50**

COURSE OVERVIEW:

The basics of Web application tools such as HTML, XHTML and CSS are introduced. The course also provides knowledge about advanced research topics such as XML, Perl and PHP.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the basic concepts of HTML code.
2. Illustrate the use of Cascading Style Sheets in web pages.
3. Demonstrate the use of Angular JS, Java Scripts and XML in real world applications.

Describe the principles of object oriented development using Perl and PHP

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Experiment with various HTML tags to create a web page for real world applications.	1 to 5 , 9,10,12	1
CO2	Apply Cascading Style Sheets to design a web page for real world applications.	1 to 5 , 9,10,12	1
CO3	Develop *client-side* environment using AngularJS, JavaScripts and XML for Web based applications.	1 to 5, 9,10,12	2,3
CO4	Build a server-side environment using PHP for Web based application	1 to 5, 9,10,12	2,3
CO5	Develop real time web applications.	1 to 5, 9,10,12	1,3
CO6	Make use of java and server side scripting languages to develop web applications.	1 to 5, 9,10,12	2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3	3	2				3	3		3	3		
CO2	3	2	2	3	2				3	3		3	3		
CO3	3	2	3	3	2				3	3		3		3	3
CO4	3	2	3	3	2				3	3		3		3	3
CO5	3	3	2	2	3				3	3		3	3		3
CO6	3	2	3	3	2				3	3		3		3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to HTML: HTML Syntax, Semantic Markup, Structure of HTML Documents, HTML Elements, HTML Semantic Structure Elements, HTML Web Storage. HTML Tables and Forms, Introducing Tables, Styling Tables, Introducing Forms, Form Control Elements, Table and Form Accessibility, Micro formats.

UNIT – 2

Introduction to CSS: What is CSS, CSS Syntax, Location of Styles, Selectors, The Cascade: How Styles Interact, CSS Text Styling. Advanced CSS: Layout, Normal Flow, Positioning Elements, Floating Elements, Constructing Multicolumn Layouts, Approaches to CSS Layout, Responsive Design, CSS Frameworks.

UNIT – 3

JavaScript: Client-Side Scripting, JavaScript's History and Uses, JavaScript Design Principles, Where Does JavaScript Go? Syntax, Control statements, Functions, JavaScript Objects, Constructors, The Document Object Model (DOM), JavaScript Events, Forms.

UNIT – 4

Introduction to server-side Development with PHP: Arrays and Super globals, Arrays, $GET and $POST Super global Arrays, $_SERVER Array, $_Files Array, Reading/Writing Files, PHP Classes and Objects, Object-Oriented Overview, Classes and Objects in PHP, Object Oriented Design, Working with Databases, SQL, Database APIs, Managing a MySQL Database. Accessing MySQL in PHP.

TEXT BOOKS:

1. 1. Randy Connolly, Ricardo Hoar, "Fundamentals of Web Development", Pearson Education India, 1st Edition, 2016
2. 2. Jeffrey C. Jackson, "Web Technologies--A Computer Science Perspective", Pearson Education, 1st Edition, 2006.
3. 3. Robert. W. Sebesta, "Programming the World Wide Web", Pearson Education, 4th Edition, 2007.

REFERENCE BOOKS:

1. Robin Nixon, "Learning PHP, MySQL &JavaScript with jQuery, CSS and HTML5", O'Reilly Publications, 4th Edition, 2015.
2. Luke Welling, Laura Thomson, "PHP and MySQL Web Development", Pearson Education, 5th Edition 2016.
3. Nicholas C Zakas, "Professional JavaScript for Web Developers", Wrox/Wiley India, 3rd Edition 2012.
4. David Sawyer Mcfarland, "JavaScript & jQuery: The Missing Manual", O'Reilly/Shroff Publishers & Distributors Pvt Ltd, 1st Edition, 2014
5. Zak Ruvalcaba Anne Boehm, "Murach's HTML5 and CSS3", Murachs/Shroff Publishers & Distributors Pvt Ltd, 3rd Edition, 2016.
6. Gerardus Blokdyk, "Representational State Transfer: Practical Integration", CreateSpace Independent Publishing Platform, 1st Edition, 2018
7. Michael Fitzgerald, 'Learning Ruby", O'Reilly, 1st Edition, 2007

JOURNALS/MAGAZINES:

1. https://www.inderscience.com/jhome.php?jcode=ijwet
2. http://stmjournals.com/Journal-of-Web-Engineering-and-Technology.html
3. https://www.scimagojr.com/journalsearch.php?q=15657&tip=sid
4. https://www.smashingmagazine.com/
5. https://www.computer.org/publications/computing-edge

SWAYAM/NPTEL/MOOCs:

1. Coursera - Web Design: Wireframes to Prototypes
2. Coursera – Web Application Technologies and Django
3. https://nptel.ac.in/courses/106/105/106105084/
4. https://www.edx.org/learn/web-development

SELF-LEARNING EXERCISES:

1. HTML5
2. JQuery
3. XML
4. Ruby
5. Introduction to REST and RESTful API

Course Title	Machine Learning				Course Type		HC	
Course Code	B20EF0503	Credits	3		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	3	3	3	39	-	50	50

COURSE OVERVIEW:

The course introduces the fundamental concepts of machine learning, data exploration, information-based learning, similarity-based learning, probability based learning, and error based learning. It also discusses the concepts of Artificial Neural networks and perform analysis on machine learning experiments.

COURSE OBJECTIVE (S):

The main objectives of this course are:

5. Understand different learning algorithms and the techniques of data exploration.
6. Illustrate supervised machine learning techniques that are suitable for applications.
7. Describe probability based machine learning algorithms and error optimization.
8. Discuss the concepts of ANN and perform evaluation on the trained models.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Understand the fundamental concepts of machine learning and data exploration.	1,2,3,5,11,12	1,2,3
CO2	Implement the concepts of supervised machine learning algorithms to predict the output class labels.	1,2,3,4,5,9,11,12	1,2,3
CO3	Demonstrate probability based learning techniques to predict the solutions for real world problems.	1,2,3,4,5,6,9,11, 12	1,2,3
CO4	Apply error minimization techniques to optimize the machine learning model.	1,2,3,5,12	1,2,3
CO5	Compare biological neuron vs artificial neuron and develop applications using neural networks.	1,2,3,4,5,9,11,12	1,2,3
CO6	Analyze and evaluate the performance of machine learning experiments.	1,2,3,4,5,6,9,11, 12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		✓				
CO2			✓			
CO3			✓			
CO4			✓			
CO5				✓		
CO6				✓	✓	

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2		3						3	3			
CO2	3	2	3	3	3				3		3	3			
CO3	3	2	3	3	3	2			3		3	3			
CO4	3	3	3		3							3			
CO5	3	2	3	3	3				3		3	3			
CO6	3	2	3	3	3	2			3		3	3			

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

UNIT – 1

Machine Learning: What is Machine Learning? How does Machine Learning Work? What can go wrong with Machine Learning? What is Predictive Data Analytics? The Predictive Data Analytics Project Life Cycle: CRISP-DM and Predictive Data Analytics Tools, Designing & Implementing Features: Different types of data, different types of features.

Data Exploration- Getting to know the Data, Preprocessing: Identifying Data Quality Issues, Handling Data Quality Issues, Advanced Data Exploration, Data Preparation, Feature selection, Forward Sequential Selection, Backward Sequential Selection.

UNIT – 2

Information-based Learning: Decision Trees, Shannon's Entropy Model, Information Gain, Standard Approach: The ID3 Algorithm, A Worked Example: Predicting Vegetation Distributions, Alternative Feature Selection & Impurity Metrics, Handling Continuous Descriptive Features, Predicting Continuous Targets, Tree Pruning and Model Ensembles, Case studies.

Similarity-based Learning: Feature Space, Measuring Similarity Using Distance Metrics, Standard Approach: The Nearest Neighbor Algorithm, Handling Noisy Data, Efficient Memory Search Data Normalization, Predicting Continuous Targets, Other Measures of Similarity, Case studies.

UNIT – 3

Probability-based Learning: Baye's Theorem, Bayesian Prediction, Conditional Independence &Factorization, Standard Approach: The Naive Bayes Model, A Worked Example.

Error-based Learning: Simple Linear Regression, Measuring Error, Error Surfaces, Standard Approach: Multivariable Linear Regression with Gradient Descent, Multivariable Linear Regression, Gradient Descent, Choosing Learning Rates & Initial Weights, A Worked Example.

Unit 4

Artificial Neural Networks: Introduction, Neural Network Representation, Appropriate problems for Neural Network Learning, Perceptrons, Multilayer Networks and Back Propagation Algorithm.

Analysis of Machine Learning Experiments: Introduction, Factors, Response, and Strategy of Experimentation, Randomization, Replication, and Blocking, Guidelines for Machine Learning Experiments, Cross-Validation and Resampling Methods, Measuring Classifier Performance, Interval Estimation, Hypothesis Testing.

TEXT BOOKS:

1. John D Kelleher, Brian Mac Namee, Aoife D'Arcy, "Fundamentals of Machine Learning for Predictive Data Analytics- Algorithms, Worked Examples and case studies", MIT Press, 2015.
2. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (INDIAN EDITION), 2013.
3. Ethem Alpaydin, - Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series), Third Edition, MIT Press, 2014.

REFERENCE BOOKS:

1. T. Hastie, R. Tibshirani, J. H. Friedman, "The Elements of Statistical Learning", Springer; 1stedition, 2001.
2. Stephen Marsland, - Machine Learning – An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

JOURNALS/MAGAZINES:

3. Springer Journal of Machine Learning.
4. International Journal of Machine Learning and Computing.

SWAYAM/NPTEL/MOOCs:

5. Coursera – Machine Learning
6. Coursera – Deep Learning
7. https://onlinecourses.nptel.ac.in/noc19_cs53/preview
8. https://www.edx.org/learn/machine-learning

SELF-LEARNING EXERCISES:

5. Data Visualization
6. Bar Plots
7. Histograms
8. Box Plots

Course Title	Communication Technologies for IoT				Course Type		SC	
Course Code	B21ETS616	Credits	3		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

This course introduces the Concept of connecting processing devices together through a network using which things can communicate with each other using internet as means of communication between them. All the things should be IP protocol enabled in order to have this concept possible. Not one but multiple technologies are involved to make IoT a great success.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Explain the basics of embedded systems and embedded system design.
2. Describe Internet-of-Things and design principles.
3. Demonstrate the use of prototyping in development of real world application.
4. Illustrate the use of internet principles and techniques for writing embedded code.

COURSE OUTCOMES:

On successful completion of this course; the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Summarize the foundation in the Internet of Things, including the components, tools, and analysis.	1,2,4,5	1,2,3
CO2	Apply Internet-of-Things and design principles in development of real-world applications.	1,2,4,5,8,12	2,3
CO3	Outline different communication characteristics and synchronization issues occur in IoT based communication.	1,2,4,5	1,2
CO4	Summarize embedded IoT Solutions using sensors and components integration for the real time application	1,2,4,5,12	1,3
CO5	Identify centralized and distributed MAC layer protocols in communication.	1,2,4,5	1,2
CO6	Compare various wireless technologies used for Communication in IoT based real world applications.	1,2,4,5	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3		√				
CO4		√				
CO5			√			
CO6		√				

COURSE ARTICULATIONMATRIX

Course Outcomes	Program Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2		3	3								**3**	**3**	**3**
CO2	2	1		3	2			2				2		**3**	**3**
CO3	3	2		3	3								**3**	**3**	
CO4	3	2		3	3							2	**3**		**3**
CO5	3	2		3	3								**3**	**3**	
CO6	3	2		3	3								**3**	**3**	**3**

COURSE CONTENT

THEORY:

UNIT – 1

Fundamentals of Sensor Networks: Introduction to computer and wireless sensor networks and Overview of the syllabus Motivation for a network of Wireless Sensor nodes- Sensing and sensors-challenges and constraints - node architecture-sensing subsystem, processor subsystem communication interfaces- prototypes,

UNIT – 2

Communication Characteristics: Wireless Transmission Technology and systems-Radio Technology Primer-Available Wireless Technologies - Hardware- Telosb, Micaz motes- Time Synchronization Clock and the

Synchronization Problem - Basics of time synchronization-Time synchronization protocols - Localization- Ranging Techniques- Range based Localization-Range Free Localization- Event driven Localization

UNIT – 3

IoT Network protocols (MAC layer): Wireless sensor networks (WSNs) and power consumption, CSMA/CA and slotting, Centralized vs. distributed, State-of-the-art MAC-layer protocols for WSNs

UNIT – 4

Wireless technologies for IoT (Layer 1 & 2): WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems

TEXTBOOKS:

1. Theodore S Rappaport, "Wireless Communications – Principles and Practice", Pearson Education Pte. Ltd., Delhi
2. William Stallings, "Wireless Communications and Networking", Pearson Education Pte. Ltd., Delhi
3. Miller, Brent A, Bisdikian, Chatschik, "Bluetooth Revealed", Addison Wesley Longman Pte Ltd., Delhi
4. Wilson, "Sensor Technology hand book," Elsevier publications 2005.
5. Andrea Goldsmith, "Wireless Communications," Cambridge University Press, 2005

REFERENCEBOOKS:

1. McKinsey Global Institute report: "Unlocking the potential of the Internet of Things". Available from : http://www.mckinsey.com/insights/business_technology/the_internet_of_things_the_value_of_digitizing_the_physical_world
2. Zhao, Feng, and Leonidas J. Guibas. Wireless sensor networks: an information processing approach. Morgan Kaufmann.
3. Karl, Holger, and Andreas Willig. Protocols and architectures for wireless sensor networks. John Wiley & Sons.
4. Dargie, Waltenegus W., and Christian Poellabauer. Fundamentals of wireless sensor networks: theory and practice. John Wiley & Sons.

JOURNALS/MAGAZINES:

1. IEEE Transactions on Internet of Things
2. Springer Journal of Internet of Things
3. Elsevier Journal of Internet of Things

SWAYAM/NPTEL/MOOCS:

1. https://www.udemy.com/ Internet of Things
2. https://www.coursera.org/learn/ Internet of Things

3. https://nptel.ac.in/courses/106106133/

SELF-LEARNINGEXERCISES:

Explore any one of the boards like Raspberry Pi, Intel Galileo, Beagle Bone Black, Dragon Board, UDOO DUAL/QUAD, ARM Boards, DIY Development boards for IoT prototyping (C.H.I.P, MediatekLinkit One, Particle Photon, Tessel, Adafruit Flora, LightBlue Bean, Udoo Neo, Intel Edison)

Course Title	Cloud Computing and DevOps				Course Type		SC	
Course Code	B21ETS617	Credits	3		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

The technological industry is constantly changing. Although the internet was born only a quarter of a century ago, it has already transformed the way that we live. This course provides a practical guide for models to be choosen for deployment, tooling, or using the best practices of the companies. Through the use of Cloud, it will be possible to build the key elements required to efficiently manage and scale the infrastructure, engineering processes, and the applications, with minimal cost and effort.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Discuss the various Cloud computing service models, deployment models in virtualized environments
2. Explain the working of cloud computing technologies like data center technology, web technology, multitenant technology and service technology.
3. Illustrate DevOps workflow in script creation and source control
4. Describe data storage options and design to survive failures

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Compare the cloud computing service models, deployment models and its applicability in virtualized environments	1 to 4, 8, 9 , 12	1
CO2	Make use of the cloud computing technologies like data center technology, virtualization technology, web technology, multitenant technology and service technology.	1 to 3, 5,9,12	1
CO3	Demonstrate the DevOps workflow in script creation, troubleshooting and error handling	1 to 5, 9, 12	3
CO4	Analyze the data storage options to overcome survive failures	1,4,5,9,12	1
CO5	Illustrate the basic services provided by Azure cloud.	1 to 5	1
CO6	Apply source control mechanism to develop real world applications.	1 to 5	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3		√				
CO4				√		
CO5		√				
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	2				1	1			1	3		
CO2	3	2	3		2				1			1	3		
CO3	3	1	2	1	2				1			1			3
CO4	3			2	2				1			1	3		
CO5	3	2	2	1	3								3		
CO6	2	2	3	2	2								3	3	

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to Cloud Computing: Origins and Influences, Basic Concepts and Terminology, Goals and Benefits, Risks and Challenges, Cloud Characteristics, Cloud Delivery Models and Cloud Deployment Models.

Virtualization: Implementation levels of virtualization, virtualization structures/tools and mechanisms, virtualization of CPU, memory and I/O devices.

UNIT – 2

Cloud Enabling Technologies: Broadband Networks and Internet Architecture, Data Center Technology; Virtualization Technology; Web Technology; Multitenant Technology; Service Technology.

Cloud Infrastructure Mechanisms: Logical Network Perimeter; Virtual Server; Cloud Storage Device; Cloud Usage Monitor; Resource Replication; Ready-made environment

UNIT – 3

Automate everything, DevOps workflow: Azure management scripts, Environment creation script, Parameters in the main script, Create the website , Create the storage account, Create the databases Store app settings and connection strings, Troubleshooting and error handling, Deployment script

Source control: Treat automation scripts as source code, Structure source branches to facilitate DevOps workflow, Add scripts to source control in Visual Studio, Store sensitive data in Azure

UNIT – 4

Data storage options: Data storage options on Azure, Hadoop and MapReduce Platform as a Service (PaaS) versus Infrastructure as a Service (IaaS), Choosing a data storage option, Demo: Using SQL Database in Azure

Design to survive failures: Types of failures, Failure scope, Machine failures, Service failures, Region failures, SLAs, Composite SLAs, Cloud SLAs compared with enterprise downtime experience

TEXT BOOKS:

1. Thomas Erl , Ricardo Puttini , Zaigham Mahmood ,"Cloud Computing: Concepts, Technology & Architecture ",PHI, 20l3.
2. Mark Simms, Scott Guthrie, and Tom Dykstra, "Building Cloud Apps with Microsoft Azure: Best Practices for DevOps, Data Sorage, High Availability and more", Published by Microsoft Press, 2014.(Chapter 1, 2, 6 and 9)

REFERENCE BOOKS:

1. SunilkumarManvi, Gopal K. Shyam, "Cloud Computing: Concepts and Technologies", First edition, CRC press, 2021.
2. Dan C. Marinescu, "Cloud Computing: Theory and Practice," MK
3. Rajkumar Buyya, James Broberg, Andrzej Goscinski," Cloud Computing- Principles and Pradigms", Wiley.
4. Gautam Shroff, "Enterprise Cloud Computing- Technology, Architecture, Applications", CAMBRIDGE.
5. Kai Hwang, Geoffrey C. Fox, Jack J Dongarra", Distributed and Cloud Computing",MK,20l2
6. Michael Collier, Robin Shahan, "Fundamentals of Azure-Microsoft Azure Essentials", Microsoft Press, 2nd Edition,20l6.
7. Neil Peterson, "Get started guide for Azure IT operators", Microsoft,20l6.
8. Roberto Brunetti, "Windows Azure-Step by Step", Oreilly Media,20ll.

JOURNALS/MAGAZINES:

1. Journal of Cloud Computing -Advances, Systems and Applications, Springer Open.
2. International Journal of Cloud Computing, INDERSCIENCE Publishers.
3. IEEE Transactions on Cloud Computing, IEEE.
4. International Journal of Cloud Applications and Computing (IJCAC), IGI Global.

SWAYAM/NPTEL/MOOCs:

1. Coursera – Introduction to Cloud computing
2. https://www.udemy.com/course/introduction-cloud-computing/
3. https://nptel.ac.in/courses/106/105/106105223/
4. https://www.edx.org/learn/Cloud-computing-Infrastructure

SELF-LEARNINGEXERCISES:

1. Creating a private cloud using Open Stack.
2. Give a report on benefit of Cloud on Health Industry.
3. Give a report on benefit of Cloud for Farmers.
4. Execute some of the Azure based projects available in Github.
5. Write a note on Azure virtual machines.
6. Develop applications using Open-source Cloud computing tools like OpenNebula and Eucalyptus
7. What are reasons that make Amazon so big?
8. Explain the security usage in the Amazon Web Services model.
9. Explain how you can vertically scale an Amazon instance. Mention the key components of AWS. Explain security management in terms of Cloud Computing.
10. Compare the three cloud computing delivery models, SaaS, PaaS, and IaaS, from the point of view of the application developers and users. Discuss the security and the reliability of each one of them. Analyze the differences between the PaaS and the IaaS.
11. Overprovisioning is the reliance on extra capacity to satisfy the needs of a large community of users when the average-to-peak resource demand ratio is very high. Give an example of a large-scale system using overprovisioning and discuss if overprovisioning is sustainable in that case and what are the limitations of it. Is cloud elasticity based on overprovisioning sustainable? Give the arguments to support your answer.
12. An organization debating whether to install a private cloud or to use a public cloud, e.g., the AWS, for its computational and storage needs, asks your advice. What information will you require to base your recommendation on, and how will you use each one of the following items: (a) the description of the algorithms and the type of the applications the organization will run; (b) the system software used by these applications; (c) the resources needed by each application; (d) the size of the user population; (e) the relative experience of the user population; (d) the costs involved.

Open elective-II:

Course Title	Data Structures				Course Type		OE	
Course Code	B21CSO601	Credits	3		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

This course covers basic data structures techniques and their implementation in Java. Familiarize the concept of Abstract Data Types (ADT), stacks, Queues and Trees. The course also introduces applications of these data structures in solving problems. Students are expected to use these data structure concepts to write simple programs.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1.Explain the basic Concepts of java and Data Structures

2. Illustrate the creation and use of singly and doubly Linked list in Java.

3. Demonstrate the use of Stacks and Queues in real world applications.

4. Discuss the concept and applications of Binary trees.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Make use of Java Arrays to solve real world problems.	1 to 5	1
CO2	Develop a java program for implementing the linked list.	1 to 5	1,2
CO3	Build a real world application in Java using stacks and queues.	1 to 5	1,2
CO4	Apply the concepts of trees for solving real world problems.	1 to 5	1,2
CO5	Identify the most suitable data structure for real world application.	1 to 5	1,2,3
CO6	Experiment with all data structures in a high-level language for problem solving.	1 to 5	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	2								3		
CO2	3	2	3	3	2								3	3	
CO3	3	1	2	3	1								3	3	
CO4	3	1	3	3	2								3	3	
CO5	3	3	3	3	1								3	3	3
CO6	3	3	3	3	2								3	3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to Data Structures: Introduction to data structures, classification of data structures, operations on data structures, abstract data type, algorithms; Arrays-Sorting an Array (Insertion Sort), java.util Methods for Arrays, Cryptography with character arrays; Two-dimensional Arrays and positional games.

UNIT – 2

Linked list: Singly Linked List, Implementing a Singly linked list class; Circularly Linked List, Round-Robin Scheduling, Designing and implementing a circularly linked list; Doublylinked List, Implementing a Doubly linked list class.

UNIT – 3

Stacks: Introduction, The Stack Abstract Data type, A Simple Array-based Stack implementation, Implementing a Stack with a Singly Linked List.

Queue: Introduction, The Queue Abstract Data type, Array-based Queue implementation, implementing a Queue with a Singly Linked List.

UNIT – 4

Trees: General Trees-Tree definitions and properties, The Tree Abstract data type, computing depth and height; Binary Trees: The Binary Tree abstract data type, properties of Binary Trees; Implementing Trees- Linked structure for Binary Trees; Tree Traversal Algorithms- Preorder, Postorder Traversals of General Tree, Inorder Traversal of a Binary Tree, Implementing Tree Traversal.

TEXTBOOKS:

3. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in JAVA ", Wiley, 6th Edition, 20l4
4. Herbert Schildt, "The Complete reference Java", 7th edition, 2007

REFERENCEBOOKS:

1. Richard Gilberg, Behrouz Forouzan, "Data Structures: A Pseudocode Approach with C", Cengage Learning,2004.
2. DebasisSamanta, "Classic Data Structures", second edition, PHI Learning Private Limited,2011.

JOURNALS/MAGAZINES:

1. https://www.imedpub.com/scholarly/data-structure-journals-articles-ppts-list.php
2. https://www.mdpi.com/journal/algorithms/special_issues/Efficient_Data_Structures
3. https://ieeexplore.ieee.org/document/4055607
4. https://ieeexplore.ieee.org/abstract/document/6312216
5. https://www.sciencedirect.com/science/article/pii/0022000083900065
6. https://www.sciencedirect.com/journal/journal-of-algorithms

SWAYAM/NPTEL/MOOCs:

1. Coursera – Data Structures and Algorithms Specialization
2. Coursera – Data Structures, University of California San Diego
3. Data Structures and Algorithms, National Research University Higher DEPARTMENT of Economics
4. https://nptel.ac.in/courses/106/102/106102064/
5. https://nptel.ac.in/courses/106/106/106106127/
6. https://nptel.ac.in/courses/106/103/106103069/

SELF-LEARNINGEXERCISES:

2. Storing game entities in a array
3. Pseudo-random number generators
4. Reversing an array using a stack
5. Matching parentheses and HTML tags
6. Double ended queue
7. Application of tree traversals

Course Title	Research Based Mini Project				Course Type		HC	
Course Code	B21ET0603	Credits	2		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	2	4	4	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**2**	**4**	**4**	**0**	**52**	**50**	**50**

COURSE OVERVIEW

The research based mini project is focused at providing the platform for students to enhance their research aptitude and develop the skills they require for developing the trending applications using the latest technologies. Additionally, this course gives a platform to students to showcase their talent by doing innovative projects that strengthen their profile making themselves employable in various domains.

COURSE OBJECTIVE (S):

1. To create an Industrial environment and culture within the DEPARTMENT of CSE.
2. To provide students hands on experience on, troubleshooting, maintenance, innovation, record keeping, documentation etc thereby enhancing the skill and competency part of technical education.
3. To promote the concept of entrepreneurship.
4. To inculcate innovative thinking and thereby preparing students for main project.

COURSE OUTCOMES (CO'S):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Demonstrate in-depth knowledge on the project topic.	7 to 12	1,2,3
CO2	Identify, analyze and formulate complex problem chosen for project workto attain substantiated conclusions.	7 to 12	1,2,3
CO3	Design solutions to the chosen project problem.	7 to 12	1,2,3
CO4	Undertake investigation of project problem to provide valid conclusions.	7 to 12	1,2,3
CO5	Use the appropriate techniques, resources and modern engineering tools necessary for project work.	7 to 12	1,2,3
CO6	Apply project results for sustainable development of the society.	7 to 12	1,2,3

CO7	Understand the impact of project results in the context of environmental sustainability.	7 to 12	1,2,3
CO8	Understand professional and ethical responsibilities while executing the project work.	7 to 12	1,2,3
CO9	Function effectively as individual and a member in the project team.	7 to 12	1,2,3
CO10	Develop communication skills, both oral and written for preparing and presenting project report.	7 to 12	1,2,3
CO11	Demonstrate knowledge and understanding of cost and time analysis required for carrying out the project.	7 to 12	1,2,3
CO12	Engage in lifelong learning to improve knowledge and competence in the chosen area of the project.	7 to 12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	**Understand (L2)**	**Apply (L3)**	**Analyze (L4)**	**Evaluate (L5)**	**Create (L6)**
CO1			√	√	√	
CO2			√	√	√	
CO3			√	√	√	
CO4			√	√	√	
CO5			√	√	√	
CO6			√	√	√	
CO7			√	√	√	
CO8			√	√	√	
CO9			√	√	√	
CO10			√	√	√	
CO11			√	√	√	
CO12			√	√	√	

COURSE ARTICULATIONMATRIX

CO#/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1							3	3	3	3	3	3	3	3	3
CO2							3	3	3	3	3	3	3	3	3
CO3							3	3	3	3	3	3	3	3	3
CO4							3	3	3	3	3	3	3	3	3
CO5							3	3	3	3	3	3	3	3	3
CO6							3	3	3	3	3	3	3	3	3
CO7							3	3	3	3	3	3	3	3	3
CO8							3	3	3	3	3	3	3	3	3
CO9							3	3	3	3	3	3	3	3	3
CO10							3	3	3	3	3	3	3	3	3
CO11							3	3	3	3	3	3	3	3	3
CO12							3	3	3	3	3	3	3	3	3

Note:1-Low,2-Medium,3-High

The following are the guidelines to be followed by the students to complete their research based mini projects.

1. The students shall form groups (max 4) and select their guides based on their area of interest in their previous semester.
2. In the beginning of the current semester the students shall corner the problem by performing the literature survey (by choosing the research papers of reputed Journals) in their area of interest.
3. The students shall choose a base paper from the list of papers they would have surveyed.
4. The students shall identify the research gaps in their selected research domain, and finalize their problem statement with objectives for the research based mini project.
5. The students shall be completing the synopsis presentation (phase-1 presentation (progress)), and phase-2 presentation (implementation with demo) as per the calendar set by the concerned coordinator.
6. Finally, the students shall complete their mini projects providing innovative solutions for the selected research problem and apply for patent / copyright / paper publication in SCOPUS indexed journals / research proposals / product development / and or startups.

Course Title	Mobile Application Development				Course Type		HC	
Course Code	B21EF0604	Credits	1		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**1**	**1**	**1**	**13**	**--**	**50**	**50**

COURSE OVERVIEW:

This course is concerned with the development of applications on mobile and wireless computing platforms. Android will be used as a basis for teaching programming techniques and design patterns related to the development of standalone applications and mobile portals to enterprise and mcommerce systems. Emphasis is placed on the processes, tools and frameworks required to develop applications for current and emerging mobile computing devices. Students will work at all stages of the software development life-cycle from inception through to implementation and testing. In doing so, students will be required to consider the impact of user characteristics, device capabilities, networking infrastructure and deployment environment, in order to develop software capable of meeting the requirements of stakeholders.

COURSE OBJECTIVE (S):

5. Explain the android SDK.
6. Illustrate about the basic understanding of Android application development
7. Demonstrate the use of knowledge of Android Studio development tool.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO-1	Understand the concepts of mobile programming that make it unique from programming for other platforms.	1,2,3,4,5,11,12	1,2,3
CO-2	Identify the mobile applications on their design pros and cons.	1,2,3,4,5,11,12	1,2,3
CO-3	Evaluate the rapid prototyping techniques to design and develop sophisticated mobile interfaces.	1,2,3,4,5,11,12	1,2,3
CO-4	Solve the Program mobile applications for the Android operating system that use basic and advanced phone features.	1,2,3,4,5,11,12	1,2,3
CO-5	Determine the Android marketplace for distribution.	1,2,3,4,5,11,12	1,2,3
CO-6	Analysis working with different types of resources.	1,2,3,4,5,11,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO-1		√				
CO-2			√			
CO-3					√	
CO-4			√			
CO-5					√	
CO-6			√			

COURSE ARTICULATIONMATRIX

CO#/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO-1	3	3	3	3	3						3	3	3	3	3
CO-2	3	3	3	3	3						3	3	3	3	3
CO-3	3	2	3	3	3						3	3	3	3	3
CO-4	3	3	3	3	3						3	3	3	3	3
CO-5	3	3	3	3	3						3	3	3	3	3
CO-6	3	2	3	3	3						3	3	3	3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY

UNIT - 1

Introduction to Android: The Android Platform, Android SDK, Eclipse Installation, Android Installation, Building you First Android application, Understanding Anatomy of Android Application, Android Manifest file.

UNIT - 2

Android Application Design Essentials: Anatomy of an Android applications, Android terminologies, Application Context, Activities, Services, Intents, Receiving and Broadcasting Intents, Android Manifest File and its common settings, Using Intent Filter, Permissions.

UNIT - 3

Android User Interface Design Essentials: User Interface Screen elements, Designing User Interfaces with Layouts, Drawing and Working with Animation.

UNIT- 4

Testing Android applications, Publishing Android application, Using Android preferences, Managing Application resources in a hierarchy, working with different types of resources.

TEXT BOOKS:

5. T1. Lauren Darcey and Shane Conder, "Android Wireless Application Development", Pearson Education, 2nd ed. (2011)

REFERENCE BOOKS:

1. Reto Meier, "Professional Android 2 Application Development", Wiley India Pvt Ltd
2. Mark L Murphy, "Beginning Android", Wiley India Pvt Ltd
3. Android Application Development All in one for Dummies by Barry Burd, Edition: I

JOURNALS/MAGAZINE:

https://ieeexplore.ieee.org/document/6104696

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/106106156
2. https://onlinecourses.nptel.ac.in/noc20_cs52/preview
3. https://www.coursera.org/learn/aadcapstone
4. https://onlinecourses.swayam2.ac.in/nou21_ge41/preview

SELF-LEARNING EXERCISES:

1. Android Development

TEXT BOOKS: 1. T1. Dawn Griffiths, "Headfirst Android Development", O'Reilly, 1st ed.

REFERENCE BOOKS: 1. R1. Reto Meier, "Android Programming for Beginners", Wiley India Pvt Ltd

Course Title	Natural Language Processing lab				Course Type		HC	
Course Code	B21ET0604	Credits	1		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	-	-	-				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**1**	**2**	**2**	**-**	**26**	**25**	**25**

COURSE OVERVIEW:

The Lab offers a number of practical projects in Natural Language Processing, focusing on Text Classification, Parts of Speech processing. Some projects require previous knowledge of computational linguistics but some assume no previous background. All projects involve programming: the end result is a relatively large-scale, well-documented and efficient software package. Some of the projects may involve also some research. Python is a open-source language with a simple syntax, and a powerful set of libraries. It is widely used in many scientific areas for, NLP, string concepts.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. To learn the fundamental programs for Natural Language processing.
2. To understand the Linux OS for stop words frequent bigrams.
3. To apply the NLP techniques for strings using python.
4. To acquire python program to remove stop words, whitespace.
5. To implement python program for stemming a parts of speech, Lemmataization.
6. To use python program for text classification.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Understand and execute simple Natural Language Programs.	1 to 5	1,2
CO2	Implement python program for stop words, frequent bigrams.	1 to 5	1,2
CO3	Apply string concepts in Natural Language Processing.	1 to 5,9,12	1,2,3
CO4	Make use of python program for stemming, POS, Lemmataization and text classification.	1 to 5,9,12	1,2
CO5	Analyze and implement string concepts for various real time application using NLP.	1 to 5,9,12	1,2,3
CO6	Analyze the different statistical approaches for different types of NLP applications.	1 to 5,9,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5				√		
CO6				√		

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	2								1	1	
CO2	3	1	2	1	2								2	2	
CO3	3	1	2	1	2				2			2	2	2	1
CO4	3	1	2	1	2				2			2	2	2	
CO5	3	2	3	1	3				3			3	2	2	3
CO6	3	3	3	1	3				3			3	1	3	2

Note:1-Low,2-Medium,3-High

PRACTICE:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	PART-A		
1	Write a program to find all words that occur at least three times in the Brown Corpus.	Windows/Linux OS, IDE, Jupyter	Create and perform word count operation.
2	Write a function that finds the 50 most frequently occurring words of a text that are not stopwords.	Windows/Linux OS, IDE, Jupyter	Create and perform word count excluding stopword operation.
3	Write a program to print the 50 most frequent bigrams (pairs of adjacent words) of a text, omitting bigrams that contain stopwords.	Windows/Linux OS, IDE, Jupyter	Create and perform frequent bigram operation.
4	Write a function word_freq() that takes a word and the name of a section of the Brown Corpus as	Windows/Linux OS,	Create and perform word

	arguments, and computes the frequency of the word in that section of the corpus.	IDE, Jupyter	count operation.
5	Define a string s = 'colorless'. Write a Python statement that changes this to “colourless” using only the slice and concatenation operations.	Windows/Linux OS, IDE, Jupyter	Create and perform slicing operation.
6	Read in some text from a corpus, tokenize it, and print the list of all wh-word types that occur. (wh-words in English are used in questions, relative clauses, and exclamations: who, which, what, and so on.) Print them in order.	Windows/Linux OS, IDE, Jupyter	Create and perform Tokenization operation.
7	Write code that removes whitespace at the beginning and end of a string, and normalizes whitespace between words to be a single-space character. a. Do this task using split() and join(). b. Do this task using regular expression substitutions.	Windows/Linux OS, IDE, Jupyter	Create and perform normalization operation.
8	Write a python program to remove stop words for a given passage from a text file using NLTK?	Windows/Linux OS, IDE, Jupyter	Implement stop word removal operation in an NLP application
9	Write a python program to implement stemming for a given sentence using NLTK?	Windows/Linux OS, IDE, Jupyter	Implement stemming operation in an NLP application
10	Write a python program to POS (Parts of Speech) tagging for the give sentence using NLTK?	Windows/Linux OS, IDE, Jupyter	Implement POS tagging operation in an NLP application
11	Write a python program to implement Lemmatization using NLTK?	Windows/Linux OS, IDE, Jupyter	Implement Lemmatization operation in an NLP application
12	Write a python program to for Text Classification for the give sentence using NLTK?	Windows/Linux OS, IDE, Jupyter	Implement Text Classification operation in an NLP application
Part-B (Mini Project: Naive Bayes Classifier with NLTK)			
Natural Language Toolkit (NLTK) is a leading platform for building Python programs to work with human language data (Natural Language Processing). NLTK is intended to support research and teaching in NLP or closely related areas, including empirical linguistics, cognitive science, artificial intelligence, information retrieval, and machine learning. A particular document is required to be classified based on the frequency of the words it has using a Document classifier trained with the frequent words from the huge corpse.			
1	Python list, tuple and dictionary square error). Create a file called list merge.py. Create a dictionary result, where the keys are the values from some list, and values from some tuple. Use list comprehension or standard loop.	Windows/Linux OS, IDE, Jupyter	**Design and Develop Naive Bayes Classifier with NLTK**
2	Lexical Analysis: tokenization Word tokenization A sentence or data can be split into words using the		

	method word tokenize()		
3	Stop word removal: English text may contain stop words like `the', `is', `are'. Stop words can be ltered from the text to be processed. There is no universal list of stop words in NLP research, however the NLTK module contains a list of stop words.		
4	Stemming: A word stem is part of a word. It is sort of a normalization idea, but linguistic. For example, the stem of the word waiting is wait. Given words, NLTK can find the stems. Start by defining some words		
5	n-grams: Find Word n-grams and Character n-grams		
6	Exploring corpora: Now, we will use the NLTK corpus module to read the corpus austen-persuasion.txt, included in the Gutenberg corpus collection, and answer the following questions: How many total words does this corpus have? How many unique words does this corpus have? What are the counts for the 10 most frequent words?		
7	Document Classification: In the previous exercises corpus is explored, which was imported from nltk.corpus. NLTK offers a package of pre-trained, labeled corpora for different purposes. In this section a simple classification task of movie reviews. The corpus can be taken from nltk.corpus.movie reviews. The classifier will be NaiveBayesClassifier.		

TEXTBOOKS:

1.Steven Bird, Ewan Klein and Edward Loper, “Natural Language Processing with Python”, First Edition, OReilly Media, 2009.

2.Yuxi (Hayden) Liu,”Python Machine Learning by Example,” First edition, Packt publisher, 2017.

Course Title	Neural Networks and Deep Learning lab				Course Type		HC	
Course Code	B21ET0605	Credits	1		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	-	-	-				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**1**	**2**	**2**	**-**	**26**	**25**	**25**

COURSE OVERVIEW:

The Deep Learning Specialization is our foundational program that will help you understand the capabilities, challenges, and consequences of deep learning and prepare you to participate in the development of leading-edge AI technology. It provides a pathway for you to gain the knowledge and skills to apply machine learning to your work, level up your technical career, and take the definitive step in the world of AI.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Understand the context of neural networks and deep learning.
2. Know how to use a neural network.
3. Understand the data needs of deep learning .
4. Have a working knowledge of neural networks, image classification and deep learning applications.
5. Explore the parameters for neural networks (Convolution and recurrent).

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Understanding of the most popular Deep Learning models and neural networks.	1 to 5	1,2
CO2	Evaluate, Implement, and train neural networks using software.	1 to 5,9,12	1,2
CO3	Apply the current research on neural networks and their applications.	1 to 5,9,12	1,2,3
CO4	Develop the concepts and techniques introduced in the course for our own applications.	1 to 5,9,12	1,2,3
CO5	Make use of technical knowledge in a image classification and neural network applications	1 to 5,9,12	1,2,3
CO6	Analyze the deep neural image classification applications in supervised learning.	1 to 5,9,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6				√		

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	2								3	3	
CO2	3	2	3	1	2				1			1	3	2	
CO3	3	2	3	1	3				2			2	2	3	2
CO4	3	2	3	2	3				3			3	2	3	3
CO5	3	2	3	2	3				3			3	2	3	3
CO6	3	3	3	2	3				3			3	2	3	3

Note:1-Low,2-Medium,3-High

PRACTICE:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	Part-A		
1.	a)Program for logistic regression with neural network. (i) Do not use loops (for/while) in your code, unless the instructions explicitly ask you to do so. (ii) Build the general architecture of a learning algorithm, including: a. Initializing parameters b. Calculating the cost function and its gradient c. Using an optimization algorithm (gradient descent) (iii) Gather all three functions above into a main model function, in the right order.	Windows/Linux OS, IDE, Jupyter Python/Tensorflow	Create and perform logistic regression with neural network.
2.	Program for planar data classification with one hidden layer: • Implement a 2-class classification neural network with a single hidden layer • Use units with a non-linear activation function, such as tanh • Compute the cross entropy loss • Implement forward and backward propagation	Windows/Linux OS, IDE, Jupyter Python/Tensorflow,CNN,Keras	Create and perform classification in neural network
3.	Program to Build your neural network: • Use non-linear units like ReLU to improve your model • Build a deeper neural network (with more than 1 hidden layer) • Implement an easy-to-use neural network class	Windows/Linux OS, IDE, Jupyter Python/Tensorflow,CNN,Keras	Neural network with ReLU
4.	Program for image classification using deep neural network	Windows/Linux OS, IDE, Jupyter Python/Tensorflow, CNN,Keras	Image classification application

5.	Convolution neural network program to an application: iii) Implement helper functions that you will use when implementing a TensorFlow model iv) Implement a fully functioning ConvNet using TensorFlow	Windows/Linux OS, IDE, Jupyter Python/Tensorflow CNN,Keras	Application program using CNN
6.	Program to build a Recurrent neural network. Recurrent Neural Networks (RNN) are very effective for Natural Language Processing and other sequence tasks because they have "memory". They can read inputs (such as words) one at a time, and remember some information/context through the hidden layer activations that get passed from one time-step to the next. This allows a uni-directional RNN to take information from the past to	Windows/Linux OS, IDE, Jupyter Python/Tensorflow , CNN,Keras	Building A RNN.
	Part-B (Mini Project: Deep neural image classification Applications)		
1.	Develop a deep neural network and apply it to cat vs non-cat image classification,Build and apply a deep neural network to supervised learning. Let's first import all the packages that you will nee during this assignment. • numpy is the fundamental package for scientific computing with Python. • matplotlib is a library to plot graphs in Python. • h5py is a common package to interact with a dataset that is stored on an H5 file. • PIL and scipy are used here to test your model with your own picture at the end. • dnn_app_utils provides the functions implemented in the "Building your Deep Neural Network: Step by Step" assignment to this notebook. • np.random.seed(1) is used to keep all the random function calls consistent	Windows/Linux OS, IDE, Jupyter Python/Tensorflo wCNN,Keras	Create a class user to read the attributes of user and store them in a file.
2	You are given a dataset ("data.h5") containing: - a training set of m_train images labelled as cat (1) or non-cat (0) - a test set of m_test images labelled as cat and non-cat - each image is of shape (num_px, num_px, 3) where 3 is for the 3 channels (RGB).	Windows/Linux OS, IDE, Jupyter Python/Tensorflo wCNN,Keras	Create a class user to read the attributes and delete the object.

3	Create the Architecture:A 2-layer neural network: The input is a (64,64,3) image which is flattened to a vector of size $(12288,1)$. The corresponding vector: $[x_0,x_1,...,x_{12287}]^T$ is then multiplied by the weight matrix $W^{[1]}$ of size $(n^{[1]}, 12288)$. You then add a bias term and take its relu to get the following vector: $[a_0^{[1]}, a_1^{[1]},..., a_{n^{[1]}-1}^{[1]}]^T$. You then repeat the same process. You multiply the resulting vector by $W^{[2]}$ and add your intercept (bias). Finally, you take the sigmoid of the result. If it is greater than 0.5, you classify it to be a cat.	Windows/Linux OS, IDE, Jupyter Python/TensorflowCNN,Keras	To create a class and edit the file.
4	Develop the L-Layer network: The input is a (64,64,3) image which is flattened to a vector of size (12288,1). The corresponding vector: $[x_0,x_1,...,x_{12287}]^T$ is then multiplied by the weight matrix $W^{[1]}$ and then you add the intercept $b^{[1]}$. The result is called the linear unit. Next, you take the relu of the linear unit. This process could be repeated several times for each $(W^{[l]}, b^{[l]})$ depending on the model architecture. Finally, you take the sigmoid of the final linear unit. If it is greater than 0.5, you classify it to be a cat.	Windows/Linux OS, IDE, Jupyter Python/TensorflowCNN,Keras	Create a class book to read the attributes of user and store them in a file.
5	Develop the geneology methodology: As usual you will follow the Deep Learning methodology to build the model: 1. Initialize parameters / Define hyperparameters 2. Loop for num_iterations: a. Forward propagation b. Compute cost function c. Backward propagation d. Update parameters (using parameters, and grads from backprop) 4. Use trained parameters to predict labels	Windows/Linux OS, IDE, Jupyter Python/TensorflowCNN,Keras	Create a class book to read the attributes and delete the object.
6	Develop the two layer neural network:Use the helper functions you have implemented in the previous assignment to build a 2-layer neural network with the following structure: *LINEAR -> RELU -> LINEAR -> SIGMOID*.	Windows/Linux OS, IDE, Jupyter Python/TensorflowCNN,Keras	To create a class and edit the file.

7	Develop the L-Layer network: Use the helper functions you have implemented previously to build an L-layer neural network with the following structure: [LINEAR ->RELU]$\times$(L-1) -> LINEAR -> SIGMOID.	Windows/Linux OS, IDE, Jupyter Python/TensorflowCNN,Keras	Create class and perform string operations.
8	Develop a convolution neural network application: • Implement helper functions that you will use when implementing a TensorFlow model • Implement a fully functioning ConvNet using TensorFlow	Windows/Linux OS, IDE, Jupyter Python/TensorflowCNN,Keras	Create class and perform string operation.
9	Create the place holders in Tensor flow: Implement the function below to create placeholders for the input image X and the output Y. You should not define the number of training examples for the moment. To do so, you could use "None" as the batch size, it will give you the flexibility to choose it later. Hence X should be of dimension **[None, n_H0, n_W0, n_C0]** and Y should be of dimension **[None, n_y]**	Windows/Linux OS, IDE, Jupyter Python/TensorflowCNN,Keras	Create class and object, perform file operations and regular expressions.
10	Implement initialize_parameters(). The dimensior for each group of filters are provided below Reminder - to initialize a parameter W of shap [1,2,3,4] in Tensorflow, use: W = tf.get_variable("W", [1,2,3,4], initializer = ...)	Windows/Linux OS, IDE, Jupyter Python/TensorflowCNN,Keras	Create class and object, perform file operations and regular expressions.
11	Forward Propagation:Implement the forward_propagation function below to build the following model: CONV2D -> RELU -> MAXPOOL -> CONV2D -> RELU -> MAXPOOL -> FLATTEN -> FULLYCONNECTED.	Windows/Linux OS, IDE, Jupyter Python/TensorflowCNN,Keras	Create class and object, perform file operations and regular expressions.
12	Complete the function below. The model below should: • create placeholders • initialize parameters • forward propagate • compute the cost • create an optimizer	Windows/Linux OS, IDE, Jupyter Python/TensorflowCNN,Keras	Create class and object, perform file operations and regular expressions.

TEXT BOOKS:

1. Goodfellow, I., Bengio,Y., and Courville, A., “Deep Learning”, MIT Press, 2016. References

2. Bishop, C. ,M., “Pattern Recognition and Machine Learning” , Springer, 2006.

Course Title	Mobile Application Development Lab				Course Type		HC	
Course Code	B21EF0606	Credits	1		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	-	-	-				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**1**	**2**	**2**	**-**	**26**	**25**	**25**

COURSE OVERVIEW:

The Android Laboratory is a 26-hours module within the Course on Mobile Application Laboratory, for the undergraduate students of REVA University . The goal of this module is to introduce the basics of mobile applications development for Android-based terminals . we aim at presenting the essential concepts of APP development and deployments for mobile and battery-constrained devices, at introducing the main characteristics and components of the Android projects, and at providing the minimum know-how required to develop (from scratch) mobile applications for the Android architecture, at increasing levels of complexity.

COURSE OBJECTIVE (S):

8. Creating robust mobile applications and learn how to integrate them with other services.
9. Creating intuitive, reliable mobile apps using the android services and components.
10. Demonstrate the use of knowledge of Android Studio development tool.
11. Creating intuitive, reliable mobile apps using the android services and components.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO-1	Build enterprise level mobile applications with Android	1,2,3,4,5,9,11,12	1,2,3
CO-2	Understand both the basic and advanced concepts of Android.	1,2,3,4,5,9,11,12	1,2,3
CO-3	Understand why use Android over Java.	1,2,3,4,5,9,11,12	1,2,3
CO-4	Install and configure Android Studio.	1,2,3,4,5,9,11,12	1,2,3
CO-5	Explain and use key Android programming concepts.	1,2,3,4,5,9,11,12	1,2,3
CO-6	Deploy the App application in different devices.	1,2,3,4,5,9,11,12	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO-1		√				
CO-2			√			
CO-3					√	
CO-4			√			
CO-5					√	
CO-6			√			

COURSE ARTICULATIONMATRIX

CO#/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO-1	3	3	3	3	3	3			3		3	3	3	3	3
CO-2	3	3	3	3	3	3			3		3	3	3	3	3
CO-3	3	2	3	3	3	3			3		3	3	3	3	3
CO-4	3	3	3	3	3	3			3		3	3	3	3	3
CO-5	3	3	3	3	3	3			3		3	3	3	3	3
CO-6	3	2	3	3	3	3			3		3	3	3	3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

PRACTICE:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	Part-A		
1.	Development Of Android APP used for agriculture and It must provide fertile agriculture content and information at every stage of the crop life cycle.	Android Studio	Java Programming Language
2.	Create a diagnostic app to book for the doctor appointment and lab test reports by the patient.	Android Studio	Java Programming Language
3.	Create an android application to develop an employee management system.	Android Studio	Java Programming Language

4.	Design an Fingerprint voting system using android application by displaying all the nominated candidates.	Android Studio	Java Programming Language
5	Mini Project	Android Studio	Java Programming Language

TEXT BOOKS:

1. Wei-Meng Lee," Beginning Android Application Development" , 1st Ed, Wiley Publishing
2. J. F. DiMarzio, "Android: A Programmers Guide", McGraw Hill Education (India) Private Limited.1st Edition

REFERENCE BOOKS:

1. Paul Deitel "Android for Programmers: An App-Driven Approach" 1st Edition, Pearson India.
2. Wei-Meng Lee, "Beginning Android 4 Application Development", Wiley India Pvt Ltd

JOURNALS/MAGAZINE:

https://ieeexplore.ieee.org/document/6104696

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/106106156
2. https://onlinecourses.nptel.ac.in/noc20_cs52/preview
3. https://www.coursera.org/learn/aadcapstone
4. https://onlinecourses.swayam2.ac.in/nou21_ge41/preview

SELF-LEARNING EXERCISES:

Android Development

Course Title	Technical Documentation				Course Type		FC	
Course Code	B21EF0607	Credits	1		Class		VI Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Practice	-	-	-	Theory	Practical	IA	SEE
	-	-	-	-				
	Total	1	1	1	13	-	50	50

COURSE OVERVIEW:

The goal of this course is to prepare engineering students with the individual and collaborative technical writing, presentation, and research skills necessary to be effective technical communicators in academic and professional environments

COURSE OBJECTIVE (S):

The objectives of this course are:

1. To emphasize on how to prepare a technical document or a research paper for publication in a journal.
2. To teaches students a step-by-step procedure through several examples, how to plan, organize, draft, develop and prepare a document for presentation.
3. To use grammar, a precise method of preparing a document simply, clearly, and concisely
4. To organize the material in a sequential manner for writing the thesis or paper
5. To address the issues related to identifying authors and their writings through their names and affiliations, and abstracts of the work, etc.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Understand the importance of technical writing and communicate effectively through a proper structure.	1 to 4, 8, 9 , 12	1
CO2	Provide technical information and knowledge in practical documents in different styles and collaborative writing.	1 to 3, 5,9,12	1
CO3	Practice the unique qualities of professional writing style, including sentence conciseness, readability, clarity and accuracy.	1 to 5, 9, 12	2
CO4	Identify the importance of editing and edit without bias	1,4,5,9,12	1
CO5	Apply the techniques of technical writing for Thesis, project proposal, and paper	1 to 5	1,3
CO6	Analyse document, and report clearly, concisely, logically, and ethically	1 to 5	2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#/ POs	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√	√		
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2				2	2			2	3		
CO2	2	2			3				3			3	3		
CO3	1	2	1	2	3				2			2		3	
CO4	1	2	3	1	2				3			2	3		
CO5	1	2	1	2	3							2	3		3
CO6	1	2	1	2	3									3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Technical Writing Structure: The Importance of Information Structures: Descriptions versus Instructions; Understanding Role of Description: Structure of object and Mechanism Description, Structure of Process Description;

UNIT – 2

Technical Writing Style: Concise Communication: Common Errors while constructing sentences; Clarity and Precision: Guidelines to clear and specific writing; American and British English; Style Manual.

UNIT – 3

Technical documentation Editing: Meaning; Types of Editing; Technical letters writing, article writing, report writing, thesis writing, slide preparation, project proposal writing, and introduction to tools for documentation like Latex in Linux and Latex in windows.

UNIT – 4

Technical documentation Ethics: What is Legal & Ethical? Ethical Issues in Technical documentation; copyright, Plagiarism

TEXTBOOKS:

1. BN Basu, "Technical Writing" , Prentice Hall India Learning Private Limited, 2009
2. SD Sharma, "Textbook of Scientific and Technical Communication Writing for Engineers and Professionals" , Ivy Publishing House, 2008

REFERENCE BOOKS:

1. P. Oliver, "Writing Your Thesis",New Delhi:Vistaar Publications, 2004.
2. F. Mittelbach and M. Goossens,"The LATEX Companion", 2nd. ed. Addison Wesley, 2004

Course Title	Skill development-2				Course Type	HC	
Course Code	B21ET0606	Credits	2		Class	VI Semester	
Course Structure	TLP	Credits	Contact	Work Load	Total Number of Classes Per Semester	Assessment in Weightage	
	Theory	2	4	-			
	Practice	-	-	-	Theory	CIE	SEE
	Tutorial	**-**	**-**	**-**			
	Total	**2**	**4**	**-**	-	-	-

COURSE OUTCOMES (CO'S):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Demonstrate in-depth knowledge on the project topic	1	1,2,3
CO2	Identify, analyze and formulate complex problem chosen for project work to attain substantiated conclusions.	2	1,2,3
CO3	Design solutions to the chosen project problem.	3	1,2,3
CO4	Undertake investigation of project problem to provide valid conclusions.	4	1,2,3
CO5	Use the appropriate techniques, resources, and modern engineering tools necessary for project work.	5	1,2,3
CO6	Apply project results for sustainable development of the society.	6	1,2,3
CO7	Understand the impact of project results in the context of environmental sustainability.	7	1,2,3
CO8	Understand professional and ethical responsibilities while executing the project work.	8	1,2,3
CO9	Function effectively as individual and a member in the project team.	9	1,2,3
CO10	Develop communication skills, both oral and written for preparing and presenting project report.	10	1,2,3
CO11	Demonstrate knowledge and understanding of cost and time analysis required for carrying out the project.	11	1,2,3
CO12	Engage in lifelong learning to improve knowledge and competence in the chosen area of the project.	12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3						√
CO4				√		
CO5			√			
C06			√			
CO7		√				
CO8		√				
CO9	√			√		
CO10			√			√
CO11		√		√		
CO12			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	3
CO2		3											3	3	3
CO3			3										3	3	3
CO4				3									3	3	3
CO5					3								3	3	3
C06						3							3	3	3
CO7							3						3	3	3
CO8								3					3	3	3
CO9									3				3	3	3
CO10										3			3	3	3

CO11											3		3	3	3
CO12												3	3	3	3

Note: 1-Low, 2-Medium, 3-High

The students are informed to follow the following instructions to complete the Skill development-2:

Students will be offered training and certifications on the trending technologies from the industry experts.

The students are evaluated and certified after the training programs.

4th Year Syllabus

VII SEMESTER

Course Title	Data Science Using R				Course Type		SC	
Course Code	B21ETS711	Credits	3		Class		VII Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

R is rapidly becoming the leading language in data science and statistics. R is the tool of choice for data science professionals in every industry and field. Whether the person is full-time number cruncher, or just the occasional data analyst, R will suit their needs. Predictive analysis will help in creating predictive models to solve real life problems.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1.Discuss the basics of R programming.

2.Demonstrate the use of Control Structures, Functions.

3.Illustrate the use of features of Graphics package in real world applications.

4.Describe the different models with respect to predictive analysis.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Make use of Control structures and functions for real world applications.	1 to 5	1
CO2	Apply the R graphics features for the given real world application	1 to 5	2,3
CO3	Solve real world problem using Regression Models.	1 to 5	2
CO4	Develop Classification model for the given real-world problem.	1 to 5	2,3
CO5	Identify the basic concepts of R Programming language.	1 to 5	1
CO6	Make use of predictive analysis to solve real world applications.	1 to 5	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	3								3		
CO2	3	2	3	1	3									3	3
CO3	3	2	3	1	3									3	
CO4	3	2	3	1	3									3	3
CO5	3	2	3	1	3								3		
CO6	3	2	2	1	2								3	3	

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

History and overview of R: R nuts and bolts, Getting Data In and Out of R, Interfaces to the Outside World, Sub setting R Objects. Managing Data Frames with the dplyr package, Control Structures, Functions, Loop functions

UNIT – 2

R Graphics: Quickly exploring data, Bar graphs: Making a Basic Bar Graph, Grouping Bars Together, Making a Bar Graph of Counts, Using Colors in a Bar Graph, Line graphs: Making a Basic Line Graph, Adding Points to a Line

Graph, Making a Line Graph with Multiple Lines, Changing the Appearance of Lines, Changing the Appearance of Points, Making a Graph with a Shaded Area, Scatter plots: Making a Basic Scatter Plot, Grouping Data Points by a Variable Using Shape or Color, Using Different Point Shapes, Mapping a Continuous Variable to Color or Size, Dealing with Over plotting.

UNIT – 3

Predictive analysis: Data preprocessing, Regression Models: Measuring performance in regression models, Linear Regression and its cousins: Linear regression, Nonlinear Regression Models: Neural networks.

UNIT – 4

Classification Models: Measuring Performance in Classification Modelling: class prediction, Evaluating predicted class, evaluating class probabilities. Discriminant Analysis and Other Linear Classification Models, Logistic Regression, Linear Discriminant Analysis, Nonlinear Classification Models: Nonlinear Discriminant Analysis, Neural Networks, Flexible Discriminant Analysis, Support Vector Machines, K-Nearest Neighbors, Na¨ıve Bayes, Computing.

TEXTBOOKS:

1. Roger D. Peng, "R Programming for Data Science", Leanpub, 2015
2. Winston Chang, "R Graphics Cookbook Practical Recipes for Visualizing Data", O'Reilly Media, 2012
3. Kuhn, Max, Johnson and Kjell, "Applied Predictive Modeling", Springer eBook.

REFERENCEBOOKS:

1. John Maindonald, W. John Braun, "Data Analysis and Graphics Using R - an Example Based Approach", 3rd Edition, Cambridge University Press, 2010. (Unit 1 & 2)
2. Johannes Ledolter, "DATA MINING AND BUSINESS ANALYTICS WITH R", WILEY, 2013. (Unit3)
3. W. N. Venables, D. M. Smith and the R Core Team, "An Introduction to R", Notes on R: A Programming Environment for Data Analysis and Graphics Version 3.2.4 (2016-03-10) (Unit 4)
4. Springer, International Journal of Data Science and Analytics.
5. Elsevier, Computational Statistics & Data Analysis
6. IEEE, Transactions on Big Data.

JOURNALS/MAGAZINES:

1. https://www.springer.com/journal/41060
2. https://www.journals.elsevier.com/computational-statistics-and-data-analysis
3. https://blog.usejournal.com/python-vs-and-r-for-data-science-833b48ccc91d

SWAYAM/NPTEL/MOOCs:

1. https://www.udemy.com/course/r-programming

2. https://nptel.ac.in/courses/106/106/106106182/
3. https://www.edx.org
4. https://www.coursera.org/learn/r-programming

SELF-LEARNINGEXERCISES:

1. Creating own datasets.
2. Functions and packages in R and using packages in R.
3. Executing linear model for example data set.
4. Creating Neural Networks for example data set.

Course Title	Virtual and Augmented Reality				Course Type		SC	
Course Code	B21ETS712	Credits	3		Class		VII Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

This course covers basic concepts of augmented reality and virtual reality. The course also introduces the student to the working of multiple models of input and output interface in VR. The course also helps the student to understand development tools and frameworks in VR. Further, this course helps the student to work on the application of VR in digital entertainment.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1.Explain the principles and multidisciplinary features of Virtual Reality.

2.Illustrate the multimodal user interaction and perception in Virtual Reality.

3.Demonstrate the use of objects for managing large scale Virtual Reality environment in real time.

4.Discuss the various solutions using Virtual Reality system framework and development tools for industry and social relevant applications.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Identify the components of Augmented and Virtual Reality	1 ,10	1
CO2	Apply multimodal user interaction and perception techniques involved in Virtual Reality.	1 to 3,5,10	3
CO3	Develop real world applications using Simulation and Interactive techniques.	1 to 3, 10	2,3
CO4	Choose the innovative Virtual Reality solutions for industrial and social relevant applications.	1,10	1
CO5	Make use of unity3D to develop innovative project.	1 to 3, 10	2,3
CO6	Apply VR modeling techniques to solve real world applications.	1,2,10	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3									3			3		
CO2	3	3	3		3					3					3
CO3	3	3	3							3				3	3
CO4	3									3			3		
CO5	3	2	2							3				3	3
CO6	3	2								2			3	3	

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to Augmented Reality (AR): Definition and Scope, A Brief History of Augmented Reality, Examples, Related Fields, System Structure of Augmented Reality, Key Technology in AR.

Introduction to Virtual Reality (VR): Fundamental Concept and Components of VR, Primary Features and Present Development on VR.

UNIT – 2

Multiple Models of Input and Output Interface in VR: Input – Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus and 3D Scanner. Output – Visual, Auditory, Haptic Devices.

UNIT – 3

Environment Modelling in VR: Geometric Modelling, Behaviour Simulation, Physically Based Simulation.

Interactive Techniques in VR: Body Track, Hand Gesture, 3D Manus, Object Grasp.

UNIT – 4

Development Tools and Frameworks in VR: Frameworks of Software Development Tools in VR, X3D Standard, Vega, MultiGen, Virtools, and Unity.

Application of VR in Digital Entertainment: VR Technology in Film and TV Production, VR Technology in Physical Exercises and Games, Demonstration of Digital Entertainment by VR.

TEXTBOOKS:

1. Dieter Schmaltzier and Tobias Hollerer, "Augmented Reality: Principles and Practice", Addison-Wesley, 2006.
2. Burdea, G. C. and P. Coffet. ,"Virtual Reality Technology", Second Edition. Wiley-IEEE Press, 2003/2006.

REFERENCEBOOKS:

1. Sherman, William R. and Alan B. Craig, "Understanding Virtual Reality – Interface, Application, and Design", Morgan Kaufmann, 2002.
2. Fei GAO, "Design and Development of Virtual Reality Application System", Tsinghua Press, March 2012.
3. Guangran LIU, "Virtual Reality Technology", Tsinghua Press, Jan. 2011.
4. International Journal of Virtual and Augmented Reality (IJVAR)
5. Springer, Virtual Reality.

JOURNALS/MAGAZINES:

1. https://www.mdpi.com/journal/electronics/special_issues/VR_AR
2. https://www.sciencedaily.com/releases/2020/04/200420145025.htm
3. https://www.springer.com/journal/10055

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/106/106/106106182/
2. https://www.classcentral.com/course/augmented-reality-virtual-reality-mixed--10508
3. https://www.edx.org/learn/augmented-reality

SELF-LEARNING COMPONENT:

1. Unity 3D, Manus VR

Course Title	Cloud Security				Course Type		SC	
Course Code	B21ETS713	Credits	3		Class		VII Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

Cloud computing infrastructure have become a mainstay of the IT industry, opening the possibility for on demand, highly elastic and infinite compute power with scalability and supporting the delivery of mission critical secure enterprise applications and services. This course provides the ground-up coverage on the high level concepts of cloud landscape, architectural principles, techniques, design patterns and real-world best practices applied to Cloud service providers and consumers and delivering secure Cloud based services. The course will describe the Cloud security architecture and explore the guiding security design principles, design patterns, industry standards, applied technologies and addressing regulatory compliance requirements critical to design, implement, deliver and manage secure cloud based services. The course delves deep into the secure cloud architectural aspects with regards to identifying and mitigating risks, protection and isolation of physical & logical infrastructures including compute, network and storage, comprehensive data protection at all OSI layers, end-to-end identity management & access control, monitoring and auditing processes and meeting compliance with industry and regulatory mandates.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explore the fundamentals of cloud computing architectures based on current standards, protocols, and best practices intended for delivering Cloud based enterprise IT services and business applications.
2. Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud based IT services.
3. Understand the concepts and guiding principles for designing and implementing appropriate safeguards and countermeasures for Cloud based IT services.
4. Approaches to designing cloud services that meets essential Cloud infrastructure characteristics – on demand computing, shared resources, elasticity and measuring usage.
5. Design security architectures that assures secure isolation of physical and logical infrastructures including compute, network and storage, comprehensive data protection at all layers, end-to-end identity and access management, monitoring and auditing processes and compliance with industry and regulatory mandates.

6. Understand the industry security standards, regulatory mandates, audit policies and compliance requirements for Cloud based infrastructures.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Illustrate the basics of Cloud Computing and a Cloud Reference Architecture.	1	1,2
CO2	Examine the Risk Tolerance in Cloud Computing.	1,2	1,2,3
CO3	Applying the Data Security Techniques in Cloud Computing.	1-5	1,2,3
CO4	Make use of the Effective Risks and Security Control techniques in Cloud.	1-5	1,2,3
CO5	Build an Internal Cloud and Analyze CSP in real world applications.	1-5	1,2,3
CO6	Evaluating the overall Cloud Security and operating a Cloud from Architecture to Efficient and Secure Operations.	1-5	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2		√				
CO3			√			
CO4						√
CO5						√
CO6						√

COURSE ARTICULATION MATRIX

CO#/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	
CO2	2	3											3	3	3
CO3	1	1	1	3	3								3	3	3
CO4	1	1	1	3	3								3	3	3
CO5	1	1	2	3	3								3	3	3
CO6	1	1	2	3	3								3	3	3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT-1

Introduction to Cloud Computing and Security: Understanding Cloud Computing, the IT Foundation for Cloud, The Bottom Line, An Historical View: Roots of Cloud Computing, A Brief Primer on Security: From 50,000 ft, A Brief Primer on Architecture, Security Architecture: A Brief Discussion, Cloud Is Driving Broad Changes. **Cloud Computing Architecture:** Cloud Reference Architecture, Control over Security in the Cloud Model, Making Sense of Cloud Deployment, Making Sense of Services Models, How Clouds Are Formed and Key Examples, Real-world Cloud Usage Scenarios.

UNIT-2

Security Concerns, Risk Issues, and Legal Aspects: Cloud Computing: Security Concerns, Assessing Your Risk Tolerance in Cloud Computing, Legal and Regulatory Issues. **Securing the Cloud: Architecture:** Security Requirements for the Architecture, Security Patterns and Architectural Elements, Cloud Security Architecture, Planning Key Strategies for Secure Operation. **Securing the Cloud: Data Security:** Overview of Data Security in Cloud Computing, Data Encryption: Applications and Limits, Cloud Data Security: Sensitive Data Categorization, Cloud Data Storage, Cloud Lock-in (the Roach Motel Syndrome).

UNIT-3

Securing the Cloud: Key Strategies and Best Practices: Overall Strategy: Effectively Managing Risk, Overview of Security Controls, The Limits of Security Controls, Best Practices, Security Monitoring. **Security Criteria:** Building an Internal Cloud: Private Clouds: Motivation and Overview, Security Criteria for Ensuring a Private Cloud. **Security Criteria: Selecting an External Cloud Provider:** Selecting a CSP: Overview of Assurance, Selecting a CSP: Overview of Risks, Selecting a CSP: Security Criteria.

UNIT-4

Evaluating Cloud Security: An Information Security Framework: Evaluating Cloud Security, Checklists for Evaluating Cloud Security, Metrics for the Checklists. **Operating a Cloud:** From Architecture to Efficient and Secure Operations, Security Operations Activities

TEXTBOOKS:

1.Vic (J.R.) Winkler, "Securing The Cloud: Cloud Computing Security Techniques and Tactics", Syngress; 1st Edition, 2011

1. Thomas Erl,"Cloud Computing Design Patterns", Prentice Hall, 2015

REFERENCEBOOKS:

1. Mahmood, Zaigham, "Cloud computing: Challenges, limitations and R&D solutions", Springer, 2014.
2. Mahmood, Zaigham, "Continued rise of the cloud", London, UK: Springer, 2014.
3. Mather, Tim, Subra Kumaraswamy, and Shahed Latif, "Cloud security and privacy: an enterprise perspective on risks and compliance", O'Reilly Media, Inc., 2009.

JOURNALS/MAGAZINES:

1. IEEE Transactions on Cloud Computing
2. ACM Journal of Cloud Computing: Advances, Systems and Applications
3. Elsevier Computers & Security

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc19_cs64/preview
2. https://www.classcentral.com/course/swayam-cloud-computing-10027
3. https://onlinecourses.swayam2.ac.in/cec20_cs09/preview

SELF-LEARNINGEXERCISES:

1. Policy, Compliance & Risk Management in Cloud Computing: Be able to understand the legal, security, forensics, personal & data privacy issues within Cloud environment, Cloud security assessment & audit reports, Laws & regulatory mandates, Personal Identifiable Information & Data Privacy, Privacy requirements for Cloud computing (ISO 27018), Metrics for Service Level Agreements (SLA), Metrics for Risk Management.
2. Cloud Service Providers – Technology Review: OpenStack Platform, Docker, Amazon Web Services

OPEN ELECTIVE -III:

Course Title	Java Programming				Course Type		OE	
Course Code	B21CSO701	Credits	3		Class		VII Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

Java's unique architecture enables programmers to develop a single application that can run across multiple platforms seamlessly and reliably. In this course, students gain extensive experience with Java, object-oriented features and advance Java programming skills. Students learn to create robust object-oriented applications with Java.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the basic data types and control structures of the Java language.
2. Illustrate the creation of classes and objects in Java.
3. Demonstrate the extending a class (inheritance) and use proper program anomaly handling structures.
4. Discuss the use of Java generics and collections.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Make use of array concepts in java to solve real world problems.	1 to 5	1
CO2	Apply the features of OOPS in java to solve the real-world problems.	1 to 5	1
CO3	Develop program for stack implementation using Exception Handling in java.	1 to 5	2, 3
CO4	Identify suitable data structures to solve real world applications.	1 to 5, 12	2
CO5	Explain the concept of generic class and methods.	1 to 5	1
CO6	Apply the garbage collection for saving the resources automatically in real world problem.	1 to 5	1

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5		√				
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1								3		
CO2	3	3	2	2	1								3		
CO3	3	3	1	1	1									3	3
CO4	3	3	3	1	2							1		3	
CO5	3	1	2	1	3								3		
CO6	3	1	2	1	3								3		

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Fundamental Programming Structures: Dissecting the "Hello, World" Program; Compiling and Running a Java Program; Primitive Types; Variables; Arithmetic Operations; Strings; Input and Output; Control Flow; Arrays; Functional Decomposition.

UNIT – 2

Object-Oriented Programming: Working with Objects; Implementing Classes; Object Construction; Static Variables and Methods, Packages; Nested Classes; Documentation Comments; Interfaces; Static, Default and Private Methods in interface; Lambda Expressions; Method and Constructor References; Local and Anonymous Classes.

UNIT – 3

Inheritance and Exceptions: Extending a Class; Object: The Cosmic Superclass; Enumerations; Runtime Type Information and Resources; Exception Handling: Throwing Exceptions; The Exception Hierarchy; Declaring Checked Exceptions; Catching Exceptions; the Try-with-Resources Statement; The finally Clause; Rethrowing and Chaining Exceptions; Uncaught Exceptions and the Stack Trace.

UNIT – 4

Generic Programming and Collections: Generic Classes; Generic Methods; Type Bounds; Type Variance and Wildcards; Restrictions on Generics; an Overview of the Collections Framework; Iterators; Sets; Maps.

TEXTBOOKS:

1. Cay S. Horstmann, ”Core Java® SE 9 for the Impatient”, Addison Wesley, Second Edition, 2018.
2. HerbertSchild, ”Java™:TheCompleteReference”,McGraw-Hill,TenthEdition,2018.
3. David Gallardo, Ed Burnette, Robert Mcgovern, ” Eclipse in Action a guide for java developers”, Manning Publications,2003.
4. Ed Burnette; ” Eclipse IDE Pocket Guide : Using the Full-Featured IDE”, O'Reilly Media, Inc, USA,2005.

REFERENCEBOOKS:

1. Cay S. Horstmann, ”Core Java™ Volume I—Fundamentals”, Prentice Hall, Tenth Edition, 2015
2. Joshua Bloch, ”Effective Java”,Addison-WesleyProfessional,ThirdEdition,2017
3. Ken Kousen, ” Modern Java Recipes”, O'Reilly Media, Inc.,2017
4. Oracle Java Documentation. (https://docs.oracle.com/javase/tutorial/)

JOURNALS/MAGAZINES:

1. https://ieeexplore.ieee.org/document/5464387
2. https://files.eric.ed.gov/fulltext/EJ1075126.pdf
3. https://www.sciencedirect.com/science/article/pii/S0167642304000590
4. https://www.informingscience.org/Publications/4322?Source=%2FJournals%2FJITEIIP%2FArticles%3FVolume%3D0-0
5. https://www.javadevjournal.com/
6. https://blogs.oracle.com/javamagazine/

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc19_cs84/preview
2. https://www.classcentral.com/course/swayam-programming-in-java-12930
3. https://swayam.gov.in/explorer?searchText=java

SELF-LEARNINGEXERCISES:

1. The Eclipse-IDE
2. Streams
3. Concurrent Programming
4. Swing and JavaFX
5. Networking- JDBC, Database Access

Course Title	Capstone-Project Phase-1				Course Type		HC	
Course Code	B21ET0701	Credits	1		Class		VII Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**1**	**2**	**2**	**0**	**26**	**25**	**25**

COURSE OVERVIEW

The major project is a two semester-long practical project with the main objective that students show their ability to apply theoretical concepts learned in lectures to solve (complex) practical problems. The results are to be presented in a project report and as an oral presentation.

The major project must be completed as a team project. Team projects are limited to a minimum of two students to a maximum number of four students.

COURSE OBJECTIVE (S):

1. To allow students to demonstrate a wide range of the skills learned during their course of study by asking them to deliver a product that has passed through the design, analysis, testing and evaluation.
2. To encourage multidisciplinary research through the integration learned in a number of courses.
3. To allow students to develop problem solving, analysis, synthesis and evaluation skills.
4. To encourage teamwork.
5. To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation

COURSE OUTCOMES (CO'S):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Demonstrate in-depth knowledge on the project topic	1	1,2,3
CO2	Identify, analyze and formulate complex problem chosen for project work to attain substantiated conclusions.	2	1,2,3
CO3	Design solutions to the chosen project problem.	3	1,2,3
CO4	Undertake investigation of project problem to provide valid conclusions.	4	1,2,3
CO5	Use the appropriate techniques, resources, and modern engineering tools necessary for project work.	5	1,2,3

CO6	Apply project results for sustainable development of the society.	6	1,2,3
CO7	Understand the impact of project results in the context of environmental sustainability.	7	1,2,3
CO8	Understand professional and ethical responsibilities while executing the project work.	8	1,2,3
CO9	Function effectively as individual and a member in the project team.	9	1,2,3
CO10	Develop communication skills, both oral and written for preparing and presenting project report.	10	1,2,3
CO11	Demonstrate knowledge and understanding of cost and time analysis required for carrying out the project.	11	1,2,3
CO12	Engage in lifelong learning to improve knowledge and competence in the chosen area of the project.	12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	**Understand (L2)**	**Apply (L3)**	**Analyze (L4)**	**Evaluate (L5)**	**Create (L6)**
CO1		√				
CO2			√			
CO3						√
CO4				√		
CO5			√			
C06			√			
CO7		√				
CO8		√				
CO9	√			√		
CO10			√			√
CO11		√		√		
CO12			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	3
CO2		3											3	3	3
CO3			3										3	3	3
CO4				3									3	3	3
CO5					3								3	3	3
C06						3							3	3	3
CO7							3						3	3	3
CO8								3					3	3	3
CO9									3				3	3	3
CO10										3			3	3	3
CO11											3		3	3	3
CO12												3	3	3	3

Note: 1-Low, 2-Medium, 3-High

The students are informed to follow the following instructions to complete the Capstone-Project Phase-1:

- Student should carry out project work in a group which is formed in the VII semester. Student must select group members from the same section as they belong to and select a faculty member from DEPARTMENT of CSE as an internal project guide based on research domain and expertise. Student may optionally also select external guide bearing domain expertise from different DEPARTMENTs within University and Industry to carry out multidisciplinary project.

- Student group must propose a project title, after consultation with guides and after carrying out a literature survey. The proposed title must be submitted in form a document (synopsis) that contains the proposed title of the project, an abstract, Introduction, Survey, Feasibility, and cost estimation to carry out the project.

- Further with the help of respective guide, each student group have to the literature review based on the literature survey, identify the research gaps in the selected research/project domain, and then finalize the problem statement and objectives for the project.

- Each student groups shall be reviewed and evaluated in two reviews through the semester.

- Review 1 shall be on the presentation of the synopsis and justification of the title and feasibility of the project

- Review 2 shall be on the presentation on the literature survey carried out.
- Finally, the Capstone-Project Phase-1 shall conclude with each project group apply for idea patent or copyright and publish a survey paper in SCOPUS indexed journals, write research proposals for fundings from various governmental organizations or industries or for product development for startups.

Course Title	Internship/Global Certification				Course Type		HC	
Course Code	B21ET0702	Credits	3		Class		VII Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	3	6	6	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**6**	**3**	**0**	**78**	**50**	**50**

Internship

COURSE OVERVIEW

An internship can present students with new skills and opportunities. Interns not only gain technical knowledge within the industry of their choice, but they also learn how to interact with professionals in a workplace setting, and develop essential soft skills like time management, organization, adaptability, problem-solving and teamwork.

COURSE OBJECTIVE (S):

1. To allow students to develop problem solving, analysis, synthesis and evaluation skills.
2. To encourage teamwork.
3. To help students to gain exposure into industries.
4. To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation

COURSE OUTCOMES (CO'S):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Demonstrate in-depth knowledge on the project topic	1	1,2,3
CO2	Identify, analyze and formulate complex problem chosen for project work to attain substantiated conclusions.	2	1,2,3
CO3	Design solutions to the chosen project problem.	3	1,2,3
CO4	Undertake investigation of project problem to provide valid conclusions.	4	1,2,3
CO5	Use the appropriate techniques, resources, and modern engineering tools necessary for project work.	5	1,2,3
CO6	Apply project results for sustainable development of the society.	6	1,2,3
CO7	Understand the impact of project results in the context of environmental sustainability.	7	1,2,3

CO8	Understand professional and ethical responsibilities while executing the project work.	8	1,2,3
CO9	Function effectively as individual and a member in the project team.	9	1,2,3
CO10	Develop communication skills, both oral and written for preparing and presenting project report.	10	1,2,3
CO11	Demonstrate knowledge and understanding of cost and time analysis required for carrying out the project.	11	1,2,3
CO12	Engage in lifelong learning to improve knowledge and competence in the chosen area of the project.	12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3						√
CO4				√		
CO5			√			
C06			√			
CO7		√				
CO8		√				
CO9	√			√		
CO10			√			√
CO11		√		√		
CO12			√			

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	3
CO2		3											3	3	3
CO3			3										3	3	3

CO4				3									3	3	3
CO5					3								3	3	3
C06						3							3	3	3
CO7							3						3	3	3
CO8								3					3	3	3
CO9									3				3	3	3
CO10										3			3	3	3
CO11											3		3	3	3
CO12												3	3	3	3

Note:1-Low,2-Medium,3-High

The students are informed to follow the following instructions to complete the Internship:

- The internship should be paid internship in IT industry.
- The internship should be for minimum of three months.
- The project title must be submitted in form a document (synopsis) that contains the proposed title of the project, an abstract, Introduction and their roles and responsibilities in company.
- Each student shall be reviewed and evaluated in two reviews through the semester.
- Review 1 shall be on the presentation of the synopsis.
- Review 2 shall be on the presentation on the roles and responsibilities carried out with module completion results(as applicable).

Global Certification

COURSE OVERVIEW

The Global Certification is a one semester intensive project based learning approach to cater with the Industry requirement. It prepares the students to up skill their knowledge base to compete in terms of latest technology and become competent enough to the industry requirement. In this, students will be able to solve complex real world problems pertaining to the domain chosen and gain confidence. It is an individual course and students have to earn the certificate based on their performances in terms of project assignment and aptitude. Student have to choose two Global certification courses.

COURSE OBJECTIVE (S):

1. To allow students to learn skills of their choice required in the current Industry perspective.
2. To encourage building multidisciplinary skill set through the integration of courses learned.

3. To allow students to develop problem solving, analysis, synthesis and evaluation skills.
4. To prepare them to face the interview as professionals by improving communication skills.

COURSE OUTCOMES (CO'S):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Demonstrate in-depth knowledge on the project topic	1	1,2,3
CO2	Identify, analyze and formulate complex problem chosen for project work to attain substantiated conclusions.	2	1,2,3
CO3	Design solutions to the chosen project problem.	3	1,2,3
CO4	Undertake investigation of project problem to provide valid conclusions.	4	1,2,3
CO5	Use the appropriate techniques, resources, and modern engineering tools necessary for project work.	5	1,2,3
CO6	Apply project results for sustainable development of the society.	6	1,2,3
CO7	Understand the impact of project results in the context of environmental sustainability.	7	1,2,3
CO8	Understand professional and ethical responsibilities while executing the project work.	8	1,2,3
CO9	Function effectively as individual and a member in the project team.	9	1,2,3
CO10	Develop communication skills, both oral and written for preparing and presenting project report.	10	1,2,3
CO11	Demonstrate knowledge and understanding of cost and time analysis required for carrying out the project.	11	1,2,3
CO12	Engage in lifelong learning to improve knowledge and competence in the chosen area of the project.	12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3						√
CO4				√		
CO5			√			
C06			√			
CO7		√				
CO8		√				
CO9	√			√		
CO10			√			√
CO11		√		√		
CO12			√			

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	3
CO2		3											3	3	3
CO3			3										3	3	3
CO4				3									3	3	3
CO5					3								3	3	3
C06						3							3	3	3
CO7							3						3	3	3
CO8								3					3	3	3
CO9									3				3	3	3
CO10										3			3	3	3

CO11											3		3	3	3
CO12												3	3	3	3

Note:1-Low,2-Medium,3-High

The students are informed to follow the following instructions to complete the Global Certification

- Student should choose two Global certifications among the available Industry ready courses to cope up with the vast changing software world.
- Student should register for the course having minimum of 39 hours of teaching and should have 100 percent attendance for all the sessions.
- Each student shall be reviewed and evaluated in two reviews through the semester.
- Review 1 shall be on the presentation of the course, assignment completed followed by viva.
- Review 2 shall be on the presentation of their overall skills learned in the course followed by their certificate verification.

VIII SEMESTER

Course Title	Capstone-Project Phase-2				Course Type		HC	
Course Code	B21ET0801	Credits	7		Class		VIII Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	7	14	14	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**7**	**14**	**14**	**0**	**182**	**50**	**50**

COURSE OVERVIEW

Capstone-Project Phase-2 is continuation of Capstone-Project Phase-1 from semester VII.

COURSE OBJECTIVE (S):

1. To allow students to demonstrate a wide range of the skills learned during their course of study by asking them to deliver a product that has passed through the design, analysis, testing and evaluation.
2. To encourage multidisciplinary research through the integration learned in a number of courses.
3. To allow students to develop problem solving, analysis, synthesis and evaluation skills.
4. To encourage teamwork.
5. To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation

COURSE OUTCOMES (CO'S):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Demonstrate in-depth knowledge on the project topic	1	1,2,3
CO2	Identify, analyze and formulate complex problem chosen for project work to attain substantiated conclusions.	2	1,2,3
CO3	Design solutions to the chosen project problem.	3	1,2,3
CO4	Undertake investigation of project problem to provide valid conclusions.	4	1,2,3
CO5	Use the appropriate techniques, resources, and modern engineering tools necessary for project work.	5	1,2,3
CO6	Apply project results for sustainable development of the society.	6	1,2,3
CO7	Understand the impact of project results in the context of environmental sustainability.	7	1,2,3
CO8	Understand professional and ethical responsibilities while executing the project work.	8	1,2,3

CO9	Function effectively as individual and a member in the project team.	9	1,2,3
CO10	Develop communication skills, both oral and written for preparing and presenting project report.	10	1,2,3
CO11	Demonstrate knowledge and understanding of cost and time analysis required for carrying out the project.	11	1,2,3
CO12	Engage in lifelong learning to improve knowledge and competence in the chosen area of the project.	12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3						√
CO4				√		
CO5			√			
C06			√			
CO7		√				
CO8		√				
CO9	√			√		
CO10			√			√
CO11		√		√		
CO12			√			

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	3
CO2		3											3	3	3
CO3			3										3	3	3
CO4				3									3	3	3

CO5					3								3	3	3
C06						3							3	3	3
CO7							3						3	3	3
CO8								3					3	3	3
CO9									3				3	3	3
CO10										3			3	3	3
CO11											3		3	3	3
CO12												3	3	3	3

Note:1-Low,2-Medium,3-High

The students are informed to follow the following instructions to complete the Capstone-Project Phase-2:

- Each student group shall, conduct the required experiment to implement the proposed project with the consultation of respective guides.
- Each student groups shall be reviewed and evaluated in two reviews through the semester and finally each group shall demonstrate the completed project to a team of examiners.
- Review 1 shall be on the presentation of the methodology employed and model created.
- Review 2 shall be on the presentation on the functional project.
- Finally, the Capstone-Project Phase-2 shall conclude with each project group apply for patent or copyright and publish a paper in SCOPUS indexed journals.
- In Semester end examination, each student in groups shall be evaluated, based on the course outcomes.

Course Title	Internship/Global Certification				Course Type		HC	
Course Code	B21ET0802	Credits	3		Class		VIII Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	3	6	3	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**6**	**3**	**0**	**78**	**50**	**50**

Internship

COURSE OVERVIEW

An internship can present students with new skills and opportunities. Interns not only gain technical knowledge within the industry of their choice, but they also learn how to interact with professionals in a workplace setting, and develop essential soft skills like time management, organization, adaptability, problem-solving and teamwork.

COURSE OBJECTIVE (S):

1. To allow students to develop problem solving, analysis, synthesis and evaluation skills.
2. To encourage teamwork.
3. To help students to gain exposure into industries.
4. To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation

COURSE OUTCOMES (CO'S):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Demonstrate in-depth knowledge on the project topic	1	1,2,3
CO2	Identify, analyze and formulate complex problem chosen for project work to attain substantiated conclusions.	2	1,2,3
CO3	Design solutions to the chosen project problem.	3	1,2,3
CO4	Undertake investigation of project problem to provide valid conclusions.	4	1,2,3
CO5	Use the appropriate techniques, resources, and modern engineering tools necessary for project work.	5	1,2,3
CO6	Apply project results for sustainable development of the society.	6	1,2,3
CO7	Understand the impact of project results in the context of environmental sustainability.	7	1,2,3

CO8	Understand professional and ethical responsibilities while executing the project work.	8	1,2,3
CO9	Function effectively as individual and a member in the project team.	9	1,2,3
CO10	Develop communication skills, both oral and written for preparing and presenting project report.	10	1,2,3
CO11	Demonstrate knowledge and understanding of cost and time analysis required for carrying out the project.	11	1,2,3
CO12	Engage in lifelong learning to improve knowledge and competence in the chosen area of the project.	12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3						√
CO4				√		
CO5			√			
C06			√			
CO7		√				
CO8		√				
CO9	√			√		
CO10			√			√
CO11		√		√		
CO12			√			

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	3
CO2		3											3	3	3
CO3			3										3	3	3

CO4				3									3	3	3
CO5					3								3	3	3
C06						3							3	3	3
CO7							3						3	3	3
CO8								3					3	3	3
CO9									3				3	3	3
CO10										3			3	3	3
CO11											3		3	3	3
CO12												3	3	3	3

Note:1-Low,2-Medium,3-High

The students are informed to follow the following instructions to complete the Internship:

- The internship should be paid internship in IT industry.
- The internship should be for minimum of three months.
- The project title must be submitted in form a document (synopsis) that contains the proposed title of the project, an abstract, Introduction and their roles and responsibilities in company.
- Each student shall be reviewed and evaluated in two reviews through the semester.
- Review 1 shall be on the presentation of the synopsis.
- Review 2 shall be on the presentation on the roles and responsibilities carried out with module competion results(as applicable).

Global Certification

COURSE OVERVIEW

The Global Certification is a one semester intensive project based learning approach to cater with the Industry requirement. It prepares the students to up skill their knowledge base to compete in terms of latest technology and become competent enough to the industry requirement. In this, students will be able to solve complex real world problems pertaining to the domain chosen and gain confidence. It is an individual course and students have to earn the certificate based on their performances in terms of project assignment and aptitude. Student have to choose two Global certification courses.

COURSE OBJECTIVE (S):

1. To allow students to learn skills of their choice required in the current Industry perspective.
2. To encourage building multidisciplinary skill set through the integration of courses learned.

3. To allow students to develop problem solving, analysis, synthesis and evaluation skills.
4. To prepare them to face the interview as professionals by improving communication skills.

COURSE OUTCOMES (CO'S):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Demonstrate in-depth knowledge on the project topic	1	1,2,3
CO2	Identify, analyze and formulate complex problem chosen for project work to attain substantiated conclusions.	2	1,2,3
CO3	Design solutions to the chosen project problem.	3	1,2,3
CO4	Undertake investigation of project problem to provide valid conclusions.	4	1,2,3
CO5	Use the appropriate techniques, resources, and modern engineering tools necessary for project work.	5	1,2,3
CO6	Apply project results for sustainable development of the society.	6	1,2,3
CO7	Understand the impact of project results in the context of environmental sustainability.	7	1,2,3
CO8	Understand professional and ethical responsibilities while executing the project work.	8	1,2,3
CO9	Function effectively as individual and a member in the project team.	9	1,2,3
CO10	Develop communication skills, both oral and written for preparing and presenting project report.	10	1,2,3
CO11	Demonstrate knowledge and understanding of cost and time analysis required for carrying out the project.	11	1,2,3
CO12	Engage in lifelong learning to improve knowledge and competence in the chosen area of the project.	12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			
CO3						√
CO4				√		
CO5			√			
C06			√			
CO7		√				
CO8		√				
CO9	√			√		
CO10			√			√
CO11		√		√		
CO12			√			

COURSE ARTICULATIONMATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	3
CO2		3											3	3	3
CO3			3										3	3	3
CO4				3									3	3	3
CO5					3								3	3	3
C06						3							3	3	3
CO7							3						3	3	3
CO8								3					3	3	3
CO9									3				3	3	3
CO10										3			3	3	3

CO11											3		3	3	3
CO12												3	3	3	3

Note:1-Low,2-Medium,3-High

The students are informed to follow the following instructions to complete the Global Certification

- Student should choose two Global certifications among the available Industry ready courses to cope up with the vast changing software world.
- Student should register for the course having minimum of 39 hours of teaching and should have 100 percent attendance for all the sessions.
- Each student shall be reviewed and evaluated in two reviews through the semester.
- Review 1 shall be on the presentation of the course, assignment completed followed by viva.
- Review 2 shall be on the presentation of their overall skills learned in the course followed by their certificate verification.

Course Title	MOOC/COMPETITIVE EXAM				Course Type		SC	
Course Code	B21ET0803	Credits	3		Class		VIII Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Practice	3	6	6	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**6**	**6**	**0**	**78**	**50**	**50**

COURSE OVERVIEW

The MOOC Course is a one semester intensive project-based learning approach to cater with the Industry requirement. It prepares the students to up skill their knowledge base to compete in terms of latest technology and become competent enough to the industry requirement. In this, students will be able to solve complex real-world problems pertaining to the domain chosen and gain confidence. It is an individual course and students have to earn the certificate based on their performances in terms of project assignment and aptitude. Student have to choose one MOOC course.

COURSE OBJECTIVE (S):

1. To allow students to learn skills of their choice required in the current Industry perspective.
2. To encourage building multidisciplinary skill set through the integration of courses learned.
3. To allow students to develop problem solving, analysis, synthesis and evaluation skills.
4. To prepare them to face the interview as professionals by improving communication skills.

COURSE OUTCOMES (CO'S):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Demonstrate in-depth knowledge on the project topic	1	1,2,3
CO2	Identify, analyze and formulate complex problem chosen for project work to attain substantiated conclusions.	2	1,2,3
CO3	Design solutions to the chosen project problem.	3	1,2,3
CO4	Undertake investigation of project problem to provide valid conclusions.	4	1,2,3
CO5	Use the appropriate techniques, resources, and modern engineering tools necessary for project work.	5	1,2,3
CO6	Apply project results for sustainable development of the society.	6	1,2,3

CO7	Understand the impact of project results in the context of environmental sustainability.	7	1,2,3
CO8	Understand professional and ethical responsibilities while executing the project work.	8	1,2,3
CO9	Function effectively as individual and a member in the project team.	9	1,2,3
CO10	Develop communication skills, both oral and written for preparing and presenting project report.	10	1,2,3
CO11	Demonstrate knowledge and understanding of cost and time analysis required for carrying out the project.	11	1,2,3
CO12	Engage in lifelong learning to improve knowledge and competence in the chosen area of the project.	12	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	**Understand (L2)**	**Apply (L3)**	**Analyze (L4)**	**Evaluate (L5)**	**Create (L6)**
CO1		√				
CO2			√			
CO3						√
CO4				√		
CO5			√			
C06			√			
CO7		√				
CO8		√				
CO9	√			√		
CO10			√			√
CO11		√		√		
CO12			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	3
CO2		3											3	3	3
CO3			3										3	3	3
CO4				3									3	3	3
CO5					3								3	3	3
C06						3							3	3	3
CO7							3						3	3	3
CO8								3					3	3	3
CO9									3				3	3	3
CO10										3			3	3	3
CO11											3		3	3	3
CO12												3	3	3	3

Note:1-Low,2-Medium,3-High

The students are informed to follow the following instructions to complete the MOOC/COMPETITIVE EXAM:

- Student should choose one **MOOC/COMPETITIVE COURSE** among the available Industry ready courses to cope up with the vast changing software world.
- Student should register for the course having minimum of 39 hours of teaching and should have 100 percent attendance for all the sessions.
- Each student shall be reviewed and evaluated in two reviews through the semester.
- Review 1 shall be on the presentation of the course, assignment completed followed by viva.
- Review 2 shall be on the presentation of their overall skills learned in the course followed by their certification verification.

Open Elective-IV:

Course Title	R Programming Language				Course Type		OE	
Course Code	B21CSO801	Credits	3		Class		VIII semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-							
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW:

This course focus on the programming in R for the effective data analysis and configuring software for statistical programming environment. The course also covers the practical issues in statistical computing which includes programming in R, reading data, accessing packages, debugging. This initiates the learning in real time data.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1.Discuss the basics of R programming.

2.Demonstrate the use of Control Structures, Functions.

3.Illustrate the use of features of text processing in real world applications.

4.Describe the models with respect to statistical analysis.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	Pos	PSOs
CO1	Outline the basics in R programming in terms of constructs, control statements, string functions.	1 to 5	1, 2, 3
CO2	Make use of R for BigData analytics in real world applications.	1 to 5	1, 2, 3
CO3	Build the data analytics solutions for real world problems, perform analysis, interpretation and reporting of data.	1 to 5	1, 2, 3
CO4	Develop R programming for a statistical real time problems.	1 to 5	1, 2, 3
CO5	Apply R programming concepts to plot, customize and save graphs to files for real world applications.	1 to 5	1
CO6	Make use of list operations for processing the raw data in data analytics.	1 to 5	1,2

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√			
CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	2								3	3	3
CO2	3	3	2	2	3								3	3	3
CO3	3	3	2	2	2								3	3	3
CO4	3	3	3	3	3								3	3	3
CO5	3	2	2	1	2								3		
CO6	3	2	3	2	3								3	3	

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY

UNIT-1

Introducing to R: R Data Structures – Help functions in R – Vectors – Scalars – Declarations – recycling – Common Vector operations – Using all and any – Vectorized operations – NA and NULL values – Filtering – Vectorised if-then else – Vector Equality – Vector Element names

UNIT-2

Matrices, Arrays And Lists: Creating matrices – Matrix operations – Applying Functions to Matrix Rows and Columns – Adding and deleting rows and columns – Vector/Matrix Distinction – Avoiding Dimension Reduction – Higher Dimensional arrays – lists – Creating lists – General list operations – Accessing list components and values – applying functions to lists – recursive lists .

UNIT-3

Data Frames: Creating Data Frames – Matrix-like operations in frames – Merging Data Frames – Applying functions to Data frames – Factors and Tables – factors and levels – Common functions used with factors – Working with tables - Other factors and table related functions - Control statements – Arithmetic and Boolean operators and values – Default values for arguments - Returning Boolean values – functions are objects – Environment and Scope issues – Writing Upstairs - Recursion –Replacement functions – Tools for composing function code – Math and Simulations in R .

UNIT-4

OOP:S3 Classes – S4 Classes – Managing your objects – Input/Output – accessing keyboard and monitor – reading and writing files – accessing the internet – String Manipulation – Graphics – Creating Graphs – Customizing Graphs – Saving graphs to files – Creating three-dimensional plots

TEXTBOOKS:

1. Norman Matloff , "The Art of R Programming: A Tour of Statistical Software Design", No Starch Press, 2011
2. Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Addison-Wesley Data & Analytics Series, 2013.

REFERENCE BOOKS:

1. Mark Gardener, " Beginning R – The Statistical Programming Language", Wiley, 2013
2. Robert Knell, "Introductory R: A Beginner's Guide to Data Visualisation, Statistical Analysis and programming in R", Amazon Digital South Asia Services Inc, 2013.

JOURNALS/MAGAZINES:

1. Journal of applied statics
2. Computational Statistics & Data Analysis
3. The Annals of Statistics

SWAYAM/NPTEL/Moocs:

1. Coursera course on R Programming - Johns Hopkins University
2. Introduction To R Programming – NPTEL Course

SELF-LEARNING EXERCISES:

Interfacing: Interfacing R to other languages – Parallel R – Basic Statistics – Linear Model – Generalized Linear models – Non-linear models – Time Series and Auto-correlation – Clustering.

REVA UNIVERSITY
Bengaluru, India

School of Computing and Information Technology

M.Tech. in Cyber Security

2021-23 Batch

HANDBOOK

Rukmini Knowledge Park

Kattigenahalli, Yelahanka, Bengaluru – 560064

www.reva.edu.in

REVA UNIVERSITY
Bengaluru, India

SCHOOL OF COMPUTING AND INFORMATION TECHNOLOGY

HANDBOOK

M. Tech. in Cyber Security

2021-23

Rukmini Knowledge Park,

Kattigenahalli, Yelahanka, Bangalore - 560 064

Phone No: +91-080-46966966

Rukmini Educational
Charitable Trust

Chancellor's Message

"Education is the most powerful weapon which you can use to change the world."

- Nelson Mandela.

There was a time when survival depended on just the realization of physiological needs. We are indeed privileged to exist in a time when 'intellectual gratification' has become indispensable. Information is easily attainable for the soul that is curious enough to go look for it. Technological boons enable information availability anywhere anytime. The difference, however, lies between those who look for information and those who look for knowledge.

It is deemed virtuous to serve seekers of knowledge and as educators it is in the ethos at REVA University to empower every learner who chooses to enter our portals. Driven by our founding philosophy of 'Knowledge is power', we believe in building a community of perpetual learners by enabling them to look beyond their abilities and achieve what they assumed impossible.

India has always been beheld as a brewing pot of unbelievable talent, acute intellect and immense potential. All it takes to turn those qualities into power is a spark of opportunity. Being at a University is an exciting and rewarding experience with opportunities to nurture abilities, challenge cognizance and gain competence.

For any University, the structure of excellence lies in the transitional abilities of its faculty and its facility. I'm always in awe of the efforts that our academic board puts in to develop the team of subject matter experts at REVA. My faculty colleagues understand our core vision of empowering our future generation to be ethically, morally and intellectually elite. They practice the art of teaching with a student-centered and transformational approach. The excellent infrastructure at the University, both educational and extra-curricular, magnificently demonstrates the importance of ambience in facilitating focused learning for our students.

A famous British politician and author from the 19th century - Benjamin Disraeli, once said 'A University should be a place of light, of liberty and of learning'. Centuries later this dictum still inspires me and I believe, it takes team-work to build successful institutions. I welcome you to REVA University to join hands in laying the foundation of your future with values, wisdom and knowledge.

Dr. P. Shyama Raju

The Founder and Hon'ble Chancellor, REVA University

Vice-Chancellor Message

The last two decades have seen a remarkable growth in higher education in India and across the globe. The move towards inter-disciplinary studies and interactive learning have opened up several options as well as created multiple challenges. India is at a juncture where a huge population of young crowd is opting for higher education. With the tremendous growth of privatization of education in India, the major focus is on creating a platform for quality in knowledge enhancement and bridging the gap between academia and industry.

A strong believer and practitioner of the dictum “Knowledge is Power”, REVA University has been on the path of delivering quality education by developing the young human resources on the foundation of ethical and moral values, while boosting their leadership qualities, research culture and innovative skills. Built on a sprawling 45 acres of green campus, this ‘temple of learning’ has excellent and state-of-the-art infrastructure facilities conducive to higher teaching-learning environment and research. The main objective of the University is to provide higher education of global standards and hence, all the programs are designed to meet international standards. Highly experienced and qualified faculty members, continuously engaged in the maintenance and enhancement of student-centric learning environment through innovative pedagogy, form the backbone of the University.

All the programs offered by REVA University follow the Choice Based Credit System (CBCS) with Outcome Based Approach. The flexibility in the curriculum has been designed with industry-specific goals in mind and the educator enjoys complete freedom to appropriate the syllabus by incorporating the latest knowledge and stimulating the creative minds of the students. Bench marked with the course of studies of various institutions of repute, our curriculum is extremely contemporary and is a culmination of efforts of great think-tanks - a large number of faculty members, experts from industries and research level organizations. The evaluation mechanism employs continuous assessment with grade point averages. We believe sincerely that it will meet the aspirations of all stakeholders – students, parents and the employers of the graduates and postgraduates of REVA University.

At REVA University, research, consultancy and innovation are regarded as our pillars of success. Most of the faculty members of the University are involved in research by attracting funded projects from various research level organizations like DST, VGST, DBT, DRDO, AICTE and industries. The outcome of the research is passed on to students through live projects from industries. The entrepreneurial zeal of the students is encouraged and nurtured through EDPs and EACs.

REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students. REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students become skilled with relevant to industry requirements. Structured training programs on soft-skills and preparatory training for competitive exams are offered here to make students more employable. 100% placement of eligible students speaks the effectiveness of these programs. The entrepreneurship development activities and establishment of "Technology Incubation Centers" in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise. With firm faith in the saying, "Intelligence plus character –that is the goal of education" (Martin Luther King, Jr.), I strongly believe REVA University is marching ahead in the right direction, providing a holistic education to the future generation and playing a positive role in nation building. We reiterate our endeavour to provide premium quality education accessible to all and an environment for the growth of over-all personality development leading to generating "GLOBAL PROFESSIONALS".

Welcome to the portals of REVA University!

Dr.M.Dhanamjaya

Vice-Chancellor, REVA University

Director's – Message

I congratulate and welcome all the students to the esteemed school of Computing and Information technology (IT). You are in the right campus to become a computer technocrat. The rising needs of automation in Industry 4.0 and improvising living standards have enabled rapid development of computer software and hardware technologies. Thus providing scope and opportunity to generate more human resources in the areas of computers and IT. The B.Tech and M.Tech program curriculum and Ph.D areas in the school are designed to cater to the requirements of industry and society. The curriculum is designed meticulously in association with persons from industries (TCS, CISCO, AMD, MPHASIS, etc.), academia and research organizations (IISc, IIIT, Florida University, Missouri S & T University, etc).

This handbook presents the M.Tech in Cyber Security program curriculum. The program is of 2 years duration and split into 4 semesters. The courses are classified into foundation core, hard core, and soft core courses. Hard core courses represent fundamentals study requirements of CSE. Soft courses provide flexibility to students to choose the options among several courses as per the specialization. Theoretical foundations of engineering, science, and computer science are taught in first two Semesters. Later, advanced courses and recent technologies are introduced in subsequent semesters for pursuing specialization.

The important features of the M.Tech Cyber security are as follows: 1) Choice based course selection and teacher selection,

2) Studies in emerging areas like cyber security programming, cyber forensics, cryptography, Ethical hacking, Python/R Programming, Genetic Engineering, Swarm Intelligence, Cyber security, -Deep Learning and Re-enforcement Learning, Knowledge Representation and Reasoning, Block Chain Technology, Virtual and Augmented Reality, Natural Language Processing, Robotic Process Automation and Internet of Things. 3) Short and long duration Internships 4) Opportunity to pursue MOOC course as per the interest in foundation and soft core courses, 5) Attain global and skill certification as per the area of specialization, 6) Self-learning components,

7) Experiential, practice, practical, hackathons, and project based learning, 8) Mini projects and major projects with research orientation and publication, 9) Soft skills training and 10) Platform for exhibiting skills in cultural, sports and technical activities through clubs and societies.

The school has well qualified faculty members in the various areas of Computing and IT including cloud computing, security, Internet of Things, Artificial IIntellegence, Machine Learning and Deep Learning, Software Engineering, Computer Networks, Cognitive Computing, etc. State of art laboratories are available for the purpose of academics and research.

Dr. Mallijkarjun M Kodabagi

Director, School of Computing and IT

CONTENTS

Sl. No.	Particulars	Page No.
1	Message from the Hon'ble Chancellor	2
2	Message from the Vice Vice- Chancellor	3
3	Message from Director	5
4	Rukmini Educational Charitable Trust	7
5	About REVA University Vision, Mission, Objectives	8
6	About School of Computing and Information Technology Vision Mission Board of studies	12
7	Programme Overview Programme Educational Objectives Programme Outcomes Programme Specific Outomes	15
8	Regulations Governing M.Tech. programmes	22
9	Curriculum- M. Tech in Cyber Security	35

RUKMINI EDUCATIONAL CHARITABLE TRUST

It was the dream of late Smt. Rukmini Shyama Raju to impart education to millions of underprivileged children as she knew the importance of education in the contemporary society. The dream of Smt. Rukmini Shyama Raju came true with the establishment of Rukmini Educational Charitable Trust (RECT), in the year 2002. Rukmini Educational Charitable Trust (RECT) is a Public Charitable Trust, set up in 2002 with the objective of promoting, establishing and conducting academic activities in the fields of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology, among others. In furtherance of these objectives, the Trust has set up the REVA Group of Educational Institutions comprising of REVA Institute of Technology & Management (RITM), REVA Institute of Science and Management (RISM), REVA Institute of Management Studies (RIMS), REVA Institute of Education (RIE), REVA First Grade College (RFGC), REVA Independent PU College at Kattigenahalli, Ganganagar and Sanjaynagar and now REVA University. Through these institutions, the Trust seeks to fulfill its vision of providing world class education and create abundant opportunities for the youth of this nation to excel in the areas of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology.

Every great human enterprise is powered by the vision of one or more extraordinary individuals and is sustained by the people who derive their motivation from the founders. The Chairman of the Trust is Dr. P. Shyama Raju, a developer and builder of repute, a captain of the industry in his own right and the Chairman and Managing Director of the DivyaSree Group of companies. The idea of creating these top notched educational institutions was born of the philanthropic instincts of Dr. P. Shyama Raju to do public good, quite in keeping with his support to other socially relevant charities such as maintaining the Richmond road park, building and donating a police station, gifting assets to organizations providing accident and trauma care, to name a few.

The Rukmini Educational Charitable Trust drives with the main aim to help students who are in pursuit of quality education for life. REVA is today a family of ten institutions providing education from PU to Post Graduation and Research leading to PhD degrees. REVA has well qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 13,000 students study various courses across REVA's three campuses equipped with exemplary state-of-the-art infrastructure and conducive environment for the knowledge driven community.

ABOUT REVA UNIVERSITY

REVA University has been established under the REVA University Act, 2012 of Government of Karnataka and notified in Karnataka State Gazette No. 80 dated 27thFebruary, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

REVA University located in between Kempegowda International Airport and Bangalore city, has a sprawling green campus spread over 45 acres of land and equipped with state-of-the-art infrastructure that provide conducive environment for higher learning and research. The REVA campus has well equipped laboratories, custom-built teaching facilities, fully air-conditioned library and central computer centre, the well planned sports facility with cricket ground, running track & variety of indoor and outdoor sports activities, facilities for cultural programs. The unique feature of REVA campus is the largest residential facility for students, faculty members and supportive staff.

REVA consistently ranked as one of the top universities in various categories because of the diverse community of international students and its teaching excellence in both theoretical and technical education in the fields of Engineering, Management, Law, Science, Commerce, Arts, Performing Arts, and Research Studies. REVA offers 28 Undergraduate Programmes, 22 Full-time and 2 Part-time Postgraduate Programmes, 18 Ph. D Programmes, and other Certificate/ Diploma/Postgraduate Diploma Programmes in various disciplines.

The curriculum of each programme is designed with a keen eye for detail by giving emphasis on hands-on training, industry relevance, social significance, and practical applications. The University offers world-class facilities and education that meets global standards.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed universities / institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The system also allows students to move forward under the fast track for those who have the capabilities to surpass others. These

programs are taught by well experienced qualified faculty supported by the experts from industries, business sectors and such other organizations. REVA University has also initiated many supportive measures such as bridge courses, special coaching, remedial classes, etc., for slow learners so as to give them the needed input and build in them confidence and courage to move forward and accomplish success in their career. The University has also entered into MOUs with many industries, business firms and other institutions seeking their help in imparting quality education through practice, internship and also assisting students' placements.

REVA University recognizing the fact that research, development and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology and other areas of study. The interdisciplinary-multidisciplinary research is given the top most priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano- Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nana Tribology, Fuel Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

The REVA University has also given utmost importance to develop the much required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) department with world class infrastructure, headed by a dynamic experienced Professor& Dean, and supported by well experienced Trainers, Counselors and Placement Officers.

The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognised as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal VikasYojana. The Centre conducts several add-on courses in challenging areas of development. It is always active in facilitating student's variety of Skill Development Training programs.

The University has collaborations with Industries, universities abroad, research institutions, corporate training organizations, and Government agencies such as Florida International University, Okalahoma State University, Western Connecticut University, University of Alabama, Huntsville, Oracle India Ltd, Texas Instruments, Nokia University Relations, EMC2, VMware, SAP, Apollo etc, to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreign universities also facilitates students to study some of the programs partly in REVA University and partly in foreign university, viz, M.S in Computer Science one year in REVA University and the next year in the University of Alabama, Huntsville, USA. The University has also given greater importance to quality in education, research, administration and all activities of the university. Therefore, it has established an independent Internal Quality division headed by a senior professor as Dean of Internal Quality. The division works on planning, designing and developing different quality tools, implementing them and monitoring the implementation of these quality tools. It concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat Ratna Prof. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr. Balaram, Former Director IISc., and noted Scientist, Dr. V S Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of Defence Dr. Sathish Reddy, Scientific Advisor, Ministry of Defence, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction. REVA organises various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVAMP conducted every year. The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions and variety of cultural events. Another important event is Shubha Vidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also recognised by distributing awards and prizes. The founders have also instituted medals and prizes for sports

achievers every year. The physical education department conducts regular yoga class'severyday to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

REVA University

Vision

REVA University aspires to become an innovative university by developing excellent human resources with leadership qualities, ethical and moral values, research culture and innovative skills through higher education of global standards.

Misson

- To create excellent infrastructure facilities and state-of-the-art laboratories and incubation centers
- To provide student-centric learning environment through innovative pedagogy and education reforms.
- To encourage research and entrepreneurship through collaborations and extension activities.
- To promote industry-institute partnerships and share knowledge for innovation and development.
- To organize society development programs for knowledge enhancement in thrust areas.
- To enhance leadership qualities among the youth and enrich personality traits, promote patriotism and moral values.

Objectives

- Creation, preservation and dissemination of knowledge and attainment of excellence in different disciplines.
- Smooth transition from teacher - centric focus to learner - centric processes and activities.
- Performing all the functions of interest to its major constituents like faculty, staff, students and the society to reach leadership position.
- Developing a sense of ethics in the University and Community, making it conscious of its obligations to the society and the nation.
- Accepting the challenges of globalization to offer high quality education and other services in a competitive manner.

About the School of Computing and Information Technology (C & IT)

The School has a rich blend of experienced and committed faculty who are well-qualified in various aspects of computing and information technology apart from the numerous state-of-the-art digital classrooms and laboratories having modern computing equipment. The School offers five undergraduate programs: B Tech in Computer Science and Engineering, B Tech in Computer Science and Engineering (Artificial Intelligence and Machine Learning), B Tech in Computer Science and Information Technology, B Tech in Information Science and Engineering. Three postgraduate programs offered in the school are: M Tech in Artificial Intelliigence. In addition, the school has a unique academic collaboration with the University of Alabama in Huntsville to jointly offer an MS program in Computer Science. In addition, the school has a research center in which students can conduct cutting edge research leading to a PhD degree.

Curricula of both undergraduate and postgraduate programs have been designed through a collaboration of academic and industry experts in order to bridge the growing gap between industry and academia. This makes the program highly practical-oriented, and thus industry-resilient. The B Tech program aims to create quality human resources to play leading roles in the contemporary, competitive industrial and corporate world. The masters' degrees focus on quality research and design in the core and application areas of computing to foster a sustainable world and to enhance the global quality of life by adopting enhanced design techniques and applications. This thought is reflected in the various courses offered in the masters' programs.

Vision

To produce excellent quality technologists and researchers of global standards in computing and Information technology who have potential to contribute to the development of the nation and the society with their expertise, skills, innovative problem-solving abilities, strong moral and ethical values.

Mission

- To create state of the art computing labs infrastructure and research facilities in information technology.
- To provide student-centric learning environment in Computing and Information technology through innovative pedagogy and education reforms.

- To encourage research, innovation and entrepreneurship in computing and information technology through industry/academia collaborations and extension activities
- Organize programs through club activities for knowledge enhancement in thrust areas of information technology.
- To enhance leadership qualities among the youth and enrich personality traits, promote patriotism, moral and ethical values.

Quality Policy

The School of Computing and Information Technology is committed to excellence through following policies.

1. Impart quality education by providing state of art curriculum, experimental learning, and state of the art labs.
2. Enhance skill set of faculty members through faculty development programmes and interaction with academia and industries.
3. Inculcate the competency in software/hardware design and programming through co-curricular activities like Hackathon, Project exihibition, Internship and Enterpreneuship Programme.
4. Provide soft skill and skill development training for personality development and better placement.
5. Promote innovation and research culture among students and support faculty members for better research and development activity.

MEMBERS OF BOARD OF STUDIES

Sl. No.	Name		Correspondence Address
1	**Dr. Mallikarjun M Kodabagi** Professor and Director School of Computing and InformationTechnology REVA University,Bangaluru	Chairperson	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
2.	**Dr. Vishwanath R Hulipalled** Professor School of Computing and Information Technology	Member	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
3.	**Dr. Udaya Rani V** Professor School of Computing and Information Technology	Member	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
4.	**Dr. Parthasarthy** Associate Professor, School of Computing and Information Technology	Member	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
5.	**Dr. Venkatesh Prasad** Associate Professor, School of Computing and Information Technology	Member	Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka 560064
6.	**Sreenivasa Ramanujam Kanduri** Academic Relationship Manager, TCS	Member (Industry Expert)	Academic Relationship Manager, Tata Consultancy Services, Bangalore.
7.	**Dr. Sundar K S** Associate Vice-President & Head, IMS Academy at Infosys	Member (Industry Expert)	Associate Vice-President & Head, IMS Academy at Infosys, Mysore
8.	**Dr. Ramabrahmam Gunturi** Consultant, TCS	Industry Expert	Tata Consultancy Services, Hyderabad.
9.	**Dr. S. A. Angadi** Professor, School of CSE VTU	Academic Expert	Professor, School of CSE Visvesvaraya, Belagavi
10.	**Dr. Bharati Arakeri** Professor**,** School of CSE BMSIT, Bangalore.	Academic Expert	Professor**,** School of CSE BMSIT, Bangalore
11.	**Abhishek Revanna Swamy** Associate Project Manager, Robert Bosch	Alumni-Member	Associate Project Manager, Robert Bosch, Bangalore

Program Overview

M. Tech. in Cyber Security

The M.Tech in Cyber Security programme is designed to provide an outcome-driven and skill-based learning to make students become proficient cyber security professionals. Experiential learning with proprietary and open software programmes is the one of the best academic facilities of this programme. The School offers state-of-the art infrastructure to reproduce a real-time simulator-like environment to defend against cyberattack scenarios.

Computers have become ubiquitous part of modern life, and new applications are introduced every day. The use of computer technologies is also commonplace in all types of organizations, in academia, research, industry, government, private and business organizations. As computers become even more pervasive, the potential for computer-related careers will continue to grow and the career paths in computer-related fields will become more diverse. Since 2001, global information and communication technologies (ICTs) have become more powerful, more accessible, and more widespread. They are now pivotal in enhancing competitiveness, enabling development, and bringing progress to all levels of society.

Designed keeping in mind the exponential growth in the usage of information technology and the demand for huge number of cyber security professionals to counter measure online cyber-attacks.

Meet the demands of the future job market especially demand for cyber security professionals.

Designed with inputs from industry professionals and academic experts from various universities in India and abroad.

Some of the important courses of study include: cryptography, cloud security, block chain technology, cyber physical systems, Firewall and UTM architecture, digital forensics, ethical hacking, security architecture with solid theoretical foundation and project-based skills.

The career opportunities o Cyber Security are Cybersecurity Analyst,Security Engineer,Security Architect,Security Administrator,Security Software Developer ,Cryptanalyst,Digital Forensic Analyst,Vulnerability Assessor,Cloud Security Architect,Intrusion Detection Specialist,Cybercrime Investigator,Malware Analyst, Data Privacy Officer,Computer Security Incident Responder,Governance Compliance & Risk (GRC) Manager,Security Consultant.

May even go for pursuing higher studies in Cyber Security or go for doctorate degree.

The School of Computing and Information Science at REVA UNIVERSITY offers M.Tech, Cyber Security programme to create motivated, innovative, creative thinking graduates to fill ICT positions across sectors who can conceptualize, design, analyse, and develop ICT applications to meet the modern day requirements.

The M.Tech, in Cyber Security curriculum developed by the faculty at the School of Computing andInformation Science, is outcome based and it comprises required theoretical concepts and practical skills in the domain. By undergoing this programme, students develop critical, innovative, creative thinking and problem solving abilities for a smooth transition from academic to real-life work environment. In addition, students are trained in interdisciplinary topics and attitudinal skills to enhance their scope. The above mentioned features of the programme, advanced teaching and learning resources, and experience of the faculty members with their strong connections with ICT sector makes this programme unique.

Program Educational Objectives (PEO's)

After few years of graduation, the graduates of M. Tech (Cyber Security) will be able to:

PEO-1: Demonstrate skills as a Cybersecurity professional and perform duties with ethical and moral values.

PEO-2: Engage in active research for professional development with an attribute of lifelong learning.

PEO-3: Be an active and useful member of the society contributing to the economic and technological development of the nation and the world.

PEO-4: Take up entrepreneurship.

Program Outcomes (POs)

On successful completion of the programme, graduates of M.Tech (Cyber security) programme will be able to:

PO1:

Demonstrate in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

PO 2:

Analyse complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

PO 3:

Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

PO 4:

Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

PO 5:

Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.

PO 6:

Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

PO 7:

Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economic and financial factors.

PO 8:

Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

PO 9:

Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

PO 10:

Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

Program Specific Outcomes (PSOs)

On successful completion of the programme, graduates of M.Tech. (Cybersecurity) will be able to:

PSO-1: Develop an in-depth knowledge and skill sets in Cyber Security to monitor, prepare, predict, detect and respond and prevent cyber-attacks and ensure enterprise security.

PSO-2: Identify, assess and protect the enterprise IT assets and risks, perform risk analysis and develop policies and procedures based on compliance and able to define the architecture, design, and management of the security of an organisation.

PSO-3: Monitor, detect, respond, remediate cyber security threat using latest hardware and software tools and technologies, along with analytical and managerial skills to arrive at cost effective and optimum solutions either independently or as a team.

PSO-4: Review scholarly work by referring journals, define a new problem, design, model, analyse and evaluate the solution and report as a project in the area of Cybersecurity.

REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Post Graduate Degree Program (M.Tech) – w.e.f Academic Year 2021-2023

Teaching and Learning Process

The teaching and learning process under CBCS-CAGP of education in each course of study will have three components, namely-

(i) L= Lecture (ii) T= Tutorial (iii) P= Practice, where:

L stands for **Lecture** session consisting of classroom instruction.

T stands for **Tutorial** session consisting participatory discussion / self-study/ desk work/ brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes.

P stands for **Practice** session and it consists of Hands on Experience / Laboratory Experiments / Field Studies / Case Studies/ Project Based Learning/ Self Study / Online courses from listed portals that equip students to acquire the much required skill component.

Classification of Courses: A course shall have either or all the three components. That means a course may have only lecture component, or only practical component or combination of any two or all the three components.

Various course of s**tudy** are labeled and defined as: (i) Core Course (CC) (ii) Hard Core Course (HC), (iii) Soft Core Course (SC), (iv) Foundation Core Course (FC) and (v) Open Elective Course (OE).

(i) **Core Course:** A course which should compulsorily be studied by a candidate as a core-requirement is termed as a Core course.

(ii) Foundation Course (FC):

The foundation Course is a core course which should be completed successfully as a part of graduate degree program irrespective of the branch of study.

(iii) Hard Core Course (HC):

The **Hard Core Course** is a Core Course in the main branch of study and related branch (es) of study, if any that the candidates have to complete compulsorily.

(iv) Soft Core Course (SC):

A Core course may be a **Soft Core** if there is a choice or an option for the candidate to choose a course from a pool of courses from the main branch of study or from a sister/related branch of study which supports the main branch of study.

(v) O**pen Elective Course:**

An elective course chosen generally from other discipline / subject, with an intention to seek exposure is called an O**pen Elective Course.**

Project Work:

Project work is a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem.

Minor Project:

A project work up to TWO to FOUR **credits** is called **Minor Project** work. A Minor Project work may be a hard core or a Soft Core as decided by the BOS / concerned.

Major Project / Dissertation:

A project work of SIX or **EIGHT or TEN credits** is called **Major Project** work. The Major Project / Dissertation shall be Hard Core.

Minimum Credits to be earned:

A candidate has to earn 72 credits for successful completion of M Tech degree with a distribution of credits for different courses as prescribed by the University.

A candidate can enroll for a maximum of 24 credits per Semester. However s/he may not successfully earn a maximum of 24 credits per semester. This maximum of 24 credits does not include the credits of courses carried forward by a candidate.

Only such full time candidates who register for a minimum prescribed number of credits in each semester from I semester to IV semester and complete successfully 72 credits in 4 successive semesters shall be considered for declaration of Ranks, Medals, Prizes and are eligible to apply for Student Fellowship, Scholarship, Free ships, and such other rewards / advantages which could be applicable for all full time students and for hostel facilities.

Add- on Proficiency Certification:

In excess to the minimum of 72 credits for the M. Tech Degree program, a candidate can opt to complete a minimum of 4 extra credits either in the same discipline/subject or in different discipline / subject to acquire **Add on Proficiency Certification** in that particular discipline / subject in his / her subject of study or in other subjects / discipline along with the M .Tech degree.

Add on Proficiency Diploma:

In excess to the minimum of 72 credits for the M. Tech degree program, a candidate can opt to complete a minimum of 18 extra credits either in the same discipline/subject or in different discipline / subject to acquire Add on Proficiency Diploma in that particular discipline / subject along with the B. Tech degree. The A**dd -on Proficiency Certification / Diploma** so issued to the candidate contains the courses studied and grades earned.

Continuous Assessment, Earning of Credits and Award of Grades.

The assessment and evaluation process happens in a continuous mode. However, for reporting purpose, **a Semester is divided into 3 components as IA1, IA2 and SEE.** The performance of a candidate in a course will be assessed for a maximum of 100 marks as explained below.

(i) Component IA1:

The first Component (IA1), of assessment is for 25 marks. This will be based on test, assignment / seminar. During the first half of the semester (i.e. by 8th week), the first 50% of the syllabus (Unit 1&2) will be completed. This shall be consolidated during the first three days of 8th week of the semester. A review test based on IA1 will be conducted and completed in the beginning of the 9th week. In case of

courses where test cannot be conducted, the form of assessment will be decided by the concerned school and such formalities of assessment will be completed in the beginning of the 9th week. The academic sessions will continue for IA2 immediately after completion of process of IA1.

The finer split - up for the award of marks in IA1 is as follows:

Assignment & Seminars .....10 marks for the **first 20% of the syllabus**
Test (Mid-Term) ..... 15 marks forthe **first 30% of the syllabus**
Total.....25 marks

(ii) Component IA2:

The second component (IA2), of assessment is for 25 marks. This will be based on test, assignment /seminar. The continuous assessment and scores of second half of the semester (9th to 16th week) will be consolidated during 16th week of the semester. During the second half of the semester the remaining units in the course will be completed. A review test based on IA2 will be conducted and completed during 16th week of the semester. In case of courses where test cannot be conducted, the form of assessment will be decided by the concerned school and such formalities of assessment will be completed during 16th week.

The 17th week will be for revision of syllabus and preparation for the semester - end examination.

The finer split - up for the award of marks in IA2 is as follows:
Assignment/Seminar ..... 10 marks for the **second 20% of the syllabus**
Review Test (Mid-Term)..... 15 marks for the **second 30% of the syllabus**
Total.....25 marks

(iii) Component SEE:

The Semester End Examination of 3 hours duration for each course shall be conducted during the 18th & 19th week. **This forms the third / final component of assessment (SEE) and the maximum marks for the final component will be 50.**

The Assessment of MOOC and Online Courses shall be decided by the concerned School Board of Studies (BOS).

For> 3 credit courses

i	IA-I	25 marks
ii	IA-2	25 marks
iii	Semester end examination by the concern school board (demo, test, viva voice etc)	50 marks
	Total	**100 marks**

For 1 & 2 credit courses

i	IA-I	15 marks
ii	IA-2	15 marks
iii	Semester end examination by the concern school board (demo, test, viva voice etc)	20 marks
	Total	**50 marks**

The 50 marks meant for Internal Assessment (IA) of the performance in carrying out practical shallfurther be allocated as under:

i	Conduction of regular practical / experiments throughout the semester	20 marks
ii	Maintenance of lab records / Activities /Models / charts etc	10 marks
iii	Performance of mid-term test (to be conducted while conducting second test for theory courses); the performance assessments of the mid-term test includes performance in the conduction of experiment and write up about the experiment.	20 marks
	Total	**50 marks**

Setting Questions Papers and Evaluation of Answer Scripts:

There shall be three sets of questions papers set for each course. Two sets of question papers shall be set by the internal and one set by external examiner for a course. The Chairperson of the BoE shall get the question papers set by internal and external examiners.

The Board of Examiners shall scrutinize and approve the question papers and scheme of valuation.

There shall be single valuation for all theory papers by internal examiners. In case, the number of internal examiners falls short, external examiners may be invited. The answer scripts evaluated both by internal and external examiners shall be moderated by the external examiner / moderator.

The examination for Practical work/ Field work/Project work will be conducted jointly by two examiners (internal and external). However, in case of non-availability of external examiner or vice versa, the Chairperson BoE at his discretion can invite internal / external examiners as the case may be, if required.

If a course is fully of (L=0):T: (P=0) type, then the examination for SEE Component will be as decided by the BoS concerned.

In case of a course with only practical component a practical examination will be conducted with two examiners and each candidate will be assessed on the basis of: a) Knowledge of relevant processes, b) Skills and operations involved, and c) Results / Products including calculation and reporting.

The duration for Semester-End practical examination shall be decided by the Controller of Examinations.

5.4. Evaluation of Minor Project / Major Project / Dissertation:

Right from the initial stage of defining the problem, the candidate has to submit the progress reports periodically and also present his/her progress in the form of seminars in addition to the regular discussion with the supervisor. At the end of the semester, the candidate has to submit final report of the project / dissertation, as the case may be, for final evaluation. The components of evaluation are as follows:

Component – I	(IA1)	Periodic Progress and Progress Reports (25%)
Component – II	(IA2)	Results of Work and Draft Report (25%)
Component– III	(SEE)	Final Evaluation and Viva-Voce (50%). Evaluation of the report is for 30% and the Viva-Voce examination is for 20%.

5.4. The schedule of continuous assessment and examinations are summarized in the following Table below.

Component	Period	Syllabus	Weightage	Activity
IA1	1st Week to 8th Week	First 50% (two units)		Instructional process and Continuous Assessment
	Last 3 days of 8th Week		25%	Consolidation of IA1
IA2	9th week to 16th week	Second 50% (remaining two units)		Instructional process and Continuous Assessment
	Last 3 days of 16th week		25%	Consolidation of IA2
SEE	17th and 18th week			Revision and preparation for Semester end examination
	19th week to 20th week	Entire syllabus	50%	Conduct of semester end examination and Evaluation concurrently
	21st week			Notification of Final Grades
***Evaluation shall begin very first day after completion of the conduct of examination of the first course and both examination and evaluation shall continue concurrently. The examination results / final grades be announced latest by 21st week**				

Note: 1. Practical examination wherever applicable shall be conducted before conducting of IA2 examination. The calendar of practical examination shall be decided by the respective school.

2. Finally**, awarding the Grades** be announced latest by 5 days after completion of the examination.

6.0 Requirements to Pass a Course

A candidate's performance from all 3 components will be in terms of scores, and the sum of all three scores will be for a maximum of 100 marks (25 + 25 + 50). A candidate who secures a minimum of 40% in the SEEand an overall 40% (IA1+IA2+SEE) in a course is said to be successful.

Eligibility to Appear for SEE (Semester -End Examination) and Provision to Drop the Course.

Only those students who fulfill 75% attendance requirement and who secure minimum 30% marks in IA1

and IA2 together in a course are eligible to appear for SEE examination in that course.

Those students who have 75% of attendance but have secured less than 30% marks in IA1 and IA2 together in a course are not eligible to appear for SEE examination in that course. They are treated as dropped the course and they will have to repeat that course whenever it is offered.

Teachers offering the courses will place the above details in the School Council meeting during the last week of the Semester, before the commencement of SEE, and subsequently a notification pertaining to the above will be brought out by the Director of the School before commencement of SEE examination. A copy of this notification shall also be sent to the office of the Controller of the Examinations.

In case a candidate secures more than 30% in IA1 and IA2 together but less than 40% in aggregate of IA1, IA2 and SEE in a course is considered as unsuccessful and such a candidate may either opt to DROP that course or appear for SEE examination during the subsequent semesters / years within the stipulated period.

In such a case wherein he / she opts to appear for just SEE examination, then the marks secured in IA1 and IA2 shall get continued. Repeat SEE examination will be conducted in respective semesters.

In case a candidate opts to drop the course he / she has to re-register for the dropped course only in subsequent semesters whenever it is offered if it is Hard Core Course and he / she may choose alternative course if it is Soft Core Course or Open Elective course or Skill Development Course. **The details of any dropped course will not appear in the Grade Card.**

Provision to Withdraw Course:

A candidate can withdraw any course within ten days from the date of notification of final results. Whenever a candidate withdraws a course, he/she has to register for the same course in case it is hard core course, the same course or an alternate course if it is soft core/open elective. **A DROPPED course is automatically considered as a course withdrawn.**

Provision for Supplementary Examination

In case a candidate fails to secure a minimum of 40% (20 marks) in Semester End Examination (SEE) and a minimum of 40% marks overall (IA and SEE together), such candidate shall seek supplementary examination of only for such course(s) wherein his / her performance is declared unsuccessful. The supplementary examinations are conducted after the announcement of even semester examination results. The candidate who is unsuccessful in a given course(s) shall appear for supplementary examination of odd and even semester course(s) to seek for improvement of the performance.

Re-Registration and Re-Admission:

A candidate's class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University and is considered as dropped the semester and is not allowed to appear for semester end examination (SEE) shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

In case a candidate fails in more than 2 courses in odd and even semesters together in a given academic year, he / she may either drop all the courses and repeat the semester or reappear (SEE-semester end examination) to such of those courses where in the candidate has failed during subsequent semester / year within a stipulated period.

In such a case where in a candidate drops all the courses in semester due to personal reasons, it is considered that the candidate has dropped the semester and he / she shall seek re-admission to such dropped semester.

Requirements to Pass the Semester andProvision to Carry Forward the Failed Subjects / Courses:

A candidate who secures a minimum of 40% in the SEE and an overall 40% (IA1+IA2+SEE) in a course is said to be successful.

7.5. Provision to Carry Forward the Failed Subjects / Courses:

A student who has failed in 4 courses in 1st and 2nd semesters together shall move to 3rd semester. And he / she shall appear for SEE examination of failed courses of the said semesters concurrently with 3rd semester end examinations (SEE) and 4th semester end examinations (SEE) of second year of study.

8.0 **Attendance Requirement:**

All students must attend every lecture, tutorial and practical classes.

In case a student is on approved leave of absence (e g:- representing the university in sports, games or athletics, placement activities, NCC, NSS activities and such others) and / or any other such contingencies like medical emergencies, the attendance requirement shall be minimum of 75% of the classes taught.

Any student with less than 75% of attendance in a course during a semester shall not be permitted to appear in the semester end examination.

Absence during mid semester examination

In case a student has been absent from a mid-semester examination due to the illness or other contingencies he / she may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Head of the School, for make-up examination. The Head of the School may consider such request depending on the merit of the case and after consultation with course instructor and class teacher, and permit such student to appear for make-up mid semester examination.

Absence during Semester End Examination:

In case a student is absent for Semester End Examination on medical grounds or such other exigencies, the student can submit request for make-up examination, with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Director of the School. The Director of the School may consider such request depending on the merit of the case and after consultation with class teacher, course instructor and permit such student to appear for make-up mid semester examination

Provisional Grade Card:

The tentative / provisional Grade Card will be issued by the Controller of Examinations at the end of every Semester indicating the courses completed successfully. The provisional grade card provides **Semester Grade Point Average** (SGPA).This statement will not contain the list of DROPPED courses.

Challenge Valuation:

A student who desires to apply for challenge valuation shall obtain a Xerox copy of the answer script by paying the prescribed fee within 10 days after the announcement of the results. He / She can challenge the Grade awarded to him/her by surrendering the Grade Card and by submitting an application along with the prescribed fee to the Controller of Examination (COE) within 15 days after the announcement of the results. This challenge valuation is only for SEE component.

The answer scripts for which challenge valuation is sought for shall be sent to another external examiner. The marks awarded will be the higher of the marks obtained in the challenge valuation and in maiden valuation.

Final Grade Card: Upon successful completion of the Post Graduate Degree a Final Grade card consisting of grades of all courses successfully completed by the Candidate will be issued by the COE.

The Grade and the Grade Point: The Grade and the Grade Point earned by the candidate in the subjectwill be as given below.

Marks P	Grade G	Grade Point (GP=V x G)	Letter Grade
90-100	10	v*10	O
80-89	9	v*9	A
70-79	8	v*8	B
60-69	7	v*7	C
50-59	6	v*6	D
40-49	5	v*5	E
0-39	0	v*0	F

O - Outstanding; A-Excellent; B-Very Good; C-Good; D-Fair; E-Satisfactory; F - Fail;

Here, P is the percentage of marks (P=[(IA1+IA2)+SEE] secured by a candidate in a course which is **rounded to nearest integer**. v is the credit value of course. G is the grade and GP is the grade point.

Computation of SGPA and CGPA

The Following procedure to compute the Semester Grade Point Average (SGPA)

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

SGPA (Si) = ∑(Ci x Gi) / ∑Ci

Where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

Illustration for Computation of SGPA and CGPA

Illustration No. 1

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade)
Course 1	**3**	**A**	**9**	**3X9=27**
Course 2	**3**	**B**	**8**	**3X8=24**
Course 3	**3**	**C**	**7**	**3X7=21**
Course 4	**3**	**O**	**10**	**3X10=30**
Course 5	**3**	**D**	**6**	**3X6=18**
Course 6	**3**	**O**	**10**	**3X10=30**
Course 7	**2**	**A**	**9**	**2X 9 = 18**
Course 8	**2**	**B**	**8**	**2X 8 = 16**
	22			**184**

Thus, **SGPA = 184 ÷ 22 = 8.36**

Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (72) for two year post graduate degree in a specialization is calculated taking into

account all the courses undergone by a student over all the semesters of a program, i. e **CGPA = ∑(Ci x Si) / ∑Ci**

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration:

CGPA after Final Semester

Semester (ith)	**No. of Credits (Ci)**	**SGPA (Si)**	**Credits x SGPA (Ci X Si)**
1	22	8.36	22 x 8.36 = 183.92
2	22	8.54	22 x 8.54 =187.88
3	16	9.35	16x9.35=149.6
4	12	9.50	12x9.50=114
Cumulative	72		635.4

Thus, **CGPA** = $\frac{22x8.36+22x8.54+16x9.35+12x9.50}{72}$ = 8.83

CONVERSION OF GRADES INTO PERCENTAGE:

Conversion formula for the conversion of CGPA into Percentage is:

Percentage of marks scored = CGPA Earned x 10

Illustration: CGPA Earned 8.83 x 10=88.30

Classification of Results

The final grade point (FGP) to be awarded to the student is based on CGPA secured by the candidate and is given as follows.

CGPA	Numerical Index	FGP Qualitative Index
> 4 =CGPA < 5	**5**	SECOND CLASS
5 > = CGPA < 6	6	
6 >= CGPA < 7	7	FIRST CLASS
7 >= CGPA < 8	8	
8 >= CGPA < 9	9	DISTINCTION
9 >= CGPA 10	10	

Overall percentage=10*CGPA

Provision for Appeal

If a candidate is not satisfied with the evaluation of IA1 and IA2 components, he/she can approach the grievance cell with the written submission together with all facts, the assignments, test papers etc, which were evaluated. He/she can do so before the commencement of semester-end examination. The grievance cell is empowered to revise the marks if the case is genuine and is also empowered to levy penalty as prescribed by the university on the candidate if his/her submission is found to be baseless and unduly motivated. This cell may recommend taking disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the grievance cell is final.

Grievance Committee

For every program there will be one Grievance Committee. The composition of the grievance committee is as follows:-

- The Controller of Examinations - Ex-officio Chairman / Convener
- One Senior Faculty Member (other than those concerned with the evaluation of the course concerned) drawn from the school / department/discipline and/or from the sister schools / departments/sister disciplines – Member.

- One Senior Faculty Members / Subject Experts drawn from outside the University school /department – Member.

M.Tech in Cyber Security

Scheme of Instructions for 2021-23

(Effective from the Academic Year 2021-22)

Sl. No	Course Code	Course Title	Course Type	Credit Pattern and Credit Value				No. of Hrs.
				L	T	P	C	
First Semester								
1	M21TF0101	Cyber Security and Programming	HC	3	0	1	4	5
2	M21TF 0102	Mathematics for Cyber Security	HC	4	0	0	4	4
3	M21TF 0103	Cyber Forensics	HC	3	0	1	4	5
4	M21TF 0104	Security and investigation of the block chain	HC	4	0	0	4	4
5	M21TF 0105	Ethical Hacking and Network Defense	HC	3	0	1	4	5
6	M21TF 0106	Mini Project	HC	0	0	2	2	4
Total Credits for the First Semester							**22**	**27**
Second Semester								
1	M21TF0201	Cloud security	HC	3	0	1	4	5
2	M21TF0202	Cyber security with ML and AI	HC	3	0	1	4	5
3	M21TF0203	Security Analytics	HC	3	0	1	4	5
4	M21TFS204	Firewall & UTM architecture	SC	3	0	0	3	3
	M21TFS205	Malware Analysis and Detection						
	M21TFS206	Web Security						
5	M21TFS207	Secure Communications	SC	3	0	0	3	3
	M21TFS208	Penetration testing & incident response						
	M21TFS209	Mobile and Wireless security						
6	M21TF0206	Forensics and VAPT Lab	HC	0	0	2	2	4
7	M21TF0207	Mini Project	HC	0	0	2	2	4
Total Credits for the Second Semester							**22**	**29**

Sl. No	Course Code	Course Title	Course Type	Credit Pattern and Credit Value				No. of Hrs.
THIRD SEMESTER								
1	M21TFS301	Security and Resilience	SC	4	0	0	4	4
	M21TFS302	IOT Security						
	M21TFS303	Advanced topics in cyber security						
2	M21TFO3XX	Open Elective	MC	4	0	0	4*	4
3	M21TF0303	Project Phase-1	HC	0	0	4	4	8
4	M21TF0304	Internship/Global Certification	HC	0	0	4	4	8
	Total Credits for the Third Semester						**12**	20
	*(MC)This course must be completed but it will not be graded and not considered for computing CGPA/SGPA							
FOURTH SEMESTER								
1	M21TF0401	Project Phase -2 and Dissertation	HC	0	0	16	16	32
	Total Credits for the Fourth Semester						**16**	32
Total Number of Credits for all Four Semesters is 72.								

Note:

Internship should be carried out in a reputed /Tier-1/R & D organization, preferably, internship should be with stipend. The internship should be approved by the REVA University authorities before completion of 3rd semester and the students should obtain the permission for the same by producing the necessary details of company, selection process, and the offer letter issued by the company. At the end of the Internship, detailed report must be submitted.

Open Electives offered to other schools

1. M21CB3021 Fundamentals of cyber security
2. M21CB3022 Ethical Hacking
3. M21CB3023 Blockchain Technology

<table>
<tr><td>Course Title</td><td colspan="4">Cyber Security And Programming</td><td colspan="2">Course type</td><td colspan="2">Integrated</td></tr>
<tr><td>Course Code</td><td>M21TF0101</td><td>Credits</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2">VII Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>-</td><td>0</td><td>-</td><td>-</td></tr>
<tr><td>Total</td><td>4</td><td>5</td><td>5</td><td>39</td><td>26</td><td>50%</td><td>50%</td></tr>
</table>

Course Overview:

The Cyber Security and Programming course gives an awareness of software Vulnerabilities in computer systems that can be used to crack the frontier problems of the current day. The C /C++ programming concepts are covered in this course are at the forefront of commercial practice in solving real-time problems. They are applicable in Exception handling – Mitigation Strategies, stack randomization, vulnerabilities in Cybersecurity. This course is designed to understand the software security concepts in cyber security to handle real world applications.

Course Objective (s):

The Objectives of this course are to:

1. Understand the most frequent programming errors to software vulnerabilities.
2. Identify and analyze security problems in software and integral security issues.
3. Apply the knowledge to the common vulnerabilities associated with file I/O.
4. Apply the specific development practices for improving the overall security of the application.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Discuss the software security concepts for cybersecurity	1, 2, 3, 4, 5	1
CO2	Analyze Exception Handling - Mitigation Strategies in computer systems.	1, 2, 3, 4, 5	2
CO3	Applying Stack Randomization-Mitigation Strategies to Notable Vulnerabilities in cybersecurity	1, 2, 3, 4, 5	2,3
CO4	Demonstrate Stack Randomization, Mitigation Strategies and Vulnerabilities	1, 2, 3, 4, 5	2,3

CO5	Design the Security Development Lifecycle for Cybersecurity	1, 2, 3, 4, 5	1
CO6	Analyze File I/O Interfaces, Access Control and File Identification	1, 2, 3, 4, 5	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2				√		
CO3			√			
CO4						√
CO5				√		
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	1								3		
CO2	3	2	3	1	2									3	
CO3	3	1	2	2	3									3	3
CO4	2	2	2	1	1									3	3
CO5	2	2	2	1	1									3	3
CO6	2	2	2	1	1									3	3

Note: 1-Low, 2-Medium, 3-High

Course Contents:

Unit-1

SOFTWARE SECURITY CONCEPTS : Gauging the Threat - Security Concepts - C and C++ - Development Platforms - Strings - Character Strings - Common String manipulation Errors - String Vulnerabilities and Exploits - Mitigation Strategies - String handling functions - runtime protection strategies - notable vulnerabilities

Unit-2

POINTER SUBTERFUGE AND INTEGER SECURITY : Data Locations - Function Pointers - Object Pointers - Modifying the Instruction Pointer - Global Offset Table - The .dtors Section - Virtual Pointers - The atexit() and on_exit() Functions - The longjmp() Function - Exception Handling - Mitigation Strategies - Integer Security - Integer Conversions - Integer Operations - Integer Vulnerabilities - Mitigation Strategies

Unit-3

FORMATTED OUTPUT FUNCTIONS: Variadic Functions - Exploiting Formatted Output Functions - Stack Randomization-Mitigation Strategies - Notable Vulnerabilities

Unit-4

File I/O: File I/O Basics - File I/O Interfaces - Access Control - File Identification - Race Conditions - Mitigation Strategies, Recommended practices: The Security Development Lifecycle - Security Training -Requirements - Design- Implementation – Verification.

Self-learning component:

Python, Java

PRACTICE:

Sl. No	**Title of the Experiment**	**Tools and Techniques**	**Expected Skill /Ability**
1.	Thread is an execution unit which consists of its program counter, a stack, and a set of registers**.** Write a c program for multi-threading and thread synchronization on a kernel such that, each thread occupied an independent memory slot.	Windows/Linux OS, IDE, C,C++	Thread operations.
2.	Demonstrate how to pass array of pointers to the thread such that, each pointer is independent to another.	Windows/Linux OS, IDE, C,C++	**Pointer operations**
3.	Demonstrate a program that is vulnerable to a buffer overflow.	Windows/Linux OS, IDE, C,C++	**Buffer overflow vulnerability**

4.	Demonstrate the concept of Signal Handler with respect to multi-threading optimization in C or C++	Windows/Linux OS, IDE, C,C++	**Multi-Threading**
5.	Demonstrate the following functions: atexit() and onexit() in C.	Windows/Linux OS, IDE, C,C++	**Standard functions**
6.	Stack may grow downward or upward depending on environment for which code is compiled. Demonstrate the growth of Stacks in C/C++.	Windows/Linux OS, IDE, C,C++	**Stacks**
7.	Integer overflow based on a real-world vulnerability in the handling of the comment field in JPEG files. Demonstrate Integer overflow vulnerability.	Windows/Linux OS, IDE, C,C++	**Integer overflow vulnerability**
8.	Write a C Programming to demonstrate mitigation strategies	Windows/Linux OS, IDE, C,C++	**Mitigation strategies**
9.	Write a C/C++ programming on File IO operation management	Windows/Linux OS, IDE, C,C++	**Files**
10.	Develop a C Program to Read content of a File and Display it	Windows/Linux OS, IDE, C,C++	**Files**

Text books:

1. Seacord, R. C., Secure Coding in C and C++, Addison c for Software Engineering Institute, 2nd edition, 2013.
2. Howard, M., LeBlanc, D., Writing Secure Code, 2nd Edition. Pearson Education, 2002

Reference books:

1 Daswani N., Kern C., Kesavan A., Foundations of Security, Apress, 2007.
2 https://www.newhorizons.com/promotions/cybersecurity-ebooks
3 https://www.coursera.org/learn/introduction-cybersecurity-cyber-attacks#syllabus

JOURNALS/MAGAZINES:

1 IEEE Transactions on Cybersecurity

2 Springer Journal of Cybersecurity.

SWAYAM/NPTEL/MOOCS:

1. https://www.udemy.com/Cybersecurity/
2. https://www.coursera.org/learn/Cybersecurity
3. https://nptel.ac.in/courses/cybersecurity/

Course Title	**Mathematics for Cyber Security**				**Course Type**		**Theory**	
Course Code	M21 TF 0102	**Credits**	**4**		**Class**		**I Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	4	4	4				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Tutorial	-	-	-				
	Total	**4**	**4**	**4**	**52**	**-**	**50%**	**50%**

COURSE OVERVIEW

The course **Mathematics for Cyber Security** with the basic aspects of number theory like, GCD, Divisibility, Prime number etc. This course includes algebraic structure for Groups, Discrete logarithms . Probability theory is important to understand the concept of probability and conditional probability. Coding theory is important for liner code, hamming code and syndrome decoding. Pseudorandom number is used for Next bit predictor and Blum-Blum-Shub Generator. All mathematical concepts are highly important for the mathematical foundation and calculation of Cyber Security for to develop strong foundations on these concepts.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the basics maths used for information security.
2. Illustrate how to Design and analyse security protocols.
3. Describe the concepts of Probability and Statistics are used in many commercial, industrial as well as web Application.
4. Demonstrate the use of the coding theory concepts will help them to develop security model.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Effectively express the concepts and results of Number Theory. Understand basic concepts of various algebraic structures and theorems like Euler's theoerem for designing security algorithm.	1-6	1,2
C02	Apply Euclidean algorithm, Fermat's theorem to the real world application.	1-6	1,2
CO3	Describe introduction to probability concepts, random variables, probability distributions (continuous and discrete),	1-6	2
CO4	Identify and evaluate the probability based on Baye's theorem.	1-6	1,2
CO5	Make use of concept of Coding Theory in real world problem.	1-6	1,2
CO6	Apply Cryptographic Hash Functions for given data	1-6	2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3		√				
CO4			√			
CO5		√				
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	1						3	3	
CO2	3	3	3	3	3	1						3	3	
CO3	3	3	2	2	3	1							2	
CO4	2	3	2	3	3	1						1	1	

CO5	2	3	2	3	3	1						1	1	
CO6	2	3	2	3	3	1							1	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

NUMBER THEORY : Logic, Mathematical reasoning, Sets, Basics of counting, Relations.

Introduction - Divisibility - Greatest common divisor - Prime numbers - Fundamental theorem of arithmetic - Mersenne primes - Fermat numbers - Euclidean algorithm.

Graph Theory: Euler graphs, Hamiltonian paths and circuits, planar graphs, trees, rooted and binary trees, distance and centres in a tree, fundamental circuits and cut sets, graph colorings and applications.

UNIT – 2

Linear Algebra: vector spaces and subspaces, linear independence, basis and dimensions, linear transformations and applications.

Pseudorandom Number Generation: Stream Ciphers Principles of Pseudorandom Number Generation, Principles of Pseudorandom Number Generation using a Block Cipher.

UNIT – 3

Probability Theory: introduction to probability concepts, random variables, probability distributions (continuous and discrete), Bayesian approach to distributions, mean and variance of a distribution, joint probability distributions, theory of estimation,

UNIT – 4

CODING THEORY: Introduction - Basic concepts: codes, minimum distance, equivalence of codes, Linear codes - Linear codes - Generator matrices and paritycheck matrices - Syndrome decoding – Hamming codes.

Cryptographic Hash Functions: Application of Cryptographic Hash Functions, Two Simple Hash Functions, Requirements and Security.

TEXT BOOKS:

1. R.P.Grimaldi, "Discrete and Combinatorial Mathematics", Fifth edition, Pearson Education, 2007.
2. K. H. Rosen, "Discrete Mathematics and its applications", Seventh Edition, Tata MCGraw-Hill Publishing company limited, New Delhi, 2007.
3. H. Anton, "Elementary Linear Algebra", John Wiley & Sons, 2010.
4. N. Deo, "Graph theory with applications to Engineering and Computer Science", Prentice Hall of India, New Delhi, 1974.
5. T. M. Apostol, "Introduction to Analytic Number Theory", Springer, 1976.

REFERENCE BOOKS:

1. Douglas C. Montgomery and George C. Runger, "Applied Statistics and Probability forEngineers", Third Edition, John Wiley & Sons Inc., 2003.
2. A. Papoulis and U. Pillai, Probability, "Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.
3. Ronald E. Walpole, Raymond H Myres, Sharon.L.Myres and Kying Ye, "Probability andStatistics for Engineers and Scientists", Seventh Edition, Pearson Education, 2002.
4. D. S. Malik, J. Mordeson, M. K. Sen, Fundamentals of abstract algebra, Tata McGraw Hill
5. P. K. Saikia, Linear algebra, Pearson Education, 2009.
6. I. Niven, H.S. Zuckerman and H. L. Montgomery, An introduction to the theory of numbers, John Wiley and Sons, 2004.
7. D P Bersekas and J N Tsitsiklis, Introduction to probability, Athena Scientific, 2008
8. Douglas Stinson, 'Cryptography – Theory and Practice', CRC Press, 2006.
9. Sheldon M Ross, "Introduction to Probability Models", Academic Press, 2003.
10. C.L. Liu, 'Elements of Discrete mathematics', McGraw Hill, 2008.
11. Behrouz A. Forouzan, " Cryptography and Network Security ", TMH Publication.

JOURNALS/MAGAZINES

1. https://ocw.mit.edu/courses/mathematics/

2. http://homes.soic.indiana.edu/yh33/Teaching/I231-2016/syllabus.html

SWAYAM/NPTEL/MOOCs:

1. http://nptel.ac.in/syllabus/106105031/

2. http://nptel.ac.in/syllabus/syllabus_pdf/106105031.pdf

3. http://nptel.ac.in/syllabus/106101004/

4 https://eliademy.com/catalog/physical-science/elementary-number-theory.html

<table>
<tr><td>Course Title</td><td colspan="4">Cyber Forensics</td><td colspan="2">Course Type</td><td colspan="2">Integrated</td></tr>
<tr><td>Course Code</td><td>M21 TF 0103</td><td colspan="2">Credits</td><td>4</td><td colspan="2">Class</td><td colspan="2">II Semester</td></tr>
<tr><td rowspan="6">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td>Theory</td><td>Practical</td><td>CIE</td><td>SEE</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>5</td><td>5</td><td>39</td><td>26</td><td>50</td><td>50</td></tr>
</table>

COURSE OVERVIEW

The goal of computer forensics is to examine digital media in a forensically sound manner with the aim of identifying, preserving, recovering, analyzing and presenting facts and opinions about the digital information. The course aims to give insight on Digital Forensic Evidence Collection and Processing,

Fundamentals of Host Forensics for Microsoft Windows. UNIX derivatives. It gives an overview of Forensic Database Systems and Network Forensics.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Understand methodology and procedures associated with digital forensic analysis in a network environment.
2. Explain Digital Forensic Framework, Fundamentals of Host Forensics for Microsoft Windows and UNIX derivatives.
3. Illustrate Forensic Analysis of Database Systems.
4. Discuss protection of consumer web.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Apply digital information for possible use as evidence in civil, criminal or administrative cases.	1 to 4, 8, 9 , 12	1
CO2	Identify importance of digital forensic principles and procedures, legal considerations, digital evidence controls	1 to 3, 5,9,12	1
CO3	Make use of concepts of forensics for UNIX derivatives - Linux operating system and File systems	1 to 5, 9, 12	2
CO4	Illustrate Forensic analysis of Database Components,	3,4,5,9,12	2
CO5	Analyze network Forensics with case studies and tools	1,4,5,9,12	1
CO6	Classify the types of Steganography and Image file Forensics	1 to 5	2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			

CO2			√			
CO3			√	√		
CO4			√			
CO5		√	√			
CO6				√		

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1	2	3	
CO3	3	1	2	1	2				1			1		2	
CO4	3			2	2				1			1	3		
CO5	3			2	2				1			1		3	
CO6	3			2	2				1			1		3	3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Digital Forensic : Framework for Digital Forensic Evidence Collection and Processing, Fundamentals of Host Forensics for Microsoft Windows - Kernel and Device driver architecture, registry, auditing and security architecture File system handling - Reconstruction of files and directory structures on the FAT and NTFS.

UNIT – 2

Linux operating system and File system: Fundamentals of Host Forensics for UNIX derivatives - Linux operating system, Kernel and Device drives architecture, Security and audit mechanisms, file system and pseudo file systems, the reconstruction of file and directory structures using UFS and Ext2/3fs as exemplars.

UNIT – 3

Forensic Database Systems: Forensic Analysis of Database Systems, Database Tampering, Forensic analysis of Database Components, table storage, transaction log, indexes, Forensic recovery for table storage.

UNIT – 4

Network Forensics: Network Forensics, investigating logs, network traffic and web attacks, Mobile Device and Wireless Forensics, Anti-Forensics. Steganography and Image file Forensics, Email investigation, Investigating Copiers, IVR, Video Surveillance, RFID and Vehicular tracking (GPS) devices, Case studies and Tools.

No	Title of the Experiment
1.	Creating a Forensic Image using FTK Imager/Encase Imager : - Creating Forensic Image - Check Integrity of Data - Analyze Forensic Image
2.	Data Acquisition: - Perform data acquisition using: - USB Write Blocker + FTK Imager
3.	Forensics Case Study : -Solve the Case study (image file) provide in lab using Encase Investigator or Autopsy
4.	Capturing and analyzing network packets using Wireshark (Fundamentals) : - Identification the live network - Capture Packets - Analyze the captured packets
5	Analyze the packets provided in lab and solve the questions using Wireshark : - What web server software is used by www.snopes.com? - About what cell phone problem is the client concerned? - According to Zillow, what instrument will Ryan learn to play? - How many web servers are running Apache?

6.	Using Sysinternals tools for Network Tracking and Process Monitoring : - Check Sysinternals tools - Monitor Live Processes - Capture RAM - Capture TCP/UDP packets - Monitor Hard Disk - Monitor Virtual Memory - Monitor Cache Memory
7	Recovering and Inspecting deleted files - Check for Deleted Files - Recover the Deleted Files - Analyzing and Inspecting the recovered files
8	Acquisition of Cell phones and Mobile devices
9	:- Email Forensics - Mail Service Providers - Email protocols
10	Web Browser Forensics . -Web Browser working -Forensics activities on browser

Text Books/References:

1. E. P. Dorothy, Real Digital Forensics for Handheld Devices , Auerback Publications, 2013.

2. J. Sammons, The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics, Syngress Publishing, 2012.

3. E. Casey, Handbook of Digital Forensics and Investigation, Academic Press, 2010 L T P C 3 0 0 3 Page 32 of 44

4. C. H. Malin, E. Casey and J. M. Aquilina, Malware Forensics Field Guide for Windows Systems: Digital Forensics Field Guides, Syngress, 2012 5. J. Wiles and A.Reyes,

5. J. Wiles and A.Reyes, The Best Damn Cybercrime and Digital Forensics Book Period, Syngress, 2007.

Online Resources:

1. https://github.com/wtsxDev/Machine-Learning-for-Cyber-Security
2. https://github.com/jivoi/awesome-ml-for-cybersecurity#-books
3. https://github.com/RegaipKURT/CyberSecurity

JOURNALS/MAGAZINES

1. https://www.journals.elsevier.com/journal-of-information-security-and-applications
2. https://www.journals.elsevier.com/computers-and-security
3. http://scholar.google.co.in/scholar_url?url=https://www.profsandhu.com/cs6393_s19/Solms-Niekerk- 3.pdf&hl=en&sa=X&ei=6QpBYLmcH5X0yATMxJGADQ&scisig=AAGBfm122ujljJW_s9W8QhWP-HQUU- uNQw&nossl=1&oi=scholarr

SWAYAM/NPTEL/MOOCs:

1. https://www.classcentral.com/course/swayam-digital-forensic-19842 2. https://nptel.ac.in/courses/106/106/106106182/

3, https://onlinecourses.swayam2.ac.in/cec20_ge10/preview **Self-Learning Exercises:**

3. **https://onlinecourses.swayam2.ac.in/ugc19_hs25/preview**

1. More exploration on GIThub
2. Data Visualization packages

Course Title	Security and investigation of the block chain				**Course Type**		**Integrated**	
Course Code	M21 TF 0104	**Credits**	**4**		**Class**		**I Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	4	4	4				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**4**	**4**	**4**	**52**	**0**	**50**	**50**

COURSE OVERVIEW

The widespread popularity of digital cryptocurrencies has led the foundation of Blockchain, which is fundamentally a public digital ledger to share information in a trustworthy and secure way. The concept and applications of Blockchain have now spread from cryptocurrencies to various other domains, including business process management, smart contracts, IoT and so on. This course is a joint venture from academia and industry, where the target is to cover both the conceptual as well as application aspects of Blockchain. This includes the fundamental design and architectural primitives of Blockchain, the system and the security aspects, along with various use cases from different application domains.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Understand the mechanism of Blockchain and Cryptocurrency.
2. Explain functionality of current implementation of blockchain technology.
3. Describe the required cryptographic background.

4. Explore the applications of Blockchain to cryptocurrencies and understanding limitations of current Blockchain and recent research.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Apply the fundamentals of Cryptography in Cryptocurrency	1 to 4, 8, 9 , 12	1
CO2	Make use of various operations associated with the life cycle of Blockchain and Cryptocurrency	1 to 3, 5,9,12	1
CO3	Explain methods for verification and validation of Bitcoin transactions	1 to 5, 9, 12	2
CO4	Explain Bitcoin as an Append only Log, Smart Property and Secure Multi Party	1 to 5	2
CO5	Analyze principles, practices and policies associated Bitcoin business and demonstrate the general ecosystem of several Cryptocurrency	1,4,5,9,12	1
CO6	Illustrate the Relationship Between Bitcoin and Altcoins	1 to 5	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√	√		
CO4		√				
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1	3		
CO3	3	1	2	1	2				1			1		3	
CO4	3			2	2				1			1	3		

CO5	3			2	2				1				2		
CO6	3			2	2				1				2		

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to Cryptography and Cryptocurrencies

Cryptographic Hash Functions, Hash Pointers and Data Structures, Digital Signatures, Public Keys as Identities, A Simple Cryptocurrency, Decentralization-Centralization vs. Decentralization-Distributed consensus, Consensus with- out identity using a blockchain, Incentives and proof of work. Simple Local Storage, Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges, Payment Services, Transaction Fees, Currency Exchange Markets.

UNIT – 2

Mechanics of Bitcoin, Mining and Anonymity

Bitcoin transactions, Bitcoin Scripts, Applications of Bitcoin scripts, Bitcoin blocks, The Bit- coin network, Limitations, and improvements. The task of Bitcoin miners, Mining Hardware, Energy consumption and ecology, Mining pools, Mining incentives and strategies Anonymity Basics, How to De-anonymize Bitcoin, Mixing, Decentralized Mixing, Zerocoin and Zerocash.

UNIT – 3

Community, Politics, and Regulation

Consensus in Bitcoin, Bitcoin Core Software, Stakeholders: Who's in Charge, Roots of Bitcoin, Governments Notice on Bitcoin, Anti Money Laundering Regulation, New York's Bit License Proposal. Bitcoin as a Platform: Bitcoin as an Append only Log, Bitcoins as Smart Property, Secure Multi Party Lotteries in Bitcoin, Bitcoin as Public Randomness, Source-Prediction Markets, and Real-World Data Feeds.

UNIT – 4

Altcoins and the Cryptocurrency Ecosystem

Altcoins: History and Motivation, A Few Altcoins in Detail, Relationship Between Bitcoin and Altcoins, Merge Mining-Atomic Cross chain Swaps-6 Bitcoin Backed Altcoins, Side Chains, Ethereum and Smart Contracts. Blockchain Use Cases – Finance, Industry

TEXT BOOKS:

1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., and Goldfeder, S. (2016). Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press.

REFERENCE BOOKS:

1. Antonopoulos, A. M. (2014). Mastering Bitcoin: unlocking digital cryptocurrencies. OReilly Media, Inc.".
2. Franco, P. (2014). Understanding Bitcoin: Cryptography, engineering and economics. John Wiley and Sons.

JOURNALS/MAGAZINES

4. https://www.inderscience.com/jhome.php?jcode=ijbc(Inderscience)
5. https://www.journals.elsevier.com/blockchain-research-and-applications(Elsevier)
6. https://www.frontiersin.org/journals/blockchain
7. https://ledgerjournal.org/ojs/ledger

SWAYAM/NPTEL/MOOCs:

4. Coursera – Blockchain technology
5. https://nptel.ac.in/courses/106/104/106104220/
6. https://www.edx.org

Self-Learning Exercises:

1. Blockchain By IBM Source: IBM Blog
2. Blockchain And Deep Learning: Future Of AI Source: Udemy
3. Bitcoin And Cryptocurrency Technologies Source: Coursera
4. Bitcoin And Cryptocurrencies Source: edX Blog
5. Introduction To Cryptocurrencies And Blockchain Source: Udemy

<table>
<tr><td>Course Title</td><td colspan="3">Ethical Hacking and Network Defense</td><td colspan="2">Course Type</td><td colspan="2">HARD CORE</td></tr>
<tr><td>Course Code</td><td>M21 TF 0105</td><td>Credits</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2">I Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td>Theory</td><td>Practical</td><td>CIE</td><td>SEE</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>5</td><td></td><td>39</td><td>26</td><td></td><td></td></tr>
</table>

COURSE OVERVIEW

Ethical Hacking and Network Defense deals with the systematic evaluation and study of various technical aspects, approaches and paradigms of ethical hacking and networking defense properties. This course on ethical hacking has been designed to learn the fundamentals of ethical hacking. You will understand how ethical hacking plays a very important role in the present-day scenario. In this course, you will learn about the basic concepts of networking defense, ethical hacking fundamentals, various secure communication protocols and security patches.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the fundamentals of Ethical Hacking and its application front in validating networks
2. Inculcate knowledge of various secure communication protocols and ethical hacking tools
3. Gain expertise in evaluating and analyzing spoofed properties and attacks
4. Evaluating and monitoring the Networking properties via ethical hacking approaches.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Evaluating the fundamentals learning's of ethical hacking and its organizational benefits.	1 to 5	2, 3
CO2	Develop ethical hacking approaches, techniques and programming patches to encounter malicious activity by ethical hacking	1 to 5	2, 3
CO3	Validating various secure communication protocols for building reliable networking defense systems	1 to 5	2, 3
CO4	Describe Building a Kali Web Server and Linux and Python server models	1 to 5	2, 3
CO5	Create and validating networking patches for various hacking attacks via ethical hacking approaches,	1 to 5	2, 3
CO6	Illustrate Information Assurance Model in detail	1 to 5	2, 3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√	√		
CO2					√	
CO3			√	√	√	
CO4			√			
CO5						√
CO6			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1	2	3	2	3	2									2	3
CO2	2	3	3	3	2									2	3
CO3	3	3	2	3	2									2	3
CO4	2	3	2	2	2									2	3
CO5	3	2	3	3	3									3	2
CO6	2	3	3	2	2									2	3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction: Legal Side of Hacking, Hacking Environment, Installing Virtual Box, Kali Linux server, Python and Ethical Hacking, General Syntaxes, variables, objects and Loops

UNIT – 2

Regular Expressions, Exceptions, Catching Errors, Classes and Databases, Sockets and Networking, Building NMAP Scanner, Dark WEB and Tor, Proxy chains, Virtual Private Networks (VPN), MAC Addresses, Security Trends

UNIT – 3

Penetration Testing: Setup of Networking Security Lab, Know Your Network, Building a Kali Web Server, Kali Linux and Python

UNIT – 4

SQL Mapping, Vulnerability Analysis, Information Assurance Model, Hashes and Passwords, Classic Modern Encryption, Exploiting Targets

PRACTICE:

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Installation of Virtual Box, Metasploitable, Kali	Windows, VMWare	Ability to learn the process of setting up a virtual lab devices for ethical hacking

2.	Write a hashed (md5) format plain text re-representing program for capturing passwords using dictionary attack.	Windows / VmWare/ python	Tracking passwords from the regular un-texted format.
3.	Write a python script to change the MAC Address and demonstrate the following a) demonstrate spoofing attack bypassing b) demonstrate to avoid device tracking in public networks	Windows / VmWare/ python	Changing the MAC Address and validate skills of ethical hacking.
4.	Demonstrate the process of Network Scanner in Python IDE using three basic methods of ICMP Echo Request, Three-way hand shaking Method and TCP Scan	Windows / VmWare/ python	Validating the network setting skills and scanning of node information
5.	Demonstrate the process Network Scanning using scapy module	Windows / VmWare/ python	Validating the network setting skills and scanning of node information
6.	Demonstrate the process of Intrusion detection and spoofing attack in Address Resolution Protocol (ARP) in KALI LINUX	Windows / VmWare/ python	Validating ARP attacks and network defense process

TEXT BOOKS:

1. Sanjib Sinha, "Beginning Ethical Hacking with Python" Apress, 2018
2. Sanjib Sinha, "Beginning Ethical Hacking with Kali, Computational Techniques for resolving security issues" Apress, 2018

REFERENCE BOOKS:

1. Patrick Engebretson, "Basics of Hacking and Penetration Testing", Second Edition, Elsevier.

Self-Learning Exercises:

1. Introduction to Ethical Hacking: https://www.tutorialspoint.com/ethical_hacking/index.htm

SECOND SEMESTER

Course Title	Cloud Security				**Course Type**		**Integrated**	
Course Code	M21TF0201	**Credits**	**4**		**Class**		**II Semester**	
Course	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	2	2				
	Practice	1	2	2	Theory	Practical	CIE	SEE

Structure	-	-	-	-				
	Total	**4**	**4**	**4**	**39**	**26**	**50**	**50**

COURSE OVERVIEW

Python is a Programming Language that can be treated in a procedural way, an object-orientated way or a functional way. It can be used on a server to create web applications, create workflows, connect to database systems, read and modify files, handle big data and perform complex mathematics. It can implement object oriented features and exception handling, It can parse the strings using regular expressions. It can be used for implementing the machine learning algorithms to develop solutions for interdisciplinary problems apart from any general problems leading to automation.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Understanding of the security challenges in the cloud environment.
2. Understanding of the issues regarding privacy and manage risks associated with it.
3. Knowledge of security standards and the audit processes to follow and ensure better cloud security.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	State the security challenges of cloud infrastructure.	1 to 4, 8, 9 , 12	1
CO2	Illustrate the application security mechanisms.	1 to 3, 5,9,12	1
CO3	Make Use of concepts of standards to define a management policy.	1 to 5, 9, 12	2
CO4	Design solutions for risk management and security threats	1,4,5,9,12	1
CO5	Analyze a cloud security audit report.	1,4,5,9,12	2
CO6	Categorize record generation, reporting and management and service level agreement models	1,4,5,9,12	2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)

CO1			√			
CO2			√			
CO3			√	√		
CO4						√
CO5			√			
CO6				√		

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1	2	3	
CO3	3	1	2	1	2				1			1		3	3
CO4	3			2	2				1			1	3		
CO5	3			2	2				1			1		2	
CO6	3			2	2				1			1		2	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Cloud Security Fundamentals:

Cloud computing security challenges – cloud computing security architecture–data security life-cycle-Security Patterns and architectural elements - Planning key Strategies for secure operation.

Cloud Application Security

Encryption techniques – homomorphic encryption - securing data Redaction - secure bitcoin – Public key infrastructure (PKI) – key management - open web application security project (OWASP) Cloud Top 10 Security Risks - Security as a service (SECaaS)

UNIT –2

Cloud Infrastructure Security

Virtualization security – securing hypervisor - securing virtual machines - designing virtual network for security - Network Security in the cloud - software-defined security - secure isolation strategy - anti- fragile cloud infrastructure - Failure as a service.

Security Management & Privacy

Managed Security Service Provider (MSSP): Availability management – configuration management - vulnerability management - identity management. - Privacy: privacy, compliance and the cloud - privacy enhancing encryption

UNIT-3

Risk Management & Security Threats

Risk management – principles - assessing the risk – strategies for managing risk – risk analysis framework – security threats – intrusion detection

Cloud Standards and Compliance

Cloud security alliance – cloud controls matrix - cloud security standards guidance – security compliance - NIST – PCI data security standards – SAS 70 - ISO 27001 **–** HIPAA – ITIL - FISMA - FIPS 140-2.

UNIT-4

Audit

Cloud-Based IT Audit Process – System and Infrastructure lifecycle management for the cloud -governance, risk management and compliance (GRC) – cloud audit assurance – auditing –record generation, reporting and management- tamper-proofing audit logs service level agreement (SLA) – legal safeguards - cloud morphing.

PRACTICE:

1.	AWS Account Setup and Services Overview
2.	AWS Resource Discovery and Instance Setup
3.	Platform/Application Provisioning and Auto Scaling Adaptation
4.	Demonstrate Intrusion Detection System (IDS) using any tool (snort or equivalent software)
5.	Installation of rootkits and study about the variety of options
6.	Demonstrate how a sniffer attack is done using Wireshark Tool.
7.	Install Jcrypt Tool (or any equivalent) to demonstrate Asymmetric and Symmetric Crypto algorithm.
8.	Demonstrate how to inject JavaScirpt using Cross Site Scripting (XSS).

TEXT BOOKS:

1. Tim Mather, Subra Kumaraswamy, Shahed Latif, Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, O'Reilly Media Inc, 2009.
2. Dave Shackleford, Virtualization security:Protecting virtualized environments, John Wiley & sons, 2013.
3. Vic (J.R.) Winkler, Securing the Cloud: Cloud Computer Security Techniques and Tactics, Syngress; 1st edition (April 29, 2011).
4. Raghu Yeluri, Enrique castro-leon, Building the infrastructure for cloud security:A Solutions view, Apress, 2014.
5. Krutz, R.L. (2010), Cloud Security A Comprehensive Guide to Secure Cloud Computing, Wiley
6. Ben Halpert , "Auditing Cloud Computing: A Security and Privacy Guide: ", John Wiley & Sons, 2011.
7. Shao ying zhu, Richard Hill, Guide to security assurance for cloud computing, Springer 2015.
8. John Rittinghouse, James F.Ransome, Cloud computing implementation, Management, security, CRC Press, 2010.
9. Stefan Rass, Daniel Slamanig, Cryptography for security and Privacy in cloud computing, Artech House, 2014.
10. OWASP - https://www.owasp.org/images/4/47/Cloud-Top10-Security-Risks.pdf
11. JOURNALS/MAGAZINES

    https://journalofcloudcomputing.springeropen.com/

    https://www.journals.elsevier.com/journal-of-information-security-and-applications

    https://www.journals.elsevier.com/computers-and-security

    https://www.journals.elsevier.com/computer-fraud-and-security

SWAYAM/NPTEL/MOOCs:

https://onlinecourses.nptel.ac.in/noc21_cs14/preview

https://nptel.ac.in/courses/106/105/106105167/

https://onlinecourses.swayam2.ac.in/cec20_cs09/preview

Self-Learning Exercises:

1. Introduction to **Cloud Computing** with Amazon Web Services. ...
2. **Cloud Computing**: The Big Picture By David Chappell. ...
3. Getting Started with **Cloud Computing** — Level 1. ...
4. **Cloud Computing** Concepts by Coursera. ...
5. AWS Certified Solutions Architect — Associate.

<table>
<tr><td>Course Title</td><td colspan="3">Cyber security with ML and AI</td><td colspan="2">Course Type</td><td colspan="2">Integrated</td></tr>
<tr><td>Course Code</td><td>M21TF0202</td><td>Credits</td><td>4</td><td colspan="2">Class</td><td colspan="2">II Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td>Theory</td><td>Practical</td><td>CIE</td><td>SEE</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>5</td><td>5</td><td>39</td><td>26</td><td>50</td><td>50</td></tr>
</table>

COURSE OVERVIEW

Machine learning has become a vital technology for cyber security. Machine learning preemptively stamps out cyber threats and bolsters security infrastructure through pattern detection, real-time cybercrime mapping and thorough penetration testing. The course aims to give insight on how machine learning has contributed to the success of modern spam filters, Quickly detect anomalies, including breaches, fraud, and impending system failure. It gives an overview of how to conduct malware analysis by extracting useful information from computer binaries, uncover attackers within the network by finding patterns inside datasets.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the fundamentals of machine learning and their applications in cyber security.
2. Gain knowledge on anomaly detection with respect to cyber security.
3. Analyze malware using static analysis and analyze network traffic analysis.
4. Discuss protection of consumer web.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Explain the fundamentals of machine learning and their applications in cyber security.	1 to 4, 8, 9 , 12	1
CO2	Develop programs for anomaly detection using suitable machine learning algorithms	1 to 3, 5,9,12	1
CO3	Understand malware analysis and network traffic analysis.	1 to 5, 9, 12	2
CO4	Build a Predictive Model to Classify Network Attacks	1 to 5, 9, 12	2
CO5	Create data science solutions for consumer web	1 4,5, 9, 12	1

CO6	Demonstrate Supervised Learning for Abuse Problems and Labeling Data	1 4,5, 9, 12	2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√	√		
CO4						√
CO5						√
CO6					√	

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1	2		
CO3	3	1	2	1	2				1			1		3	
CO4	3			2	2				1			1		3	
CO5	3			2	2				1			1	3		
CO6	3			2	2				1			1		3	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Why Machine Learning and Security? Cyber Threat Landscape, The Cyber Attacker's Economy, What Is Machine Learning? Real-World Uses of Machine Learning in Security, Spam Fighting: An Iterative Approach, Limitations of Machine Learning in Security

Classifying and Clustering: Machine Learning: Problems and Approaches, Machine Learning in Practice: A Worked Example, Training Algorithms to Learn, Supervised Classification Algorithms, Practical Considerations in Classification, Clustering

UNIT – 2

Anomaly Detection: When to Use Anomaly Detection Versus Supervised Learning, Intrusion Detection with Heuristics, Data-Driven Methods, Feature Engineering for Anomaly Detection, Anomaly Detection with Data and Algorithms, Challenges of Using Machine Learning in Anomaly Detection, Response and Mitigation, Practical System Design Concerns

Malware Analysis: Understanding Malware, Feature Generation, From Features to Classification

UNIT – 3

Network Traffic Analysis: Theory of Network Defense, Access Control and Authentication, Intrusion Detection, Detecting In-Network Attackers, Data-Centric Security, Honeypots, Machine Learning and Network Security, From Captures to Features, Threats in the Network, Botnets and You, Building a Predictive Model to Classify Network Attacks, Exploring the Data, Data Preparation, Classification, Supervised Learning, Semi-Supervised Learning, Unsupervised Learning, Advanced Ensembling

UNIT – 4

Protecting the Consumer Web: Monetizing the Consumer Web, Types of Abuse and the Data That Can Stop Them, Authentication and Account Takeover, Account Creation, Financial Fraud, Bot Activity

Supervised Learning for Abuse Problems, Labeling Data, Cold Start Versus Warm Start, False Positives and False Negatives, Multiple Responses, Large Attacks, Clustering Abuse, Example: Clustering Spam Domains, Generating Clusters, Scoring Clusters

PRACTICE:

No	Title of the Experiment
1.	Regression (or prediction) is simple. The knowledge about the existing data is utilized to have an idea of the new data. Take an example of house prices prediction. In cyber security, it can be applied to fraud detection. The features (e.g., the total amount of suspicious transaction, location, etc.) determine a probability of fraudulent actions.. Write a program to perform linear regression on any dataset.

2.	Classification is also straightforward. Imagine you have two piles of pictures classified by type (e.g., dogs and cats). In terms of cybersecurity, a spam filter separating spams from other messages can serve as an example. Spam filters are probably the first ML approach applied to Cybersecurity tasks. type (e.g., dogs and cats). In terms of cybersecurity, a spam filter separating spams from other messages can serve as an example write a program to perform classification of any suitable data using any suitable classification algorithm
3.	Clustering is similar to classification with the only but major difference. The information about the classes of the data is unknown. There is no idea whether this data can be classified. This is unsupervised learning. Implement clustering on a suitable dataset using k means
4.	Forensic Challenge You receive a letter from a friend, who is suspicious that a neighbor is up to no good. Your friend has not heard anything from the neighbor in a while. However, your friend did capture some of the neighbor's packets about a week ago. Putting the ethical sides of the problem aside, help your friend figure out where the neighbor has gone and what the neighbor is up to. What is the neighbor's name? What is the neighbor's email address? What is the neighbor's email password? What are the email addresses (at least two) of the neighbor's correspondents? What is the email of the correspondent the neighbor is most likely have gone to visit? What is the name of the file containing the meeting location? Bonus: where are they meeting and what is the correspondent bringing?
5	Touch Biometrics In this question, we explore continuous authentication methods for users who are using a smartphone. Our friends across the bay built 30 features on top of the raw data. You can find the details of the approach and the data at http://www.mariofrank.net/touchalytics/index.html Implement two more features in addition to the 30 found in the database. Do they have positive information gain? That is, are the features useful? Report correlation of these feature to the rest of the implemented features. Train your model on a binary classifier of your choice ("true user" or "false user" classification problem) using the following 4 scenarios in which you use a feature selection method to choose top 10 features. Describe this process. Use 10-fold cross validation to compute precision and recall in the following scenarios. Try to maximize F1 score when optimizing your classifier. Report F1 and any methods you used to optimize your classifier. i) 10 top features, ii) 10 top features & your features iii) 30 computed features, iv) 30 computed features & your features Qualitatively describe which family of features are most discriminating in your classifier.

6.	Merits of Entropy in Attack Detection/Diagnostics (30 points) Consider the following dataset: http://web.stanford.edu/class/cs259d/hw/server-log.txt ii) Two attacks happened this unfortunate day, both somewhere around 8am and 8pm noon. Please identify the exact date and time. What approach did the attackers use? iii) Columns for the server log are the following: iv) Start Start Src Dest Src Dest v) Date Time Duration Serv Port Port IP IP
7	There has been significant literature discussing how entropy can be used to detect these attacks. To do it effectively, approximation schemes are usually used. You do not have to implement these approximation techniques, but do present an analysis of whether entropy is useful and which combinations you tried, e.g. src ip, dest ip, src-port, dst-port, etc. Do any reveal anomalies when the two attacks happen? i) Sources for literature: ii) Lall, et all 2013. Data Streaming Algorithms for Estimating Entropy of Network Traffic. iii) Clifford, Cosma, 2013. A simple sketching algorithm for entropy estimation over streaming data
8	Supposedly, the best task for clustering is forensic analysis. The reasons, course, and consequences of an incident are obscure. It's required to classify all activities to find anomalies. Solutions to malware analysis (i.e., malware protection or secure email gateways) may implement it to separate legal files from outliers.
9	Another interesting area where clustering can be applied is user behavior analytics. In this instance, application users cluster together so that it is possible to see if they should belong to a particular group.

TEXT BOOKS:

1. Clarence Chio, David Freeman, "Machine Learning and Security", O'Reilly Media, Inc, 2018.

REFERENCE BOOKS:

1. Soma Halder , Sinan Ozdemir, "Machine Learning for Cybersecurity Cookbook", Packt publisher, 2018
2. Joshua Saxe and Hillary Sanders " Malware Data Science, Attack Detection and Attribution", No starch press publishers, 2018
3. The Cylance Data Science Team, " Introduction to Artificial Intelligence for Security Professionals", Apple Inc publishers, 2017
4. Sumeet Dua and Xian Du, " Data Mining and Machine Learning in Cybersecurity", 2011
5. "Machine Learning and Data Mining for Computer Security", Springer 2006
6. Network Anomaly Detection: A Machine Learning Perspective
7. Machine Learning for Hackers: Case Studies and Algorithms to Get You Started

Online Resources:

1. https://github.com/wtsxDev/Machine-Learning-for-Cyber-Security
2. https://github.com/jivoi/awesome-ml-for-cybersecurity#-books

JOURNALS/MAGAZINES

8. https://www.journals.elsevier.com/journal-of-information-security-and-applications
9. https://www.journals.elsevier.com/computers-and-security
3. Journal of big data, springer

SWAYAM/NPTEL/MOOCs:

7. https://iisc.talentsprint.com/deeplearning/?utm_source=googlesearch&utm_medium=tcpa&utm_campaign=ts-googlesearch-iisc-dl-tcpa-people-looking-for-training-programs-for-ai-and-deep-tech-deep-learning&utm_content=deep-learning-certification&utm_term=Deep%20learning%20certificate&gclid=Cj0KCQiApsiBBhCKARIsAN8o_4gcH-BYIAUHBTD27DFDoiCGFCkuG7eOi3wnLfXlXerEFWq06DtMRggaAtFkEALw
8. https://www.udemy.com/course/cybersecurity-data-science/
9. https://nptel.ac.in/courses/106/106/106106182/
10. https://www.edx.org/learn/python

Self-Learning Exercises:

3. More exploration on GIThub
4. Data Visualization packages

Course Title	Security Analytics				**Course Type**		**Integrated**	
Course Code	M21TF0203	**Credits**	**4**		**Class**		**IISemester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	1	2	2	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**4**	**5**	**5**	**39**	**26**	**50**	**50**

COURSE OVERVIEW

Security analytics is the process of using data collection, aggregation, and **analysis** tools for **security** monitoring and threat detection. Depending on the types of tools installed, **security analytics** solutions can incorporate large and diverse data sets into their detection algorithms.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Understanding basics of IAM
2. Able to understand cloud Resources
3. Understanding basics of IAM Covering ML Modelling around use cases.
4. Knowledge on use cases using Tensor flow/Python and Pyspark.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Must be able to run the programming and data structures required for data analysis with Python	1 ,3, 8, 9	1
CO2	Identify Source of Data and how to capture Test and Training Sets from the data.	1 , 3, 5	2
CO3	Develop important ML models to predict intrusion detection and User behavior analysis	1 ,3,5, 9,12	2
CO4	Describe end user behavior model	1 ,3,5, 9,12	3
CO5	Assess insider threat model for an attack	1 ,3,5, 9,12	3
CO6	Build ML model for creating data lake	1 ,3,5, 9,12	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2	√	√	√	√		
CO3		√	√	√		
CO4		√	√			
CO5					√	√
CO6					√	√

COURSE ARTICULATION MATRIX

CO#/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	2				1	1			1	2		
CO2	3	2	3		2				1			1		2	
CO3	3	1	2	1	2				1			1		3	
CO4	3		2	1	2				1			1			3

CO5	3		2		2				1			1			3
CO6	3		2		2				1			1			3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Primitive data structures – (constants, variable, data types), Advanced data structures –(list, tuples, dictionary), selection logic, looping logic, functions/methods, file handling Pandas – object model – data loading-exploration – visualization – sampling – data manipulation Project – Network Intrusion Detection System (IDS) data analysis.

UNIT – 2

Data Sources – Network via Access Logs and IPS IDS Training Set and Test Set creation, Install Tensor flow and start creating a model via Python.

UNIT – 3

Build ML models using Tensor flow and python for user behavioral analysis Bot Analysis End User behavior monitoring.

UNIT – 4

Build ML models using Tensor flow and python for, Data Exfiltration, Insider Threats, Threat Hunting Basics, Creating your Data Lake.

LEARNING RESOURCES:

1. Security Analytics For Dummies Securonix Special Edition

2. Machine Learning Approaches In Cyber Security Analytics; Springer; Tony Thomas, Athira P Vijayaraghavan, Sabu Emmanuel

JOURNALS/MAGAZINES:

1. https://ieeexplore.ieee.org/document/6725337
2. https://ieeexplore.ieee.org/document/8258128

SWAYAM/NPTEL/MOOCs:

1. Security analytics | Coursera

2. Security analytics tools | Coursera

Self-Learning Exercises:

5. Explore primitive data structures
6. More exploration on Security challenges
7. Explore on Network Intrusion Detection System (IDS) data analysis

Lab Components:

1. Install Tensor flow and start creating a model via Python.

2. Build ML models using Tensorflow.

Course Title	Firewall & UTM architecture				**Course Type**		**Softcore**	
Course Code	M21TFS204	**Credits**	**3**		**Class**		**II Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**36**		**50**	**50**

COURSE OVERVIEW

For every class of security problem, there is almost certainly either an open source or proprietary solution designed to combat it. This is particularly true in the areas of network intrusion detection systems and network access control devices—firewalls, filtering routers, and the like. A trend in firewall technology is to combine application layer inspection techniques from the intrusion detection world with the ability to filter network traffic, something firewalls have been doing for a long time. It is the goal of this subject to show that the iptables firewall on Linux systems is well positioned to take advantage of this trend, especially when it is combined with some additional software designed to leverage iptables from an intrusion detection standpoint.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Gain expertise in Designing secure firewall protected networks.
2. Inculcate knowledge of types of firewalls and how filtering is done..
3. Gain expertise in Evaluating firewalls.
4. Implement UTM architecture and configure firewalls.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Make use of opensource platform to secure firewall.	1 to 4, 8, 9 , 12	1
CO2	Compare different firewalls and will be able to apply filtering.	1 to 3, 5,9,12	1
CO3	Design and develop a open source firewall and evaluate it.	1 to 5, 9, 12	2
CO4	Create UTM architecture and configure based on requirements.	1,4,5,9,12	1
CO5	Demonstrate UTM security concepts	1,4,5,9,12	3
CO6	Appraise UTM firewall rules	1,4,5,9,12	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√	√		
CO4					√	√
CO5				√	√	
CO6				√	√	

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1	2		
CO3	3	1	2	1	2				1			1		3	
CO4	3			2	2				1			1	3		
CO5	3			2	2				1			1			3
CO6	3			2	2				1			1			3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Firewall Fundamentals: What is firewall, why do you need firewall, How firewalls work, Types of firewalls, Individual and SOHO firewall Options, Uses for Host Software Firewall, Next Generation Firewalls, Types of Filtering, Selecting right firewall for your needs , the difference between buying firewall and building a firewall.

UNIT – 2

Firewall implementation: examining your network and it's security needs, proper firewall implementation procedure, constructing, configuring, and managing a firewall, PF sense requirements, planning a firewall implementation with PF sense, installing the be up since firewall configuring a firewall with PF sense .

UNIT – 3

Firewall deployment considerations: common security strategies for firewall deployment's, authentication authorization and accounting, placement of network hardware firewalls, benefit and purpose of rivers proxy use and benefit of port forwarding.

Configuring firewalls, firewall rules, composing firewall rules, ordering firewall rules, what should you allow and what should you block , Essential elements of firewall policy limitations of firewalls improving performance,

UNIT – 4

UTM Architecture Sophos: basic UTM security concepts, getting to basic SOPHOS UTM configuration, installing SOPHOS UTM VM, basic system settings configuration, interfaces basic configuration, network definition configuration, DNS configuration, SOPHOS with OSP F routing protocol, Sophos UTM with firewall rules.

TEXT BOOKS:

3. Network Security, Firewalls And VPNs, J. Michael Stewart, Jones & Bartlett Learning, 2013, ISBN-10: 1284031675, ISBN-13: 978-1284031676.
4. Unified Threat Management For Dummies®, 2nd Fortinet Special Edition, Published by John Wiley & Sons, Inc.

REFERENCE BOOKS:

1. Network Security: Private Communications in a Public World, M. Speciner, R. Perlman, C. Kaufman, Prentice Hall, 2002.
2. Linux iptables Pocket Reference, Gregor N. Purdy, O'Reilly, 2004, ISBN-13: 978-0596005696.
3. Linux Firewalls, by Michael Rash, No Starch Press, October 2007, ISBN: 978-1-59327-141-1.
4. The Network Security Test Lab: A Step-By-Step Guide, Michael Gregg, Dreamtech Press, 2015, ISBN-10:8126558148, ISBN-13: 978-8126558148.

<table>
<tr><td>Course Title</td><td colspan="3">Malware Analysis and Design</td><td colspan="2">Course Type</td><td colspan="2">Integrated</td></tr>
<tr><td>Course Code</td><td>M21TFS205</td><td>Credits</td><td>3</td><td colspan="2">Class</td><td colspan="2">II Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td>Theory</td><td>Practical</td><td>CIE</td><td>SEE</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50</td><td>50</td></tr>
</table>

COURSE OVERVIEW

Malware analysis is the art of dissecting malware to understand how it works, how to identify it, and how to defeat or eliminate it. And you don't need to be an uber-hacker to perform malware analysis. Malware analysis is critical for anyone who responds to computer security incidents. And, with a shortage of malware analysis professionals, the skilled malware analyst is in serious demand. The course aims to give insights about Introduction to Malware Analysis, Data collection methods, windows basics. Dynamic malware analysis, basic static analysis, android malware analysis and recent trends.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the types of malware through analysis methods
2. Illustrate basics and advanced malware analysis techniques
3. Demonstrate the android malware analysis techniques for real world applications
4. Illustrate the various tools of malware analysis

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Identify various malwares and understand the behavior of malwares in real world applications.	1 to 4, 8, 9 , 12	1
CO2	Implement different malware analysis techniques.	1 to 3, 5,9,12	1
CO3	Analyze the malware behavior in windows and android.	1 to 5, 9, 12	2
CO4	Identify the various tools for malware analysis.	1,4,5,9,12	1
CO5	Illustrate File System and Directory structure and Registry	1,4,5,9,12	3
CO6	Demonstrate masterkey vulnerability structure	1,4,5,9,12	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√	√		
CO4					√	√
CO5					√	√
CO6					√	√

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1	2		
CO3	3	1	2	1	2				1			1		3	
CO4	3			2	2				1			1	3		
CO5	3			1	2				1			1			3
CO6	3			2	2				1			1			3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction: Malware Analysis Goals of Malware Analysis, Techniques Static and Dynamic Analysis, Types of Malware Backdoor, Botnet, Downloader, Information Stealing malware, Launcher, Rootkit, Scareware, Worm or Virus.

Data Collection Methods: Volatile Data Collection Methodology-Preservation of Volatile Data, Physical Memory Acquisition on a Live Windows System, Identifying Users Logged into the System, Non-Volatile Data Collection Inspect Prefetch Files, Examine the File System, Remote Registry Analysis, Examine Web Browsing Activities, Examine Cookie Files.

UNIT – 2

Windows Basics: Introduction to Windows Malware - Windows Basics Relevant to Malware Behavior-File System and Directory structure, Registry, Boot Sequence, Malware payloads.

Dynamic Malware Analysis: Malware activities, Self-Start techniques, Essential setup for executing malware, Executing DLL files, Classifying Malware Based on their Behavior

UNIT – 3

Basic Static Analysis: Number System Static Analysis with File Attributes and PE Header Packet Identification

Advanced Static Analysis Reverse Engineering: Advanced Static Analysis Reverse Engineering Assembly level computing Standard x86 instructions, Introduction to IDA, OllyDbg, Advanced Malware Analysis Virus, Trojan. Parsing Basic Analysis of an APK.

UNIT – 4

Android Malware Analysis: APK File Structure Security Model Android Root Brief Description of Spreading and Dis- tribution Introduction to Android Debugging Tools and Their Usage Dex Structure Parsing Basic Analysis of an APK. Exploits MasterKey VulnerabilityFileNameLength Vulnerability Introduction to Obfuscation DEX code obfuscation. Recent Trends.

TEXT BOOKS:

5. Cameron H. Malin, Eoghan Casey, James M. Aquilina and Curtis W. Rose, Malware Forensics Field Guide for Windows Systems, Syngress, Elsevier, 2012.
6. Christopher C. Elisan , Advanced Malware Analysis, Tata McGraw Hill, 2015 3.Cameron H. Malin, Eoghan Casey, James M. Aquilina and Curtis W. Rose, Malware

REFERENCE BOOKS:

1. Cameron H. Malin, Eoghan Casey, James M. Aquilina and Curtis W. Rose, Malware Forensics Field Guide for Linux Systems, Syngress, Elsevier, 2014.
2. Ken Dunham, Saeed Abu-Nimeh, Michael Becher and Seth Fogie, Mobile Malware Attacks and Defense, Syngress, Elsevier, 2009
3. John Aycock, Computer Viruses and Malware, Springer, 2006.
4. ErciFiliol, Computer Viruses: from theory to applications, Springer, 2005

JOURNALS/MAGAZINES

5. Abhinav Singh, Metasploit Penetration Testing Cookbook, PACKT Publishing, 2012. ISBN 978-1-84951-742-3
6. Ken Dunham, Mobile Malware Attacks and Defence, Syngress Publisher 2009. ISBN: 978-1-59749-298-0

SWAYAM/NPTEL/MOOCs:

1. Anti-Virus/Anti-Malware - Detection and Prevention tools | Coursera
2. Malware Continued - Understanding Security Threats | Coursera
3. Malware and Ransomware - A brief overview of types of actors and their motives | Coursera

Self-Learning Exercises:

1. Set up of Kali Linux in a Virtual machine and setup with DNS info and collection of local network
2. Scan the network for Windows XP and Windows 7 Target machines in local network and virtual network
3. Identify the open ports and firewall rules setup

Course Title	Web Security				Course Type		Soft Core	
Course Code	M21TFS206	Credits	3		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**0**	**39**	**0**	**50**	**50**

COURSE OVERVIEW

Web is the platform of choice for writing complex, interactive applications such as from mail clients to image editors to computer games and a medium reaching hundreds of millions of casual users around the globe. The resulting issues have quickly emerged as some of the most significant and prevalent threats to data security today. It provides a systematic and thorough analysis of the current state of affairs in the world of web application security, it aims to shed light on the uniqueness of the security challenges for web security engineers, web developers, and users have to face every day.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Outline common web application security vulnerabilities.
2. Identify different web application design assumptions and threats.
3. Discover the capabilities of various Browser scripts and proxies.
4. Illustrate to detect Authentication and Session Vulnerabilities

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Identify underlying security principles of the web.	1,2,5	1
CO2	Outline the different concrete threats against web applications	1	2
CO3	Examine common web application attacks and countermeasures	1	2
CO4	Interpret the current best practices for secure web applications	1,2, 5	1
CO5	Categorize extrinsic site priviledges	1,2,3,4,5	3

CO6	Analyze Security Model Extension Frameworks and Security Model Restriction Frameworks	1,2,3,4,5	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2		√				
CO3				√		
CO4		√				
CO5					√	
CO6					√	

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3			1								1		
CO2	2													2	
CO3	3													1	
CO4	2	2			1								1		
CO5	2	3	3	2	1										3
CO6	2	3	3	2	1										3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Security in the World of Web Applications: Information Security in a Nutshell, a Brief History of the Web, the Evolution of a Threat.

It Starts With A URL: Uniform Resource Locator Structure, Reserved Characters and Percent Encoding, Common URL Schemes and Their Function, Resolution of Relative URLs, Security Engineering Cheat Sheet.

Hypertext Transfer Protocol: Basic Syntax of HTTP Traffic, HTTP Request Types, Server Response Codes, Keepalive Sessions, Chunked Data Transfers, Caching Behavior, HTTP Cookie Semantics, HTTP Authentication, Protocol-Level Encryption and Client Certificates.

UNIT – 2

Hypertext Markup Language: Basic Concepts Behind HTML Documents, Understanding HTML Parser Behavior, Entity Encoding, HTTP/HTML Integration Semantics, Hyperlinking and Content Inclusion.

C**ascading Style Sheets:** Basic CSS Syntax, Parser Resynchronization Risks, Character Encoding.

Browser-Side Scripts: Basic Characteristics of JavaScript, Standard Object Hierarchy, Script Character Encoding, Code Inclusion Modes and Nesting Risks, The Living Dead: Visual Basic.

Non-Html Document Types: Plaintext Files, Bitmap Images, Audio and Video, XML-Based Documents, A Note on Nonrenderable File Types.

UNIT – 3

Content Rendering With Browser Plug-Ins: Invoking a Plug-in, Document Rendering Helpers, Plug-in-Based Application Frameworks, ActiveX Controls, Living with Other Plug-ins.

Content Isolation Logic: Same-Origin Policy for the Document Object Model, Same-Origin Policy for XML Http Request, Same-Origin Policy for Web Storage, Security Policy for Cookies, Plug-in Security Rules, Coping with Ambiguous or Unexpected Origins.

Life outside Same-Origin Rules: Window and Frame Interactions, Cross-Domain Content Inclusion, Privacy-Related Side Channels, Other SOP Loopholes and Their Uses.

Other Security Boundaries: Navigation to Sensitive Schemes, Access to Internal Networks, Prohibited Ports, Limitations on Third-Party Cookies.

UNIT – 4

Content Recognition Mechanisms: Document Type Detection Logic, Character Set Handling.

Dealing with Rogue Scripts: Denial-of-Service Attacks, Window-Positioning and Appearance Problems, Timing Attacks on User Interfaces.

Extrinsic Site Privileges: Browser- and Plug-in-Managed Site Permissions, Form-Based Password Managers, Internet Explorer's Zone Model.

New and Upcoming Security Features: Security Model Extension Frameworks, Security Model Restriction Frameworks, Other Developments.

TEXT BOOKS:

1. Michal Zalewski, "The Tangled Web: A Guide to Securing Modern Web Applications", No Starch Press, 2011.

REFERENCE BOOKS:

1. Dafydd Stuttard, Marcus Pinto," The Web Application Hacker's Handbook: Discovering and Exploiting Security Flaws", Wiley publications, 2008.
2. O'Reilly, "Web Security, Privacy & Commerce", 2nd Edition, O'Reilly Media, Inc, 2001.

JOURNALS/MAGAZINES

1. https://ieeexplore.ieee.org/abstract/document/8342469
2. https://link.springer.com/referenceworkentry/10.1007/978-1-4419-5906-5_1235
3. https://link.springer.com/book/10.1007/978-3-319-12226-7

SWAYAM/NPTEL/MOOCs:

11. https://www.coursera.org/projects/web-application-security-testing-with-owsap-zap
12. https://www.coursera.org/projects/web-application-security-testing-burp-suite
13. https://www.coursera.org/learn/ibm-cybersecurity-analyst-assessment

Self-Learning Exercises:

8. origin inheritance
9. Other Browser Mechanisms
10. Common Web Vulnerabilities

<table>
<tr><td>Course Title</td><td colspan="4">Secure Communications</td><td colspan="2">Course Type</td><td colspan="2">Integrated</td></tr>
<tr><td>Course Code</td><td>M21TFS207</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">II Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td>Theory</td><td>Practical</td><td>CIE</td><td>SEE</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td colspan="5"></td><td>39</td><td>0</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW

Secure communication is when two entities are communicating and do not want a third party to listen in. In order for this to be the case, entities need to communicate in a way unsusception to eavesdropping or interception. Secure communication includes means by which people can share information with varying degrees of certainty that third parties cannot intercept what is said. Other than spoken face-to-face communication with no possible eavesdropper, it is probably safe to say that no communication is guaranteed

to be secure in this sense, although practical obstacles such as legislation, resources, technical issues (interception and encryption), and the sheer volume of communication serve to limit surveillance.

With many communications taking place over long distance and mediated by technology, and increasing awareness of the importance of interception issues, technology and its compromise are at the heart of this debate. For this reason, this article focuses on communications mediated or intercepted by technology.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Understand the importance and goals of communication network and information security and introduce him to the different types of attacks.
2. Expose the different approaches to handling security and the algorithms in use for maintaining data integrity and authenticity.
3. Enable to appreciate the practical aspects of security features design and their implementation in wired and wireless internetworking domains.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Demonstrate an understanding of the ways in which communication network security may get compromised and the basic principles of security algorithm design.	1,2,3,4	1,2
CO2	Exposed to the different approaches that handle security and the algorithms in use for maintaining data integrity and authenticity.	1,2,3,4	1,2
CO3	Implement and analyze the different algorithms and compare their performances.	1,2,3,4	1,2
CO4	Apply his knowledge for designing or modifying existing algorithms and implementing them at least by simulation.	1,2,3,4	1,2
CO5	Illustrate key management technique in RSA algorithm	1,2,3,5	1,2
CO6	Demonstrate password management techniques	1,2,3,5	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√	√	√			
CO2	√		√	√		
CO3			√	√	√	
CO4			√	√		
CO5				√	√	
CO6				√	√	

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1									3	2	
CO2	2	3	3	2									3	2	
CO3	3	3	2	2									3	2	
CO4	3	3	2	2									3	2	
CO5	3	3	2		2								3	2	
CO6	3	3	2		2								3	2	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction on security, security goals and types of attacks: Passive attack, active attack, attacks on confidentiality, attacks on integrity and availability, Security services and mechanisms.

Modular arithmetic: Groups, Ring, Fields. The Euclidean algorithm, Finite fields of the form GF(p)

UNIT – 2

Polynomial arithmetic: Finite fields of the form GF (2n).

Symmetric Ciphers, Symmetric Cipher Model, Substitution Techniques, Caesar Cipher, Mono alphabetic Cipher, Play fair cipher, Hill cipher, Poly alphabetic Cipher, one time pad

UNIT – 3

Transposition techniques, Block Ciphers, Data encryption Standards, DES Encryption, DES decryption, Differential and Linear Crypt analysis Advanced Encryption standard, The AES Cipher, substitute bytes transformation, Shift row transformation, Mix Column transformation.

Public key cryptosystem, Application for Public key cryptosystem requirements

UNIT – 4

RSA algorithm, Key management, Distribution of public key, public key certificates, Distribution of secret keys.

Intruders: Intrusion techniques, Intrusion detection, Statistical anomaly detection, Rule based intrusion detection, Distributed intrusion detection, Honey pot, Intrusion detection exchange format.

Password management: Password protection, password selection strategies.

TEXT BOOKS:

7. Behrouz A. Forouzan , “Cryptography and Network security” Tata McGraw-Hill, 3rd Edition, 2015
8. William Stallings, “Cryptography and Network security: principles and practice", 7th Edition, Prentice Hall of India, New Delhi, 2017

REFERENCE BOOKS:

7. David S. Dummit & Richard M Foote, "Abstract Algebra", 3rd Edition, Wiley India Pvt. Ltd., 2011.
8. Douglas A. Stinson, "Cryptography, Theory and Practice", 2/e, Chapman & Hall, CRC Press Company, Washington, 4th Edition, 2019.
9. Lawrence C. Washington, "Elliptic Curves: Theory and Cryptography", Chapman & Hall, CRC Press Company, Washington, 2008.
10. N. Koeblitz: "A course in Number theory and Cryptography", 2008.
11. Thomas Koshy:" Elementary Number Theory with Applications", 2/e, Academic Press, 2007
12. Tyagi and Yadav , "Cryptography and network security", Dhanpatrai, 2012

JOURNALS/MAGAZINES

1. https://ieeexplore.ieee.org/document/809184
2. https://ieeexplore.ieee.org/document/1221784
3. https://www.journals.elsevier.com/computers-and-security
4. https://www.springer.com/journal/10207

SWAYAM/NPTEL/MOOCs:

14. https://nptel.ac.in/courses/106/105/106105082/
15. https://onlinecourses.swayam2.ac.in/nou19_cs08/preview
16. Coursera – Cryptography, University of MaryLand

<table>
<tr><td>Course Title</td><td colspan="3">Penetration testing & incident response</td><td colspan="2">Course Type</td><td colspan="2">SC</td></tr>
<tr><td>Course Code</td><td>M21TFS208</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">II Semester</td></tr>
<tr><td rowspan="6">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50</td><td>50</td></tr>
</table>

COURSE OVERVIEW

This course gives background needed to gain Cybersecurity skills, students will learn about the different phases of penetration testing, how to gather data for penetration test and popular penetration testing tools. Furthermore, they will also learn the phases of an incident response, important documentation to collect, and the components of an incident response policy and team.

This course is intended for anyone who wants to gain a basic understanding of cybersecurity.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the fundamental concepts of penetration testing and the different steps involved.

2. Inculcate the knowledge of different phases in penetration testing and ethical hacking.
3. Introduce the concept of incident and incident management.
4. Introduce different types of cyberattacks, and develop understanding of cyber forensics.

COURSEOUTCOMES(COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Understanding of fundamental concepts of penetration testing and the different steps involved	1,2,5	1
CO2	Students would have the knowledge of different phases in penetration testing and ethical hacking.	1,4,6	1
CO3	Understanding of incident and incident management.	2,3,8	2
CO4	Understanding of different types of cyberattacks and cyber forensics	1,4,5,9	1
CO5	Analyze Disk and Network forensics and Log analysis	1,4,5,9	3
CO6	Demonstrate Malware identification and Analysis, Lateral Movement and Side Channel Attack Analysis	1,4,5,9	3

BLOOM'S LEVELOF THECOURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√	√		
CO4	√	√				
CO5				√	√	
CO6				√	√	

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		

CO2	3	2	3		2				1			1	3		
CO3	3	1	2	1	2				1			1		2	
CO4	3			2	2				1			1	3		
CO5	3			2	2				1						3
CO6	3			2	2				1						3

Note:1-Low,2-Medium,3-High

COURSE CONTENT

THEORY:

UNIT – 1

Introduction to penetration testing, Scope, roles and responsibilities of a penetration tester, Scoping and Exclusions in a Penetration Testing Assignment, Steps of Penetration Testing, Threat Modeling, Using Kali Linux as Penetration testing Tool kit, Web penetration Testing, OWASP top10, network penetration Testing, Network Penetration Testing, Application penetration Testing

UNIT – 2

Penetration Testing phases/Testing Process, types and Techniques, Blue/Red Teaming, Strategies of Testing, Non Disclosure Agreement Checklist, Phases of hacking, Open-source/proprietary Pentest Methodologies

UNIT – 3

Introduction to Incident - Incident Response Methodology – Steps - Activities in Initial Response Phase after detection of an incident.

UNIT – 4

Indicators of Compromise, Attack Motivations and Attack Methods, Profiling an Adversary, Incident readiness- Tools, Techniques and Procedure, Triaging tools, Memory, Disk and Network forensics and Log analysis, Malware identification and Analysis, Lateral Movement and Side Channel Attack Analysis, Lessons Learnt, Mitigation Efforts

TEXTBOOKS:

9. Kali Linux Wireless Penetration Testing Beginner's Guide by Vivek Ramachandran, Cameron Buchanan, 2015 Packt Publishing
10. Travis E. Oliphant, “Guide to NumPy”, Trelgol publishers,2006.

11. Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGrawHill,2006.

REFERENCEBOOKS:

13. Kali Linux 2: Windows Penetration Testing, By Wolf Halton, Bo Weaver , June 2016 Packt Publishing
14. Mastering Modern Web Penetration Testing By Prakhar Prasad, October 2016 Packt Publishing.
15.

JOURNALS/MAGAZINES

10. https://www.springer.com/de/book/9781484218563
11. http://courses.ncirl.ie/index.cfm/page/module/moduleId/68126
12. https://site.ieee.org/spokane/2017/01/23/cyber-security-incident-response-february-16-2017-2/
13. https://journal-bcs.springeropen.com/articles/10.1186/s13173-017-0051-1

SWAYAM/NPTEL/MOOCs:

17. https://www.classcentral.com/course/ibm-penetration-testing-incident-response-forensi-20194
18. https://www.coursera.org/learn/ibm-penetration-testing-incident-response-forensics
19. https://www.coursera.org/lecture/ibm-penetration-testing-incident-response-forensics/penetration-testing-discovery-oS1qL

Self-LearningExercises:

11. http://www.cyberforensics.in/?AspxAutoDetectCookieSupport=1
12. https://www.cdac.in/index.aspx?id=cyber_security

Course Title	**Mobile and Wireless Security**				**Course Type**		**Softcore**	
Course Code	M21TFS209	**Credits**	**3**		**Class**		**II Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**0**	**50**	**50**

COURSE OVERVIEW

Wireless security is the prevention of unauthorized access or damage to computers or data using wireless networks, which include Wi-Fi networks. The most common type is Wi-Fi security, which includes Wired Equivalent Privacy (WEP) and Wi-Fi Protected Access (WPA). Mobile security is the protection of smartphones, tablets, laptops and other portable computing devices and the networks they connect to, from threats and vulnerabilities associated with wireless computing.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain network security protocols.
2. Gain knowledge about Wireless Network and Security.
3. Shed light on Mobile Networks and security.
4. Gain insights into Mobile Application Security.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Summarize concepts of Network Security and Security in Wireless Networks.	1 to 4, 8, 9 , 12	1
CO2	Illustrate the concepts of Wireless Network Security.	1 to 3, 5,9,12	1
CO3	Use to solve problems in Mobile Network Security.	1 to 5, 9, 12	2
CO4	Develop security systems for Mobile application.	1,4,5,9,12	1
CO5	Demonstrate Android security model	1,4,5,9,12	3
Co6	Illustrate Mobile Geolocation and Mobile Web Security models	1,4,5,9,12	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√					
CO2	√	√				
CO3			√	√		

CO4			√	√		
CO5				√	√	
Co6				√	√	

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1	2		
CO3	3	1	2	1	2				1			1		3	
CO4	3			2	2				1			1	3		
CO5	3			2	2				1			1			3
Co6	3			2	2				1			1			3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Network Security: Network Security Protocols, Security and Layered Architecture, Voice-Oriented Wireless Networks, Data-Oriented Wireless Networks.

UNIT – 2

Wireless Network Security: Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), Robust Secure Network (RSN) and Virtual Private Network (VPN).

UNIT – 3

Mobile Security: Security of GSM Networks, Security of UMTS Networks, LTE Security, Wi-Fi and Bluetooth Security, SIM/UICC Security.

UNIT – 4

Mobile Malware and App Security: Android Security Model, IOS Security Model, Security Model of the Windows Phone, SMS/MMS, Mobile Geolocation and Mobile Web Security, Security of Mobile VoIP Communications, Emerging Trends in Mobile Security.

TEXT BOOKS:

1. **Sunilkumar S. Manvi and Mahabaleshwar S. Kakkasageri,"**Wireless and Mobile Networks", Concepts and Protocols, 2nd Ed. Wiley Publications, 2010. (Unit 3).

2. **Man Ho Au and Kim-Kwang Raymond Choo**, "Mobile Security and Privacy", Syngress publications, 2016.
3. **Himanshu Dwivedi, Chris Clark and David Theil**, "Mobile Application Security", Tata McGraw-Hill Publication, 2010.

REFERENCE BOOKS:

16. Steven Furnell, "Mobile Security – A Packet Guide", IT Governance Publications, 2009.
17. Noureddine Boudriga, "Security of Mobile Communications", CRC Press Publications, 2009.
18. N Asokan, Lucas Davi, "Mobile Platform Security", M & C Publishers, 2014.

JOURNALS/MAGAZINES

14. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=7742
15. http://www.ieee-security.org/TC/SPW2017/MoST/

SWAYAM/NPTEL/MOOCs:

20. https://www.coursera.org/learn/network-security-database-vulnerabilities
21. **https://www.coursera.org/learn/smart-device-mobile-emerging-technologies**

Self-Learning Exercises:

13. Web Security
14. Firewall
15. DoS Attack
16. Email Security

<table>
<tr><td>Course Title</td><td colspan="3">Forensics and VAPT Lab</td><td colspan="2">Course Type</td><td colspan="2">Integrated</td></tr>
<tr><td>Course Code</td><td>M21TF0206</td><td>Credits</td><td colspan="2">2</td><td colspan="2">Class</td><td colspan="2">II Semester</td></tr>
<tr><td rowspan="6">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Practice</td><td>2</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Total</td><td>2</td><td>2</td><td>2</td><td>0</td><td>2</td><td>20</td><td>30</td></tr>
</table>

PRACTICE:

No	Title of the Experiment
1.	Study of Computer Forensics and different tools used for forensic investigation
2.	How to Recover Deleted Files using Forensics Tools
3.	Study the steps for hiding and extract any text file behind an image file/ Audio file using Command Prompt.

4.	How to Extract Exchangeable image file format (EXIF) Data from Image Files using Exifreader Software
5.	How to make the forensic image of the hard drive using EnCase Forensics.
6.	How to Restoring the Evidence Image using EnCase Forensics
7	How to Collect Email Evidence in Victim PC
8	How to Extracting Browser Artifacts
9	How to View Last Activity of Your PC
10	Find Last Connected USB on your system (USB Forensics)
11	Comparison of two Files for forensics investigation by Compare IT software
12	Live Forensics Case Investigation using Autopsy

THIRD SEMESTER…

Course Title	**Security and Resilience**				**Course Type**		**Integrated**	
Course Code	M21TFS301	**Credits**	**3**		**Class**			
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3		3				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**3**	**3**	**3**	**39**	**-**	**50**	**50**

COURSE OVERVIEW

The course provides an overview a Cybersecurity and Cyber Resiliency strategies. This course discusses all the steps required from conception of the plan from preplanning, project management directives, cyber threat and vulnerability analysis, cyber risk and controls assessment to reporting and measurement techniques for plan success and overall strategic plan performance. Also guides to implement a truly resilient Cybersecurity framework.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Understand the purpose of cyber resilience strategy and the associated control objectives
2. Develop Cybersecurity and Cyber Resiliency strategies
3. Demonstrates a methodology to target high risk threats
4. Evaluation of risk assessment methodologies

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Understand the methodologies for efficient utilization of resources and target high risk threats	1,2,5	1
CO2	Develop a unified Cybersecurity and Cyber Resiliency strategies	1,2,3,4,5,9,12	1,2
CO3	Implement security improvement plan, including all risk assessments and project plan	1,2,3,4,5,9,12	1,2
CO4	Evaluating the performance against various risk and performance indicators	1,2,3,4,5,9,12	1,2
CO5	Develop project strategy management flow	1,2,3,4,5,9,12	1,2
CO6	Demonstrate RACI strategy development matrix	1,2,3,4,5,9,12	1,2

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1		√				
CO2			√			√
CO3				√		
CO4				√	√	
CO5				√	√	
CO6				√	√	

COURSE ARTICULATION MATRIX

CO#/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			2								3		
CO2	3	2	3	2	2				1			1	3	3	
CO3	3	1	1	1	2				1			1	3	3	
CO4	3	2	1	2	2				1			1	3	3	
CO5	3	2	1	2	2				1			1	3	3	
CO6	3	2	1	2	2				1			1	3	3	

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Why Cybersecurity and Cyber Resiliency Strategies *:The Value Proposition, The 6 STEPs for Developing and Maintaining a Cyber security and Cyber Resiliency Strategy, Cybersecurity and Cyber Resiliency Strategy Key Players, Initiating the Strategy, Triggers to Create a Corporate Cybersecurity and Cyber Resiliency Strategy, Information Security vs. Cybersecurity, Cyber Resiliency vs. Traditional Resiliency, Cybersecurity and Cyber Resiliency Strategy Life Cycle, Cyber Strategies and Cyber programs, Cybersecurity and Cyber Resiliency Architecture: Standards and Frameworks, Cyber Program Preplanning, Technical Areas of Concentration for a Cyber Program*

UNIT – 2

Steps in Developing and Maintaining a Cybersecurity and Cyber Resiliency Strategy*: Preplanning: Preparation for Strategy Development, Strategy Project Management, Cyber Threats, Vulnerabilities, and Intelligence Analysis, Cyber Risks and Controls, Assessing Current and Target States, Measuring Strategic Plan Performance and End of Year (EoY) Tasks***,** *Governance Cycles and Processes,* P*roposing New Initiatives to Mitigate Threats and Reduce Risk, Checklists and Templates*

Strategy Project Management: *Vision to Initiative Flow, Strategy Project Charter, Strategy Preparation Checklist, Strategy Timeline, Strategy Gantt Chart, Strategy Swimlane, Data Flow Diagrams for STEPs 2, 3, 4, 5, and 6, RACI Strategy Development Matrix, NIST CSF Initiative Mapping, The Final Strategy Deliverable*

UNIT – 3

Cyber Threats, Vulnerabilities, and Intelligence Analysis: *Cyber Threats, Vulnerabilities*

Cyber Risks and Controls: *Cyber Risk, IT Controls, Cyber Insurance*

Current and Target State Assessments: *Introduction to Assessments, Current State Assessments, Conducting a Current State Assessment, Unmapped Initiatives Discussion, Target State Assessment, How to Rate Current and Target States*

UNIT – 4

Measuring Strategic Plan Performance and End of Year (EoY) Tasks: *Evaluating the Strategy Against the Critical Success Factors, Key Risk Indicators (KRIs), Key Performance Indicators (KPIs), Reporting on the Strategies, Determining New Initiatives for the Next Year, End of Year Tasks*

Checklists and Templates to Help Create an Enterprise-Wide Cybersecurity and Cyber Resiliency Strategy: *Guides to Strategy Preparation, STEP 1: Preplanning: Preparation for Strategy Development, STEP 2: Strategy Project Management, STEPs 3 and 4: Cyber Threats, Vulnerabilities, Intelligence Analysis, Risks, and Controls, STEP 5: Current and Target State Assessments, TEP 6: Measuring Plan Performance and EoY Tasks*

TEXT BOOKS:

1. Carol A. Siegel Mark Sweeney, Cyber Strategy: Risk-Driven Security and Resiliency, CRS Press, Taylor & Francis Group, Auerbach Publications,2020
2. Alexander Kott ,Igor Linkov , Cyber Resilience of Systems and Networks (Risk, Systems and Decisions) 1st ed. 2019 Edition

SWAYAM/NPTEL/MOOCs:

1. Coursera – Introduction to Cyber Security Specialization
2. https://onlinecourses.nptel.ac.in/noc21_cs30/preview

<table>
<tr><td>Course Title</td><td colspan="4">IOT Security</td><td colspan="2">Course Type</td><td colspan="2">Integrated</td></tr>
<tr><td>Course Code</td><td>M21TFS302</td><td>Credits</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2">III Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td>Theory</td><td>Practical</td><td>CIE</td><td>SEE</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>52</td><td>00</td><td>50</td><td>50</td></tr>
</table>

COURSE OVERVIEW

IoT security is the act of securing **Internet** of Things devices and the networks they're connected to. Hardware, software and connectivity will all need to be **secure** for **IoT** objects to work effectively. Without **security**, any connected object, from refrigerators to manufacturing bots, can be hacked. Once hackers gain control, they can usurp the object's functionality and steal the user's digital data.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Have a good working understanding of the best practices laid down by the IoT Security Foundation
2. Inculcate knowledge to be able to develop a security patching strategy and product update life-cycle.
3. Know how to research and assess IoT threats and risks as they arise.
4. Able to discuss the main threats and attacks on IoT products and services

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Make use of IOT models and work effectively with security researchers on reported IoT security issues and concerns.	1 ,3, 8, 9 , 12	1
CO2	Recognize IoT security and vulnerability threats.	1 , 3, 5,9,12	1
CO3	Interpret how to secure an IoT environment	1 ,3,45, 9, 12	2
CO4	Interpret different IoT types of attacks.	1,4,5,9,12	1
CO5	Formulate Test Device Range-Latency and Capacity for IoT hardware	1,4,5,9,12	3
CO6	Design Trusted IoT Application Platforms	1,4,5,9,12	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3		√	√	√		
CO4			√	√	√	
CO5						√
CO6						√

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1	3		
CO3	3	1	2	1	2				1			1		3	
CO4	3			2	2				1			1	3		
CO5	3			2	2				1			1	3		3
CO6	3			2	2				1			1	3		3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

IOT-SECURITY OVERVIEW

IoT Reference Model- Introduction -Functional View, **IoT Security Challenges**-Hardware Security Risks -Hardcoded/Default Passwords -Resource Constrained Computations -Legacy Assets Connections -Devices Physical Security, Software Security Risks -Software Vulnerabilities -Data Interception -Identification of Endpoints -Tamper Detection, **Lack of Industrial Standards.**

UNIT – 2

IOT- SECURITY & VULNERABILITY ISSUES

IoT Security Requirements -Data Confidentiality -Data Encryption -Data Authentication -Secured Access Control –**IoT-Vulnerabilities** – Secret-Key, Authentication/Authorization for Smart Devices -Constrained System Resources -Device Heterogeneity -Fixed Firmware.**IoT Attacks** -Side-channel Attacks -Reconnaissance -Spoofing -Sniffing -Neighbour -Discovery -Rogue Devices-Man-in-Middle

UNIT – 3

SECURED PROTOCOLS FOR IOT

Infrastructure-IPv6 -LowPAN , **Identification**-Electronic Product Code -uCode, **Transport**-Bluetooth -**LPWAN**, **Data** -MQTT -CoAP, **Multi-layer Frameworks**-Alljoyn,-IoTivity

UNIT – 4

SECURING INTERNET OF THINGS ENVIRONMENT

IoT Hardware -Test Device Range-Latency and Capacity -Manufacturability Test -Secure from Physical Attacks, **IoT Software -**Trusted IoT Application Platforms, -Secure Firmware Updating -Network Enforced Policy -Secure Analytics Visibility and Control

LEARNING RESOURCES:

4. https://www.postscapes.com/internet-of-things-protocols/
5. https://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html
6. https://www.cisco.com/c/en/us/about/security-center/secure-iot-proposed-framework.html
7. https://www.iotforall.com/5-worst-iot-hacking-vulnerabilities/

JOURNALS/MAGAZINES:

1.https://ieeexplore.ieee.org/document/8600738/
2.https://ieeexplore.ieee.org/document/7005393/
3.https://scholar.google.com/scholar_lookup?title=A%20survey%20of%20secure%20middleware%20for%204.4.he%20Internet%20of%20Things&publication_year=2017&author=P.%20Fremantle&author=P.%20Scott
https://scholar.google.com/scholar_lookup?title=Internet%20of%20things%3A%20Vision%2C%20applications%20and%20research%20challenges&publication_year=2012&author=D.%20Miorandi&author=S.%20Sicari&author=F.%20De%20Pellegrini&author=I.%20Chlamtac

SWAYAM/NPTEL/MOOCs:

1. IOT Security: Mobility Security and Deception | Coursera
2. Welcome to Cybersecurity and the Internet of Things! | Coursera
3. Fundamentals of IoT Security-Udemy.

Self-Learning Exercises:

17. Explore different IOT security models
18. More exploration on Security challenges
19. Protocols for IOT Security
20. Explore applications of IOT

Course Title	Advanced topics in cyber security				**Course Type**		**Integrated**	
Course Code	M21TFS303	**Credits**	**3**		**Class**		**III Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	4	4	4				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**4**	**4**	**4**	**52**	**0**	**50**	**50**

COURSE OVERVIEW

Cybersecurity is security as it is applied to information technology. All information technology devices and facilities need to be secured against intrusion, unauthorized use, and vandalism. Additionally, the users of information technology should be protected from theft of assets, extortion, identity theft, loss of privacy and confidentiality of personal information, malicious mischief, damage to equipment, business process compromise, and the general activity of cybercriminals. The general public should be protected against acts of cyberterrorism, such as the compromise or loss of the electric power grid. Cybersecurity is a major endeavor of the IT industry. Although billions of dollars are spent annually on cybersecurity, no computer or network is immune from attacks or can be considered completely secure.

COURSE OBJECTIVE (S):

- To enable students to develop approaches that are in the frontier of cyber security engineering and research.
- To provide the student with knowledge about the state of the art in a plethora of cutting-edge cyber security topics.
- To provide the student with knowledge about how research is conducted in cyber security.
- To provide the student with knowledge about recent developments in network and application security via the utilization of newly established technologies.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Understand the fundamental pillars of cyber security research and evaluation. Must have knowledge on a broad spectrum of innovative technologies and on how they can be applied in the context of cyber security.	1,2,3,4,8,9,12	1
CO2	Identify research questions and challenges for a variety of topics in cyber security. Must be able to use various state of the art frameworks for analyzing network traffic, identifying adversaries, as well as for developing/deploying attacks.	1,2,3,5,9,12	1
CO3	Able to the ability to critically review, summarize and discuss scientific content in cyber security	1,2,3,4,8,9,12	2
CO4	Must be able to use various state of the art frameworks for analyzing network traffic, identifying adversaries, as well as for developing/deploying attacks	1,4,8,9,12	1

CO5	Carry out Computer Forensics Investigation	1,2,3,4,5	3
CO6	Hypothesize for Global Perspective on Cybercrime	1,2,3,4,5	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√	√		
CO4			√	√		
CO5					√	√
CO6					√	√

COURSE ARTICULATION MATRIX

CO#/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1	3		
CO3	3	1	2	1	2				1			1		3	
CO4	3			2	2				1			1	3		
CO5	3	3	3	2	2										3
CO6	3	2	2	2	2										3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1

Network Attacks ,Threat Landscape - Network Security: threats to watch , emerging threats, firewall .**Intrusion Detection And Prevention System:** IDPS - detection technologies, types of intrusion detection and prevention system (IDPS), security information and event management (SIEM), honeypot,

Network Infrastructure Security Best Practices: threats to the organization network infrastructure, best practices for network infrastructure security, critical security controls, physical security- information and communications technology: data center security – guidelines, environment security - information and communications technology

UNIT 2

addressing threats, baisc deployment questions, nstallation & configuration, securing the server platform, enforcing and maintaing security best practices, operations & maintenance, incident handling

web servers security, email security, database server security, dns servers security, web-application security versus perimeter security, attack surface, secure web application development- best practices, web application security testing, what do we need to secure?, security protocols

UNIT 3

windows security controls essential for home user, principle of least privilege(plp), autorun /autoplay, software restriction policy, browsers and security, mbsa (microsoft baseline security analyser), set up and configure windows firewall, physical security, basic guidelines for enabling security in your desktop, enabling security features in ms office, wireless network security: vulnerabilities, threats and countermeasures, wlan threats, attacks cause loss of integrity, attacks causing loss of availability, authentication attacks, attacks on encryption standards, home wireless threats, public wireless threats, malware analysis fundamentals, setting up malware analysis facility, static analysis, dynamic analysis, automatic analysis, malware collection process woth malware honeypots, memory analysis

Introduction to Cybercrime: Cybercrime: Definition and Origins of the Word, Cybercrime and Information Security, Who are Cybercriminals?, Classifications of Cybercrimes, Cybercrime: The Legal Perspectives, Cybercrimes: An Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes, Cybercrime Era: Survival Mantra for the Netizens. Cyberoffenses: How Criminals Plan Them: How Criminals Plan the Attacks, Social Engineering, Cyberstalking, Cybercafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing.

UNIT – 4

Understanding Computer Forensics: Introduction, Historical Background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber forensics and Digital Evidence, Forensics Analysis of E-Mail, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Computer Forensics Investigation, Setting up a Computer Forensics Laboratory: Understanding the Requirements, Computer Forensics and Steganography, Relevance of the OSI 7 Layer Model to Computer Forensics, Forensics and Social Networking Sites: The Security/Privacy Threats, Computer Forensics from Compliance Perspective, Challenges in Computer Forensics, Special Tools and Techniques, Forensics Auditing, Antiforensics.

TEXT BOOKS:

12. https://www.cemca.org/ckfinder/userfiles/files/PG_Diploma_in_Cyber_Security/Course%20VIII_Advanced_Cyber_Security_Techniques.pdf
13. Sunit Belapure and Nina Godbole, Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives, Wiley India Pvt Ltd, 2013
14. Surya Prakash Tripathi, Ritendra Goyal, Praveen Kumar Shukla, Introduction to information security and cyber laws, Dreamtech Press, 2015

REFERENCE BOOKS:

19. Thomas J. MowbrayA , Cybersecurity: Managing Systems, Conducting Testing, and Investigating Intrusions, John Wiley & Sons,
20. James Graham, Ryan Olson, Rick Howard, Cyber Security Essentials, CRC Press, 2010

JOURNALS/MAGAZINES

1) *cybersecurity.springeropen.com*
2) *academic.oup.com* › cybersecurity
3) https://www.techscience.com/journal/JCS
4) https://cyber.fiu.edu/security-journals/

SWAYAM/NPTEL/MOOCs:

1) https://www.mooc-list.com/tags/cybersecurity
2) https://www.coursera.org/specializations/cyber-security
3) https://www.cyberdegrees.org/resources/free-online-courses/

Self-Learning Exercises:

OPEN ELECTIVES….

Course Title	**Fundamentals of Cybersecurity**				**Course Type**		**Integrated**	
Course Code	M21CB302	**Credits**	**4**		**Class**		**I/II Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	4	4	4				
	Practice	0	0	0	Theory	Practical	IA	SEE
	-	-	-	-				
	Total	**4**	**4**	**4**	**52**	**00**	**50**	**50**

COURSE OVERVIEW:

The fundamentals of cybersecurity course covers various concepts on providing security to networks, data, programs and other cyber infrastructure. The growing usage of internet by individuals and organizations is demanding for cyber security applications that protect cyber infrastructure and other resource to provides, therefore this course is very important and provides fundamental knowledge on cyber security.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Explain the fundamentals of cyber security and their applications.
2. Inculcate knowledge of attacker techniques.
3. Describe integer and string vulnerabilities

4. Discuss the malicious code to steal information

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Make use of fundamentals of cyber security to solve real world problems.	1 to 4, 8, 9 , 12	1
CO2	Develop solutions for defending various attacks in cyber security.	1 to 3, 5,9,12	1
CO3	Apply techniques to develop solutions to address various vulnerabilities	1 to 5, 9, 12	2
CO4	Create cyber security solutions to protect stealing information	1,4,5,9,12	1
CO5	Demonstrate Misdirection, Reconnaissance, and Disruption Methods	1,4,5,9,12	3
CO6	Summarize on stealing in formation and exploitation	1,4,5,9,12	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√	√		
CO4						√
CO5					√	
CO6					√	

COURSE ARTICULATION MATRIX

CO#/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1	3		

CO3	3	1	2	1	2				1			1		3	
CO4	3			2	2				1			1	3		
CO5	3			2	2				1			1			3
CO6	3			2	2				1			1			3

Note: 1-Low, 2-Medium, 3-High

Course Content:

Theory:

Contents
Unit1: **Cyber security Fundamentals: Network and security concepts**: Information assurance fundamentals,cryptography, encryption,public key encryption, domain name system, firewalls,virtualization, radio-frequency identification. **security principles**:-tokens, messaging, program execution.
Unit 2: **Attacker techniques and motivations:** Hackers cover tractks, tunneling techniques, fraud techniques, threat infrastructure.
Unit 3: **Exploitation: Techniques to gain foothold:** shell code, Integer vulnerabilities, stack overflow, string vulnerabilities, SQL Injection, malicious pdf files, race conditions, web tools, DoS conditions, bruteforce **and dictionary,** Misdirection, Reconnaissance, and Disruption Methods.
Unit 4: **Malicious code**: self replicating malicious code, evading detection and elevating privilages, rootkits, spyware, attacks against user accounts, token kidnapping, virtual machine detection, stealing in formation and exploitation.

Text Book:

1. James Graham et al, "Cyber security essentials", CRC press, 2010

Reference Books:

1. Thomos jhonson et al, "cyber security protecting critical infrastructure from cyber attack and warfare", springer, 2015.
2. Martti lehto, "Cyber security", springer, 2015

Journals/Magazines

1. Journal of cyber security
2. Springer journal of cyber security.
3. Elsevier computers and security

SWAYAM/NPTEL/MOOCs:

1. udacity – Introduction to cyber security
2. Coursera – cyber security

Self-Learning Exercises:

1. Python programming for cyber security
2. Ethical hacking and python

Course Title	**Ethical Hacking**				**Course Type**		**Soft Core**	
Course Code	M21TF3022	**Credits**	**3**		**Class**		**II Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	4	4	4				
	Practice	0	0	0	Theory	Practical	CIE	SEE
	-	-	-	-				
	Total	**4**	**4**	**4**	**52**	**0**	**50**	**50**

COURSE OVERVIEW

Ethical hacking refers to the act of locating weaknesses and vulnerabilities of computer and information systems by duplicating the intent and actions of malicious hackers. Ethical hacking is also known as penetration testing, intrusion testing, or red teaming. An ethical hacker is a security professional who applies their hacking skills for defensive purposes on behalf of the owners of information systems. This course offers the insights about Casting the Establishment, Securing Permission, Wireless Hacking and Remote Control Insecurities.

COURSE OBJECTIVE (S):

The objectives of this course are to:

1. Learn aspects of security, importance of data gathering, foot printing and system hacking.
2. Learn tools and techniques to carry out a penetration testing.
3. Explain Intrusion Detection, Policy Creation, Social Engineering, DDoS Attacks, Buffer Overflows and Virus Creation.
4. Compare different types of hacking tools.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Explain aspects of security, importance of data gathering, foot printing and system hacking	1 to 4, 8, 9 , 12	1
CO2	Explain aspects of security, importance of data gathering, foot printing and system hacking	1 to 3, 5,9,12	1
CO3	Demonstrate how intruders escalate privileges.	1 to 5, 9, 12	2
CO4	Demonstrate how intruders escalate privileges..	1,4,5,9,12	1
CO5	Summarize Advanced Techniques Session Hijacking	1,4,5,9,12	3
CO6	Assess Web server hacking and web application hacking	1,4,5,9,12	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2			√			
CO3			√	√		
CO4					√	√
CO5				√	√	
CO6				√	√	

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1	2		
CO3	3	1	2	1	2				1			1		3	
CO4	3			2	2				1			1	3		
CO5	3			2	2				1			1			3

CO6	3			2	2				1			1			3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT

THEORY:

UNIT – 1 **10hrs**

Casing the Establishment: What is foot printing, Internet Foot printing, Scanning, Enumeration, basic banner grabbing, Enumerating Common Network services. Case study: Network Security Monitoring.

UNIT – 2

Securing permission: Securing file and folder permission, Using the encrypting file system, Securing registry permissions. Securing service: Managing service permission, Default services in windows 2000 and windows XP. Unix: The Quest for Root, Remote Access vs Local access, Remote access, Local access, after hacking root.

UNIT – 3

Wireless Hacking: Wireless Foot printing, Wireless Scanning and Enumeration, Gaining Access, Tools that exploiting WEP Weakness, Denial of Services Attacks, Firewalls: Firewalls landscape, Firewall Identification-Scanning Through firewalls, packet Filtering, Application Proxy Vulnerabilities, Denial of Service Attacks, Motivation of Dos Attackers, Types of DoS attacks, Generic Dos Attacks, UNIX and Windows DoS.

UNIT – 4

Remote Control Insecurities, Discovering Remote Control Software, Connection, Weakness. VNC, Microsoft Terminal Server and Citrix ICA, Advanced Techniques Session Hijacking, Back Doors, Trojans, Cryptography, Subverting the systems Environment, Social Engineering, Web Hacking, Web server hacking web application hacking, Hacking the internet Use, Malicious Mobile code, SSL fraud, E-mail Hacking, IRC hacking, Global countermeasures to Internet User Hacking.

TEXT BOOKS:

1. Stuart McClure, Joel Scambray and Goerge Kurtz, Hacking Exposed 7: Network Security Secrets & Solutions, Tata Mc Graw Hill Publishers, 2010.

2. Bensmith, and Brian Komer, Microsoft Windows Security Resource Kit, Prentice Hall of India, 2010. **REFERENCE BOOKS:**

1. Stuart McClure, Joel Scambray and Goerge Kurtz, “Hacking Exposed Network Security Secrets & Solutions”, 5th Edition, Tata Mc Graw Hill Publishers, 2010.

2. Rafay Baloch, “A Beginners Guide to Ethical Hacking”.

3. Allen Harper, Shon Harris, Jonathan Ness, Chris Eagle, “Gray Hat Hacking The Ethical Hackers Handbook”, 3rd Edition, McGraw-Hill Osborne Media paperback (January 27, 2011)

JOURNALS/MAGAZINES

1. International Journal of Computer Science Trends and Technology (IJCST) – Volume 2 Issue 4, Nov-Dec 2014

2. E. S. Raymond, The New Hacker's Dictionary, MIT Press, Cambridge, MA (1991).

3. S. Garfinkel, Database Nation, O'Reilly & Associates, Cambridge, MA (2000).

4.The first use of the term "ethical hackers" appears to have been in an interview with John Patrick of IBM by Gary Anthens that appeared in a June 1995 issue of Computer World

SWAYAM/NPTEL/MOOCs:

1. StationX – The Complete Ethical Hacking Course Bundle.
2. Udemy – Learn Ethical Hacking From Scratch.
3. Cybrary – The Art of Exploitation.
4. EH Academy – The Complete Cyber Security & Hacking Course.
5. Offensive Security – Metasploit Unleashed.
6. Coursera – Cryptography.

<table>
<tr><td>Course Title</td><td colspan="4">BLOCK CHAIN TECHNOLOGY</td><td colspan="2">Course Type</td><td colspan="2">Theory</td></tr>
<tr><td>Course Code</td><td>M21TF3023</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">I semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">13Hrs/ Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>--</td><td>--</td><td>---</td></tr>
<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>52</td><td>0</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

Course Description: Block chain is the distributed and decentralized database technology behind this crypto currency. This course explores the fundamentals of the public, transparent, secure, immutable and distributed database called block chain. Block chains can be used to record and transfer any digital asset not just currency. This course will introduce students to the workings and applications of this potentially disruptive technology. Its potential impact on financial services, government, banking, contracting and identity management.

COURSE OBJECTIVE

1. Understand the basic of Cryptography, Blockchain technology and tools

2. Demonstrate Ethereum principles and development cycle from Ethereum to bitcoin with necessary tools and techniques

3. Illustrate Wallets and client software and programming techniques with solidity and DApps

4. Analyse different Blockchain Platforms that can be used in real world applications.

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Analyze various cryptography mechanisms and list out cryptography constructs for blockchain technology	1,2,3,5,6	1,2,3
CO2	Discuss various tools used for blockchain	1,2,3,5,6	1,2,3
CO3	Illustrate the concept of Ethereum for crypto currency and implementation aspects of DAO	1,2,3,5,6	1,2,3
CO4	Infer the concept of Wallets and client hardware and software for building a running client	1,2,3,5,6	1,2,3
CO5	Interpret various applications of Blockchain	1,2,3,5,6	1,2,3
CO6	Point out on Programming with solidity and DApps	1,2,3,5,6	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1			√			
CO2	√	√				

CO3			√			
CO4		√	√			
CO5			√			

COURSE ARTICULATION MATRIX

CO#/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2		2	3							2	3	2
CO2	3	1	2		3	2							1	3	2
CO3	2	1	2		2	1							2	1	2
CO4	3	2	1		2	3							2	2	3
CO5	3	2	1		2	3							2	2	3
CO6	3	2	1		2	3									3

Note: 1-Low, 2-Medium, 3-High

COURSE CONTENT
THEORY

Contents
UNIT-1
Introduction to cryptography and Block chain: Introduction to cryptography-Symmetric and Public-key cryptography, Hash function, Digital Signatures-ECDSA, Memory Hard Algorithm,. **Introduction to Block chain:** Cryptographic constructs and block chain technology, Zero Knowledge Proof , Advantage over conventional distributed database, Block chain as Public Ledgers, networks, Types of Block chain.
UNIT-2
Ethereum: Crypto currency: History, Distributed Ledger, Bitcoin an overview, protocols - Mining strategy and rewards, bitcoin limitations, What Is Ethereum? Development from Bit coin to Ethereum, Ethereum vs Ether, Ethereum

netwoks, components of ethereum ecosystem, Ethereum Virtual Machine (EVM): Accounts, Transactions, Gas, Ether, Memory, Smart contracts, Truffle Design , Implementations of DAO, DAO and Intellectual Property.
UNIT-3
Wallets and client software: Nodes and miners, hardware and software requirements for building a running client, Wallets technology overview, wallet best practices. **Programming with solidity and DApps:** Data types, pre defined global variables and function, error handling, What is DApp, data storage, communication protocols, Basic DApp example: Auction DApp, Ethereum Name Service (ENS) history, specifications, and layers.
UNIT-4
Blockchain Applications: Internet of Things, Medical Record Management System, and Blockchain in Government and Block chain Security, Block chain Use Cases –Finance, Domain Name Service and future of Block chain.**Enterprise Blockchains and Applications:** Enterprise Blockchains: Hyperledger, R3 Corda, Quorum

SELF-LEARNING COMPONENT:

Distributed Ledger in Blockchain, Decentralized Applications.

TEXT BOOKS:

1. Joseph J. Bambara Paul R. Allen," Blockchain,A Practical Guide to Developing Business, Law, and Technology Solutions", McGraw-Hill Education Professional , Second edition, 2018
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).
3. Melanie Swan "Blockchain: Blueprint for a New Economy", O'Reilly Media, Third edition, Aug 2015.
4. Andreas M. Antonopoulos, Gavin Wood "Mastering Ethereum", O'Reilly Media, Inc., November 2018
5. Joseph Holbrook "Architecting Enterprise Blockchain Solutions", Sybex, February 2020

REFERENCE BOOKS:

1. Mingjun Dai; Shengli Zhang; Hui Wang; Shi Jin "A Low Storage Room Requirement Framework for Distributed Ledger in Blockchain" Volume: 6, Pages: 22970 – 22975, Year: 2018.
2. Ruiguo Yu, Jianrong Wang, Tianyi Xu, Jie Gao Yongli An Gong Zhang, And Mei Yu "Authentication With Block-Chain Algorithm and Text Encryption Protocol in Calculationof Social Network ",Volume: 5,pp: 24944 – 24951, 09 November 2017.
3. Ashiq Anjum; Manu Sporny; Alan Sill " Blockchain Standards for Compliance and Trust" , Volume: 4, Issue: 4 ,Pages: 84 – 90,Year: 2017.
4. Morgen E. Peck; Samuel K. Moore "The blossoming of the blockchain" , Volume: 54, Issue: 10 Pages: 24 – 25, Year: 2017.
5. Inderscience Journal of blockchain and cryptocurrency.
6. Ledger Journal of Cryptocurrency and Blockchain Technology.

REVA UNIVERSITY
Bengaluru, India

APPLIED SCIENCES

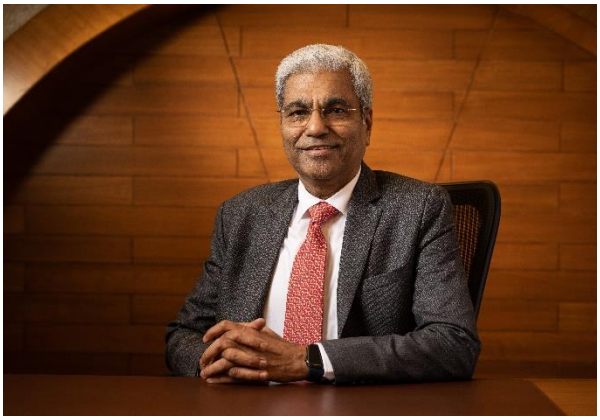
MSc Chemistry HANDBOOK

2021-23

Chancellor's Message

"Education is the most powerful weapon which you can use to change the world."

- Nelson Mandela.



There was a time when survival depended on just the realization of physiological needs. We are indeed privileged to exist in a time when 'intellectual gratification' has become indispensable. Information is easily attainable for the soul that is curious enough to go look for it. Technological boons enable information availability anywhere anytime. The difference, however, lies between those who look for information and those who look for knowledge.

It is deemed virtuous to serve seekers of knowledge and as educators it is in the ethos at REVA University to empower every learner who chooses to enter our portals. Driven by our founding philosophy of 'Knowledge is Power', we believe in building a community of perpetual learners by enabling them to look beyond their abilities and achieve what they assumed impossible.

India has always been beheld as a brewing pot of unbelievable talent, acute intellect and immense potential. All it takes to turn those qualities into power is a spark of opportunity. Being at a University is an exciting and rewarding experience with opportunities to nurture abilities, challenge cognizance and gain competence.

For any University, the structure of excellence lies in the transitional abilities of its faculty and its facility. I'm always in awe of the efforts that our academic board puts in to develop the team of subject matter experts at REVA. My faculty colleagues understand our core vision of empowering our future generation to be ethically, morally and intellectually elite. They practice the art of teaching with a student-centered and transformational approach. The excellent infrastructure at the University, both educational and extra-curricular, magnificently demonstrates the importance of ambience in facilitating focused learning for our students.

A famous British politician and author from the 19th century - Benjamin Disraeli, once said 'A University should be a place of light, of liberty and of learning'. Centuries later this dictum still inspires me and I believe, it takes team-work to build successful institutions. I welcome you to REVA University to join hands in laying the foundation of your future with values, wisdom and knowledge.

Dr. P. Shyama Raju
The Founder and Hon'ble Chancellor, REVA University

Vice-Chancellor's Message

The last two decades have seen a remarkable growth in higher education in India and across the globe. The move towards inter-disciplinary studies and interactive learning have opened up several options as well as created multiple challenges. India is at a juncture where a huge population of young crowd is opting for higher education. With the tremendous growth of privatization of education in India, the major focus is on creating a platform for quality in knowledge enhancement and bridging the gap between academia and industry.

A strong believer and practitioner of the dictum "Knowledge is Power", REVA University has been on the path of delivering quality education by developing the young human resources on the foundation of ethical and moral values, while boosting their leadership qualities, research culture and innovative skills. Built on a sprawling 45 acres of green campus, this 'temple of learning' has excellent and state-of-the-art infrastructure facilities conducive to higher teaching-learning environment and research. The main objective of the University is to provide higher education of global standards and hence, all the programs are designed to meet international standards. Highly experienced and qualified faculty members, continuously engaged in the maintenance and enhancement of student-centric learning environment through innovative pedagogy, form the backbone of the University.

All the programs offered by REVA University follow the Choice Based Credit System (CBCS) with Outcome Based Approach. The flexibility in the curriculum has been designed with industry-specific goals in mind and the educator enjoys complete freedom to appropriate the syllabus by incorporating the latest knowledge and stimulating the creative minds of the students. Bench marked with the course of studies of various institutions of repute, our curriculum is extremely contemporary and is a culmination of efforts of great think-tanks - a large number of faculty members, experts from industries and research level organizations. The evaluation mechanism employs continuous assessment with grade point averages. We believe sincerely that it will meet the aspirations of all stakeholders – students, parents and the employers of the graduates and postgraduates of REVA University.

At REVA University, research, consultancy and innovation are regarded as our pillars of success. Most of the faculty members of the University are involved in research by attracting funded projects from various research level organizations like DST, VGST, DBT, DRDO, AICTE and industries. The outcome

of the research is passed on to students through live projects from industries. The entrepreneurial zeal of the students is encouraged and nurtured through EDPs and EACs.

REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students. REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students become skilled with relevant to industry requirements. Structured training programs on soft-skills and preparatory training for competitive exams are offered here to make students more employable. 100% placement of eligible students speaks the effectiveness of these programs. The entrepreneurship development activities and establishment of "Technology Incubation Centers" in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise.

With firm faith in the saying, "Intelligence plus character –that is the goal of education" (Martin Luther King, Jr.), I strongly believe REVA University is marching ahead in the right direction, providing a holistic education to the future generation and playing a positive role in nation building. We reiterate our endeavour to provide premium quality education accessible to all and an environment for the growth of over-all personality development leading to generating "GLOBAL PROFESSIONALS".

Welcome to the portals of REVA University!

Dr. M Dhanamjaya
Vice-Chancellor, REVA University

Director's Message

Higher education across the globe is opening doors of its academic disciplines to the real-world experiences. The disciplinary legitimacy is under critical review. Trans-border mobility and practice learning are being fore-grounded as guiding principles. Interactive learning, bridging disciplines and facilitating learners to gain different competencies through judicious management of time is viewed as one of the greatest and fascinating priorities and challenges today.

The M.Sc. Chemistry is designed keeping in view the current situation and possible future developments, both at national and global levels. This course is designed to give greater emphasis on Research. There are ample number of courses providing knowledge in specialized areas like reaction kinetics, Spectroscopy, Quantum Mechanics, Nanomaterials and analytical techniques, facilitating students to choose specialized areas of their interest. Adequate attention is given to provide students the basic concepts of chemistry and modern computation techniques to be used and knowledge on application of such concepts in practical field. The project, being part of the curriculum will certainly provide students the experience of practical exposure in working environment. The curriculum caters to and has relevance to local, regional, national and global developmental needs. Maximum number of courses are integrated with cross cutting issues with relevant to professional ethics, gender, human values, environmental and sustainability.

The L: T: P structure of teaching and learning under Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) would certainly help our students learn and build competencies needed in this knowledge based society.

This handy document containing brief information about M.Sc. Chemistry, scheme of instruction, course content, CBCS-CAGP regulations and its advantages and calendar of events for the year will serve as a guiding path to students to move forward in a right direction. It would mould them with knowledge, skill and ethical values to face the challenges of this competitive world with greater confidence in becoming proud citizens of mother India.

Prof. Shilpha B R
Director
School of Applied Sciences

CONTENTS

Sl. No.	Particulars	Page No.
1	Message from the Hon'ble Chancellor	2
2	Message from the Vice- Chancellor	3-4
3	Message from the Director	5
4	Rukmini Educational Charitable Trust	7
5	About REVA University, Vision, Mission, Objectives	8-11
6	**About School of Applied Sciences** - Vision - Mission - BoS	12
7	**M Sc (Chemistry) Program** - Program Overview - Program Educational Objectives - Program Outcomes - Program Specific Outcomes - Mapping of Course Outcomes with Programme Outcomes - Mapping Programme Outcomes with Programme Educational Objectives	15-17
8	Regulations Governing Applied Science Programmes	18-37
9	Curriculum – PG (Chemistry)	38-220
10	Career opportunities	221-222

RUKMINI EDUCATIONAL CHARITABLE TRUST

It was the dream of late Smt. Rukmini Shyama Raju to impart education to millions of underprivileged children as she knew the importance of education in the contemporary society. The dream of Smt. Rukmini Shyama Raju came true with the establishment of Rukmini Educational Charitable Trust (RECT), in the year 2002. Rukmini Educational Charitable Trust (RECT) is a Public Charitable Trust, set up in 2002 with the objective of promoting, establishing and conducting academic activities in the fields of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology, among others. In furtherance of these objectives, the Trust has set up the REVA Group of Educational Institutions comprising of REVA Institute of Technology & Management (RITM), REVA Institute of Science and Management (RISM), REVA Institute of Management Studies (RIMS), REVA Institute of Education (RIE), REVA First Grade College (RFGC), REVA Independent PU College at Kattigenahalli, Ganganagar and Sanjaynagar and now REVA University. Through these institutions, the Trust seeks to fulfil its vision of providing world class education and create abundant opportunities for the youth of this nation to excel in the areas of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology.

Every great human enterprise is powered by the vision of one or more extraordinary individuals and is sustained by the people who derive their motivation from the founders. The Chairman of the Trust is Dr. P. Shyama Raju, a developer and builder of repute, a captain of the industry in his own right and the Chairman and Managing Director of the Divya Sree Group of companies. The idea of creating these top notched educational institutions was born of the philanthropic instincts of Dr. P. Shyama Raju to do public good, quite in keeping with his support to other socially relevant charities such as maintaining the Richmond road park, building and donating a police station, gifting assets to organizations providing accident and trauma care, to name a few.

The Rukmini Educational Charitable Trust drives with the main aim to help students who are in pursuit of quality education for life. REVA is today a family of ten institutions providing education from PU to Post Graduation and Research leading to PhD degrees. REVA has well qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 15,000+ students study various courses across REVA's three campuses equipped with exemplary state-of-the-art infrastructure and conducive environment for the knowledge driven community.

ABOUT REVA UNIVERSITY

REVA University has been established under the REVA University Act, 2012 of Government of Karnataka and notified in Karnataka State Gazette No. 80 dated 27th February, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

REVA University located in between Kempegowda International Airport and Bangalore city, has a sprawling green campus spread over 45 acres of land and equipped with state-of-the-art infrastructure that provide conducive environment for higher learning and research. The REVA campus has well equipped laboratories, custom-built teaching facilities, fully air-conditioned library and central computer centre, the well planned sports facility with cricket ground, running track & variety of indoor and outdoor sports activities, facilities for cultural programs. The unique feature of REVA campus is the largest residential facility for students, faculty members and supportive staff.

REVA consistently ranked as one of the top universities in various categories because of the diverse community of international students and its teaching excellence in both theoretical and technical education in the fields of Engineering, Management, Law, Science, Commerce, Arts, Performing Arts, and Research Studies. REVA offers 28 Undergraduate Programmes, 22 Full-time and 2 Part-time Postgraduate Programmes, 18 Ph. D Programmes, and other Certificate/ Diploma/Postgraduate Diploma Programmes in various disciplines.

The curriculum of each programme is designed with a keen eye for detail by giving emphasis on hands-on training, industry relevance, social significance, and practical applications. The University offers world-class facilities and education that meets global standards.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed universities / institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The system also allows students to move forward under the fast track for those who have the capabilities to surpass others. These programs are taught by well experienced

qualified faculty supported by the experts from industries, business sectors and such other organizations. REVA University has also initiated many supportive measures such as bridge courses, special coaching, remedial classes, etc., for slow learners so as to give them the needed input and build in them confidence and courage to move forward and accomplish success in their career. The University has also entered into MOUs with many industries, business firms and other institutions seeking their help in imparting quality education through practice, internship and also assisting students' placements.

REVA University recognizing the fact that research, development and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology and other areas of study. The interdisciplinary-multidisciplinary research is given the top most priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano- Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nana Tribology, Fuel Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

The REVA University has also given utmost importance to develop the much required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) department with world class infrastructure, headed by a dynamic experienced Professor& Dean, and supported by well experienced Trainers, Counsellors and Placement Officers.

The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognised as a Centre of Skill Development and Training by NSDC (National

Skill Development Corporation) under Pradhan Mantri Kaushal VikasYojana. The Centre conducts several add-on courses in challenging areas of development. It is always active in facilitating student's variety of Skill Development Training programs.

The University has collaborations with Industries, universities abroad, research institutions, corporate training organizations, and Government agencies such as Florida International University, Okalahoma State University, Western Connecticut University, University of Alabama, Huntsville, Oracle India Ltd, Texas Instruments, Nokia University Relations, EMC^2, VMware, SAP, Apollo etc, to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreign universities also facilitates students to study some of the programs partly in REVA University and partly in foreign university, viz, M.S in Computer Science one year in REVA University and the next year in the University of Alabama, Huntsville, USA.

The University has also given greater importance to quality in education, research, administration and all activities of the university. Therefore, it has established an independent Internal Quality division headed by a senior professor as Dean of Internal Quality. The division works on planning, designing and developing different quality tools, implementing them and monitoring the implementation of these quality tools. It concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat RatnaProf. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr.Balaram, Former Director IISc., and noted Scientist, Dr. V S Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of DefenceDr.Sathish Reddy, Scientific Advisor, Ministry of Defence, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

REVA organises various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVAMP conducted every year. The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions and variety of cultural events. Another

important event is Shubha Vidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also recognised by distributing awards and prizes. The founders have also instituted medals and prizes for sports achievers every year. The physical education department conducts regular yoga class's everyday to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

Vision

REVA University aspires to become an innovative university by developing excellent human resources with leadership qualities, ethical and moral values, research culture and innovative skills through higher education of global standards.

Mission

- To create excellent infrastructure facilities and state-of-the-art laboratories and incubation centres
- To provide student-centric learning environment through innovative pedagogy and education reforms
- To encourage research and entrepreneurship through collaborations and extension activities
- To promote industry-institute partnerships and share knowledge for innovation and development
- To organize society development programs for knowledge enhancement in thrust areas
- To enhance leadership qualities among the youth and enrich personality traits, promote patriotism and moral values.

Objectives

- Creation, preservation and dissemination of knowledge and attainment of excellence in different disciplines
- Smooth transition from teacher - centric focus to learner - centric processes and activities
- Performing all the functions of interest to its major constituents like faculty, staff, students and the society to reach leadership position
- Developing a sense of ethics in the University and Community, making it conscious of its obligations to the society and the nation
- Accepting the challenges of globalization to offer high quality education and other services in a competitive manner.

ABOUT THE SCHOOL OF APPLIED SCIENCES

The School of Applied Sciences offers graduate and post graduate programs in Biotechnology, Biochemistry, Chemistry, Physics and Mathematics which are incredibly fascinating. It aims to attract talented youth and train them to acquire knowledge and skills useful to industrial sectors, research laboratories, and educational institutions. The School presently offers M.Sc. degree programs in Bio-Chemistry, Bio-Technology, Chemistry, Physics, Mathematics and B Sc with various combinations viz, Physics Chemistry and Mathematics, Mathematics , Physics and Statistics, Mathematics Statistics and Computer Science, and Biology Mathematics & Computer Science and also Post Graduate Diploma in Clinical Research Management. The School also facilitates research leading to PhD in Biotechnology, Biochemistry, Physics, Chemistry, Mathematics and related areas of study.

The School of Applied Sciences is shouldered by well qualified, experienced and highly committed faculty. The state-of-the-art infrastructure digital classrooms, well equipped laboratories, conference rooms and the serene academic atmosphere at REVA University will enhance the transfer as well as creation of knowledge. The school provides an interactive, collaborative peer tutoring environment that encourages students to break down complex problems and develop strategies for finding solutions across a variety of situations and disciplines. The school aims to develop a learning community of critical thinkers who serves as models of innovative problems solving in the university environment to enrich their academic and professional careers.

Vision

To nurture intellect, creativity, character and professionalism among students and impart contemporary knowledge in various branches of Chemical, Biological, Physical and Mathematical Sciences that are socially relevant and transform them to become global citizens.

Mission

- To create excellent infrastructure facilities and state-of-the-art laboratories and incubation centres
- To provide student-centric learning environment through innovative pedagogy and education reforms
- To encourage research and entrepreneurship through collaborations and extension activities
- To promote industry-institute partnerships and share knowledge for innovation and development
- To organize society development programs for knowledge enhancement in thrust areas
- To enhance leadership qualities among the youth and enrich personality traits, promote patriotism and moral values.

BOS MEMBERS

Name and Position	
Dr. N. Ramesh Professor and Registrar i/c REVA University Ph: +91-9880514718 E-mail:dean.tpp@reva.edu.in **(Chairperson)**	
Dr. Arun Kumar Gupta Research Director Syngene International Limited, BBRC A Biocon Group, Bangalore Ph: +91-9731133411 E-mail:akg1966@yahoo.com **(External Member - Industry Expert)**	
Dr. Shivaraj Y. Associate Professor Department of Chemistry Bangalore University Ph +91-9972001267 E-mail : shivaraj_y@rediffmail.com **(External Member-Academic)**	
Dr. Madhusudana Reddy M. B. Assistant Director and Professor School of Chemical Sciences REVA University Ph:+91-9480224757 E-mail: madhusudana@reva.edu.in **(Internal Member)**	
Dr. Sakthivel Kandaiah Associate Professor School of Chemical Sciences REVA University Ph:+91-9742585588 E-mail: sakthivel@reva.edu.in **(Internal Member)**	

Dr. Lakshmi B Associate Professor School of Chemical Sciences REVA University Ph:+91-9902632762 E-mail:lakshmib@reva.edu.in **(Internal Member)**	
Dr. Nagendra G. Assistant Professor School of Chemical Sciences Reva University Ph:+91-9844722805 E-mail: nagendra.g@reva.edu.in **(Internal Member)**	
Miss. Megha Dash R18MCH010 **(Alumni Student)**	

M.Sc. (Chemistry) Program Overview

Chemical sciences are branch of the natural sciences dealing with the composition of substances and their properties and reactions. The chemical sciences provide understanding of the physical and chemical properties of atoms and molecules and practical methods for creating new molecular structures with useful applications. Chemistry is a 'platform science', contributing to fundamental aspects of a range of other sciences and underpinning the dramatic advances seen in recent decades in such fields as biotechnology, energy, the environment, genetics, materials and medicine.

Since the mid-20thcentury, the importance of S&T for development has increasingly been recognized by international agencies, development assistance partners and the governments of low- and middle-income countries (LMICs). One outstanding example of success is the case of Taiwan, whose per capita Gross National Product rose from US$ 919 in the 1950s to US$ 7358 in 1990, as the agrarian economy was transformed into an export-oriented industrial one. By the early 1990s, the chemical industry was the largest industrial sector, contributing 24.2% of the total production value of US$ 165.3 billion, but only 8.5% directly to export sales of US$ 95.6 billion. This demonstrates the strategic importance of the chemical industry as a supplier of materials and chemicals in underpinning other export industries, including electrical/electronic goods and textiles.

Chemistry is important in storage and use of energy, Creation of new materials, Advances in agriculture, food and nutrition, Better health and Economic growth. Thus, Chemistry is an essential part of the educational system of an advanced society. Indian Society has embraced knowledge economy and its economic growth rate is one of the highest in the world. India has shown highest level of progress in engineering, space, nuclear, aeronautics, biotech, and pharmaceutics. The subject of chemistry has played a major role in the development of country.In this context, Universities across the country offer Chemistry as a subject at undergraduate and Chemistry as a programme at postgraduate level.

M.Sc. (Chemistry) program at **REVA UNIVERSITY** has been designed to meet the human resources needs of existing and futuristic research establishments, industries and academic institutions. The program is designed to produce graduates with higher order critical, analytical, problem solving and research skills; ability to think rigorously and independently to meet higher level expectations of industries, research organization and academic institutions.

The program focuses on theoretical and practical aspects of physical, analytical, organic and Inorganic chemistry aspects with opportunities for project work in the subject area. The courses are tailored to prepare students in teaching and research as well as in community activities and development. The minor project work that the students must undertake compulsorily is integrated with industry experience. This will not only enhance acquaintance with applications of chemistry to real world problems but improve students' knowledge and self-confidence. The school also has a research program leading to a doctoral degree. The program focuses on research to offer professional services at National and International levels.

In this context, University Programmes at undergraduate and postgraduate level in Chemistry across the Country have become relevant.

Program Educational Objectives (PEOs)

The aim of the program is to produce postgraduates with - advanced knowledge and understanding of Chemistry; higher order critical, analytical, problem solving and attitudinal skills (transferable) to meet expectations of research establishments, relevant industry and academia. Hence,

After few years of graduation, the graduates of M. Sc Chemistry will:

PEO1 Work as a scientist or faculty in educational institutions and research organizations in a team with further training.

PEO2 Develop strong ethics and communication as consultant with an attitude of lifelong learning.

PEO3 Pursue higher studies and participate in societal activities and address the problems of the society

Program Outcomes (POs)

After successful completetion of the program, the student will be able to:

PO1: Knowledge Sharing: Apply the knowledge of fundamentals mathematics, physics and advanced chemistry to resolve the problems pertaining chemical sciences.

PO2: Problem analysis: Analysis of research problems and chemical structures of compounds and provide solutions at national and international level.

PO3: Design/development of solutions: Design and development of solutions for reactions based on kinetics, thermodynamic, quantum mechanical approaches to solve the chemical structure through mechanistic approaches.

PO4: Conduct investigations of complex problems: Formulate and develop methods and utilize advanced scientific tools and techniques to probe complex chemical problems and interpret the data.

PO5: Research skills: Enhance the research skills and carryout the extensive research literature in advanced chemical studies.

PO6: Environment and sustainability: Apply critical thinking ability to achieve sustainable solutions for energy and environment.

PO7: Ethics: Apply ethical principles and commit to ethics, and responsibilities and norms of the professional practice

PO8: Individual and team work: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO9: Communication: Communicate effectively with the professional community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

PO10:Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. Lead a team to successfully complete projects, and communicate across teams.

Program Specific Outcomes (PSO)

After successful completion of the program, the student will be able to:

PSO1: Dmonstrate strong foundation in the fundamentals and applications of current chemical and scientific theories of those in Analytical, Inorganic, Organic and Physical Chemistries.

PSO2: Design and carry out scientific experiments as well as accurately record and analyze the results of experiments and skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.

PSO3: Explore new areas of research in the field of chemical sciences and allied fields of science and technology.

REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Postgraduate Degree programs- 2021

(Framed as per the provisions under Section 35 (ii), Section 7 (x) and Section 8 (xvi) & (xxi) of the REVA University Act, 2012)

1. Title and Commencement:

1.1. These Regulations shall be called the **"REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Post Graduate Degree Programs- 2021".**

1.2. These Regulations shall come into force from the date of assent of the Chancellor.

2. The Programs:

The following programs and all Graduate Degree programs to be instituted and introduced in REVA University in coming years shall follow these regulations.

M.Sc in:

Biotechnology

Biochemistry

Chemistry

Physics

Mathematics

3. Definitions:

Course: Every course offered will have three components associated with the teaching-learning process of the course, namely:

(i) L= Lecture (ii) T= Tutorial (iii) P=Practice;

Where:

L stands for **Lecture** session consisting of classroom instruction.

T stands for **Tutorial** session consisting participatory discussion / self study/ desk work/ brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes.

P stands for **Practice** session and it consists of Hands on Experience / Laboratory Experiments / Field Studies / Case Studies that equip students to acquire the much required skill component.

4. Courses of study and Credits

4.1. The study of various subjects in M. Sc., degree program are grouped under various courses. Each of these course carries credits which are based on the number of hours of teaching and learning.

4.1.1. In terms of credits, every **one hour session of L amounts to 1 credit per Semester** and a minimum of **two hour session of T or P amounts to 1 credit per Semester** over a period of one Semester of 16 weeks for teaching-learning process.

4.1.2. **The total duration of a semester is 20 weeks inclusive of semester-end examination.**

4.1.3. **A course shall have either or all the four components.** That means a course may have only lecture component, or only practical component or combination of any two or all the three components.

4.1.4. **The concerned BoS will assign Credit Pattern for every course based on the requirement. However, generally, courses can be assigned with 1-4 Credits depending on the size of the course.**

4.1.5. Different **Courses of Study** are labelled and defined as follows:

Core Course:

A course which should compulsorily be studied by a candidate as a core-requirement is termed as a Core course. The CORE courses of Study are of THREE types, viz – (i) Hard Core Course, and (ii) Soft Core Course.

A. Hard Core Course (HC):

The **Hard Core Course** is a Core Course in the main branch of study and related branch (es) of study, if any that the candidates have to complete compulsorily.

B. Hard Core Course (HC):

The **Hard Core Course** is a Core Course in the main branch of study and related branch (es) of study, if any that the candidates have to complete compulsorily.

C. Soft Core Course (SC):

A Core course may be a **Soft Core** if there is a choice or an option for the candidate to choose a course from a pool of courses from the main branch of study or from a sister/related branch of study which supports the main branch of study.

D. Open Elective Course (OE):

An elective course chosen generally from other discipline / subject, with an intention to seek exposure to the basics of subjects other than the main discipline the student is studying is called an O**pen Elective Course.**

E. Project Work / Dissertation:

Project work / Dissertation work is a special course involving application of knowledge in solving / analysing /exploring a real life situation / difficult problem. A project work carrying **FOUR or SIX** credits is called **Minor Project** work / **Dissertation.** A project work of **EIGHT, TEN, TWELVE or SIXTEEN** credits is called **Major Project** work / **Dissertation**. **A Project work may be a hard core or a Soft Core as decided by the BoS / concerned.**

5. Eligibility for Admission:

Bachelors Degree of three years with Chemistry subject/Physical Science as one of the cognate / major / optional subjects with 45% (40% in case of candidates belonging to SC/ST) of marks in aggregate from any recognized University / Institution or any other qualification recognized as equivalent thereto.

6. Scheme, Duration and Medium of Instructions:

6.1. M.Sc., degree program is of 4 semesters - 2 years duration. A candidate can avail a maximum of 6 semesters (3 years) including blank semesters, if any to successfully complete M. Sc. degree. Whenever a candidate opts for blank semester, he/she has to study the prevailing courses offered by the School when he/she resumes his/her studies.

6.2. The medium of instruction shall be English.

7. Credits and Credit Distribution:

7.1. A candidate has to earn 96 credits for successful completion of Two Year Postgraduate degree with a distribution of credits for different courses as given in Table - 1 given below:

Table-1

Credits and Credit Distribution for Two Year Post Graduate degree programs

Course Type	**Credits for Two Year (4 Semesters) Post Graduate Degree Programs**
Core Course	A minimum of 60 but not exceeding 70
DSEC (SC)	A minimum of 14 but not exceeding 30
Open Elective (OE)	A minimum of 04
Project	A minimum of 8
MOOC/Online	A minimum of 2 but not exceeding 8
Total	**90**

7.2. The concerned BOS based on the credits distribution pattern given above shall prescribe the credits to various types of courses and shall assign title to every course including project work, practical work, field work, self-study elective, as **Hard Core (HC)/Core Course (CC) or Soft Core/DSEC (SC) or Open Elective (OE)**. The concerned BOS based on the credits distribution pattern given above shall prescribe the credits to various types of courses and shall assign title to every course including project work, practical work, field work, self-study elective, as **Hard Core (HC)/Core Course (CC) or Soft Core/DSEC (SC) or Open Elective (OE)**.

7.3 Every course including project work, practical work, field work, self-study elective should be entitled as Hard Core (HC) or Soft Core (SC) or Open Elective (OE) by the BoS concerned.

However, following shall be the RULO (REVA Unique Learning Offerings) courses with credits mentioned against them, common to all branches of study. However the BoS of respective program/ discipline shall decide about the total credits for RULO courses.

MOOCCourses		
Sl. No.	**Course Title**	**Number of Credits**
2	MOOC / Swayam/ Coursera/Internship /Soft Skill Training/ Attending conferences/Webinars/Industrial Visits/In-house R&D etc.	4
	Total	**4**

7.4. The concerned BOS shall specify the desired Program Objectives, Program Educational Objectives, Program Specific Outcomes and Course Outcomes while preparing the curriculum of a particular program.

7.5. A candidate can enrol for a maximum of 30 credits and a minimum of 20 credits per Semester. However he / she may not successfully earn a maximum of 30 credits per semester. This maximum of 30 credits does not include the credits of courses carried forward by a candidate.

7.6. Only such full time candidates who register for a minimum prescribed number of credits in each semester from I semester to IV semester and complete successfully 96 credits in 4 successive semesters shall be considered for declaration of Ranks, Medals, Prizes and are eligible to apply for Student Fellowship, Scholarship, Free ships, and such other rewards / advantages which could be applicable for all full time students and for hostel facilities.

8. Add-on Proficiency Certification / Diploma:

8.1. Add- on Proficiency Certification:

To acquire Add on Proficiency Certification a candidate can opt to complete a minimum of 4 extra credits either in the same discipline /subject or in different discipline / subject in excess to 90 credits for the Two Year Post Graduate degree programs.

8.2. Add on Proficiency Diploma:

To acquire Add on Proficiency Diploma, a candidate can opt to complete a minimum of 18 extra credits either in the same discipline /subject or in different discipline / subject in excess to 90 credits for the Two Year Post Graduate degree programs.

The Add on Proficiency Certification / Diploma so issued to the candidate contains the courses studied and grades earned.

9. Assessment and Evaluation:

A. Each course is assessed for a total weight of 100%. Out of the total 100% weight; 50% weight is for Continuous Internal Assessment (CIA or IA) and the remaining 50% for the Semester End Examination (SEE). This applicable for theory, laboratory, workshop, studio and any such courses

B. Out of 50% weight earmarked for Internal Assessment (IA)- 15% for test-1, 15% for test-2 and 20% for Assignments/and this is applicable for theory based courses

C. The tests and assignments are conducted as per the semester academic calendar provided by the University.

The details as given in the table:

Component	**Description**	**Conduction**	**Weight Percentage**
C1	Test-1: IA1	8th week from the starting date of semester	15
	Test-2: IA2	16th week from the starting date of semester	15
C2	1 Assignment	7th week	10
	2 Assignment	13th week	10
C3	SEE including practical	between 17th Week-20th Week	50
Results to be Announced			**By the end of 21st Week**

Note: IA or CIA includes C1 and C2

Each test must be conducted for a duration of 60 minutes, setting the test question paper for a maximum of 30 marks. The final examination must be conducted for a duration of 3 hours and the question paper must be set for a maximum of 100 marks.

D. Students are required to complete courses like technical skills, placement related courses, Open electives and any such value addition or specialized courses through online platforms like SWAYAM/NPTEL/Any other reputed online education aggregator. Students are required to choose the courses on the advice of their course coordinator/Director and required to submit the course completion certificate along with percentage of marks/grade scored in the assessment conducted by the online education aggregator. If the online education aggregator has issued a certificate along with the grade or marks scored to students, such courses will be considered for SGPA calculations, in case the aggregator has issued only a certificate and not marks scored, then such courses will be graded through an examination by concerned School. The Online/MOOCs courses will not have continuous internal assessment component.

Such of those students who would like to discontinue with the open elective course that they have already registered for earning required credits can do so, however, they need to complete the required credits by choosing an alternative open elective course.

Setting question paper and evaluation of answer scripts:

i. For SEE, three sets of question papers shall be set for each theory course out of which two sets will be by the internal examiners and one set will be by an external examiner. In subsequent years by carrying forward the unused question papers, an overall three sets of question papers should be managed and depending on the consumption of question papers either internal or external examiner be called for setting the question paper to maintain an overall tally of 3 papers with the conditioned mentioned earlier. The internal examiner who sets the question paper should have been course tutor.

ii. The Chairman of BoE shall get the question papers set by internal and external examiners.

iii. There shall be single valuation for all theory papers by internal examiners. However, there shall be moderation by the external examiner who has the subject background. In case no external examiner with subject background is available, a senior faculty member within the discipline shall be appointed as moderator.

iv. The SEE examination for Practical work / Field work / Project work/Internship will be conducted jointly by internal and external examiners as detailed below: However, the BoE on its discretion can also permit two internal examiners.

v. If a course is fully of (L=0): T :(P=0) type or a course is partly P type i.e, (L=3): (T=0) (P=1), then the examination for SEE component will be as decided by the BoS concerned.

10. Evaluation of Practical's and Minor Project / Major Project / Dissertation:

10.1. A practical examination shall be assessed on the basis of:

A. Knowledge of relevant processes;

B. Skills and operations involved;

C. Results / products including calculation and reporting.

10.2. In case a course is fully of P type (L=0:T=0:P=4), the performance of a candidate shall be assessed for a maximum of 100 marks as explained below:

A. Continuous Internal assessment (CIA) = 50 marks.

B. Semester end practical examination (SEE) = 50 marks.

I	Conduction of regular practical throughout the semester	20 marks
Ii	Maintenance of lab records /industry reports/SDP reports	15 marks
Iii	Laboratory test and viva	15 marks

	Total	**50 marks**

The 25 marks for continuous assessment shall further be allocated as under (IA or CIA):

The 50 marks meant for Semester End Examination shall be allocated as under:

i	Conduction of semester end practical examination	30 marks
ii	Write up about the experiment / practical conducted	10 marks
iii	Viva Voce	10 marks
	Total	50 marks

10.3. The SEE for Practical work will be conducted jointly by internal and external examiners. However, if external examiner does not turn up, then both the examiners will be internal examiners. In case a course is partly P type i.e, (L=3): (T=0) (P=1), then the examination for SEE component will be as decided by the BoS concerned.

10.4. The duration for semester-end practical examination shall be decided by the concerned School Board.

10.5. Evaluation of Minor Project / Major Project / Dissertation:

Right from the initial stage of defining the problem, the candidate must submit the progress reports periodically and present his/her progress in the form of seminars in addition to the regular discussion with the supervisor. At the end of the semester, the candidate has to submit final report of the project / dissertation, as the case may be, for final evaluation. The components of evaluation are as follows:

1	First Dissertation presentation describing the problem definition	Should be done a semester before the project semester	Weightage: 0%
2	Dissertation Progress presentation-1	7^{th} week from the start date of project semester	Weightage: 25%
3	Dissertation progress presentation-2	14^{th} Week from the start date of project semester	Weightage -25%
4	Final project Viva and Dissertation Submission	17^{th}-20^{th} Week of project Semester	Weightage: 30% for Dissertation Weightage : 20% for Final Viva Voce

11. Provision for Appeal:

If a candidate is not satisfied with the evaluation of C1, C2 components, he/she can approach the grievance cell with the written submission together with all facts, the assignments, test papers etc,

which were evaluated. He/she can do so before the commencement of semester-end examination. The grievance cell is empowered to revise the marks if the case is genuine and is also empowered to levy penalty as prescribed by the university on the candidate if his/her submission is found to be baseless and unduly motivated. This cell may recommend taking disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the grievance cell is final.

For every program there will be one grievance cell. The composition of the grievance cell is as follows:-

- The Registrar (Evaluation) - Ex-officio Chairman / Convener.
- One Senior Faculty Member (other than those concerned with the evaluation of the course concerned) drawn from the school / department/discipline and/or from the sister schools / departments/sister disciplines – Member.
- One Senior Faculty Members / Subject Experts drawn from outside the University school / department – Member.

12. Eligibility to Appear Semester End Examination (SEE)

12.1. Only those students who fulfil a minimum of 75% attendance in aggregate of all the courses including practical courses / field visits etc, as part of the course(s), as provided in the succeeding sections, shall be eligible to appear for SEE examination.

12.2. Requirements to Pass a Course

Students are required to score a total minimum of 40% (Continuous Internal assessment and SEE) in each course offered by the University/ Department for a pass (other than online courses) with a minimum of 20 (40% of 50) marks in final examination

13. Requirements to Pass the Semester

To pass the semester, a candidate has to secure minimum of 40% marks in each subject / course of the study prescribed in that semester.

13.1. Provision to Carry Forward the Failed Subjects / Courses:

A student who has failed in a given number of courses in odd and even semesters of first year shall move to third semester of second and final year of the study. However, he / she shall have to clear all courses of all semesters within the double duration, i. e., within four years of admission of the first semester failing which the student has to re-register to the entire program.

13.2. Provision to Withdraw Course:

A candidate can withdraw any course within ten days from the date of notification of final results. Whenever a candidate withdraws a course, he/she has to register for the same course in case it is hard core course, the same course or an alternate course if it is Soft Core Course or Open Elective Course.

A DROPPED course is automatically considered as a course withdrawn.

13.3. Re-Registration and Re-Admission:

A. In case a candidate's class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University, such a candidate is considered as dropped the semester and is not allowed to appear for end semester examination (C3) and he / she shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

B. In such case where in a candidate drops all the courses in a semester due to personal reasons, it is considered that the candidate has dropped the semester and he / she shall seek re-admission to such dropped semester.

14. Attendance Requirement:

14.1. All students must attend every lecture, tutorial and practical classes.

14.2. In case a student is on approved leave of absence (e g:- representing the university in sports, games or athletics, placement activities, NCC, NSS activities and such others) and / or any other such contingencies like medical emergencies, the attendance requirement shall be minimum of 75% of the classes taught.

A. Any student with less than 75% of attendance in aggregate of all the courses including practical courses / field visits etc, during a semester shall not be permitted to appear to the end semester (C4) examination and such student shall seek re-admission as provided in 7.8.4.

B. Teachers offering the courses will place the above details in the School Board meeting during the last week of the semester, before the commencement of C3, and subsequently a notification pertaining to the above will be brought out by the Director of the School before the commencement of C3 examination. A copy of this notification shall also be sent to the office of the Registrar & Registrar (Evaluation).

15. Absence during Mid Semester Examination:

In case a student has been absent from a mid-semester (C1, C2) examination due to the illness or other contingencies he / she may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Head of the School, for make-up examination. The Head of the School may consider such request depending on the merit of the case and after consultation with course instructor and class teacher, and arrange to conduct a special test for such candidate(s) well in advance before the C3 examination of that respective semester. Under no circumstances C1, C2 test shall be held after C3 examination.

16. Grade Card and Grade Point

16.1. **Provisional Grade Card**: The tentative / provisional grade card will be issued by the Registrar (Evaluation) at the end of every semester indicating the courses completed successfully. The provisional grade card provides **Semester Grade Point Average** (SGPA).

16.2. **Final Grade Card:** Upon successful completion of M.Sc., Degree a Final Grade card consisting

of grades of all courses successfully completed by the candidate will be issued by the Registrar (Evaluation).

16.3. The Grade and the Grade Point: The Grade and the Grade Point earned by the candidate in the subject will be as given below.

Marks P	Grade G	Grade Point (GP=V x G)	Letter Grade
90-100	10	v*10	O
80 - 89	9	v*9	A+
70 - 79	8	v*8	A
60 - 69	7	v*7	B+
55 -59	6	v*6	B
50 - 54	5.5	V*5.5	C +
40 - 49	5	v*5	C
0-39	0	v*0	F
ABSENT			AB

O - Outstanding; A-Excellent; B-Very Good; C-Good; D-Fair; E-Satisfactory; F - Fail
Here, P is the percentage of marks (P= [C1+C2+C3]) secured by a candidate in a course which is **rounded to nearest integer**. V is the credit value of course. G is the grade and GP is the grade point.

16.3.1 Computation of SGPA and CGPA

The Following procedure to compute the Semester Grade Point Average (SGPA).

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student in a given semester, i.e:

SGPA (Si) = ∑ (Ci x Gi) / ∑Ci Where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

Illustration for Computation of SGPA and CGPA

Illustration No. 1

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit x Grade)
Course 1	4	A+	9	4X9=36
Course 2	4	A	8	4X8=32
Course 3	3	B+	7	3X7=21
Course 4	3	O	10	3X10=30
Course 5	3	P	5	3X5=15
Course 6	3	B	6	3X6=18
Course 7	2	O	10	2X10=20
Course 8	2	A	8	2X8=16
	24			188

Thus, **SGPA = 188 ÷ 24 = 7.83**

Illustration No. 2

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade point)
Course 1	4	A	8	4X8=32
Course 2	4	B+	7	4X7=28
Course 3	3	A+	9	3X9=27
Course 4	3	B+	7	3X7=21
Course 5	3	B	6	3X6=18
Course 6	3	P	5	3X5=15
Course 7	2	B+	7	2X7=21
Course 8	2	O	10	2X10=20
	24			**175**

Thus, **SGPA = 175 ÷ 24 = 7.29**

Illustration No.3

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit x Grade point)
Course 1	4	O	10	4 x 10 = 40
Course 2	4	A+	9	4 x 9 = 36
Course 3	3	B+	7	3 x 7 = 21
Course 4	3	B	6	3 x 6 = 18
Course 5	3	A+	9	3 x 9 = 27
Course 6	3	B+	7	3 x 7 = 21
Course 7	2	A+	9	2 x 9 = 18
Course 8	2	A+	9	2 x 9 = 18
	24			**199**

Thus**, SGPA = 199 ÷ 24 = 8.29**

Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (96) for Two year Post Graduate degree program is calculated taking into account all the courses undergone by a student over all the semesters of a program i. e.,

$$CGPA = \sum(Ci \times Si) / \sum Ci$$

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration: No.4

CGPA after Final Semester

Semester (ith)	**No. of Credits (Ci)**	**SGPA (Si)**	**Credits x SGPA (Ci X Si)**
1	24	6.83	24 x 6.83 = 163.92
2	26	7.71	26 x 7.71 =200.46
3	24	8.68	24 x 8.68 = 208.32
4	16	9.20	16 x 9.20 = 147.20
Cumulative	90		719.9

Thus, CGPA = 24×6.83+26×7.71+24×8.68+24×9.20 = 7.99 (90)

16.3.2 Conversion of Grades into Percentage:

Conversion formula for the conversion of CGPA into Percentage is:

Percentage of marks scored = CGPA Earned x 10

Illustration: CGPA Earned 8.10 x 10=81.0

16.3.3 Classification of Results

The final grade point (FGP) to be awarded to the student is based on CGPA secured by the candidate and is given as follows.

CGPA	**Grade (Numerical Index)**	**Letter Grade**	**Performenace**	**FGP**
	G			**Qualitative Index**
9 >= CGPA 10	10	O	Outstanding	First Class with Distinction
8 >= CGPA < 9	9	A+	Excellent	
7 >= CGPA < 8	8	A	Very Good	First Class
6 >= CGPA < 7	7	B+	Good	
5.5> = CGPA < 6	6	B	Above average	Second Class
> 5 CGPA < 5.5	5.5	C	Average	
> 4 CGPA <5	5	P	Satisfactory	Pass Class
< 4 CGPA	0	F	Not Satisfactory	Unsuccessful

Overall percentage=10*CGPA

Mapping of PEOs with respect to POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
PEO1	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO2	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO3	√	√	√	√	√	√	√	√	√	√	√	√	√

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21SM 0101	CO1	2	3	2	1			1		1	1	3	2	2
	CO2	2	2	2	1			1		1	1	3	2	2
	CO3	2	2	2	1			1		1	1	3	2	2
	CO4	2	2	2	1			1		1	1	3	2	2
M21SM 0102	CO1	1	2	1	2	3		2				1	1	1
	CO2	1	3		2	3						1	2	2
	CO3	1	2		2	3						2	2	2
	CO4	1	2	1		3					1	1	3	2
M21SM 0103	CO1	1					1			1	2	2		
	CO2						1			1	2	1		
	CO3	1				1	1	1	1	2	2	2		1
	CO4	1				1	1	1	1	2	2	2		2
M21SM 0104	CO1	1	1	2	2	2			1					1
	CO2	2	1	2	2	2			1			1	1	1
	CO3	2	1	1	1	2			2			2	1	2
	CO4	2	2	2	2	3			2			2	3	2
M21SM 0105	CO1	3	3		2	2		1			3	1		2
	CO2	3	3		2	2		1			2	1		
	CO3	3	3		1	1		1			2	1		1
	CO4	3	3		2	1		1			2	1		1
M21SM S101	CO1	2	2	1	2	1	1				1	3	1	1
	CO2	2	2	2	2	1	1				1	3	1	1
	CO3	2	1	2	1	1	1				1	3	2	2
	CO4	2	1	2	2	2	1				1	3	2	3
M21SM S102	CO1	3	2	2	1	2				1	2	3	4	3
	CO2	3	3	3	4	3	1			1	2	3	4	3

	CO3	3	3	3	2	3				1	2	3	4	3
	CO4	3	2	3	1	3	3			1	2	3	3	3
M21SMS103	CO1	3	2	1	1	2	2	2	2	1	2	2	1	1
	CO2	2	2	2	2	3	2	1	2	2	1	2	2	2
	CO3	3	2	2	2	3	2	2	2	3	3	2	2	2
	CO4	3	3	3	2	3	2	1	3	2	2	3	2	1
M21SM0104	CO1	2	1	1	2	3	1			1	2	2	2	3
	CO2	1	2	1	3	3	1			1	2	1	1	3
	CO3	2	2	2	1	2	1			2	2	1	3	2
	CO4	2	3	2	3	3	2			2	2	2	2	1
M21SM0106	CO1	3	2	3	1	2	3	2			1	2	3	2
	CO2	2	2	2	3	2	2	2			1	3	2	3
	CO3	2	2	3	1	3	2	3			1	3	3	2
	CO4	3	2	3	1	2	1	2			1	2	2	3
M21SMS107	CO1	1	2	1	2	1	2		2			2	2	2
	CO2	2	1	2	2	2	1		2			1	2	1
	CO3	2	2	2	1	1	2		1			2	1	2
	CO4	2	2	2	2	2	2		2			2		
M21SM0201	CO1	3	1		2	1	1		2		2	1	2	
	CO2	3	3	2	2	1	1	1	2	1	2	2	2	2
	CO3	3	2	1	2		2		2	2	2	1	1	2
	CO4	2	3	2	1	2	2	2	2	2	3	2	1	3
M21SM0202	CO1	3	2		2	2	2			1	1	3	2	1
	CO2	3	3	1	2	2	2			1	1	3	2	2
	CO3	3	3	1	2	2	1			1	1	3	2	2
	CO4	2	2	1	2	2	2			1	1	3	2	2
M21SM0203	CO1	2	3	2	2	2	1			1	2	2	2	2
	CO2	2	2	1	2	2	1			1	2	2	1	2
	CO3	2	3	2	2	2	1			1	2	2	2	3
	CO4	3	3	2	2	2	1			1	2	3	2	3
M21SM0204	CO1	1	2			3	1	3	1	2	2	2	3	3
	CO2	1	2		1	3	2	3	1	2	2	2	3	3
	CO3	1	2		1	3	2	3	1	2	2	2	3	3
	CO4	1	1			2	1	2	1	2	1	2	1	2
	CO1	**2**	**1**	**2**	**1**	**2**	**1**	**1**			**1**	**3**	**1**	**2**

M21SM 0205	**CO2**	**3**	**2**	**1**	**2**	**2**	**3**	**2**			**1**	**1**	**1**	**3**
	CO3	**2**	**2**	**2**	**3**	**3**	**2**	**1**			**1**	**3**	**1**	**2**
	CO4	**3**	**2**	**1**	**2**	**1**	**2**	**2**			**1**	**3**	**1**	**2**
M21SM S201	CO1	1	1			2	2					2	2	
	CO2	2	1		1	2	1					1	2	2
	CO3	2	2		1	2	2					2		2
	CO4	2	2		2	2	2					2	2	2
M21SM S202	CO1	2	1	2	1	2	1	1			1	2	1	2
	CO2	3	1	1	2	2	1	2			1	2	1	3
	CO3	2	2	2	1	3	2	2			1	2	1	2
	CO4	3	2	1	2	1	2	2			1	3	1	2
M21SM S203	CO1	2	1	2	1	2	1	1			1	2	1	2
	CO2	3	1	1	2	2	1	2			1	2	1	3
	CO3	2	2	2	1	3	2	2			1	2	1	2
	CO4	3	2	1	2	1	2	2			1	3	1	2
M21SM S204	CO1	2	2		2	1	1					1	2	2
	CO2	2	1		2	1	1					2	2	2
	CO3	2	2	1	1	2	2		1			1	2	1
	CO4	2	1	2	2	2	1		2			2	2	2
M21SM 0206	CO1	3	2	2	2	2	2	2	2	2	2	3	1	
	CO2	2	3	1	2	2	2	1	1	2	2	3	2	1
	CO3	3	2	2	2	3	2	1	3	3	2	3	2	3
	CO4	2	2	2	3	3	2	1	2	2	2	3	2	3
M21SM 0207	CO1	3	2	1	1	1	2	3	2	2	2	2		2
	CO2	1	2	1	1	3	2	2	2	2	2	2		2
	CO3	2	2		1	2	2	2	1	2	2	2		2
	CO4	1	2	1		2	2	2	2	2	1	1		2
M21SM Z301	CO1	2	1	3	3	2	2			1	2	3	3	2
	CO2	4	3	2	2	2	1			1	2	3	3	2
	CO3	2	2		3	3	1			1	2	3	3	3
	CO4	4	3	1	2	2	1			1	2	4	3	3
M21SM Z302	2	2	1	2	2	1			1	1	3	1	2	2
	2	2	1	2	1	1			1	1	2	1	2	2
	2	1	1	2	1	2			2	1	2	1	2	2
	2	1	1	1	1	2			2	2	2	1	2	2

M21SMZ303	CO1	2	2			1	2	2		1	2	3	1	1
	CO2	2	2	2	2	3	2	2	2	1	2	2	3	1
	CO3	2	2	2	3	2	1	2	2	2	2	2	2	1
	CO4	2	2	3	2	3	2	2	2	1	3	2	3	1
M21SMZ304	CO1	2	1		3	1						2	3	1
	CO2	3			3	1						3	3	1
	CO3	3			3	1						2	3	1
	CO4	3			3	1						2	3	1
M21SMS301	CO1	2	1	2			1			1	1	2		1
	CO2	1	1	1			1	1		1	1	2		1
	CO3	1		1		1	2	1	1	1	1	2		
	CO4	1	1	1		1	1	1	1	1	1	1		
M21SMZ305	CO1	3	3	3	3	3	2	1	1	1	2	2	3	2
	CO2	3	3	2	3	3	2	1	2	1	2	2	2	2
	CO3	2	3	2	2	3	2	1	1	1	2	3	2	3
	CO4	2	2	2	2	2	2	2	1	1	2	2	2	2
M21SMZ306	CO1	3	2	2	2	3	2	2		1	2	1	2	2
	CO2	3	2	2	2	2	2	2	2	1	2	2	3	2
	CO3	2	2	2	3	2	1	2	2	2	2	2	2	3
	CO4	2	3	3	2	2	2	2	2	1	2	2	2	2
M21SMZ307	CO1	3	1	2	1	2	3	1			1	2	1	2
	CO2	2	1	2	2	2	1	2			1	2	2	3
	CO3	2	2	1	1	3	2	3			1	3	1	2
	CO4	3	2	2	1	2	1	2			1	2	2	3
M21SMZ308	CO1	3	3		1	3	1	2		1	2	3	2	2
	CO2	1	1	1	1	3	2	2		1	2	4	2	2
	CO3	1	2		2	3	1			1	2	1	2	2
	CO4	1	3		2	3	1	2		1	2	1	2	2
M21SMZ309	CO1	3	2		1	2				1	1	3	2	2
	CO2	3	2	3	3	2				1	1	3	2	2
	CO3	2	2	3	2	2				1	1	3	2	1
	CO4	2	2	2	2	3	2			1	1	3	2	2
M21SMZ310	CO1	1		1	1	1		1	1			1	1	1
	CO2	2	1	2		3	1	2	2			2	2	2

	CO3	2	1	2		3	1	2	2			2	2	2
	CO4	2	1	1		2	1	1	2			2	1	1
M21SM S302	CO1	2	2	1	2	1	2		1			2	2	1
	CO2	3	1	2	2	2	3		2			2	1	2
	CO3	2	3	2	1	2	2		2			1	2	3
	CO4	3	2	2	1	2	1		2			2	2	3
M21SM Z311	CO1	3	2	1	3	2		3			1	3	3	2
	CO2	2	2	1	3	1	1	1		3	1	3	2	2
	CO3	2	2	2	3	2	2	2		2	1	3	2	2
	CO4	2	2	1	1	2	1				1	3	2	1
M21SM Z312	CO1	2	3	3	3	3	3	3	3	1	2	2	3	3
	CO2	2	3	3	3	2	2	3	1	2	2	2	3	3
	CO3	2	2	2	2	3	3	2	2	1	1	2	3	3
	CO4	3	3	3	3	2	2	1	2	1	3	2	3	3
M21SM Z313	CO1	2	2	1	1	1	2	2	1	1	2	2	2	1
	CO2	1	2	2	2	2	2	2	2	1	2	3	2	2
	CO3	2	1	2	3	2	1	3	2	2	2	2	1	1
	CO4	2	2	3	2	2	2	2	2	1	3	3	2	2
M21SM Z314	CO1	2	2	3	3	3	3	1	1	1	2	3	3	3
	CO2	2	3	1	2	2	2	1	2	1	2	3	2	2
	CO3	3	3	1	2	3	1	1	2	1	2	2	2	2
	CO4	2	2	3	3	3	3	1	1	1	2	3	3	3
M21SM Z315	CO1	3	2	1	3	2	3	1	1	1	1	3	2	2
	CO2	3	2	1	1	2	2	1	1	1	1	3	2	2
	CO3	3	2	1	2	2	1	2	1	1	1	3	2	2
	CO4	3	2	3	1	1	1	1	2	1	1	3	2	2
M21SM Z316	CO1	2	1	1	2	1	1	1	2	1	2	2	2	1
	CO2	2	2	2	2	1	2	1	2	1	2	2	2	2
	CO3	2	1	1	1	1	2	1	1	1	1	2	2	2
	CO4	2	1	2	1	1	1	1	1	1	2	2	2	1
M21SM S303	CO1	2	1	2	1	1	2	1	1	2	1	2	1	2
	CO2	1	1	1	2	1	2	1	1	1		1	1	1
	CO3	3	1	2	1	2	1	1	1	1	1	1	1	1
	CO4	2	2	2	2	2	2	1	1	1	1	2	3	2
	CO1	3	2		2	3		1	1	1	2	3	3	3

M21SM Z319	CO2	2	2	1	3	3	2	1	1	1	2	3	2	3
	CO3	3	3		3	3	1	2	1	1	2	4	3	2
	CO4	4	3	1	3	3	1	2	1	1	2	4	4	3
M21SM Z320	CO1	3	3	1		2	1	1	2		2	2	4	3
	CO2	4	3	3	2	3	3	1	2	1	2	3	4	2
	CO3	2	1	3	3	3	2	1	1	1	2	3	4	3
	CO4	1	3	3	2	3	3	1		1	2	2	4	2
M21SM Z321	CO1	3	2	2	1	3	1	2	2	2	1	3	3	3
	CO2	2	1	2	2	3	1	2	2	2	2	2	2	3
	CO3	3	3	2	2	2	1	1	2	2	2	2	2	3
	CO4	3	3	1	2	3	1	1	3	3	2	3	3	3
M21SM Z322	CO1	2	1		3	1						2	3	1
	CO2	3			3	1						3	3	1
	CO3	3			3	1						2	3	1
	CO4	3			3	1						2	3	1
M21SM S304	**CO1**	3	3	1		1	3	3	1	1	3		1	
	CO2	1	3	2	2	1	1	1	1		1		1	1
	CO3	1	3	1	1	1	2	2			1	1	3	1
	CO4	1	2	3	3	3	1	1	1		1	2	3	2
M21SM Z323	CO1	2	3	3	3	3	3	3	3	1	2	2	3	3
	CO2	2	3	3	3	2	2	3	1	2	2	2	3	3
	CO3	2	2	2	2	3	3	2	2	1	1	2	3	3
	CO4	3	3	3	3	2	2	1	2	1	3	2	3	3
M21SM Z324	CO1	2	3	3	3	3	3	3	3	1	2	2	3	3
	CO2	2	3	3	3	2	2	3	1	2	2	2	3	3
	CO3	2	2	2	2	3	3	2	2	1	1	2	3	3
	CO4	3	3	3	3	2	2	1	2	1	3	2	3	3
M21SM O301	CO1	2	2	1	2	1	2			1	1	2	3	1
	CO2	2		2	1	1	1			1	0	1	2	2
	CO3	1		2	1	2	1			1		1	2	2
	CO4	2	1		1	2	1			1	1	1	3	1
M21SM O302	**CO1**	2	2				2		2			2	2	2
	CO2	2	2	3			3		3			2	2	3
	CO3	1	3				2		2			2	1	2
	CO4	2	2	3		2	3		3			2	2	2

M21SMO303	CO1	2	2	1	2	1	2			1	1	2	3	1
	CO2	1		1	1	1	1			1	0	1	2	2
	CO3	1		2	1	2	1			1		2	2	2
	CO4	1	1		1	2	1			1	1	1	3	1
M21SMO304	**CO1**	**2**	**1**	**2**	**2**	**2**	**1**	**1**	**0**	**0**	**1**	**3**	**1**	**2**
	CO2	**3**	**2**	**1**	**2**	**2**	**3**	**2**	**0**	**0**	**1**	**2**	**1**	**3**
	CO3	**2**	**3**	**2**	**3**	**3**	**2**	**1**	**0**	**0**	**1**	**3**	**1**	**2**
	CO4	**3**	**2**	**1**	**2**	**2**	**2**	**2**	**0**	**0**	**1**	**3**	**1**	**3**
M21SMO305	CO1	2			1	1	1				1	1	1	2
	CO2	2			1	1	1				1	1	1	2
	CO3	2			1	1	1				1	1	1	2
	CO4	2			1	1	1				1	1	1	2
M21SMO306	**CO1**	**3**	**1**	**1**	**2**	**1**	**1**	**0**	**0**	**1**	**1**	**2**	**3**	**1**
	CO2	**1**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**1**	**2**	**2**
	CO3	**1**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**1**	**2**	**2**
	CO4	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**3**	**1**
M21SMS401	CO1	2	3	1	2	3				1	2	3	2	3
	CO2	3	3	1	2	3	2			1	2	3	3	3
	CO3	3	3		2	2				1	2	3	3	3
	CO4	3	2	1	2	3	1			1	2	1	1	3
M21SMS402	CO1	3		1	2							3	2	2
	CO2	1	1	2			3					3	2	1
	CO3	2		2	2		2			2		2	2	2
	CO4	3	1	3	3	2	2			2		2	3	2
M21SMS403	CO1	3	2	1	1	1	2	3	2	2	2	2		2
	CO2	1	2	1	1	3	2	2	2	2	2	2		2
	CO3	2	2		1	2	2	2	1	2	2	2		2
	CO4	1	2	1		2	2	2	2	2	1	1		2
M21SMS404	CO1	3	1		3	2		2	2		2	2	2	1
	CO2	2	2	2	3	3		1	2	2	3		2	2
	CO3	3	2	2	2	2	1	2	2	2	2	1	1	2
	CO4	2	3	2	1	2	2	2	2	2	3	2	1	2
M21SMS405	CO1	3	3	1		2	1				2	2	2	3
	CO2	1	3	3	2	3	3			1	2	3	2	2
	CO3	2	1	3	3	3	2			1	2	3	1	3

	CO4	1	3	3	2	3	3			1	2	2	1	2
M21SMS406	CO1	3	2	2	2	1	3	2	1	2	1	3	2	2
	CO2	2	2	3	2	2	2	2	2	2	2	3	3	2
	CO3	2	3	2	3	3	1	2	2	2	2	2	2	3
	CO4	3	1	1	2	2	2	2	2	3	3	2	3	2
M21SMS407	CO1	2	1		2	1						2	2	1
	CO2	2			2	1						2	2	1
	CO3	2	1		1	1						2	2	1
	CO4	2		2			1					2	2	1
M21SM0S407	CO1	3	2	2	2	2	2		1	1	1	3	3	3
	CO2	3	2		3	2	1				1	3	3	2
	CO3	3	3	3	2	3	1			1	1	3	2	2
	CO4	3	2		2	2	2			1	1	3	3	3
M21SMS408	CO1	2	1	2	2	2	1			1	1	2	2	2
	CO2	2	1	1	2	2	1			1	2	2	1	3
	CO3	2	1	2	2	2	1			2	2	2	2	2
	CO4	3	1	2	2	2	2			1	2	3	2	3
M21SMS409	CO1	3	2	2	2	2	2		1	1	1	3	3	3
	CO2	3	2		3	2	1				1	3	3	2
	CO3	3	3	3	2	3	1			1	1	3	2	2
	CO4	3	2		2	2	2			1	1	3	3	3
M21SMS411	CO1	2	3	3	3	3	3	3	3	1	2	2	3	3
	CO2	2	3	3	3	2	2	3	1	2	2	2	3	3
	CO3	2	2	2	2	3	3	2	2	1	1	2	3	3
	CO4	3	3	3	3	2	2	1	2	1	3	2	3	3

3: highly relevant, 2: moderate, 1: Low

Assessment Table

Hardcore	COs	IA1	IA2	Assignment	SEE	Total	Hours
	CO1	7.5		5	12.5	25	15
	CO2	7.5		5	12.5	25	15
	CO3		7.5	5	12.5	25	15
	CO4		7.5	5	12.5	25	15
Softcore	**COs**	**IA1**	**IA2**	**Assignment**	**SEE**	**Total**	**Hours**
	CO1	7.5		5	12.5	25	12
	CO2	7.5		5	12.5	25	12
	CO3		7.5	5	12.5	25	12
	CO4		7.5	5	12.5	25	12

M.Sc. (Chemistry) Program

Scheme of Instructions (Effective for Academic Year 2021-22)

Sl. No.	Course Code	Course Title	Course Type	Credit Pattern and Value L				Weekly Contact Hours	Teaching School/Dept.
				L	T	P	C		
First Semester									
1	M21SM0101	Inorganic Chemistry -I	HC	4	0	0	4	4	Chemistry
2	M21SM0102	Organic Chemistry -I	HC	4	0	0	4	4	Chemistry
3	M21SM0103	Physical Chemistry -I	HC	4	0	0	4	4	Chemistry
4	M21SM0104	Analytical Chemistry- I	HC	4	0	0	4	4	Chemistry
5	M21SM0105	Computers and Mathematics for Chemist	HC / AECC	2	0	0	2	2	Chemistry
Inorganic chemistry									
6	M21SMS101	Introduction to Nano-science and Nanotechnology - I.1	SC*	2	0	0	2	2	Chemistry
Organic Chemistry									
7	M21SMS102	Heterocyclic Chemistry and Chemistry of Bio-Molecules - I.2	SC*	2	0	0	2	2	Chemistry
Physical Chemistry									
8	M21SMS103	Surface, Interfaces and Catalysis - I.3	SC*	2	0	0	2	2	Chemistry
Analytical Chemistry									
9	M21SMS104	Advanced Instrumental Methods of Analysis- I.4	SC*	2	0	0	2	2	Chemistry
Practical Courses									
10	M21SM0106	Organic Chemistry Practicals-I	HC	0	0	2	2	4	Chemistry
11	M21SM0107	Physical Chemistry Practicals-I	HC	0	0	2	2	4	Chemistry
Total				**20**	**0**	**4**	**24**	**30**	
Note:*Students shall choose any **ONE DSEC*- Soft Core (SC)** out of Four Soft Core Courses									
Second Semester									
1	M21SM0201	Inorganic Chemistry -II	HC	4	0	0	4	4	Chemistry
2	M21SM0202	Organic Chemistry -II	HC	4	0	0	4	4	Chemistry
3	M21SM0203	Physical Chemistry -II	HC	4	0	0	4	4	Chemistry

4	M21SM0204	Organic Spectroscopy	HC	4	0	0	4	4	Chemistry
5	M21SM0205	Challenges in Industrial Research and Development	HC / AECC	2	0	0	2	2	Chemistry
Inorganic Chemistry									
6	M21SMS201	Chemistry of Life -II.1	SC*	2	0	0	2	2	Chemistry
Organic Chemistry									
7	M21SMS202	Introduction to Medicinal Chemistry-II.2	SC*	2	0	0	2	2	Chemistry
Physical chemistry									
8	M21SMS203	Advanced Chemical Kinetics and Thermodynamics-II.3	SC*	2	0	0	2	2	Chemistry
Analytical Chemistry									
9	M21SMS204	Separation and Electro Analytical Techniques-II.4	SC*	2	0	0	2	2	Chemistry
Practical Courses									
13	M21SM0206	Inorganic Chemistry Practicals -II	HC	0	0	2	2	4	Chemistry
14	M21SM0207	Analytical Chemistry Practicals-II	HC	0	0	2	2	4	Chemistry
Total				**22**	**0**	**4**	**26**	**30**	
Note:*Students shall choose any **ONE Soft Core** (SC) out of four Soft Core Courses									
Third Semester									
Inorganic Chemistry-III									
1	M21SMZ301	Advanced Inorganic Chemistry III.1	HC	4	0	0	4	4	Chemistry
2	M21SMZ302	Organometallics-III.2	HC	4	0	0	4	4	Chemistry
3	M21SMZ303	Solid state chemistry and Advanced Materials -III.3	HC	4	0	0	4	4	Chemistry
4	M21SMZ304	Structural Methods in Inorganic Chemistry-III. 4	HC	4	0	0	4	4	
5	M21SMS301	Industrial Inorganic Chemistry-III.5	SC*	2	0	0	2	2	Chemistry
6	M21SMS302	Green Chemistry-III .5	SC*	2	0	0	2	2	Chemistry
7	M21SMS303	Energy and Energy Conversion Systems -III.5	SC*	2	0	0	2	2	Chemistry
8	M21SMS304	Environmental Chemistry and Applied Analysis -III.5	SC*	2	0	0	2	2	Chemistry
9	M21SMZ305	Inorganic Chemistry Practicals-III.1	HC	0	0	2	2	4	Chemistry
10	M21SMZ306	Advanced Inorganic Chemistry Practicals-III.2	HC	0	0	2	2	4	Chemistry
Organic Chemistry-III									
1	M21SMZ307	Advanced Organic Chemistry -III.1	HC	4	0	0	4	4	Chemistry

2	M21SMZ308	Advanced Organic Synthesis -III.2	HC	4	0	0	4	4	Chemistry
3	M21SMZ309	Natural Products and Bioorganic Chemistry-III.3	HC	4	0	0	4	4	Chemistry
4	M21SMZ310	Organometallic Chemistry in Organic Synthesis-III.4	HC	4	0	0	4	4	Chemistry
5	M21SMS301	Industrial Inorganic Chemistry-III.5	SC*	2	0	0	2	2	Chemistry
6	M21SMS302	Green Chemistry-III .5	SC*	2	0	0	2	2	Chemistry
7	M21SMS303	Energy and Energy Conversion Systems -III.5	SC*	2	0	0	2	2	Chemistry
8	M21SMS304	Environmental Chemistry and Applied Analysis -III.5	SC*	2	0	0	2	2	Chemistry
9	M21SMZ311	Organic Chemistry Practicals-III.1	HC	0	0	0	2	4	Chemistry
10	M21SMZ312	Advanced Organic Chemistry Practicals-III.2	HC	0	0	0	2	4	Chemistry
Physical Chemistry III									
1	M21SMZ313	Photo-physical Processes and Applications -III.1	HC	4	0	0	4	4	Chemistry
2	M21SMZ314	Fundamentals of Electrochemistry and Applications-III.2	HC	4	0	0	4	4	Chemistry
3	M21SMZ315	Advanced Physical Chemistry -III.3	HC	4	0	0	4	4	Chemistry
4	M21SMZ316	Polymer Science and Technology -III.4	HC	4	0	0	4	4	Chemistry
5	M21SMS301	Industrial Inorganic Chemistry-III.5	SC*	2	0	0	2	2	Chemistry
6	M21SMS302	Green Chemistry-III .5	SC*	2	0	0	2	2	Chemistry
7	M21SMS303	Energy and Energy Conversion Systems -III.5	SC*	2	0	0	2	2	Chemistry
8	M21SMS304	Environmental Chemistry and Applied Analysis -III.5	SC*	2	0	0	2	2	Chemistry
9	M21SMZ317	Physical Chemistry Practicals – III.1	HC	0	0	0	2	4	Chemistry
10	M21SMZ318	Advanced Physical Chemistry Practicals – III.2	HC	0	0	0	2	4	Chemsitry
Analytical Chemistry III									
1	M21SMZ319	Advanced analytical Chemistry -III.1	HC	4	0	0	4	4	Chemistry

2	M21SMZ320	Advanced Materials Analysis and Electron Spectroscopy-III.2	HC	4	0	0	4	4	Chemistry
3	M21SMZ321	Electrochemistry and Electroanalytical Techniques-III.3	HC	4	0	0	4	4	Chemistry
4	M21SMZ322	Instrumental and Analytical Analysis Techniques –III.4	HC	4	0	0	4	4	Chemistry
5	M21SMS301	Industrial Inorganic Chemistry-III.5	SC*	2	0	0	2	2	Chemistry
6	M21SMS302	Green Chemistry-III .5	SC*	2	0	0	2	2	Chemistry
7	M21SMS303	Energy and Energy Conversion Systems -III.5	SC*	2	0	0	2	2	Chemistry
8	M21SMS304	Environmental Chemistry and Applied Analysis -III.5	SC*	2	0	0	2	2	Chemistry
9	M21SMZ323	Analytical Chemistry Practicals – III.1	HC	0	0	0	2	4	Chemistry
10	M21SMZ324	Analytical Chemistry Practicals – III.2	HC	0	0	0	2	4	Chemsitry
Open Elective #									
1	M21SMO301	Advanced Materials in Semiconductor Device Technologies	OE#	4	0	0	4	4	Chemistry to all other schools/Dept.s
2	M21SMO302	Biodiesel : An Alternative Renewable EnergySource	OE*	4	0	0	4	4	Chemistry to all other schools/Dept.s
3	M21SMO303	Chemistry of Materials	OE*	4	0	0	4	4	Chemistry to all other schools/Dept.s
4	M21SMO304	Chemsitry of Food and Beverages	OE#	4	0	0	4	4	Chemistry to all other schools/Dept.s
5	M21SMO305	Nanotechnology	OE*	4	0	0	4	4	Chemistry to all other schools/Dept.s
6	M21SMO306	Sensor Technologies: Physical Sensors, Chemical Sensors, Biosensors, Gas Sensors and their Instrumentation	OE*	4	0	0	4	4	Chemistry to all other schools/Dept.s
Soft Skills (Non Credit)									
27	M21SMM301	Internship / Skill Development	RULO	0	0	-	-	2	Chemsitry/Training & Placement
Total				**20**	**0**	**4**	**24**	**30**	

Note:
i) *Students shall choose any **ONE Soft Core** out of **FOUR** Soft Core Courses in all specialization.

ii) #Open Elective (OE) is offered for students other than chemistry discipline. The students of MSc Chemistry shall choose open elective from other disciplines.

Fourth Semester

1	M21SM0401	Major Project	HC	0	0	8	8	20	Chemistry
2	M21SMS401	Functional inorganic materials	SC*	2	0	0	2	2	Chemistry
3	M21SMS402	Advanced functional organic materials							
4	M21SMS403	Advanced spectroscopy and applications in structural analysis							
5	M21SMS404	Advanced electroanalytical techniques							
6	M21SMS405	Advances in surface, interface and Catalysis							
7	M21SMS406	Advanced materials in energy storage and conversion devices							
8	M21SMS407	Advances in polymer science and technology							
9	M21SMON1	MOOC/SWAYAM/HARVARD/EDX/ Internship/Attending Conferences/Webinars/Industrial Visit/ In-House R&D, etc. (All Semester)	SEC/MOOC	4	0	0	4	4	Chemistry/ others
Practical Courses									
10	M21SMS408	Advanced organic chemistry Practicals-IV.1	SC*	0	0	2	2	4	Chemistry
11	M21SMS409	Advanced Inorganic chemistry Practicals-IV.2	SC*	**0**	0	2	2	4	Chemistry
12	M21SMS410	Physical Chemistry Practicals-IV.3	SC*	**0**	0	2	2	4	Chemistry
13	M21SMS411	Analytical Chemistry Practicals-IV.4	SC*	**0**	0	2	2	4	Chemistry
Total				**6**	**0**	**2**	**16**	**30**	

NOTE:

1. *****Students shall choose **ONE** in each SC and Lab Courses.
2. Major project is compulsory and will begin in 4thSemester. Students will either choose internal guide from the school and continue with in-house projects or choose to do project work either in industry or research organization.

HC=Hard Core; SC=Soft Core; OE=Open Elective;

Credits Semester-wise (2021-23)

Semester	I	II	III	IV	Total
HC-Theory	16	16	16	- -	48
HC-Lab	4	4	4	- -	12
SC-Theory	2	2	2	2	8
HC/AECC-Theory	2	2	--	--	4
SC-Lab	- -	- -	- -	2	2
OE	- -	- -	4	- -	4
Project/HC	- -	- -	- -	8	8
SEC/MOOC	- -	--	--	4	4
Total	**24**	**24**	**26**	**16**	**90**

Semester-wise Credit Distribution

Semesters	No. of Credits	No. of Hours
I	24	30
II	24	30
III	26	30
IV	16	30
Total	**90**	**120**

Semester-wise Course Types & Credit Distribution
Credits Based on L: T: P

Semester	HC	SC	HC/AECC	OE	SEC/MOOC	TOTAL
I	20	2	2	-	-	24
II	20	2	2	-	-	24
III	20	2		4	-	26
IV	8	4		-	4	16
Total	**68**	**10**	**4**	**4**	**4**	**90**

Semester	L	T	P	Total-C	Total Hours
I	20	0	2	24	30
II	22	0	2	26	30
III	20	0	4	24	30
IV	6	0	2	16	30
Total	**41**	**0**	**33**	**90**	**120**

M.Sc. (Chemistry) Program

DETAILED SYLLABUS (Effective from the Academic Year 2021-22)

SEMESTER-I: HARD CORE (HC)

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SM1010	**INORGANIC CHEMISTRY – I**	HC	4	0	0	4	4

Course Objectives:

This course aims to provide for the student to

i. Learn the Structure, bonding and properties through Lewis, VSEPR, Valence bond and Molecular orbital theory.
ii. Explore the fundamentals of the chemistry of the main group elements include the structure, bonding and properties of Silanes, silicone, boranes, phosphates and inorganic ring system.
iii. Know the classification of acids and bases, HSAB rule, and non-aqueous solvents.
iv. Develop knowledge of the structure, bonding and stability of Metal Clusters, Isopoly, Hetropolyacids and Nobel Gases.

Course Outcomes:

After successful completion of this course, the student will be able to:

CO1: Discuss the principles of bonding, predicting the geometries of simple molecules and properties through VSEPR, Valence bond and Molecular orbital theory.

CO2: Explain the fundamentals of the chemistry of the main group elements include the structure, bonding and properties of Silanes, silicone, boranes, phosphates and inorganic ring system.

CO3: Classify the substances softness and hardness by using HSAB rule and discuss the properties of non-aqueous solvents.

CO4: Develop the knowledge to explain the structure, bonding and stability of Metal Clusters, Isopoly, Hetropolyacids and Nobel Gases.

Course Content:

UNIT-I

Chemical Bonding and Structures: Atomic states and term symbols. Bonding and structure: Types of bonds, orbital symmetry and overlaps, concept of Lewis, hybridization, VSEPR theory, VB theory and MO theory with examples, properties, merits and drawbacks, Born Haber cycle, Born-Lande equation, Kapustinskii equation, partial covalent character, radius-ratio rules, structures of simple solids. Bond energy and covalent radii, concept of resonance, molecular dipole moment; polarizing power and polarizability, Fajan's rules and Slater rules.

UNIT-II

Chemistry of main group elements: Periodic anomalies in main block elements, Inert Pair effect, Relativistic effect.

Boron and Silicon based compounds: Boron hydrides (small boranes and their anions, B1−B4), boron nitride, borazines, carboranes, metalloboranes, metallocarboranes; silicates, silicones, diamond, graphite, zeolites. Nitrogen, Phosphorous, Sulphur and noble gas compounds: Hydrides, oxides and oxy acids of

Nitrogen, Phosphorous, Sulphur and halogens; phosphazines, sulphur-nitrogen compounds, inter halogen compounds, pseudo halogens.

UNIT-III

Acid-Bases: Bronsted-Lowry concept, proton transfer equilibria under aqueous conditions, non-aqueous solvents and acid-base strength, periodic trends in aqua acid strength, oxoacids, anhydrous oxides, Bronsted-Lowry acidity of aqueous cations, Lewis acid- base concept and frontier orbitals, examples of Lewis acids and bases, quantification of Lewis basicity, inductive and steric effects on Lewis acidity and basicity, frustrated Lewis pairs.

HSAB concept: Basis of HSAB concept, Frontier MO approach acid-base strength, hardness and softness, symbiosis, applications of HSAB concept and Chatt theory

Non-aqueous solvents: Classification of solvents, Properties of solvents (dielectric constant, donor and acceptor properties) protic solvents (anhydrous H_2SO_4, HF and glacial acetic acid) aprotic solvents (liquid SO_2, BrF_3 and N_2O_4). Solutions of metals in liquid ammonia, hydrated electron. Super acids. Acid- base concept in non-aqueous media.

UNIT-IV

Clusters and Cages: M-M bond and metal atom clusters, halide clusters, bonding in $[ReCl_8]^{2-}$. Metal carbonyl clusters- LNCC's and HNCC's. Electron counting in carbonyl/Nitrosyl clusters, important reactions of metal carbonyls, preparation. Cluster valence electrons and Wade-Mingos-Lauher rules. Structure elucidation based on CVE, Isolobal analogies. Applications of metal clusters.

Isopoly and heteropoly acids of W, Mo and V, preparations, properties, structure and applications, Zintle ions.

Nobel Gases: Preparation, Structure, properties and bonding in halides and oxo-halides of xenon compounds.

References:

1. F.A. Cotton, G. Wilkinson and P.L. Gaus, Basic Inorganic Chemistry, John Wiley and Sons, 3rd Edition, 2002.
2. Inorganic Chemistry, 3rd Edition. James E. Huheey, Harper and Row Publishers (1983).
3. Inorganic Chemistry, 3rdEdition. G.L. Miessler and D.A. Tarr, Pearson Education (2004).
4. Inorganic Chemistry, 2nd Edition. D.F. Shriver, P.W. Atkins and C.H. Langford, Oxford University Press (1994).
5. Inorganic Chemistry, 2nd Edition. C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd. (2005).
6. Introduction to Modern Inorganic Chemistry, K.M. Mackay and R.A. Mackay, Blackie Publication (1989).
7. Principles of Inorganic Chemistry, 33rdEdition, Puri, Sharma, Kalia, Milestone Publications & Distributors, (2018).
8. Advanced Inorganic Chemistry, 2ndEdition, S. P. Banerjee, Books and Allied (p) Ltd, (2017).
9. Chemistry of the Elements, 2ndEdition, N. N. Greenwood, A. Earnshaw, Pergamon Press, (1989).

Mapping of Course Outcomes with program Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
M21SM0101	**CO1**	2	3	2	1			1		1	1	3	1	2
	CO2	2	2	2	1			1		1	1	3	1	2
	CO3	2	2	2	1			1		1	1	3	1	2
	CO4	2	2	2	1			1		1	1	3	1	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SM012	**ORGANIC CHEMISTRY – I**	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. Analyze the effect of conjugation, hyperconjugation delocalization, resonance and aromaticity in organic molecules.
ii. Identify the reactive intermediates in the reaction mechanism and also examine the energy profile of the reactions.
iii. Discuss the core concepts of stereochemistry in organic molecules.
iv. Explain the chemistry of carbohydrates, synthesis and biological importance of vitamins.

Course Outcome:

By the completion of course student will be able to

CO1. Explain the effect of conjugation, hyperconjugation delocalization, resonance and aromaticity in organic molecules.

CO2. Analyze role of reactive intermediates such as carbocations, carboanion, carbines, nitrenes and kinetics reaction.

CO3. Predict R/S, E/Z configuration, chirality in molecules by applying concepts of stereochemistry

CO4. Discuss the chemistry of carbohydrates, synthesis and biological importance of vitamins.

Course Content:

UNIT-I

Nature of Bonding and Aromaticity in Organic Molecules-Delocalization, Conjugation, Resonance, Mesomericeffects Inductive effect, Hyperconjugation, Tautomerism, Hybridization. Concepts of Aromaticity, non-aromaticity and antiaromaticity, Aromaticity in non-benzenoids compound, Alternant and non-alternant hydrocarbons, Transition state structure, Hammond postulate, Curtin-Hammett principle, kinetic and thermodynamic control, Hard and soft acids and bases. **[15 hrs]**

UNIT-II

Reaction Mechanisms and intermediates- Generation structure, stability and reactivity of carbocations, carbanions, carbon free radicals, carbenes and nitrenes. Effect of structure on reactivity: Classification of reactions and mechanisms. Nucleophilic substitution reaction at a saturated carbon: S_N1, S_N2, S_Ni .Aromatic Substitution Reactions**:** Electrophilic Substitution Reactions: The arenium ion mechanism.

Orientation and reactivity. Energy profile diagrams. Nucleophilic substitution reactions: The SNAr, ArSN1, and benzyne mechanisms. Elimination Reactions: The E1, E2 and E1cB mechanisms and Orientation of the double bond. Saytzeff and Hoffmann rules. **[15 hrs]**

UNIT-III

Stereochemistry-I: Geometrical isomerism, cis-trans and E-Z nomenclature. Optical isomerism: Elements of symmetry, chirality, topocity, and prochirality. Optical activity, Absolute and relative configurations, D/L, d/l notations. CIP rules, assigning R, S configuration. Methods of resolution of racemic mixtures. Optical activity due to helicity, M P conventions, Chiral derivatizing agents, Chiral solvating agents. Fischer, Newman, Sawhorse and flying wedge projections and their interconversions. Conformational analysis of acyclic (butane) and cyclic alkanes (cyclopentane, cyclohexane mono and di substituted). Conformations in fused rings. **[15 hrs]**

UNIT-IV

Carbohydrates and Vitamins: Introduction, Kiliani-Fischer synthesis, Determination of configuration of the monosaccharides, conformational analysis of monosaccharides. Reactions of Carbohydrates, Synthesis of aldonic, uronic, Aldric acids and alditols. Structure elucidation of sucrose and maltose. Structures of lactose, gentiobiose and meliobiose. Vitamins –Structure and Biological importance of vitamins A C and E. Synthesis of- Vitamin B1 (thiamine), B2(riboflavin), B5(pantothenic acid), B9(folic acid), H (biotin), K1 and K2. **[15 hrs]**

References:

1. Advanced Organic Chemistry – Reactions, Mechanism and Structure, Jerry March, John Wiley (2008)
2. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman, (2000)
3. Stereochemistry of Organic Compounds, D. Nasipuri, New-Age International, (1999)
4. Organic chemistry-Jonathan Clayden, Stuart Warren, Nick Greeves (2001)
5. Organic Chemistry, Volumes I and II, I. L. Finar, Longman, (1999)

6. Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S M0102	**CO1**	1	2	1	2	3		2				1	1	1
	CO2	1	3		2	3						1	2	2
	CO3	1	2		2	3						2	2	2
	CO4	1	2	1		3					1	1	3	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SM0103	PHYSICAL CHEMISTRY - I	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. Correlate the basic concepts of Thermodynamics in the in the day to day life and in the industrial perspective.
ii. Illustrate the quantum statistical methods that uses molecular properties to predict the behavior of macroscopic quantities of compounds.
iii. Conclude the theories of chemical kinetics and study the reactions with advanced flow techniques.
iv. Design the electrode and electrolyte systems by the electrode kinetics using the basic knowledge of the electrochemistry.

Course Outcomes:

By the completion of course student will be able to

CO1. Apply the knowledge of thermodynamic laws to the energy conversion processes in daily life.

CO2. Explain the behavior of microscopic systems with BE, FD, MB statistics and distribution, ensembles, partition functions and molecular partition functions.

CO3. Illustrate the kinetics to the complex reactions, Parallel, consecutive, fast reactions and reversible reactions by the modern flow techniques.

CO4. Judge the Electrochemical reactions by the Debye-Huckel theory, transport numbers, Helmholtz-Perrin, Gouy-Chapman and Stern electrical double layer, reversible and irreversible electrodes to the electrochemical processes.

Course Content:

UNIT – I

Chemical Thermodynamics

Thermodynamics: Brief overview of thermodynamic laws, Concepts of Work, heat, energy, Enthalpy, entropy and free energy. Expansion of work, Molar heat capacities, Joul Thomson experiment, Carnot cycle, Entropy change during spontaneous process. Gibbs and Maxwell relations, Helmholtz and Gibbs free energies. Thermodynamic criteria of equilibrium and spontaneity. Variation of free energy with temperature and pressure. Third law of thermodynamics - calculation of absolute entropies.

Partial molar properties: Partial molar volumes and their determination by intercept method and from density measurements. Chemical potential and its significance. Variation of chemical potential with temperature and pressure. Formulation of the Gibbs Duhem equation. **[15 hrs]**

UNIT – II

Statistical Thermodynamics

Fugacity: Determination of fugacity of gases. Variation of fugacity with temperature and pressure. Activity and activity coefficients. Variation of activity with temperature and pressure. Determination of activity co-efficient by vapor pressure, depression in freezing point, solubility measurements by electrical methods. Thermodynamics of dilute solutions: Raoult's law, Henry's law. Ideal and non-ideal solutions.

Statistical Thermodynamics: Different ensembles and Partition functions-translational, rotational, vibrational and Electronic partition functions BE, FD, MB statistics and distribution, ensembles, partition functions and molecular partition functions, mean energy, Residual entropy, heat capacity of mono and diatomic gases, Einstein theory of heat capacity of solids. **[15 hrs]**

UNIT – III: **CHEMICAL KINETICS**

Kinetics: Theory of reaction rates, kinetics of complex reactions, Parallel, consecutive and reversible reactions. Determination of order of reaction. Energy of activation and its experimental determination. Simple collision theory - mechanism of bimolecular reaction. Lindemann's theory, Hinshelwood's theory, for unimolecular reaction (No derivation). Activated complex theory of reaction rate, classical thermodynamic treatment, partition function, statistical thermodynamic treatment. Kinetics of reactions in solution - Salt effect, effect of dielectric constant (single sphere and double sphere model), effect of pressure, volume and entropy change on reaction rates.

Fast reactions: Study of kinetics by flow techniques, equation for contact time, stopped flow and continuous flow methods. Relaxation method, equation for relaxation time, temperature jump and pressure jump methods, flash photolysis, pulse radiolysis and shock tube method. Potential energy surface, theoretical calculation of energy of activation. **[15 hrs]**

UNIT – IV: Electro Chemistry

Introduction, Mobility and conductivity of electrolytes, Arrhenius theory of strong and weak electrolytes and its limitations, Concept of activity and activity coefficients in electrolytes, Debye-Huckel theory of strong electrolytes, Debye Huckel-Onsager equation, Debye-Huckel limiting equation for activity co-efficient. A brief survey of Helmholtz-Perrin, Gouy-Chapman and Stern electrical double layer (No Derivation). Liquid junction potential and its determination. Transport Number: Determination of transport number by Hittorf method and e.m.f method. Effect of temperature and concentration on transport number. Reversible and irreversible electrodes, reversible and irreversible cells. Electrode and cell

potentials, Polarization, over voltage. Experimental determination of over voltage. decomposition potential Equations for concentration over potential, diffusion current – stationary current, potential curves at a dropping mercury electrode, polarography, half wave potential, application in qualitative and quantitative analysis. Butler-Volmer equation, Tafel equation (No derivation). **[15 hrs]**

References:

1. Thermodynamics for Chemists by S. Glasstone, Affiliated East-West Press, New Delhi, (1965).
2. Chemical Thermodynamics, I.M. Klotz, W.A. Benzamin Inc. New York, Amsterdam (1964).
3. Text Book of Physical Chemistry,2nd edition, Samuel Glasstone, MacMillan Indian Ltd., (1974).
4. Elements of Physical Chemistry, Lewis and Glasstone.
5. Physical Chemistry, P.W. Atkins, ELBS, 4th edition, Oxford University Press (1990).
6. Introduction to Electrochemistry, S. Glasstone.
7. Principles of Physical Chemistry, Puri, LR Sharma and Pathania, Vishal publishing Co.

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PS O1**	**PS O2**	**PS O3**
M21S M0103	CO1	2	1	3	1	1	2		1	1	2	2	1	2
	CO2	1	2	2	1	1			1	1	2	1	1	2
	CO3	1	1	1	2	2	1	1	2	1	2	2	1	1
	CO4	2	1	2	1	1	1	1	1	2	2	2	1	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SM0104	ANALYTICAL CHEMISTRY -I	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. Application of principles of analytical chemistry in chemistry.
ii. Knowledge on the basic concepts of Errors and treatments of analytical data.
iii. Analysis of chemical data using various statistical tools.
iv. Describe various fundamentals of analytical techniques.

Course Outcome:

By the completion of course student will be able to

CO1. Apply various statistical tools for data analysis.
CO2. Formulate experimental data into appropriate statistical model.
CO3. Infer various analytical techniques and their working principles.
CO4. Explain various analytical techniques available for sample analysis in laboratories.

Course Content:

UNIT – I

Errors and data analysis: Introduction to analytical techniques, factors affecting choice of techniques. Basic definitions, Way of expressing accuracy, Errors: determinateand indeterminate and their minimization. Distribution of random errors and explanation using the normal distribution curve (Gaussian distribution). Propagation of determinant and indeterminate errors (problems), Statistical treatment of finite samples; standard deviation and variance. Student's t-test, confidence interval of mean. Testing for significance - comparison of two standard deviations, Comparison of two means, Comparison of an experimental mean and a true mean, rejection of a result - Q-test.

How to plot best fitting straight line; the least squares methods, standard deviations of the slope and intercept, correlation between two variables, detection limit, statistics of sampling - sample size, minimum sample size, and minimum number of samples. **[15 hrs]**

UNIT – II

Titrimetric analysis: Acid-base titrations in non-aqueous media - Introduction to aqueous acid – base titration, Role of non-aqueous solvent in acid-base titrations, differentiating ability of a solvent, levelling effect, selected solvents, titration curves, determining the equivalence point, typical applications - determination of carboxylic acids, phenols and amines.

Precipitation titrations: Principles of precipitation, common-ion effect, salt effect, Titration curves, feasibility of precipitation titrations, factors affecting shape - titrant and analyte concentration, completeness of the reaction, titrants and standards, indicators for precipitation titrations involving silver nitrate, the Volhard, the Mohr and the Fajan's methods, typical applications.

Complexometric titrations: Complex formation reactions, stability of complexes, role of metal ions and ligands, stepwise formation constants, chelating agents, EDTA - acidic properties, complexes with metal ions, equilibrium calculations involving EDTA, conditional formation constants, EDTA titration curves, factors affecting the shape of titration curves - completeness of reaction, indicators for EDTA titrations - theory of common indicators, titration methods employing EDTA - direct, back and displacement titrations, indirect determinations. **[15 hrs]**

UNIT-III

Introduction to electro-analytical techniques: an over view of electrochemistry – electrochemical cells and reactions, electrode processes – faradaic and non-faradaic processes, brief description of electrical double layer and double-layer capacitance and charging current in electrochemical measurements, introduction to mass-transfer-controlled reactions, mechanism of mass transport, various currents in electrochemical cells – charging, residual current, migration, diffusion and convection currents, The current response to applied potential (in terms of Fermi and molecular orbitals)

Electrogravimetry,Coulometry, and Coulometric titrations, Amperometry, Polarography a voltammetric technique at a dropping mercury electrode (DME): Review of the principles of normal dc polarography, types of currents obtained at a DME,Ilkovic equation and its application, current-potential relation for a cathodic process – half-wave potential, basic aspects of electron transfer across the electrode–electrolyte interface, reversible and irreversible polarographic process, criteria for diffusion current and reversibility in polarography, electron transfer tests for the reversibility of a process – irreversible processes at a DME, a brief introduction to cyclic voltammeter. **[15 hrs]**

UNIT-IV

Chromatographic and Thermal methods: Basic theory of chromatography - Definition, principles of separation, classification of chromatographic techniques. General descriptions of column chromatography - frontal analysis, displacement analysis and elution analysis. General theory of column chromatography: characterizing a chromatogram - retention time, retention volume and baseline width.

Chromatographic resolution, capacity factor, column selectivity. Column efficiency – band broadening, rate theory and plate theory. Peak capacity, non-ideal behavior. Optimizing chromatographic separations using capacity factor, column selectivity and column efficiency - Van Demeter equation, Golay and Huber-Knox equations (only equations and terms involved).

Gas chromatography (GC): Principle, instrumentation - mobile phase, chromatographic columns, stationary phases, sample introduction, temperature control, and detectors for gas chromatography (naming of detectors) and applications.

High performance liquid chromatography (HPLC): Principle, instrumentation – columns (analytical and guard columns), examples for stationary phases, mobile phases used in HPLC, introduction to isocratic *vs* gradient elution process, detectors for HPLC (naming of detectors) and applications.

Thermal Methods

Thermogravimetric analysis - TGA, DTA and DSC, principle, instrumentation, and factors affecting the results, difference between TG and DTA, study of thermal stability of $CuSO_4.5H_2O$ and $Ca_2C_2O_4\,2H_2O$ by TGA. **[15 hrs]**

References:

1. Fundamental of Analytical Chemistry, 8thEdition, D.A. Skoog, D.M. West, Holler and Crouch, Saunders College Publishing, (New York).
2. Analytical Chemistry, 5thEdition,G.D. Christian, John Wiley & Sons, Inc, India,(2001).
3. Vogel's Textbook of Quantitative Chemical Analysis, 6thEdition Third Indian Reprint, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, Pearson Education Pvt. Ltd., New Delhi (2003).
4. Quantitative chemical analysis, 7thEdition, Daniel C. Harris, W.H. Freeman and company
5. Electrochemical methods - fundamentals and applications, 2ndEdition,Allen J. Bard, Larry R. Faulkner, John Wiley and Sons
6. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, (2000).
7. Analytical Chemistry Principles, John H. Kennedy, 2ndEdition, Saunders College Publishing, California, (1990).
8. Chromatographic methods, 5thEdition, A. Braithwaite and F J Smith, Kulwer Academic publishers.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21SM 0104	CO1	1	1	2	2	2			1					1
	CO2	2	1	2	2	2			1			1	1	1
	CO3	2	1	1	1	2			2			2	1	2
	CO4	2	2	2	2	3			2			2	3	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SM0105	COMPUTERS AND MATHEMATICS FOR CHEMISTRY	AECC/ HC	2	0	0	2	2

Course Objectives:

This course aims to provide the student to

i. Understand the basics of computer and parts of computer components, software, hardware and operating systems.
ii. Learn few computer applications towards solving chemistry problems and also to make the student to use chemistry software programs.
iii. Find the importance of mathematics in chemistry and to solve the chemical problems.
iv. Apply mathematical concepts like vectors, algebra, differentiation and integrations to solve the quantum mechanics related problems.

Course Outcomes:

By the completion of course student will be able to

CO1: Use the computer and allied electronic devices in day to day life with basic knowledge of software and hardware.

CO2: Solve the chemistry related problems through Fortran/C programming and also able to use chemistry applications in research and pharma.

CO3: Apply the mathematical concepts like vectors and algebra to find solutions to the chemistry problems.

CO4: Implicate knowledge of differentiation and integration in solving the basic mathematics problems in chemistry.

Course Content:

Unit I: Introduction to Computing

History of development of computers, mainframe, mini, micro and supercomputer systems. Personal computers. General awareness of computer hardware, CPU, input and output devices, Storage devices, Printers, Bits and Bytes, Memory: Primary Memory, Secondary Memory., other peripheral devices, auxiliary storage devices.

Software - System software and application software.

Programming languages: machine language, assembly language and high level languages. Interpreter and compiler. Flow charts and Algorithms.

General awareness of operating systems: Disk operating system, Windows, MaCintosh, Linux. General awareness of Software packages and other scientific application packages.

8 hrs

Unit II: Computer Applications

The students will be taught to operate a PC and how to run standard programs and packages such as word, excel, power point. Applications and uses of common softwares in chemistry: Origin, sigma plot,

Chemsketch/Chemdraw, MNova/MestreC etc and to solve chemistry problems. Cheminformatic tools: SAS, SAAS, SSBI. Basic ideas on the use of Internet in Chemistry education, Literature review. Application to API bulk drugs,

Application of Fortran /C programming in problem solving (Problems will be taken preferably from physical chemistry for plotting first and second derivative curves, linear plots etc. Problems from chemical kinetics, polymer chemistry, analytical chemistry, electrochemistry, spectroscopy etc. will be solved.)

7 hrs

Unit III: Vectors and Matrix Algebra

Vectors: dot and cross products; scalar and vector triple products and their applications. Tensors and their applications.

Matrix Algebra: Review of different types of matrices (including Hermitian and skew Hermitian); matrix addition and multiplication; determinant of a square matrix, transpose, adjoint and inverse of a square matrix. **7 hrs**

Unit IV: Differentiation and Integrations

Calculus: Rule for differentiation; Chain rule for ($f(x)=U^n$, sinu, logu etc). Implicit differentiation and parametric differentiation and successive differentiation of order 2 (for explicit functions only).

Applications of differentiation: Derivative as a slope of the tangent, derivative as a rate measure velocity and acceleration. Increasing and decreasing functions-Maxima and minima.

Integrations: Basic rules-simple substitution-Method of partial fractions-Integration by parts. Define integral and application to areas of plane curves. Functions of several variables: partial derivatives; co-ordinate transformation from cartesian coordinates to spherical and cylindrical coordinates and vice-versa. Elementary differential equation: Variable separable, exact first order equations, linear and homogeneous equation. **8 hrs**

References:

1. Understanding Computers, Madric and Donevan, McGraw Hill.
2. Computers in Chemistry, K.V. Raman, Tata McGraw Hill (1993).
3. Personal Computers in Chemistry, P. Lykose, John Wiley and Sons, New York (1981).
4. Computers and their applications to Chemistry, 2nd Edition, Ramesh Kumari, Alpha Science.
5. Computers in Chemistry, Biggs Pete, Oxford University Press (2000).
6. Using Artificial Intelligence in Chemistry and Biology: A Practical Guide, Cartwright Hugh, CRC Press, (2008).
7. Mathematical Computer Programs for Physical Chemistry, Cropper William H, Springer.
8. Chemistry by Computer: An Overview of the Applications of Computers in Chemistry, Stephen Wilson, Plenum Pub Corp (1986).
9. Computer Software Applications in Chemistry, 2nd Edition, Peter C. Jurs, John Wiley &Sons.
10. Mathematical Preparation for physical chemistry, F. Daniells, Tata McGraw Hill Inc., US (1959).
11. Mathematics for chemists, D. M. Hirst, Chemical Publishing Company Incorporated, New York (1979).
12. Mathematics for chemists, P. G. Francis, Springer (2011).
13. Basic Mathematics for chemists, P. Jebutt, Wiley-Blackwell (1994).
14. Calculus and analytic geometry, 9th Edition, C. G. Thomas, R. L. Finney, Addison-Wesley Publishing Company, lnc (1996).
15. Short Course in differential equations, Rainvilles and Bedient, IBH publishers (1968).

16. Mathematics for chemistry, G. Doggett and B. T. Sutcliffe Longmann publishers (1995).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S M0105	CO1	3	3		2	2		1			3	1		2
	CO2	3	3		2	2		1			2	1		
	CO3	3	3		1	1		1			2	1		1
	CO4	3	3		2	1		1			2	1		1

SEMESTER-I: SOFT CORE (SC)/DSEC*

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS101	**INTRODUCTION TO NANO-SCIENCE AND NANO-TECHNOLOGY**	DSEC*/ SC	2	0	0	2	2

Course Objectives:

This course aims to provide the student to

i. Introduction to nanotechnology.
ii. Classification of nanostructures and the methods of synthesizing.
iii. The various Nanomaterials characterization techniques nanomaterials and Carbon nanomaterials.
iv. The applications of nanomaterials in nanoelectronics and Biochemical sensor.

Course Outcomes:

By the completion of course student will be able to:

CO1. Explain the methods of synthesis of nanomaterials with properties and applications.

CO2. Categorize the Types of Nanostructures includes carbon nanomaterials and discuss the preparation, properties and applications.

CO3. Describe the various types of nanomaterials characterization techniques like imaging techniques and Spectroscopic techniques.

CO4. Apply the acquired theoretical knowledge to classify as nanocatalysts, chemical sensors, biosensors, drug delivery, Biochemical sensor, Biophysical sensor and nano electronics.

Course Content:

UNIT-I

Background to Nanotechnology: Atom, molecules and nanoscale materials, Electrons in nanostructures, Quantum size effects, Density of states, Size effects on surface energy, surface area, optical, electrical, magnetic, thermal properties. Emergence of Nanotechnology – Challenges in Nanotechnology.

Synthesis issues of nanomaterials: Nucleation-Growth mechanism of nanomaterials, Influence of nucleation rate on the size of the crystals- macroscopic to microscopic crystals and nanocrystals - large surface to volume ratio, top-down and bottom-up approaches-self-assembly process-grain boundary volume in nanocrystals-defects in nanocrystals-surface effects on the properties. Stability of nanomaterials, Synthesis approaches, Physical methods, Chemical methods, Chemical interactions at nanoparticle surfaces, Functionalization of nanostructures, Self-assembly of nanostructures, Nano Lithographic

techniques, Electrodeposition. **[8 hrs]**

UNIT-II

Types of Nanostructures: Definition of a Nano system – Types of Nanocrystals-One Dimensional (1D)-Two Dimensional (2D) –Three Dimensional (3D) nanostructured materials – Quantum dots – Quantum wire, Quantum wells, Core/Shell structures. Their electronic properties, Physical and chemical methods for preparation of nanomaterials

Carbon nanomaterials:

Fullerenes: Structure and reactivity of fullerenes, preparation of fullerenes and Functionalization of fullerenes, chemistry of fullerenes, physical properties of fullerenes, Applications – solar cells, medicine, superconductors,

CNT: CNT formation mechanism, Electronic properties of SWNT, DWNT, MWNTs, CNT growth techniques, structure and properties (electrical conduction, magnetic, magnetoresistance, mechanical, thermal), Nanocomposites of CNTs, Applications,

Graphene, Electronic properties of graphene, Diarc fermions in graphene, Anamolous Quantum Hall Effect, Ambipolar conductivity, optical, mechanical properties of graphene, Experimental detection of number of layers, Preparation of graphene: Micromechanical, chemical methods, physical methods, Functionalization, Applications

Nanodiamond and Diamond like carbon: Structure, synthesis, Surface structures, reactivities of nanodiamond, Phase diagram of DLC, Effects on properties with DLC composition, device applications

[7 hrs]

UNIT-III

Nanomaterials characterization techniques:

Imaging techniques: Scanning Electron Microscope (SEM) – Field Emission scanning Electron microscope(FESEM)-Atomic force microscopy (AFM), Chemical force microscopy (CFM), optical tweezers for force measurements, scanning tunneling microscopy (STM), scanning near field optical microscopy (SNOM) – Transmission Electron Microscopy (TEM).

Raman Scattering –MicroRaman-tipenhanced Raman-Surface Enhanced Raman scattering (SERS)– Photoluminescence (PL)– Cathodeluminescence (CL). **[8 hrs]**

UNIT-IV

Applications of Nanomaterials: Molecular electronics and nanoelectronics – Quantum electronic devices - CNT based transistor and Field Emission Display – Nano magnetics, nanophotonics nanospintronics, Biological applications - Inorganic nanoprobes in Quantum dots, Inorganic nanosystems/biomolecules interface toward nanotechnologies, biophysicochemical interaction at the nano/bio interface, Biochemical

sensor - Membrane based water purification. Renewable energy (nano solar cells), Photoelectrochemical cells, coloured glasses, (gold and silver ruby glasses), Nanocatalysts, chemical sensors, biosensors, SAM, electrical and electronics,(RAM). Chemical and photocatalytic applications. Drug delivery targeting and medical applications, micro-electrochemical machines (MEMS).

[7 hrs]

References:

1. Nanotechnology: Basic science and Emerging technologies,1st Edition,M. Wilson, K. Kannangara, G Smith, M. Simmons, B. Raguse, Overseas Press India Pvt Ltd, New Delhi, (2005).
2. The Chemistry of Nanomaterials: Synthesis, properties and applications, C.N.R. Rao, A.Muller, A.K.Cheetham (Eds), Wiley VCH Verlag Gmbh&Co, Weinheim, (2004).
3. Nanoscale Materials Science, Kenneth J. Klabunde (Eds), John Wiley & Sons, Inc, (2001).
4. Nanofabrication towards biomedical applications, C.S.S.R. Kumar, J.Hormes, C.Leuschner, Wiley –VCH Verlag GmbH & Co, Weinheim, (2004).
5. Nano Electronics and information Technology,W. Rainer, Wiley, (2003).
6. Nano systems, K.E. Drexler, Wiley, (1992).
7. Nanostructures and Nanomaterials: Synthesis, properties and applications,G. Cao, Imperical College Press, (2004).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS101	CO1	2	2	1	2	1	1				1	3	1	1
	CO2	2	2	2	2	1	1				1	3	1	1
	CO3	2	1	2	1	1	1				1	3	2	2
	CO4	2	1	2	2	2	1				1	3	2	3

Course Code	Course Title	DSEC/	L	T	P	C	Hrs/Week
M21SMS102	HETEROCYCLIC CHEMISTRY AND CHEMISTRY OF BIO-MOLECULES	DSEC/SC	2	0	0	2	2

Course Objectives:

This course aims to provide the student to

i. To use different heteroatoms in the ring and uses in drug production.
ii. Provides the synthesis of five, six and seven membered monocycles and the fused heterocycles.
iii. It also provides assembly of amino acids, peptide and protein structures.
iv. Discuss the topics include chemical and biochemical strategies used to elucidate natural product pathways.

Course Outcomes:

By the completion of course students will be able to

CO1. Explain the fundamental concepts of reactivity and aromaticity of various heterocyclic compounds.

CO2. Illustrate the synthesis of various heterocyclic compounds.

CO3. Analyze the different types of heterocyclic compounds.

CO4. Outline the synthesis of prostaglandins-E1, E2 and vitamins.

CO5. Apply the biological importance of DNA, RNA and classify the different types of proteins.

Course Content:

UNIT-1

Synthesis and reactivity of pyrrole, furan and thiophene. Basicity of pyrrole and pyridine.

Small ring heterocycles-Three and four membered heterocycles- synthesis and reactions of aziridines, oxiranes, oxitanes, thietane. Five membered heterocycles containing two/three heteroatoms- synthesis and reactions of imidazoles, thiazoles. Synthesis and reactions of benzo pyrrole, benzo furans and benzo thiophene. **[7 hrs]**

UNIT-II

Six membered heterocycles with one heteroatom: Synthesis and reactions of pyrylium, pyridinium and thiopyrylium salts. Six membered heterocycles with two and more heteroatoms-Synthesis and reactions of diazine (pyrazine, pyridazine, oxazine, thiazine) & triazine (1, 2, 3, and 1, 2, 4). Seven membered heterocycles –Synthesis,and reactions of azepine, oxepine & thiepine. **[8 hrs]**

UNIT-III

Introduction of biomolecules: Examples of biomolecules and building blocks of biopolymers. **Nucleic Acids**-Purine and pyrimidine bases. Structure and synthesis of nucleosides and nucleotides. (DCC, phosphor tri ester approach Properties of nucleic acids in solution. Base pairing, forces stabilizing nucleic acid structure. Methods used in nucleic acid separation and characterization. Hydrolysis of nucleic acids by acid and base. Enzymatic hydrolysis, Nuclease specificity and restriction endonucleases.

Prostaglandins-General study, nomenclature, classification, structure and biological role of PGE1, PGE2 and PGE3. **[8 hrs]**

UNIT-IV

Biochemical mechanisms

Introduction. The mechanistic role of the following in living systems.

1. Thiamine pyrophosphate (TPP) in decarboxylation of α-ketoacids and in the formation of α-ketols.
2. Pyridoxal phosphate (PLP) in transamination, decarboxylation, dealdolisation and elimination reactions of amino acids.
3. Lipoic acid in the transfer of acyl group reactions.
4. Coenzyme A (CoASH) in the transfer of acyl group.
5. Tetrahydrofolic acid (H4F) in one-carbon transfer reactions.
6. Vitamin B12 coenzymes in molecular rearrangement reactions and in the synthesis of methionine and methane.
7. Nicotinamide and Flavin coenzymes in biological redox reactions. **[7hrs]**

References:

1. Heterocyclic chemistry, Joule & Smith, Van Nostrand.
2. Heterocyclic chemistry,R. K. Bansal, Wiley Ed.
3. Principals of modern heterocyclic chemistry,L. A. Paquitte.
4. The structure and reactions of heterocyclic compounds,M. H. Palamer.
5. Advances in Heterocyclic chemistry,A. R. Katritzky.
6. Biochemistry, J. David Rawn, Neil Pattuson publishers, North Carolina, USA (1989).
7. Organic Chemistry,6th Edition,Vol I and Vol II, I. L. Finar, ELBS & Longman, London, (1975).
8. Introduction to Lipids, D. Chapman, McGraw-Hill, (1969).
9. Advanced general Organic Chemistry, S. K. Ghosh, DK and Allied publishers (UBS), Calcutta, (1998).

10. Textbook of Biochemistry, E. S. West, W. R. Todd, H. S. Mason & J. T. Van Bugen, 4th Edn. Amerind publishing co. (New Delhi), (1974).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21SM S102	CO1	3	2	2	1	2				1	2	3	4	3
	CO2	3	3	3	4	3	1			1	2	3	4	3
	CO3	3	3	3	2	3				1	2	3	4	3
	CO4	3	2	3	1	3	3			1	2	3	3	3

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS103	SURFACE, INTERFACES AND CATALYSIS	SC	2	0	0	2	2

Course Objective:

This course aims to provide the student to

i. Correlate the topics like Surface phenomena of solids, solid-liquid interfaces, Homogenous and Heterogeneous Catalysis and Instrumental methods of catalyst characterization.
ii. Illustrate Homogenous and Heterogeneous Catalysis and Instrumental methods of catalyst characterization. Describe the *lock-and-key* and *induced-fit* models of enzyme action.
iii. Explain the function of a catalyst in terms of reaction mechanisms and potential energy diagrams
iv. Gain the Knowledge of Catalyst characteristics, Mechanism of catalytic reactions and design of catalytic Reactor.

Course Outcomes:

By the completion of course student will be able to

CO1. Use modern methods when planning strategies for synthesis of new substances and characterization of products.

CO2. Depth knowledge about chemical reactions with a focus on principles for effective synthesis strategies, stereo selectivity, catalysis,

CO3. Predicting the chemical reaction using efficient computational models can be used to develop high-throughput screening techniques.

CO4. Research-based in-depth understanding in the field of design and production (synthesis) of complex molecules.

Course Content:

UNIT – I

Surface phenomena: Surface forces, Structure of clean surfaces; Solid surfaces: External and internal surfaces; Bulk and surface structure of FCC, BCC and HCP metals, Notation of surface structure; Structure of adsorbate layers; Stepped surfaces; Surface relaxation and reconstruction of surfaces; homogeneous and heterogeneous surfaces. **[7 hrs]**

UNIT-II

Types of interfaces. Liquid surfaces: Microscopic picture of interfaces; curved interfaces; Young - Laplace and Kelvin equations; capillary condensation; surface tension; measuring surface tension.

Solid-liquid interfaces: Contact angle and wetting, Gibbs adsorption isotherm. Solid-gas interfaces: Types of adsorption; Adsorption isotherms – Langmuir, Tempkin and BET. Determination of surface area of adsorbents; temperature dependence of adsorption isotherms. **[8 hrs]**

UNIT – III

Fundamentals of Homogenous and Heterogeneous Catalysis: Mechanism, Adsorption isotherms, surface area, pore size and acid strength measurements; Porous solids; Catalysis by metals, semiconductors and solid acids; Supported metal catalysts; Catalyst preparation, deactivation and regeneration. Model catalysts: Ammonia synthesis; Hydrogenation of carbon monoxide; Hydrocarbon conversion. Some important heterogeneous catalytic processes. **[8 hrs]**

UNIT – IV

Instrumental methods of catalyst characterization: Diffraction techniques – X-Ray, Neutron, electron, surface area and thermal methods; spectroscopic, ionization techniques, and microscopic techniques. Determination of the extent and rates of adsorption and desorption. **[7 hrs]**

References:

1. Physics at Surfaces, A. Zangwill, Cambridge Univ. Press, (1988).
2. Catalytic Chemistry, B. Gates, Wiley, 1992.
3. Physical Chemistry of Surfaces, A.W. Adamson, A.P. Gast, Wiley, (1997).
4. Principles and Practice of Heterogeneous Catalysis, J. M. Thomas and W.J. Thomas, Wiley-VCH, (1997).
5. Surface Science: Foundations of Catalysis and Nanoscience, K.W. Kolasinski, Wiley, (2002).
6. Heterogeneous Catalysis, D.K. Chakrabarty and B. Viswanathan, New Age, (2008).
7. Introduction to Surface Chemistry and Catalysis, G.A. Somorjai, Y. Li, Wiley, (2010).
8. Physical chemistry of surfaces, Arthur W. Adamson,(1990).
9. Chemical kinetics and catalysis, R.I. Masel, Wiley-Interscience, (2001).
10. The chemical physics of surfaces, Roy S. Morrison, S. Roy, (1990).
11. An introduction to chemisorption and catalysis by metals, R.P.H. Gasser, (1985).
12. Modern techniques of surface science, D.P. Woodruff, T.A. Delchar, Cambridge Univ. Press, (1994).
13. Introduction to Scanning Tunneling Microscopy, C. J. Chen, Oxford University Press, New York, (1993).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21SMS103	**CO1**	3	2	1	1	2	2	2	2	1	2	2	1	1
	CO2	2	2	2	2	3	2	1	2	2	1	2	2	2
	CO3	3	2	2	2	3	2	2	2	3	3	2	2	2
	CO4	3	3	3	2	3	2	1	3	2	2	3	2	1

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS104	ADVANCED INSTRUMENTAL METHODS OF ANALYSIS	DSEC*/SC	2	0	0	2	2

Course Objectives:

This course aims to provide students

i. To get knowledge on concepts of absorption spectroscopy, emission spectroscopy, voltammetry, thermogravimetry, introduction to NMR.
ii. Understanding on the principles and applications of advanced instrumental techniques.
iii. Introduce the spectroscopic techniques importance in analysis of chemical compounds.
iv. Advances in various analytical techniques.

Course Outcomes:

By the completion of course student will be able to

CO1. Apply the knowledge gained on advanced instrumentation in interpretation of analytical data.
CO2. Choose the advanced characterization techniques required for complex material analysis.
CO3. Analyze the surface and interfacial processes using advanced characterization tools.
CO4. Evaluate the need of instrumental analysis in multidisciplinary research and industrial processes.

Course Content:

UNIT-I

Absorption Spectroscopy: absorption, emission, fluorescence phenomenon, principles and differences, Flame AAS, Instrumentation, different types of nebulizers, Non flame techniques, GAAS, electrothermal vapourisers, graphite furnace, cold vapor AAS, radiation sources, HCL, EDL, TGL etc. detectors, photo emissive cells, PMT, photodiodes, Interferences, spectral, chemical, matrix, background absorption, correction methods, deuterium arc, zeeman effect, Smith-Hieftje methos, single beam and double beam instruments, evaluation procedures, applications of AAS. **[8 hrs]**

UNIT-II

Atomic Emission Spectroscopy: Emission-principle, inductively coupled plasma optical emission spectrometry, theory, ICP characteristics, sample introduction methods, tourch configuration and view modes, analytical performance. Merits and limitations of AES over AAS, Detection limit, application to

elemental analysis, Microwave induced plasma systems in atomic spectrometry, principal processes and applications. **[7 hrs]**

UNIT-III

Electroanalytical Techniques: Electrode Potential, Currents in Electrochemical cells, Potentiometric titrations. Electrogravimetry-faraday's laws of electrolysis, Coulometry, Coulometric titrations. Voltammetry- principle, DME-advantages, limitations, Hydrodynamic Voltammetry, Cyclic voltammetry-principle, conditions for reversible, quasi reversible and irreversible reactions Anodic stripping voltammetry-principle and applications, Polarography, Pulse polarography, Amperometry-titrations, different titration curves, applications, numerical problems on all these techniques. **[7 hrs]**

UNIT-IV

Thermal Methods of Analysis: Principle, methodology and applications: thermogravimetric and differential thermal analysis, differential scanning calorimetry; Thermo-mechanical and dynamic mechanical analysis; thermometric titrations. Thermal stability of polymers, applications, decomposition patterns, decomposition reactions-examples. **[7 hrs]**

References:

1. Analytical Chemistry, Gary D Christian, 5thEdition, John – Wiley and Sons Inc., (1994)
2. Fundamentals of Analytical Chemistry,7thEdition, D. A. Skoog, D. M. West and F. J. Holler, Saunders College Publishing (1996).
3. Instrumental methods of Analysis, H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Set, CBS Publishers (1996).
4. Instrumental methods of Chemical Analysis, G. W. Ewing, 5th edition, McGraw-Hill, New York, (1988).
5. Electrochemical methods, 2nd Edition, A.J. Bard & l. R. Faulkner, Wiley, New York, (2000).
6. Vogel's text book of Quantitative Chemical analysis, 5th edition, Jeffery et. al., ELBS/Longman, (1989).
7. Encyclopedia of Analytical Chemistry, R.A. Meyers Vol. 1 – 15, John Wiley, (2000).
8. Fundamentals of Instrumental Analysis, 8thEdition, Skoog, D. M. West and F. J. Holler, Saunders College Publishing (2004).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS104	**CO1**	2	1	1	2	3	1			1	2	2	2	3
	CO2	1	2	1	3	3	1			1	2	1	1	3
	CO3	2	2	2	1	2	1			2	2	1	3	2
	CO4	2	3	2	3	3	2			2	2	2	2	1

SEMESTER-I: PRACTICALS

Course Code	Course Title	TYPE	L	T	P	C	Hrs/Week
M21SM0106	ORGANIC CHEMISTRY-I PRACTICAL	HC	0	0	2	2	4

Course Objectives:

The practical course on organic chemistry intends to

i. Develop scientific skills in qualitative and preparative techniques.
ii. Analyze and conclude from the systematically recorded observations.
iii. Apply the experimental knowledge for analytical reasoning and rational improvisation.
iv. Evaluate the scientific data and transform into tangible outcomes.

Course Outcomes:

On successful completion of the course, the student will be able to

CO1. Develop proficiency to carry out conventional organic synthesis, reactions at inert atmosphere, low temperature, reflux conditions and develop a basic understanding of the reactivity of functional groups

CO2. Acquire skills to perform laboratory techniques such as distillation, re-crystallization, vacuum filtration, solvent extraction and chromatography

CO3. Predict the mechanism of organic reactions, and characterize the molecules by physical methods such as Melting point or Boiling point.

CO4. Evaluate the spectral data to determine the identity and purity of the products.

Course Content:

1. Cannizarro reaction: Benzaldehyde
2. Fries rearrangement: Phenyl acetate
3. Friedel-Crafts reaction: Benzene and Acetyl chloride
4. Sandmeyer reaction: 4-Chlorotoluene from 4-toluidine
5. Pechmann reaction: Resorcinol and ethylacetoacetate
6. Oxidation of cyclohexanol
7. Preparation of S- benzylisothiuronium chloride
8. Synthesis of p-iodonitrobenzene
9. Synthesis of N-Phenyl-2,4-dinitroaniline
10. Synthesis of 2,4,6-tribromoaniline
11. Synthesis of 2,4-dichlorophenoxyacetic acid

12. 2,4-Dinitrophenylhydrazine from chloronitrobenzene
13. Anthranilic acid from phthalic acid
14. Benzanilide from benzophenone
15. Benzilic acid from benzoin
16. Synthesis of acridone
17. Synthesis of hydantoin
18. Synthesis of 2-aryl benzimidazole
19. Synthesis of *t*-alcohol by Barbier reaction
20. Synthesis of tetralin
21. Asymmetric reductive amination
22. Asymmetric aldol reaction

References:

1. Experimental Organic Chemistry: A Mini and Macroscale Approach, Fifth Edition, John C. Gilbert, Stephen F.Martin, Brooks/Cole, Boston, (2011).
2. Microscale Organic Laboratory, 5thEdition, Dana W. Mayo, Ronald M. Pike, David C. Forbes, Wiley, New Jersey, (2011).
3. Modern Organic Synthesis in the Laboratory, 1stEdition, Jie Jack Li, Chris Limberakis, Derek A. Pflum, Oxford University Press, (2007).
4. Vogel's Text Book of Practical Organic Chemistry, 5thEdition, Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, Austin R. Tatchell, Longman Scientific and Technical, (1989).

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21SM S0106	CO1	3	2	3	1	2	3	2			1	2	3	2
	CO2	2	2	2	3	2	2	2			1	3	2	3
	CO3	2	2	3	1	3	2	3			1	3	3	2
	CO4	3	2	3	1	2	1	2			1	2	2	3

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SM0107	PHYSICAL CHEMISTRY – I PRACTICAL	HC	0	0	2	2	4

Course Objectives:

This course aims to provide the student to

1. Knowledge on various analytical techniques for the examination of analyte
2. Apply Skills in qualitative and preparative techniques.
3. Observe and assess the role of electrodes
4. Compare various factors that influence experimental values.

Course outcomes

By the completion of course student will be able to

1. Operate instruments during conduction of experiments.
2. Analyze and interpret the experimental data.
3. Demonstrate experimental skills in laboratories.
4. Identify causes for erratic results and achieve better results.

Course Content:

pH Experiments

1. Calibration of pH meter and pKa measurements

2. Determination of pKa of orthophosphoric acid by pH & Potentiometric methods.

Conductivity experiments

1. To determine the equivalence conductance of strong electrolytes (CH_3COONa, $NaNO_3$, KNO3) at several concentrations and hence verify the Onsagar equation

2. To determine the equivalent conductance of electrolytes at infinite dilution using Kohlrausch law.

Viscosity experiments

1. Determination of the molecular weight of a polymer material by viscosity measurements (polyvinyl alcohol).

Spectrophotometric experiments

1. Verification of Beer's law and calculation of molar extinction coefficient for $CuSO_4$system.

2. Spectrophotometric titration of $FeSO_4$ against $K_2Cr_2O_7$.

3. To determine the concentration of liquids in a binary mixture containing $K_2Cr_2O_7$ and $KMnO_4$ using spectrophotometer.

Potentiometric experiments

1. To determine pH of buffer solutions potentiometrically.

Surface chemistry

1. Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal
2. Adsorption of acetic acid on charcoal and silica gel.

Kinetics

1. Study of Kinetics of hydrolysis of esters using HCl/ H_2SO_4 at two different temperatures, determination of rate constants and energy of activation.
2. To study the effect of addition of electrolyte (KCl) on the rate of reaction between potassium persulphate and potassium iodide **(Equal concentration)**.

Reference Books:

1. Practical Physical Chemistry, A.J. Findlay.
2. Experimental Physical Chemistry, F. Daniels et al.
3. Experiments in Physical Chemistry, Yadav, Geol Publishing House.
4. Experiments in Physical Chemistry, Palmer.
4. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata Mc Graw Hill.

Mapping of Course Outcomes with programme Outcomes

Course .Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S M0107	CO1	1	2	1	2	1	2	1	2	2	2	2	2	2
	CO2	2	1	2	2	2	1	1	2	1	2	1	2	1
	CO3	2	2	2	1	1	2	1	1	1	2	2	1	2
	CO4	2	2	2	2	2	2	1	2	1	2	2	1	1

SEMESTER-II

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SM0201	INORGANIC CHEMISTRY –II	HC	3	1	0	4	5

Course Objectives:

This course aims to provide the student to

i. Correlate topics in coordination chemistry like metal – ligand equilibria, electronic spectra and magnetic properties of metal complexes.
ii. Illustrate the MOT of different types of bonding in metal complexes
iii. Conclude the varies types of inorganic reaction, mechanism and there application
iv. Design the students to have a dynamic interaction to adapt to changes in life

Course Outcomes:

By the completion of course student will be able to

CO1. Apply the Knowledge of d and f-block elements in explaining, interpreting and examining bonding, structure reactivity of complexes

CO2. Illustrate the electronic transitions and magnetic behavior and magnetic susceptibility of the complexes determined by new methods.

CO3. Acquire the detailed knowledge on substation, elimination, oxidation and reduction, photochemical reactions.

CO4. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.

Course Content:

UNIT – I

Metal-Ligand equilibria in solution: Step-wise and overall formation constant and their relationship, trends in step-wise constant, kinetic and thermodynamic stability of metal complexes, factors affecting the stability of metal complexes with reference to the nature of the metal ion and ligand, chelate effect, macrocyclic effect trans effect (sigma and pi bonding effect) and their thermodynamic origin. Determination of binary formation constant by pH metry, spectrophotometry, polarography and ion exchange methods. Introduction to redox chemistry of complexes. Redox chemistry and analytical applications.

Structure and bonding - Structure and bonding in hydride, dihydrogen, dioxygen, isocyanide, CO, NO, N_2 and tertiary phosphine complexes of transition metals. **[15 hrs]**

UNIT- II

Metal- ligand bonding: Stereoisomerism- coordination numbers 3 to 8. Optical isomerism(ORD and CD) Crystal field theory, salient features, spectrochemical series, splitting of d-orbitals in tetragonal, square planar, trigonal bipyramidal and square-pyramidal geometry, applications of CFT- colours of transition metal complexes, magnetic properties of octahedral complex, distortion of octahedral complex, Jahn-Teller distortions CFSE and their uses, factors affecting CFSE, limitations of CFT, experimental evidence for metal-ligand covalent bonding in complexes, nephelauxetic effect, Ligand Field Theory, MO theory: Square planar complex tetrahedral and octahedral complexes (including sigma and singma and π- interactions), angular overlap model. Redox chemistry and analytical applications. **[15 hrs]**

UNIT– III

Electronic spectra of coordination compounds:Spectroscopic ground states, selection rules, term symbols for d^n ions, Spin-Orbit coupling, Racah parameters, Orgel, Correlation and Tanaube-Sugano diagrams, spectra of 3d metal-aqua complexes of trivalent V, Cr, divalent Mn, Co and Ni, $CoCl_4^{2-}$, calculation of Dq, B and β parameters, Jahn-Teller distortions and spectra, CT spectra. Spectral properties of Lanthanide and Actinide metal complexes. Photochemical reactions of transition metals complexes: Basic photochemical processes, Kasha's rule, quantum yield, Jabolnskii diagrams, photo substitution reactions, photo-redox reactions, ligand photoreactions, and metal complexes as photosensitizers. **[15 hrs]**

UNIT– IV

Magnetic properties of coordination compounds: Origin and Types of magnetic behaviour, magnetic susceptibility and its determination- Gouy, Faraday, VSM method Quinke's method, Evans NMR method, Magnetic titrations. Curie's law and Curie-Weiss law, Diamagnetic correction, orbital contribution, spin-orbital coupling, ferro and antiferromagnetic coupling, spin crossover. Magnetic properties of axially symmetric crystal field, high spin/low spin equilibrium, Magnetic properties of Lanthanide and Actinide metal complexes.

Higher coordination numbers, symbiosis, Introduction to ligand substitution reactions: Inert and labile compounds, mechanism of substitutions – reaction pathways, Linear free energy relationships, selected examples, Introduction to redox chemistry of complexes. **[15 hrs]**

References:

1. Basic Inorganic Chemistry, 6thEdition, F. A. Cotton, G. Wilkinson and P. L. Gaus; John Wiley and sons. Inc, (1999).
2. Chemistry of elements, N. N. Greenwood and A. E. Earnshaw, Butterworth Heinemann (1997).
3. Inorganic Chemistry,4thEdition; J. E. Huheey, E. A. Keiter and R. L. Keiter, Addison; Wesley (1993).
4. Inorganic Chemistry, 2nd Edition, D. F. Shriver, P. W. Atkins and C. H. Langford, ELBS; Oxford

University Press, (1994).

5. Inorganic Electronic spectroscopy, A. B. P. Lever, Elsevier. (1968).

6. Magnetochemistry, R.L. Carlin, Springer Verlag.

7. Electronic Absorption Spectroscopy and related Techniques, D. N. Sathyanarayana, University Press (2001).

8. Inorganic Chemistry A Unified Approach, 2nd Edition, W. W. Porterfield, Elsevier (2005).

9. Textbook of inorganic chemistry, G. S. Sodhi, Viva books Pvt. Ltd (2006).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S M0201	CO1	3	1		2	1	1		2		2	1	2	
	CO2	3	3	2	2	1	1	1	2	1	2	2	2	2
	CO3	3	2	1	2		2		2	2	2	1	1	2
	CO4	2	3	2	1	2	2	2	2	2	3	2	1	3

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SM0202	ORGANIC CHEMISTRY – II	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. It deals with the relationships between Organic chemical structures and their reactivity.
ii. Focuses on studies of reaction mechanisms in addition, elimination, substitution reactions
iii. To bring the importance of mechanism in C-C and C-N containing organic compounds and rearrangement reactions
iv. To identify the suitable regent for organic reaction and to determine their reaction mechanisms.

Course Outcomes:

By the completion of course student will be able to

CO1. Analyze functional groups effect on electron density, properties and reactivity in organic compound.

CO2. Illustrate the reaction mechanical aspects in organic synthesis.

CO3. Explain the reaction mechanism involved in organic named reactions with respect to C-C and C-N bonding

CO4. Identify and inspect the mechanisms involved in named reactions, reagents, oxidations and reductions in solving chemistry problems.

Course Content:

UNIT-I

Addition to carbon-heteroatom multiple bonds: Mechanism of metal hydride reduction ($LiAlH_4$, $NaBH_4$, $NaBH(OAc)_3$, $NaBH_3(CN)$) of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents and organolithium reagents to carbonyl compounds and unsaturated carbonyl Compounds. Hydrolysis of nitriles and addition of amines isocyanates Wittig, Mannich and Stobbe reactions.

Addition to carbon-carbon multiple bonds: mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals. Regio, stereo- and chemoselectivities. Orientation and reactivity. Addition to cyclopropane ring. Michael reaction.

Self-Study: Vilsmeier-Haack reaction, Gatterman reaction, Gattermann-Koch reaction and Hoesh reaction. Von Richter reaction, Sommelet-Hauser and Smiles rearrangements, Addition of alkenes and/or alkynes to alkenes and/or alkynes. Ene synthesis. **[15 hrs]**

UNIT-II

Molecular Rearrangements: Molecular rearrangements: Definition and classification. Molecular rearrangements involving i) electron deficient carbon: Wagner- Meerwein, Pinacol-Pinacolone, and Wolf rearrangement. ii) electron deficient Nitrogen: Hofmann, Lossen, Curtius, Schmidt rearrangements iii) electron deficient Oxygen: Baeyer-Villiger oxidation. iv) Base catalysed rearrangements: Aldol condensation, Benzoin, Knoevengel, Sommlett-Hauser and Smiles rearrangement.

Multi-component Reactions: Studies on the mechanistic aspects and use of the following reactions in organic synthesis: Passerini-Ugi; Hantsch; Biginelli; Doebner-Miller; Ritter; Jacobson; Betti; Robinson-Schopf; Barbier; Baylis-Hilmann; Ivanov and Suzuki coupling reaction. **[15 hrs]**

UNIT-III

C-C and C-N bond forming reactions: Darzen's reaction, Use of acetylides in C-C bond formation reactions. Acid-catalyzed self-condensation of olefins, Prins reaction, Shapiro reaction, Dieckmann cyclization, Robinson annulations, Hofmann-Loeffler-Freytag reaction. Hofmann-Martius reaction. Acyloin condensation. Houben-Hoesch reaction. Stork-enamine synthesis. Meyer synthesis. Use of nucleophilic nitrogen and electrophilic carbon (NH_3, amines and nitrite as nucleophiles in substitution, NH_3 and amines in addition to ketones and aldehydes) and electrophilic nitrogen and nucleophilic carbon (nitration, nitrosation) for the bond formation reactions.

***Self-Study**:* Chichibabin reaction, Skraup synthesis, Mitsunobu reaction, N-Nitroaromatic amine rearrangement, Fisher-Hepp reaction, Japp-Klingemann reaction. **[15 hrs]**

UNIT-IV

Reagents in organic synthesis: Use of the following in organic synthesis and functional group tansformations. Aluminium iso-propoxide, NBS, LDA, DCC, DDQ, 1,3-Dithiane (reactivity and umpolung), Sulphur ylides, PPA, Yamaguchi reagent. Woodward and Prevost hydroxylation

Oxidations-I: Cr (VI) oxidants, Mn (VII) oxidants, OsO_4- and co-oxidants SeO_2, Pb $(OAc)_4$, IBX and related reagents.

Oxidations-II: ozone, peroxides (H_2O_2, t-BuOOH, dibenzoylperoxide) and per acids (Preparation, properties and applications of CF_3COOOH, m-CPBA, monoperphthalic acid) as oxidizing agents.

Reductions: Complex metal hydrides, dissolving metal reductions (including Birch, Benkeser, Clemmensen reductions), diimide reduction, catalytic hydrogenation (homogeneous and heterogeneous), Hydrogenation of double and triple bonds, hydrogenation of aromatic rings.McMurry reaction. Pummer, Willgerdo.

[15 hrs]

Self-Study: Corey-Chaykovsky reagent, Raney-Nickel, diazomethane, TMS-chloride, HIO_4, Ag_2O, DMSO, Dess-Martin oxidation. Wolf-Kishner reduction Corey-Bakshi-Shibata and Tishchenko reactions, Junjappa-Ila hetero aromatic annulation reaction.

References:

1. Advanced Organic Chemistry, Reactions, Mechanism and Structure, Jerry March, John Wiley (2008).
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum (1990).
3. A Guide Book to Mechanism of Organic Chemistry, Peter Sykes, Longman (2000).
4. Structure and Mechanism of Organic Chemistry, C. K. Ingold, Cornell University Press.
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall (1998).
6. Modern Organic Reactions, H. O. House, Benjamin (1972).
7. Principles of Organic Synthesis, ROC Norman and J. M. Coxon, Blackie Academic and Professional (1996).

Mapping of Course Outcomes with programme Outcomes.

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S M0202	CO1	3	2		2	2	2			1	1	3	2	1
	CO2	3	3	1	2	2	2			1	1	3	2	2
	CO3	3	3	1	2	2	1			1	1	3	2	2
	CO4	2	2	1	2	2	2			1	1	3	2	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SM0203	PHYSICAL CHEMISTRY- II	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. Provides students to enlighten the knowledge on Quantum chemistry,
ii. To give insights on molecular symmetry and group theory.
iii. Focuses on representation and applications of various spectroscopic techniques like microwave, vibrational, electronic, Raman, EPR and NMR.
iv. Understand the importance of physical Principles in spectroscopy and bonding.

Course Outcomes:

After successful completion of this course, the student will be able to:

CO1. Apply the fundamental knowledge of quantum mechanical processes involved in atoms and molecules, and interpret the symmetry, spectroscopic and electronic properties of matter

CO2. Devise the character tables to identify the allowed vibrational transitions and analyze the importance of symmetry in chemical bonding

CO3. Analyze the rotational and vibrational spectra to evaluate the bond strength, bond length and the amount of isotopes mixtures.

CO4. Interpret various spectroscopic data of materials obtained using advanced analytical tools by utilizing the theoretical basis and predict the structure of chemical compounds.

Course Content:

UNIT – I

Quantum Chemistry: Planck's concept of quantization, Wave-particle duality of material particles, de Broglie equation, Heisenberg Uncertainty principle, Concept of operators (operator–operand), Algebra of operators, commutative and non-commutative operators, linear operator, Laplacian operator, Hamiltonian operator, Eigen value, Eigen function, class Q function, Hermitian operator. Schrodinger wave equation for particles, Eigen values and Eigen functions, postulates of quantum mechanics. Application of Schrodinger equation to a free particle (one dimension and three dimensions). Degeneracy, Wave equation for H-atom, Physical interpretation of wave function, separation and solution of R, ϕ and θ equations. Orbital and spin momentum interpretation. Particle in a box, Application of Schrodinger equation to rigid rotator and harmonic oscillator. Approximate methods – approximate methods, perturbation method, the theory of perturbation method – first order and second order corrections, application to He-atom (first order correction only) – calculation of first ionization potential and binding energy. Variation theorem: statement

and proof. Orbitals shapes and electron density distribution, quantum mechanics in periodic properties, MO formation, Quantum tunneling.

Unit II

Symmetry elements and symmetry operations, point groups, examples. Group theory: Concept of a group, definition of a point group, procedure for classification of molecules into point groups. Subgroups. Schoenflies and Hermann-Maugin symbols for point groups. Multiplication tables for the symmetry operations of simple molecules. Matrix notation for the symmetry elements and for geometric transformations. Class of a group and similarity transformation.

Representation of groups: Reducible and irreducible representations. Labeling of irreducible representations. Group theory and hybrid orbitals to form bonds. Character tables (Cs, Ci, C_2, C_{2V}, C_2h), GOT.

Applications of group theory: Symmetries of Molecular orbitals, Basic MOT, orbital symmetries, Applications of group theory to crystal field, Symmetry and dipole moments, symmetry and optical activity, crystallography.

UNIT – III

Microwave spectroscopy: Rotation spectra of diatomic Molecules - rigid and non-rigid rotator model. Rotational quantum number and selection rule. Effect of isotopic substitution on rotation spectra. Classification of polyatomic molecules based on moment of inertia - Linear, symmetric top, asymmetric top and spherical molecules.

Rotation spectra of polyatomic molecules, Moment of inertia expression for linear tri-atomic molecules. Applications - Principles of determination of Bond length and moment of inertia from rotational spectra. determination of dipole moments.

Vibration spectroscopy*:* Vibration of diatomic molecules, vibrational energy curves for simple harmonic oscillator. Effects of anharmonic oscillation. Vibration - rotation spectra of carbon monoxide. Expressions for fundamental and overtone frequencies. Vibration of polyatomic molecules – The number of degrees of freedom of vibration and their symmetry. Parallel and perpendicular vibrations (CO_2 and H_2O). Fundamental, overtone, combination and difference bands. Fermi resonance. Force constant and its significance. Theory of infrared absorption and theoretical group frequency. Intensity of absorption band and types of absorptions. Structures of small molecules: XY_2. Factors affecting the group frequency – Physical state, vibrational coupling, electrical effect, hydrogen bonding, steric effect and ring strain.

UNIT – IV

Raman spectroscopy: Introduction, Raman and Rayleigh scattering, Stokes and anti-Stokes lines, polarization of Raman lines, depolarization factor, polarizability ellipsoid. Theories of Raman spectra -

classical and quantum theory. Rotation-Raman and vibration-Raman spectra. Comparison of Raman and IR spectra, rule of mutual exclusion principle.

Electronic Spectroscopy: Franck-Condon principle, Transition moments, assignment of electronic transitions of N_2, H_2O and formaldehyde using group theory, solvent effect,

Introduction to NMR:- Origin of magnetic moments in matter, electronic and nuclear moments, interaction with magnetic field, Larmor equation - conditions for magnetic resonance absorption, relaxation times, line widths and line shapes, chemical shifts, ring currents, diamagnetic anisotropy, solvent effect, Hydrogen bonding effect, spin-spin splitting, Coupling constant, high resolution NMR spectra of simple molecules, first and second order treatment of AB systems - FT techniques. C^{13}NMR introduction, problems and structure solution.

Other Resonance Spectroscopy Methods:- EPR, Electron spin resonance: g value, hyperfine and fine structure, ESR of organic free radicals, ESR of solids, ESR of inorganic ions, ESR of simple free radicals in solutions.

References:

1. Lewis and Glasstone, Elements of Physical Chemistry, The Sciencec Study series, Macmillian, 1963
2. P.W. Atkins, Physical Chemistry, ELBS, Oxford University Press 4th Edition, (1990).
3. W.J. Moore, Basic Physical Chemistry, Prentice Hall, New Delhi, (1986).
4. G.M. Barrow, Physical Chemistry, McGraw Hill International Service (1988).
5. A.K. Chandra, Quantum Chemistry, Tata McGraw Hill Publishing Co. Ltd., 2nd Edition, (1983).
6. Eyring, Walter and Kimball, Quantum Chemistry, John Wiley and Sons, Inc., New York.
7. Quantum Chemistry, I.N. Levine. Pearson Education, New Delhi, (2000).
8. Theoretical Chemistry, S. Glasstone. East West Press, New Delhi, (1973).
9. Quantum Chemistry, R.K. Prasad, New Age International Publishers, (1996).83)
10. D.A. McQuarrie. Quantum Chemistry, University Science book publishers, 1983
11. C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill, New Delhi. 4th Edition,
12. Pavia, Lampman and Kriz, Introduction to Spectroscopy, Thomson. Learning academy resources, 3rd Edition, 2001
13. B.P. Straughan and S. Walker, Spectroscopy, John Wiley & Sons Inc., New York, Vol. 1 and 2, (1976).
14. D.N. Satyanarayana, Vibration Spectroscopy Theory and Applications, New Age International, New Delhi.
15. Alberty, Silbey, Bawendi, Physical Chemsitry, Wiley, 4th Edition, 2004

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S M0203	CO1	2	3	2	2	2	1			1	2	2	2	2
	CO2	2	2	1	2	2	1			1	2	2	1	2
	CO3	2	3	2	2	2	1			1	2	2	2	3
	CO4	3	3	2	2	2	1			1	2	3	2	3

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SM0204	ORGANIC SPECTROSCOPY	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. Device the basic concepts of UV-Visible and IR spectroscopic techniques to analyze the chemical compound and structure,

ii. Analyze the organic compound structure by using the knowledge of Chemical shift values and data interpretation.

iii. Evaluate the mass of the organic compound by the fragmentation pattern and study the compounds by different modern ionization techniques.

iv. Illustrate the of unpaired electron compounds by the principle of ESR technique and Elucidate the structure of organic compound by using the spectral data.

Course Outcomes:

By the completion of course student will be able to

CO1. Conclude the structure and composition by using the UV-Visible and IR spectroscopic techniques.

CO2. Apply the knowledge of nuclear spin resonance phenomenon to identify the structure of compounds by the chemical shift values of shielded and De-shielded compounds.

CO3. Evaluate the mass of the compound by the knowledge of ionization, fragmentation in the process of structure analysis.

CO4. Decide the structure of unpaired electron system and elucidate the structure of organic compound by using the spectral data.

Course Content:

UNIT-I

UV AND Visible Spectroscopy: Introduction to EMR, principle and instrumentation, Terminology, classification of electronic transitions. Effect of substituent and conjugation on the spectra of alkenes. Electronic spectra of carbonyl compounds. Effect of solvent on $\pi - \pi^*$ and $n - \pi^*$ transitions. Woodward's rules for calculating absorption maximum in dienes, carbonyl compounds, Applications and structure analysis.

Infrared Spectroscopy: Principle and instrumentation, types of IR vibrational bands, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides.). Effect of solvent, Electronic effects and hydrogen bonding on the vibrational frequencies in alcohols. Applications and structure analysis. **[15 hrs]**

UNIT-II

H^1-NMR Spectroscopy: Introduction, basic principles and instrumentation of NMR spectroscopy. The chemical shift and shielding. Factors affecting chemical shift. Magnetic anisotropy, electronic effects, hydrogen bonding. Relaxation processes. Spin – spin coupling and splitting of NMR signals. Spin – spin interactions – AX, AX2, AX3, AMX and AB types. The coupling constant. Intensities of multiplets – Pascal's triangle. Equivalence of protons – chemical and magnetic equivalence. Low and high-resolution spectra of ethanol – chemical exchange. Geminal and vicinal coupling. Karplus equation and Karplus curve. Effect of hindered rotation on the NMR spectrum.

C^{13}-NMR Spectroscopy: The carbon – 13 nucleus, carbon – 13 chemical shift. Proton coupled and proton decoupled carbon – 13 spectra. NOE, COSY, HETCOR, Problems with integration in carbon -13 spectra. Off resonance decoupling. Applications in structural elucidation. **[15 hrs]**

UNIT-III

Mass Spectrometry: Introduction, principle and instrumentation. Ion production electron impact, chemical ionization, field desorption and fast atom bombardment, APCI, MALDI techniques. High resolution mass spectrometry base peak, molecular ion, parent ion, fragmentation ion, metastable and isotopic peaks. Factors affecting fragmentation, ion analysis and ion abundance. Mass spectral fragmentation of organic compounds (hydrocarbons, aromatic compounds, alcohols, carbonyl compounds). Mc-Lafferty rearrangement, ortho-effect. Determination of molecular weight and molecular formula. Structuralelucidation. **[15 hrs]**

UNIT-IV

Electron Spin Resonance Spectroscopy: Theoretical principle and Instrumentation, 'g' factor, hyperfine splitting, Kramers degeneracy. Illustration of hyperfine splitting using examples, cyclopentadienyl radical, radical anions of benzene, naphthalene, p-benzosemi Quinone. Isotropic spectra of some transition metal complexes and compounds, bis(salicylaldimine) Cu(II), $[VO(glycolate)_2]^{-2}$, $[(NH_3)_5Co\text{-}O\text{-}O\text{-}Co(NH_3)_5]^{5+}$, Mn^{2+} as a substitution impurity in MgO.

Structuralelucidation of different organic compounds by using the spectral data. **[15 hrs]**

References:

1. Spectrometric Identification of Organic Compounds, R.M. Silverstein and W.P. Webster, Wiley & Sons, (1999).

2. Principles of Instrumental Analysis, 5th Edition,D.A. Skoog, S.J. Holler, T.A. Nilman, Saunders College Publishing, London, (1998).

3. Organic spectroscopy, 3rd Edition, Willium Kemp, Palgrave, London (1991).

4. Organic spectroscopy, L.D.S Yadav, Sprnger, Dordrecht (2005).

5. Molecular spectroscopy, C.N. Banwell, third edition, MC graw-Hill, London (1983).

6. Organic spectroscopy, Y.R. Sharma

7. Introduction to Spectroscopy, Donald Pavia.

Mapping of Course Outcomes with programme Outcomes

c	**POS/ Cos**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PS O1**	**PS O2**	**PS O3**
M21S M0204	CO1	1	2	1	2	3	1	3	2	2	2	2	3	3
	CO2	1	2	2	2	3	2	3	1	2	2	2	2	3
	CO3	1	2	1	1	3	2	3	1	2	2	2	2	3
	CO4	1	1	1	1	2	1	2	1	2	1	2	1	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SM0205	CHALLENGES IN INDUSTRIAL RESEARCH AND DEVELOPMENT	AECC/HC	2	0	0	2	2

COURSE OBJECTIVES:

This course enables the students to

1. Understand the industrial protocols and regulations
2. Gain sufficient information about the resources and uses of chemicals
3. Demonstrate the concepts of manufacturing
4. Develop the knowledge on GLP and GMP

COURSE OUTCOMES:

After the completion of the course, a student should be able to

1. Appreciate the importance of standard operating procedures
2. Understand the significant aspects of process development
3. Assess the impact of chemicals on environment
4. Realize the various safety regulations in industries

Unit 1

Introduction and importance of chemistry research, Basic research methodologies, literature survey, research Journals, research ethics and practices, bridging gaps: Academics to industry translation, product requirements and developments, challenges, patents, Industrial requirements. Vital industrial R&D

Unit 2

Green Chemistry, Principles, Pollution prevention, Atom economy, Less hazardous chemical syntheses , Designing safer chemicals, Safer solvents and auxiliaries, Design for energy efficiency, Use of renewable feed stocks, Reduce derivatives, Catalysis, Design for degradation, Real-time analysis for pollution prevention, Inherently safer chemistry for accident prevention.

Unit 3

Characteristics of the industry, Scale of operations, Chemical production, Major sectors and their products, Turning chemicals into useful end products, Environmental issues, Sources of organic chemicals, Organic chemicals from oil and natural gas, Organic chemicals from coal, Organic chemicals from carbohydrates, Organic chemicals from animal and vegetable oils and fats, Sources of inorganic chemicals, Recycling of materials, Catalysis, Essential features, Initiators, Co-reactants, Inhibition, Homogeneous and Heterogeneous catalysis, Applications and Mechanisms, Petrochemicals, Crude oil, gas and refinery operations, Lower olefins and acetylene, Synthesis gas, ammonia and methanol, Acetic acid and anhydride, C1, C2, C3 and C4 products, C5 aliphatics, Aromatics, Nylons.

Unit 4

Research and Development, Manufacturing, Intent of Regulations, Regulatory authorities, U.S. Food and Drug Administration (FDA), GLP and GMP, Organization and Personnel, Facilities and Equipments, Testing Facilities, Control articles, Nonclinical studies, Laboratory Controls, Control of Components and Drug Products, Production and Process Controls, Packaging and Labeling Control, Holding and Distribution, Records and Reports, Documentation

***

The subject requires

Minor Project with respective research mentors, Industrial Visit, Thesis/Report - weightage 20 %

Bibliography

1. An Introduction to Industrial Chemistry, Second Edition, C. R, Heaton, Blackie Academic & Professional, 1992

2. Handbook of Industrial Chemistry, Organic Chemicals, M. Ali, Bassam El Ali, McGraw Hill, 2005

3. Fundamentals of Industrial Chemistry, John A. Tyrell, Wiley, 2014

4. Organic Chemistry Principles and Industrial Practice, Mark M. Green, Harold A. Wittcoff, De Gruyter, 2003

5. Industrial Inorganic Chemistry, Mark Anthony Benvenuto, De Gruyter, 2015.

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8		PO 9	PO 10	PS O1	PS O2	PS O3
M21S M0205	**CO1**	**2**	**1**	**2**	**1**	**2**	**1**	**1**				**1**	**3**	**1**	**2**
	CO2	**3**	**2**	**1**	**2**	**2**	**3**	**2**				**1**	**1**	**1**	**3**
	CO3	**2**	**2**	**2**	**3**	**3**	**2**	**1**				**1**	**3**	**1**	**2**
	CO4	**3**	**2**	**1**	**2**	**1**	**2**	**2**				**1**	**3**	**1**	**2**

SEMESTER-II: SOFTCORE (SC)

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS201	CHEMISTRY OF LIFE	SC	2	0	0	2	2

Course Objectives:

This course aims to provide the student to

i. Knowledge on green chemistry concepts.
ii. Applications of various green technology in materials synthesis.
iii. Class of green chemicals and compounds for sustainability.
iv. Categorization of reaction mechanisms and schemes for green synthesis.

Course Outcomes:

By the completion of course student will be able to

CO1. Discriminate the role metal ions in biological systems.
CO2. Categorize biomolecules based on their biological functioning.
CO3. Appraise the role of chemistry principles in biological systems.
CO4. Explain the role of analytical techniques in the purification of biomolecules.

Course Content:

UNIT-I

Bioinorganic chemistry: Introduction to elements and their occurrence, role of some alkali, alkaline and transition elements in Biosystems. Basic principle of selection of metal ions in Biosystems; Irving – Williams's series and its significance. HSAB concept-classification and its importance. Relationship between ionic specificity and field strength. Coordination sites in biomolecules (Proteins, DNA and Vitamins). Respiratory Proteins; Iron storage proteins (Ferritin, apoferritin and Transferrin). Structural aspects of Haemoglobin and myoglobin and their role in oxygen transport. Spin state of iron, Spatial and electronic aspects in dioxygen binding (about d-configuration), oxygenation curve (Bohr Effect). Functional aspects of Cytochromes (c, c oxidase and P-450), Copper-Blue proteins (Type – I, II and III), Fe-S proteins (Rubredoxin and Ferredoxins), peroxidase, catalase, Molybdenum and tungsten enzymes in Biosystems. Bio mineralization (role of Minerals). **[12 hrs]**

UNIT-II

Physical Chemistry in Bio-systems: Bio electrochemistry: Electrochemical cells and membrane potentials, nature of driving forces, origin of membrane potentials, electrochemical potential and Nernst equation for Electroneutrality. Introduction to bilayer lipid membranes and its structure. Membrane transport; purpose of transport process, factors governing permeation and transport, the nature of driving force (Fick's law of diffusion). Types of transport; active, facilitated and passive transports (terms involved), example of K^+/Na^+ pump and Na^+/Ca^{2+} pumps across the membranes (for all the cases diagrammatic representations). Properties of lipids described using chemical potential and phenomenon of lipid and detergent formation into micelles and bilayers. Determination of micelle formation using surface tension. Enzyme catalysis, and its kinetics- Michaelis-Menten equation, and its modified form and Lineweaver–Burk plot; enzyme inhibition types (competitive, non-competitive and un-competitive) and Lineweaver–Burk plots. Osmosis and Donnan membrane potential and its biological significance. Protein solubility and crystallisation; principle (Hoffmeister series) "Salting In" and "Salting Out" for protein purification.

[12 hrs]

UNIT-III

Bioenergetics: Oxidation and reduction reactions and bioenergetics (concept of midpoint potential). The central role of ATP in Metabolism and its stability. Mitochondrial flow of electrons from NADH to O_2. Oxidative phosphorylation and respiratory chain. Energetics of electron transfer –I (Introduction to Marcus theory and Frank Condon principle). Thermodynamic principles in coupled reactions (endothermic & exothermic). Mechanism of muscle contraction – role of actin and myosin in presence of ATP. Introduction to enthalpy, free energy, entropy, heat capacity and chemical potential.

Application of some instrumental techniques in the study of biomolecules:

(i) Differential Scanning Calorimetry and ITC: Principle, instrumentation and its application in the study of folding and unfolding biomolecules such as, DNA and proteins.

(ii) Circular Dichroism: Principle, instrumentation and general explanation for its application in the study of based on chirality in proteins and chirality of bases due to double helix model of the DNA. **[12 hrs]**

UNIT-IV

Bio-organic chemistry: Interactions in Bio systems; hydrogen bonding (in proteins, Nucleic acid, Carbohydrates), Vander walls forces, electrostatic, hydrophobic (Apolar bond), stacking and covalent interactions. Proteins structures (primary, secondary, tertiary and quaternary). Protein folding and unfolding. Detection of intrastrand disulfide bonds in proteins hierarchy of structural organization. Introduction to biopolymers; DNA and its polymerisation, RNA, Chemical methods involved in sequencing of DNA and Proteins. Chemical and biochemical synthesis of DNA- Phosphoramidite method and

replication. Chemical and biochemical synthesis of peptides/proteins- solution phase and solid phase peptide synthesis methods and ribosomal synthesis of proteins. Applications of PNAS.

Non-redox metalloenzymes and their functions: Carboxypeptidase-A, alcohol dehydrogenase, leucine aminopeptidase and carbonic anhydrase (Nitrogen cycle). **[12 hrs]**

Self-study: Protein folding and Prions

References:

1. Bioinorganic Chemistry, 2nd Edition, W. Kaim, John Wiley (2013).
2. Inorganic Chemistry, D. F. Shriver, P. W. Atkins, C. H. Langford, ELBS (1990).
3. Biophysical Chemistry, C.R. Cantor & P.R. Schimmel, W.H. Freeman & Company, (1980).
4. Introduction to Bioorganic Chemistry and Chemical Biology, David Van Vranken and Gregory A, Garland Science (Taylor & Francis), (2012).
5. Advanced Organic Chemistry, I.L. Finar, Vol. 2 ELBS, New Delhi, (1975).
6. Biophysical Chemistry- Principle and Technique,A. Upadhyay, K. Upadhyay and N. Nath, Himalaya Publishing House, Bombay, (1998).
7. Bioinorganic Chemistry, K. Hussain Reddy, New Age International Publishers, (2003).
8. Biophysical Chemistry, Alan Cooper, Glasgow University, RSC, (2004).
9. Biophysical Chemistry, James P. Allen, Wiley – Blackwell Publication, (2008).
10. Bioinorganic Chemistry,Ivano Bertini, Harry B. Gray, Stephen J. Lippard and Joan Swlverstone Valentine, University Science Books, (1994).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS201	CO1	1	1			2	2					2	2	
	CO2	2	1		1	2	1					1	2	2
	CO3	2	2		1	2	2					2		2
	CO4	2	2		2	2	2					2	2	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS202	INTRODUCTION TO MEDICINAL CHEMISTRY	DSEC*/SC	2	0	0	2	2

Course Objectives:

i. This course will deal with the topics which provide insights on how the different substrates act as drug targets.

ii. Various aspects of the drug discovery such as pharmacokinetics, structure-activity relationships and computer assisted drug discovery will be examined.

iii. The mechanism of action of antibacterial agents and bacterial resistance to antibiotics will be explored.

iv. The cause of the cancer and the mode of action of anticancer agents will be surveyed.

Course Outcomes:

On successful completion of this course the student shall be able to:

CO1. Understand the importance of drug targets and its relevance for drug discovery.

CO2. Analyze the concepts of pharmacokinetics and structure-activity relationships.

CO3. Identify the mechanism of action of antibacterial agents, and the causes of bacterial resistance.

CO4. Evaluate anticancer agents based on therapeutic applications and mode of action.

Course Content:

UNIT - I

Drug Targets

Enzymes: Inhibitors acting at the active site of an enzyme, Inhibitors acting at allosteric binding sites, Uncompetitive and non-competitive inhibitors, Transition-state analogues, Suicide substrates, Isozyme selectivity of inhibitors, Enzyme inhibitors, Enzyme kinetics

Receptors: Agonists, Antagonists, Partial agonists, Inverse agonists, Desensitization and sensitization, Tolerance and dependence, Receptor types and subtypes, Affinity, efficacy, and potency

Nucleic acids: Intercalating drugs acting on DNA, Topoisomerase poisons, Alkylating and metallating agents, Chain cutters, Chain terminators, Control of gene transcription, Agents that act on RNA

Miscellaneous: Transport proteins as drug targets, Structural proteins as drug targets, Biosynthetic building blocks as drug targets, Biosynthetic processes as drug targets, Protein-protein interactions, Lipids as drug targets, Carbohydrates as drug targets. **[12hrs]**

UNIT - II

Pharmacokinetics

Drug absorption, Drug distribution, Drug metabolism, Drug excretion, Drug administration, Drug dosing, Formulation, Drug delivery

Quantitative Structure - Activity Relationships (QSAR)

Hydrophobicity, Electronic effects, steric factors, Hansch equation, The Craig plot, The Topliss scheme, Bioisosteres, Three-dimensional QSAR (CoMFA)

Computers in Medicinal Chemistry

Molecular mechanics, Quantum mechanics, Energy minimization, Conformational analysis, Structure comparisons and overlays, Identifying the active conformation, 3D Pharmacophore identification, Docking procedures, Automated screening, Protein mapping, *De novo* drug design. **[12 hrs]**

UNIT – III

Antibacterial Agents

Bacterial cell, Mechanisms of antibacterial action

Antibacterial agents which act against cell metabolism - Sulphonamides

Antibacterial agents which inhibit cell wall synthesis - Penicillins, Cephalosporins, Other β-lactam antibiotics, β-Lactamase inhibitors, other drugs which act on bacterial cell wall biosynthesis

Antibacterial agents which act on the plasma membrane structure - Valinomycin and gramicidin A, Polymyxin B, Killer nanotubes, Cyclic lipopeptides

Antibacterial agents which impair protein synthesis: translation - Aminoglycosides, Tetracyclines, Chloramphenicol, Macrolides, Lincosamides, Streptogramins, Oxazolidinones

Agents that act on nucleic acid transcription and replication - Quinolones and fluoroquinolones, Aminoacridines, Rifamycins, Nitroimidazoles and nitrofurantoin, Inhibitors of bacterial RNA polymerase

Miscellaneous agents, Drug resistance - Drug resistance by mutation, Drug resistance by genetic transfer. **[12hrs]**

UNIT - IV

Anticancer agents

Cancer - Causes of cancer, Genetic faults leading to cancer: proto-oncogenes and oncogenes, Abnormal signalling pathways, Insensitivity to growth-inhibitory signals, Abnormalities in cell cycle regulation,

Apoptosis and the p53 protein, Telomeres, Angiogenesis, Tissue invasion and metastasis, Treatment of cancer, Resistance

Drugs acting directly on nucleic acids - Intercalating agents, Non-intercalating agents, Alkylating and metallating agents, Chain cutters, Antisense therapy

Drugs acting on enzymes: antimetabolites - Dihydrofolate reductase inhibitors, Inhibitors of thymidylate synthase, Inhibitors of ribonucleotide reductase, Inhibitors of adenosine deaminase, Inhibitors of DNA polymerases, Purine antagonists, Inhibitors of poly ADP ribose polymerase

Hormone-based therapies - Glucocorticoids, estrogens, progestins, and androgens, Luteinizing hormone-releasing hormone agonists, Anti-estrogens, Anti-androgens, Aromatase inhibitors

Drugs acting on structural proteins - Agents which inhibit tubulin polymerization, Agents which inhibit tubulin depolymerisation

Inhibitors of signalling pathways - Inhibition of farnesyl transferase and the Ras protein, Protein kinase inhibitors

Miscellaneous enzyme inhibitors - Matrix metalloproteinase inhibitors, Proteasome inhibitors, Histone deacetylase inhibitors, other enzyme targets

Miscellaneous anticancer agents - Synthetic agents, Natural products, Protein therapy, Modulation of transcription factor – co-activator interactions

Antibodies, antibody conjugates and gene therapy - Monoclonal antibodies, Antibody-drug conjugates, Antibody-directed enzyme prodrug therapy (ADEPT), Antibody-directed abzyme prodrug therapy (ADAPT), Gene-directed enzyme prodrug therapy (GDEPT), other forms of gene therapy

Photodynamic therapy. **[12hrs]**

References:

1. Text Book of Organic Medicinal and Pharmaceutical Chemistry, 12thEdition,John M. Beale Jr., John H. Block, Wolters Kluwer/Lippincott Williams & Wilkins, Baltimore, (2011).
2. Medicinal Chemistry an Introduction, 2nd Edition, Gareth Thomas, Wiley, England, (2007).
3. An Introduction to Medicinal Chemistry, 5th Edition, Graham L. Patrick, Oxford University Press, Oxford, (2013).
4. Medicinal Chemistry: A Molecular and Biochemical Approach, 3rdEdition, Thomas Nogrady, Donald F. Weaver, Oxford University Press, Oxford, (2005).
5. Pharmaceutical Chemistry, 1stEdition, David G. Watson, Churchill Livingstone/Elsevier, Edinburgh, (2011).
6. The Organic Chemistry of Drug Design and Drug Action, 3rdEdition, Richard B. Silverman, Mark W. Holladay, Elsevier, San Diego, (2014).
7. Foye's Principles of Medicinal Chemistry, 7thEdition, Thomas L. Lemke, David A. Williams, Victoria F. Roche, S. William Zito, Lippincott Williams and Wilkins/Wolters Kluwer, Baltimore, (2013).

8. Pharmacology, 5th Edition,Michelle A. Clark, Richard Finkel, Jose A. Rey, Karen Whalen, Wolters Kluwer/Lippincott Williams and Wilkins, Baltimore, (2012).
9. Molecular Biology, 3rd Edition, Phil Turner, Alexander McLennan, Andy Bates, Mike White, Taylor &Francis, New York, (2005).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS202	CO1	2	1	2	1	2	1	1			1	2	1	2
	CO2	3	1	1	2	2	1	2			1	2	1	3
	CO3	2	2	2	1	3	2	2			1	2	1	2
	CO4	3	2	1	2	1	2	2			1	3	1	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS203	ADVANCED CHEMICAL KINETICS AND THERMODYNAMICS	SC	2	0	0	2	2

Course Objectives:

i. To provide the student with principles and kinetic tools useful in analyzing the rates of chemical reactions for both homogeneous and heterogenous reactions.

ii. To increase the student's ability to do chemical reactor design by providing the knowledge and tools required to obtain, evaluate, and improve rate equations for use in design, operation and optimization of chemical reactors.

iii. To present a comprehensive and rigorous treatment of classical thermodynamics while retaining an engineering perspective.

iv. To lay the groundwork for subsequent studies in such fields as fluid mechanics, heat transfer and to prepare the students to effectively use thermodynamics in the practice of industry.

v. To develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments.

vi. To present a wealth of real world industrial examples to give students a feel for how thermodynamics is applied in engineering practice.

Course Outcomes:

By the completion of course student will,

CO1. Acquire knowledge on theories of reaction rates, Kinetics of Unimolecular and bimolecular photo physical and photochemical processes.

CO2. Classify the activation and diffusion-controlled processes, different types of overpotentials, Kinetics in the Excited State.

CO3. Explain the concept of thermodynamic work. Calculate and compare work in case of a closed system executing different thermodynamic processes or different thermodynamic cycles.

CO4. Get knowledge about advanced solution thermodynamics, Modern experimental techniques.

Course Content:

UNIT – I

Chemical kinetics: Overview of theories of Reaction Rates, Potential energy surfaces-adiabatic and non-adiabatic curve crossing Processes- transition state theory- activation/thermodynamic parameters. Various theories of Unimolecular reactions (Lindemann- Christiansen hypothesis; Hinshelwood, RRK and RRKM theories; non RRKM behavior)

Elementary Reactions in Solutions: Influence of solvent properties on rate. Different types of molecular interactions in solution. Diffusion and activation-controlled reactions.

Kinetics in the Excited State: Jablonski diagram. Kinetics of Unimolecular and bimolecular photophysical and photochemical processes. Resonance energy transfer rates-Fluorescence quenching kinetics in solution and gas phase. **[8 hrs]**

UNIT – II

Electrode Kinetics: Metal/solution interface: Dependence of electrochemical reaction rate on overpotential-current density for single step and multi-step processes-Influence of electrical double layer on rate constants. Activation and diffusion-controlled processes- Marcus kinetics and quadratic dependence of Gibbs free energies-electron transfer processes involving organic and inorganic compounds. Different types of overpotentials- polarization behavior-Mechanism of hydrogen evolution and oxygen reduction in acid and alkaline media- Experimental methods for elucidation of reaction mechanism.

[8 hrs]

UNIT – III

Applications of Chemical Kinetics: Homogenous catalysis: Acid-base catalysis, specific acid and base catalysis. General acid and base catalysis. Oxidation of amino acids and carbohydrates in presence of acid and base catalysis. Acidity functions - Bronstead, Hückel, Hammett and Bunnett hypothesis.

Chain reactions: Rice-Herzfeld mechanism for the thermal decomposition of acetaldehyde, Kinetics of explosive reactions, explosion limits (H_2 and O_2 reaction). Kinetics of autocatalytic and oscillatory chemical reactions, oscillatory chemical reaction of oxidation of malic acid by bromate ion catalyzed by Ce(III). Catalyzed and uncatalyzed reaction: Ru(III) catalyzed oxidation reaction of primary amines by chloramine – T in HCl medium.

Heterogenous catalysis, surface and interaction with solids, kinetics of reactions of solids. **[7 hrs]**

UNIT – IV

Advanced solution thermodynamics: Ideal and non-ideal solutions, activity and activity coefficients, mixing and excess properties of liquid-liquid mixtures. Theories of solutions of electrolyte and non-electrolyte liquids: van Laar theory, van der Waals theory, Scatchard-Hildebrand theory, Lattice theory.

Modern experimental techniques: determination of vapour-liquid equilibrium by static and dynamic methods, heat capacity and heat of mixing by calorimeters, and determination of volumetric, transport, acoustic and optical properties of liquid-liquid mixtures. Partial molar properties, their physical significance and methods of their determination. Study of non-ideal behaviour of various types of solutions: nonpolar + nonpolar, polar + nonpolar, polar + polar, and mixtures with hydrogen-bond formation and charge transfer complexes; interpretation in terms of molecular interactions. **[7 hrs]**

References:

1. Text Book of Physical Chemistry, 2nd Edition, Samuel Glasstone, MacMillan Indian Ltd., (1974).
2. Elements of Physical Chemistry, S. Glasstone, MacMillan.
3. Solid State Chemistry, N.B. Hannay.
4. A Text Book of Physical Chemistry, G.M. Barrow, Mc Graw Hill – Tokyo, (1973).
5. Elements of Physical Chemistry, Lewis and Glasstone.
6. Theoretical Chemistry, S. Glasstone.
7. Statistical Themodynamics, B.C. Meclelland, Chapman and Hall, London (1973).
8. Elementary Statistical Thermodynamics, N.D. Smith Plenum Press, NY (1982).
9. Elements of Classical and Statistical Thermodynamics, L.K. Nash, Addison-Wesley (1970).
10. Statistical Thermodynamics, I.M. Klotz.
11. Introduction to Statistical Thermodynamics, M. Dole, Prantice-Hall, (1962).
12. Chemical Kinetics and Dynamics, 2nd Edition, Jeffrey I Steinfeld, Joseph S. Francisco and William L. Hase, Prentice Hall, (1998).
13. Chemical Kinetics, 3rd Edition 1997, K. J. Laidler, Benjamin-Cummings. Indian reprint – Pearson,(2009).
14. Laser Spectroscopy, 3rd Edition, Basic concepts and instrumentation, W. Demtroder, Springer,(2004).
15. Fundamentals of Photochemistry, K. K. Rohatgi, Mukkerjee, Wiley Eastern Ltd., (1992).
16. Electrode kinetics, W. J. Albery, Clarendon Press, Oxford (1975).
17. Comprehensive chemical kinetics, C.H. Banford and R.G. Compton (ed),Vol 26, Electrode kinetics – principles and methodology, Elsevier science publishers (1986).

Mapping of Course Outcomes with Pogramme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS03	CO1	2	1	2	1	2	1	1	1	2	1	2	1	2
	CO2	3	1	1	2	2	1	2	1	1	1	2	1	3
	CO3	2	2	2	1	3	2	2	1	1	1	2	1	2
	CO4	3	2	1	2	1	2	2	1	1	1	3	1	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS204	SEPARATION AND ELECTRO ANALYTICAL TECHNIQUES-II.4	DSEC*/SC	2	0	0	2	2

Course Objectives:

This course aims to provide the student to

i. Detailed theoretical background of various separation and electroanalytical techniques.
ii. Various types of liquid chromatographic techniques.
iii. Detailed working of both GC and HPLC techniques.
iv. Principle and applications, also electro analytical techniques like electrophoresis and Voltammetry.

Course outcomes:

By the completion of course student will be able to

CO1. Apprise the use of various separation techniques for sample analysis.
CO2. Categorize specificity of analytical techniques based on nature of the sample.
CO3. Analyse principles that govern compounds separation.
CO4. Outline the role of electroanalytical techniques for materials analysis.

Course Content:

UNIT - I: Liquid chromatographic techniques

(i) Reversed phase chromatography: Objectives, mechanism of reversed phase HPLC, applications of reversed phase HPLC, analyte, retention in reversed phase HPLC, retention order in reversed phase HPLC, reversed phase mobile phase solvents, solvent properties, mobile phase strength and retention, role of organic modifier, eluotropic Series, selecting reversed phase columns, buffers for reversed phase HPLC.

(ii) Normal phase Chromatography: Objectives, mechanism of normal phase chromatography, retention and Selectivity in normal Phase chromatography, separation of isomers using normal phase chromatography, mechanism of isomer recognition in normal phase HPLC, stationary phases for normal phase HPLC, typical mobile phases HPLC, controlling retention, mobile phase optimisation, problems with Water in the mobile Phase

(iii) Ion Exchange chromatography- ion exchangers, ion exchange resins, ion exchange selectivity and selectivity coefficient, Donnan equilibrium, conducting ion exchange chromatography, applications

(vi) Affinity chromatography – working principle, components - Matrix, ligand, spacer arm and their required for efficient and effective chromatographic, matrix-partial structure of agarose-Types of ligands-need of spacer arm. Immobilized metal affinity chromatography.

(v) Introduction to UPLC: Basic principle, difference between HPLC and UPLC, Instrumentation – sample injection, columns, detectors, applications, advantages and dis advantages. **[8 hrs]**

UNIT-II

Gas Chromatography: Separation process in gas chromatography with schematic diagram, open and closed tubular columns and comparison, effect of column inner diameter and length of the Column, choice of liquid stationary phase, chiral phases for separating optical isomers, molecular sieves as stationary phase, retention index, temperature and pressure programming, role of Van -Deemter principle in carrier gas selection, types of columns in HPLC - Guard columns and retention gaps, mode of sample injections - split injection, split less injection, and on column injection, detector characteristics-signal to noise ratio, detection limits, Linearity.

Detectors-thermal conductivity detector, flame ionisation detector, electron capture detector, naming of other detectors,GC- MS-Element specific plasma detectors, Sample preparation-solid phase micro extraction, purge and trap, derivatisation in GC, method development in GC. **[7 hrs]**

UNIT-III

High-Performance Liquid Chromatography: The chromatographic process-effect of small particles, scaling relation between columns, relation between number of theoretical plates and particle size, column pressure, stationary phase and bonded stationary phases, monolithic silica columns, The elution process - isocratic and gradient elution, selecting the separation mode, maintaining symmetric band shape, dead volume, Injection and detection in HPLC, Detector characteristics, signal to noise ratio, detection limits, Linearity, detectors - Spectro-photometric detectors, refractive index detector, Evaporative Light scattering detector, Method development in reverse phase separation, criteria for adequate separation, solvent optimisation - optimisation with one organic solvent, optimization with two or three different organic solvents, choosing a stationary phase, Gradient separations- Dwell volume and Dwell time, Chiral separation techniques. **[7 hrs]**

UNIT-IV Electrodes and voltammetric techniques

Electrodes: Baisc principles,Reference electrodes, metallic indicator electrodes- electrodes of first and second kind, redox electrodes, membrane electrodes-membrane potential, selectivity of membrane, glass ion selective electrodes- Composition and structure of glass membrane, Hygroscopicity of glass membrane, membrane and boundary potential and expression for Eb, alkaline error, crystalline membrane electrode, conductivity of a crystalline membrane, solid state ion selective electrode, liquid based ion selective electrodes, gas sensing electrodes, potentiometric biosensors- enzyme electrodes.

Voltammetric techniques: Introduction, Objectives, Common Voltammetric Methods, Direct Methods - Linear Sweep Voltammetry, Sampled DC Polarography, Hydrodynamic Voltammetry, Pulse Methods

Normal Pulse Voltammetry, Differential Pulse Voltammetry, Square Wave Voltammetry, Cyclic Voltammetry - Principle of cyclic Voltammetry, cyclic voltammogram of $K_3[Fe(CN)_6]$, criteria of reversibility of electrochemical reactions, quasi- reversible and irreversible processes, Stripping Methods - Anodic Stripping Voltammetry, Cathodic Stripping Voltammetry, Adsorptive Stripping Voltammetry, Alternating Current Methods - Voltammetry-Instrument. **[8 hrs]**

References:

1. Quantitative Chemical Analysis, 7thEdition, Daniel C.Harris;. W. H. Freeman and Company, New York, (2006).
2. Principles of Instrumental Methods of Analysis, 5thEdition, Skoog, Holler and Nieman, Saunders College Publishing, International Ltd. (1999).
3. Hand Book of Instrumental Techniques For Analytical Chemistry, Frank Settle, Prentice Hall PTR, (1997).
4. Chromatographic methods, 5thEdition, A. Braithwaite and F J Smith, Kulwer Academic publishers.
5. Modern Analytical Chemistry David Harvey; McGraw Hill Higher education publishers, (2000).
6. Vogel's Text book of quantitative chemical analysis, 6thEdition, Pearson Education Limited, (2007).
7. Electrochemical Methods Fundamentals and Applications, Allen J. Bard and Larry R Faulkner, John Wiley and Sons, (1980).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS204	CO1	2	2		2	1	1					1	2	2
	CO2	2	1		2	1	1					2	2	2
	CO3	2	2	1	1	2	2		1			1	2	1
	CO4	2	1	2	2	2	1		2			2	2	2

SEMESTER-II: PRACTICAL

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SM0206	INORGANIC CHEMISTRY-II PRACTICALS	HC	0	1	2	3	5

Course Objectives:

This course aims to provide the student to

i. Correlate To expose the students to a breadth of experimental techniques using modern instrumentation.

ii. To provide a broad foundation in Chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective. Endeavors to contribute to industry and address problems of societal importance.

iii. Design To make the Department a growing center of excellence in teaching, cutting-edge research, curriculum development and popularizing Chemistry.

iv. To demonstrate the ability to synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation.

Course Outcomes:

By the completion of course student will be able to

CO1. Have sound knowledge about the fundamentals and applications of chemical and scientific theories

CO2. Analyze the data obtained from sophisticated instruments (like FTIR, NMR, GCMS, HPLC, GCMS UV-Vis, Fluorescence, and TGA) for the structure determination and chemical analysis.

CO3. Acquires the ability to synthesize, separate and characterize compounds using laboratory and instrumentation techniques

CO4. Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries.

Course Content:

PART – I

1. Determination of iron in haematite using cerium (IV) solution (0.02M) as the titrant, and gravimetric estimation of insoluble residue.
2. Estimation of calcium and magnesium carbonates in dolomite using EDTA titration, and gravimetric analysis of insoluble residue.
3. Determination of manganese dioxide in pyrolusite using permanganate titration.
4. Quantitative analysis of copper-nickel in alloy/mixture:

i. Copper volumetrically using KIO_3.

ii. Nickel gravimetrically using DMG

5. Determination of lead and tin in a mixture: Analysis of solder using EDTA titration.

6. Quantitative analysis of chloride and iodide in a mixture:

i. Iodide volumetrically using KIO_3

ii. Total halide gravimetrically

7. Spectrophotometric determinations of:

a. Titanium using hydrogen peroxide

b. Chromium using diphenyl carbazide in industrial effluents

c. Iron using thiocyanate/1, 10-phenanthroline method in commercial samples

d. Nickel using dimethylglyoxime in steel solution

PART – II

Semi micro qualitative analysis of mixtures containing two anions and two cations(excluding sodium, potassium and ammonium cations) and one of the following less common cations: W, Mo, Ce, Th, Ti, Zr, V, U and Li.

References:

1. Vogel's Text Book of Quantitative Chemical Analysis, 5thEdition, J. Basset, R.C.Denney, G.H. Jeffery and J. Mendhom.

2. A Text Book of Quantitative Inorganic Analysis, 3rd Edition, A.I. Vogel,.

3. Spectrophotometric Determination of Elements, Z. Marczenko.

4. Vogel's Qualitative Inorganic Analysis, Svelha.

5. Macro and Semimicro Inorganic Qualitative Analysis, A.I. Vogel.

6. Semimicro Qualitative Analysis, F.J. Welcher and R.B. Halin.

7. Quantitative Chemical Analysis, 7th Edition, Daniel C. Harris, (2006).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S M0206	CO1	3	2	2	2	2	2	2	2	2	2	3	1	
	CO2	2	3	1	2	2	2	1	1	2	2	3	2	1
	CO3	3	2	2	2	3	2	1	3	3	2	3	2	3
	CO4	2	2	2	3	3	2	1	2	2	2	3	2	3

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SM0207	ANALYTICAL CHEMISTRY-II PRACTICALS	HC	0	1	2	2	4

Course Objectives:

The practical course on Analytical chemistry intends to provide the students to,

i. Acquire the scientific skills in qualitative and preparative techniques.
ii. Appreciate the importance of being systematic in life.
iii. Understand the chemical methods employed for elemental and compound analysis.
iv. Develop honesty, punctuality, analytical reasoning, questioning, critical evaluation and thinking among students.

Course Out comes:

On successful completion of the practical course students shall be able to:

CO1. Develop practical skills related to analytical chemistry in analysis of constituents present in different samples.
CO2. Illustrate the experimental skills on different instrumental analysis of the given compounds.
CO3. Defend the experimental results with validation.
CO4. Acquire the critical thinking, punctuality, team work and honesty during the conduction of the experiments.

Course Content:

1. Determination of Saponification value and Iodine value of an oil sample.
2. Determination of residual Chlorine in water by Iodometry
3. Flame emission spectrometric determination of sodium and potassium in river/lake water.
4. Analysis of a mixture of iron (II) and iron (III) by EDTA titration using pH control.
5. Potentiometric titration of a mixture of chloride and iodide.
6. Estimation of DO and COD of waste water sample.
7. Spectrophotometric determination of iron in natural waters using thiocyanate and 1,10- phenanthroline as reagents.
8. Conductometric titration of sodium acetate with HCl and NH4Cl with NaOH.
9. Separation of amino acids in a mixture by TLC using Ninhydrin.
10. Determination of composition of Complex by Job's Method and Mole ratio Method of Cu(II)-EDTA complex
11. Analysis of waste water for alkalinity by visual, pH metric and conductometric titrations.
12. Spectrophotometric determination of Paracetamol.

References:

1. Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, Third Indian Reprint, Pearson Education Pvt. Ltd., New Delhi,(2003).
2. Analytical Chemistry Principles, 2nd Edition, John H. Kennedy, Saunders College Publishing, California, (1990).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21SM 0207	CO1	3	2	1	1	1	2	3	2	2	2	2	1	2
	CO2	1	2	1	1	3	2	2	2	2	2	2	1	2
	CO3	2	2		1	2	2	2	1	2	2	2	1	2
	CO4	1	2	1	1	2	2	2	2	2	1	1	1	2

SEMESTER-III: INORGANIC CHEMISTRY HARD CORE

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ301	ADVANCED INORGANIC CHEMISTRY-III	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. Understand the brief of transition metal orbitals, electron counting, formal oxidation state,18-e rule, geometries for transition metal complexes (Crystal Field theory, MO description), σ- and π bonding, metal-metal bonding.

ii. Identify survey of types of ligands for TM complexes and their electronic and steric properties. Typical spectroscopic methods and techniques for the characterization of TM complexes.

iii. Discuss the Chemical processes on TM: ligand exchange, oxidative addition, and reductive elimination, migratory insertion, nucleophilic attach on the ligand. Mechanisms and synthetic outcomes.

iv. Explain the concepts of selected representative applications of TM complexes in catalysis, with emphasis on the impact of modern chemistry on urgent global needs such as processes for clean energy: mechanistic and practical aspects.

Course Outcomes:

By the completion of course student will be able to

CO1. Build the knowledge of inorganic photochemistry, metal complexes in drugs, medicinal bioinorganic chemistry and advance nuclear chemistry.

CO2. Evaluating transition metal coordination compounds in terms of their geometry and interpret at a basic level their electronic properties.

CO3. Explain the Tabulate the coordination complexes undergoing a variety of reactions including electron transfer, ligand exchange and associative process.

CO4. Identifying the shapes and structure of coordination complexes with coordination numbers ranging from 4- 12.

Course Content:

UNIT-I

Ligand substitution reactions of complexes: Labile, inert, stable and unstable complexes, classification of mechanisms - associative (A), dissociative (D) and interchange (I_a and I_d).Mechanism of ligand substitution in octahedral complexes- kinetics, factors affecting substitution in octahedral complexes: Leaving group, chelate and metal effects. Acid-Base catalysis: Acid catalyzed aquation and anation

reactions, base hydrolysis, conjugate base hydrolysis, stereochemistry of octahedral substitution. Fuoss-Eigen equation and factors determining A or D mechanisms, lability and inertness of complexes. Mechanism of ligand substitution in square planar complexes- factors affecting substitution, trans-effect and its theories, cis-effect, designing synthetic routs to cis-platin and other complexes of Pt group elements. Metal exchange and ligand exchange reaction, and reaction of the coordinated ligand. **[15 hrs]**

UNIT – II

Redox process and reactions of coordinated ligands: Electron transfer reactions, complementary and non-complementary, outer sphere electro transfer- Marcus equation, their excited state electron transfer, Inner sphere electron transfer-one and two electron transfer and use of electron transfer reactions for the synthesis of complexes. Kinetics, effect of metal and ligands, Bridging group effects. Mixed metal Complexes (Electron transfer), mixed valence complexes. Mechanism of atom transfer processes, halogen, Oxo-and hydride transfer reactions, electron transfer reactions. Applications of redox process in bioinorganic chemistry: Reactions involving N_2, H_2O_2 and molecular oxygen. Reactions of coordinated Ligands: Acid dissociation, hydrolysis of amino acid esters, peptides, proteins, substitution, amine exchange, trans amination, thermodynamic and kinetic template effects, metal assisted macrocyclization. Chemistry of variable oxidation states of Transition metals: Low and High oxidation states, negative oxidation states, stability, effect of concentrations on stability, electronic configuration, EMF, properties. Application of XPS in oxidation state analysis. MOSSBAUER SPECTROSCOPY: Mossbauer effect and Mossbauer nuclei, isomer shift, quadrupole splitting and magnetic hyperfine interactions, Chemical isomer shift, elucidation of electronic structures of Fe(II) and Fe(III) systems.

[15 hrs]

UNIT-III

Photochemistry of co-ordination complexes: Fundamental concepts, Jablonski diagram, classification of photochemical reaction. Electronic transitions in metal complexes - metal centered and charge transfer transitions - various photophysical and photochemical processes of coordination compounds - unimolecular charge-transfer photochemistry of cobalt (III) complexes - mechanism of CTTM photoreduction. Ligand field photochemistry of Cr(III) complexes - Adamson's rule - photoactive excited states - V-C model - photophysics and photochemistry of Ru-polypyridine complexes - emission and redox properties - photochemistry of organometallic compounds - metal-carbonyl compounds - compounds with metal-metal bonding - Reinecke's salt - chemical actinometer. Application in water photolysis, Nitrogen and CO_2reduction. Metal porphins compounds, phthalocyanines complex, photoinduced emission and aggregation emission. **[15 hrs]**

UNIT-IV

Metal complexes as drugs and therapeutic agents: Introduction, antimicrobial agents, antiviral agents, antiarthritis agents and anticancer agents. Antidote complexes.

Medicinal Bioinorganic Chemistry: Bioinorganic Chemistry of quintessentially toxic metals. Lead, Cadmium, Mercury, Aluminium, Chromium, Iron, Copper, Plutonium. Toxic effects-Mechanism of toxic effects Detoxification by metal chelation - Chelating agents for Hg, Pb, Cd, As toxicity. Drugs that act by binding at the metal sites of Metalloenzymes. Chemotherapy: Chemotherapy with compounds of certain non-essential elements. Platinum complexes in cancer therapy – Cisplatin and its mode of action and side effects: – Cytotoxic compounds of other metals – Gold containing drugs as anti-rheumatic agents and their mode of action - Lithium in Psychopharmacological drugs. Radiopharmaceuticals – Technetium. Metal complexes in diagnosis-gold complexes in magnetic resonance imaging (MRI). Introduction to nanomedicine and applications. **[15 hrs]**

References:

1. Inorganic Reactions Mechanism,J. O. Edwards and W. A. Benjamin, INC, New York, (1965).
2. C. H. Langford and H. B. Gray, Ligand Substitution Processes, W. A. Benjamin, New York, (1966).
3. Mechanism of Inorganic Reactions, 2nd Edition, F. Basolo and R. G. Pearson, Wiley, New York, (1967).
4. Mechanisms of Inorganic Reactions, D. Katakis and G. Gordon, John Wiley & Sons, New York, (1987).
5. Kinetics and Mechanism of Reactions of Transition Metal Complexes, 2nd Edition, R. G. Wilkinns, VCH, Weinheim, (1991).
6. Reaction Mechanisms of Inorganic and Organometallic Systems, R. B. Jordan, Oxford University Press, Oxford, (1998).
7. Inorganic and Organometallic Reaction Mechanisms, 2nd Edition, J. D. Atwood, Wiley-VCH, Weinheim, (1997).
8. Fundamental Chemical Kinetics – An Explanatory Introduction to the Concepts, M. B. Wright, Harwood Publishing, Chichester, (1999).
9. Chemical Kinetics and Inorganic Reaction Mechanisms, 2nd Edition, S. Asperger, Springer, London, (2012).
10. Homogeneous Catalysis, G. W. Parshall, Wiley, New York, (1980).
11. Heterogeneous Catalysis in Practice, C. N. Satterfield, McGraw-Hill, New York, (1980).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MZ301	CO1	2	1	3	3	2	2			1	2	3	3	2
	CO2	4	3	2	2	2	1			1	2	3	3	2
	CO3	2	2		3	3	1			1	2	3	3	3
	CO4	4	3	1	2	2	1			1	2	4	3	3

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ302	ORGANOMETALLICS	HC	4	0	0	4	4

Course Objectives:

After successful completion of this course, the student will be able to:

i. To provide knowledge on typical organometallic reactions, the use of organometallic reagents in catalysis and organic synthesis,

ii. The deep focus on structure and bonding properties and reactivity of main group organometallics (including Grignard reagents, organolithium reagents, organophosphorus compounds, etc.) Organo transition metal chemistry and organometallic catalysis.

iii. The constructive components will aim to develop skills in the handling of air-sensitive compounds using the Schlenk technique and the purification of compounds using chromatographic techniques.

iv. Also provide orientation about industrial applications for organometallic chemistry.

Course Outcomes:

On successful completion of this course, the student will be able to:

CO1. Analyze the bonding modes, stability and determine reactivity for ligands in organometallic complexes and their applications.

CO2. Recognize the typical organometallic reactions, explain their mechanisms and interpret them reactivity based on the structure.

CO3. Correlate the importance of number of homogenous and heterogenous catalysis reactions of organometallic compounds in industries and environment e.g. hydrogenation, hydroformylation and polymerization.

CO4. Defend, detect and exemplify organometallic applications in novel organic synthesis, pharmaceutical compounds and in conversion processes in petrochemical and energy industries

Course Content:

UNIT-I

Organometallic Chemistry 1: Compounds with transition metal to carbon bonds: classification of ligands, nomenclature, Bonding: Ionic vs Covalent model, MOT back bonding and eighteen electron rule; Counting electrons in complexes, Hapticity, Limitations of 18-electron rule, Oxidation states stability, transition metal carbonyls: range of compounds and structure, bonding, Inner and outer sphere coordination, Polynuclear carbonyl complexes, vibrational spectra of metal carbonyls, preparation, reactions; transition metal organometallics: square planar complexes, Carbonylates, Carbonyl hydrides, Ligands similar to CO, Non

aromatic metal alkyls, Metal carbenes, metal alkylidenes and metal alkylidynes; Bridging alkyls, Structure and bonding: metal-olefin bond and arene metal bond MO approach. Nitrogen activation.

UNIT-II

Organometallic Chemistry 2: Compounds with ligands having extended pi systems: cyclic pi systems, bis(cyclopentadienyl) compounds, MO of metallocenes, cyclopentadienyl carbonyl compounds, bis(arene) compounds, arene carbonyl compounds; isolobal analogy, Extensions of analogy, Applications of the analogy metal-metal multiple bonds, Metal-carbonyl-metal bonds, transition metal clusters; clusters and catalysis; hydride and dihydrogen complexes; bridging hydrides, Non carbon ancillary ligands, Phosphines, organometallic fluxionality.

UNIT-III

Organometallic Chemistry 3: Organometallic reactions and catalysis: Ligand dissociation and substituition – stereochemical aspect, Ligand cone angles, Redox effects, oxidative addition, reductive elimination, Nucleophiles activity, Nucleophilic and electrophilic attack of coordinated ligands, carbonalyte anions, insertion, hydride elimination, abstraction; Catalysis : Homogenous and heterogenous catalysis, alkene hydrogenation, Tolman catalytic loop, Synthesis gas, hydroformylation, Wacker process, Ziegler-Natta polymerisation, cyclo oligomerisation, olefin isomerisation, olefin metathesis, Monsanto acetic acid synthesis, Fischer-Tropsch process, hydrosilylation. Organometallic Nitrogen fixation.

UNIT-IV

Organometallics Chemistry 4: Chemistry of Organolithium, Organomagnesium, Activity of Nucleophiles, Organoboranes, organosilicon and selected transition metal compounds, copper complexes, Vasaka complex, Bonding of Pd and Rh with olefins applications in C-C , C-N bond formations, Heck reaction, Carbonylation, hydroformylation, olefin isomerism, arylation, aryl amination using Pd reagents, olefin metathesis, Stille coupling, Sonogashira reaction, Buchwald reaction and Pauson -Khand reaction. Surface supported organometallic catalysts. Asymmetric catalysis, Organometallics in medicinal applications.

References:

1. P. Powell, Principles of Organometallic Chemistry, ELBS, 2nd Edition, (1991).
2. J. E. Huheey, Inorganic Chemistry, 3rd Edition, Harper International, (1983).
3. M. F. Purcell, J.C. Kotz, Inorganic Chemistry, Saunder, (1977).
4. A F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 5thEdition, JohnWiley.
5. J. Clayden,N. Greeves, S.Warren, Organic Chemistry, Oxford University press, 2ndEdition, (2012).

6. Gary L. Miessler, Donald A. Tarr, Inorganic Chemistry, Pearson publishers.
7. Robert H. Crabtree, The organometallic chemistry of transition metals, Wiley Interscience.
3. Didier Astruc, Organometallic Chemistry and Catalysis, Springer.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MZ302	CO1	2	2	1	2	2	1			1	1	3	1	2
	CO2	2	2	1	2	1	1			1	1	2	1	2
	CO3	2	1	1	2	1	2			2	1	2	1	2
	CO4	2	1	1	1	1	2			2	2	2	1	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ303	SOLID STATE CHEMISTRY AND ADVANCED MATERIALS	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. Introduction to solid state chemistry is one semester college course on the principles of chemistry.

ii. The unique and popular course satisfies the general degree requirement, with an emphasis on solid-state materials and their application to engineering systems.

iii. Enroute with an exploration of the fundamental relationship between electronic structure, chemical bonding and atomic order, then proceed to the chemical properties of "aggregates of molecules", including crystals, metals, glasses, semiconductors, solutions and acid-base equilibria, polymers, and biomaterials.

iv. Real-world examples are drawn from industrial practice (e.g. semiconductor manufacturing), energy generation and storage (e.g. automobile engines, lithium batteries), emerging technologies (e.g. photonic and biomedical devices) and the environment impact of chemical processing (e.g. recycling glass, metal and plastic).

Course Outcomes:

By the completion of course student will be able to

CO1. Predict the properties and interactions of chemical substances by understanding their composition at the atomic level, making connections to structure, bonding, and thermodynamics as necessary.

CO2. Reflecting and reviewing the principles of materials science (specifically microstructure design and selection) to the selection of materials for specific engineering applications.

CO3. Assess the quality of text and graphics in textbooks and other published sources, and understand the advantages and limitations of different models proposed to explain each concept.

CO4. Summarize and identify the similarities and differences among important classes of materials including glasses, metals, polymers, biomaterials, and semiconductors.

Course Content:

UNIT-I

The solid state: Types of solids, Bonding in solids, isomorphism and polymorphism, laws of crystallography, lattice types, lattice energies, Packing efficiencies, X-ray diffraction, Bragg's equation, Miller indices, Bragg Method, Experimental methods-powder and rotating crystal methods, indexing of

powder and rotating crystal photographs.Debye Scherrer method of X-ray structure analysis of crystals, indexing of reflections, identification of unit cells from systematic absence in diffraction pattern, structure of simple lattice and X-Ray intensities, structure factor and its relation to intensity and electron density, phase problem, procedure for an X-ray structure determination. Defects in crystals, Stoichiometric imbalance in crystals. **[15 hrs]**

UNIT-II

Solid State Reactions: General principle, nucleation and growth process of crystals, types of reactions: Additive, structure sensitive, decomposition and phase transition reactions, tarnish reactions, kinetics of solid state reactions, factors affecting the reactivity of solid state reactions. Methods of Single Crystal Growth Solution growth; Melt Growth-Bridgeman, Czochralski, Kyropoulus, Chemical Vapour Transport; plasma enhanced deposition, catalytic chemical vapour deposition, arc discharge method,Fused Salt Electrolysis; Hydrothermal method; Flux Growth. **[15 hrs]**

UNIT-III

Electronic Properties and Band Theory: Metals, insulators and semi-conductors, free electron theory and its applications, electronic structure of solids, band theory, band structure of metals, insulator, and semiconductors, doping in semiconductors, photoactive semiconductors, Junction Properties: Metal-metal junctions, metal-semiconductor junctions, p-n junctions, industrial applications of semiconductors: mixed oxides, spinels and other magnetic materials. Super conductors:Meissner effect, type I and II super conductors, isotope effect, basic concepts of BCS theory, manifestations of the energy gap,ionic conductivity in solids, diffusion, drift conductivity, optical properties of solids, photo-conduction and photoelectric effects, laser action, solid state laser and their applications. Thermal conductivity in metals, semiconductors and insulators. **[15 hrs]**

UNIT-IV

Advanced materials: Advanced semiconductor materials, electronic materials, solar energy conversion materials, Photonics and spintronics materials, solid state structural aspects - electrode materials in electrochemical energy conversion devices, solid state electronic and Ionic conductors, Thermo electric and piezoelectric, perovskites, Superconducting materials, Photoluminescent materials, Inorganic-organic hybrid materials:Synthesis of metal oxides and its composite nanoparticles by sol-gel, solvothermal and hydrothermal method.Porous materials: Hard and soft template methods : Carbonaceous materials, metal oxides. **[15 hrs]**

References:

1. A guide to laser in chemistry, Gerald R., Van Hecke, Keny K. Karokitis.
2. Principals of solid state, H. V. Keer, Wiley Eastern.
3. Solid state chemistry, N. B. Hannay.
4. Solid state chemistry, D. K. Chakrabarty, New Age International.
5. An Introduction to Crystallography, F. G. Philips.
6. Crystal Structure Analysis, M. J. Buerger.
7. The Structure and properties of materials, Vol. III, Electronic properties, John Walss.
8. Electronic processes in materials, L. U. Azroff and J. J. Brophy.
2. Chemistry of imperfect crystal, F. A. Krogen.
3. Elements of X-ray Diffraction, B. D. Cullity, Addison, Weily.
4. Solid state Chemistry, A.R.West (Plenum).
5. Electronics made simple, Jacobwitz. Paper: PCH: 304 B: Advanced Chemical Kinetics (Elective).

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PS O1**	**PS O2**	**PS O3**
M21SM Z303	CO1	2	2			1	2	2		1	2	3	1	1
	CO2	2	2	2	2	3	2	2	2	1	2	2	3	1
	CO3	2	2	2	3	2	1	2	2	2	2	2	2	1
	CO4	2	2	3	2	3	2	2	2	1	3	2	3	1

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ304	STRUCTURAL METHODS IN INORGANIC CHEMISTRY-III	HC	4	0	0	4	4

Course objectives:

This course aims to provide the student to

i. Demonstrate the knowledge of the basic concept of spectroscopy laser, optical spectroscopy, mechanism of fluorescence.
ii. Explore understanding of photoelectron spectroscopy (PES) and electron energy loss spectroscopy for chemical analysis and other most important applications.
iii. Create broad advanced techniques knowledge of SEM, SAM, SPM, STM, LEED, TEM, ASS and ICPMS for structure and chemical analysis applications.
iv. Acquire knowledge of non-destructive techniques for various metals, product analysis, effects and other applications.

Course outcomes:

By the completion of course student will be able to

CO1. Basic spectroscopy, laser, mechanism fluorescence.
CO2. Applications, electron spectroscopy, chemical analysis.
CO3. Advanced techniques, applications, analysis.
CO4. Analysis, applications, effects chemical reactions.

Course Content:

UNIT-I

Basic concept of spectroscopy: Overview of basic concepts: Light-matter interaction, transition dipole moment, selection rules for electronic transitions.

Laser: Einstein coefficients, introduction to lasers, application of lasers in spectroscopy.

Molecular luminescence spectroscopy: Basic principles of fluorescence and phosphorescence, excitation and deactivation processes (energy level diagram), factors affecting fluorescence and phosphorescence, quenching of fluorescence, fluorescence (or phosphorescence) intensity, fluorescence and chemical structure, instrumentation for fluorimetry and phosphorimetry, application of fluorimetry and phosphorimetry, fluorescent indicators,comparison between fluorimetry and phosphorimetry, chemiluminescence, spectral studies of some inorganic complexes.

[12 hrs]

UNIT- II

Advanced optical Spectroscopy: Surface plasmon spectroscopy, multiphoton spectroscopy, single-molecule spectroscopy, and applications.

Electron spectroscopy: Principle, working, components, instrumentation and applications in chemical analysis.

Electron energy loss spectroscopy: Principle, working, components, instrumentation, and applications for chemical analysis.

[12 hrs]

UNIT - III

Imaging and Depth Profiling techniques: basic principle, instrumentation and application of scanning electron microscopy (SEM); secondary Auger microscopy (SAM); scanning probe microscopy (SPM); scanning tunneling microscopy (STM); transmission electron microscopy (TEM); low energy electron diffraction (LEED).

Destructive techniques: Basic principle, instrumentation and application of Atiomic absorption spectrocopy AAS, inductively coupled plasma-atomic emission spectroscopy (ICP-AES). **[12 hrs]**

UNIT-IV

Non-destructive techniques: Basic principle, instrumentation and application of Wavelength and energy dispersive X-ray fluorescence spectroscopy (WDS and EDS); X-ray absorption spectroscopy (XANES and EXAFS); secondary ion mass spectrometry (SIMS); temperature programmed desorption (TPD); thermal desorption spectroscopy (TDS).

Structure characterization of any advanced materials by Fluorescence Spectra, XPS, EELS, SEM, AFM, STM, TEM, HR-TEM, IC-AES, EDS, XANES, SIMS, TPD and TDS.

[12 hrs]

References:

1. Modern Spectroscopy, 4th Edition, J. M. Hollas, John Wiley & Sons, (2004).
2. Modern Optical Spectroscopy, Student Edition, William W. Parson, Springer, (2009).
3. Fundamentals of Photochemistry, K. K. Rohatgi-Mukhejee, Wiley Eastern Ltd, (1992).
4. Principles of Fluorescence Spectroscopy, 3rdEdition,J. R. Lakowicz, Springer, (2006).
5. Laser Spectroscopy- Basic concepts and instrumentation, 3rdEdition, W. Demtroder, Springer,(2004).
6. Scanning Probe Microscopy and Spectroscopy, R. Wiesendanger, Cambridge University Press, (1994).

7. Handbook of instrumental techniques for analytical chemistry, Frank A. Settle, Prince Hall, New Jersey, (1997).
8. Foundations of catalysis and nanoscience, K. W. Kolasinski John Wiley and Sons, West Susses, (2002).
9. Physics at Surfaces, A. Zangwill, Cambridge Univ. Press, (1988).
10. Introduction to Surface Chemistry and Catalysis, G.A. Somorjai, Y. Li, Wiley, (2010).
11. Physical chemistry of surfaces, Arthur W. Adamson (1990).
12. The chemical physics of surfaces, Roy S. Morrison, S. Roy, (1990).
13. Modern techniques of surface science, D.P. Woodruff, T.A. Delchar, Cambridge Univ. Press, (1994).
14. Introduction to Scanning Tunneling Microscopy by C. J. Chen, Oxford University Press, New York, (1993).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21SM Z304	CO1	2	1		3	1						2	3	1
	CO2	3			3	1						3	3	1
	CO3	3			3	1						2	3	1
	CO4	3			3	1						2	3	1

SEMESTER-III: INORGANIC CHEMISTRY SOFT CORE

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS301	INDUSTRIAL INORGANIC CHEMISTRY-III	SC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

i. Conclude the preparation of some industrial inorganic products and challenges in the production.
ii. Defend the following topics: Sulfur industry, Nitrogen based industrial products, inorganic solvents, mineral fertilizers, industrial and domestic water production, industrial gas productions, inorganic solids, cement, glasses and pigments.
iii. Appraise the importance of inorganic chemical industry, their economic impact, individual chemical processes and production challenges.
iv. Develop practical skills to synthesis of industrial inorganic compounds by the acquired knowledge.

Course Outcomes:

By the completion of course student will be able to

CO1. Illustrate the basic chemical process involved in the production of major commercial products in industrial Inorganic chemistry.

CO2. Conclude the operation and solve problems relating to the production process in industrial inorganic chemistry, written and verbal.

CO3. Evaluate the product in industrial production by the suitable technique.

CO4. Analyze environmental issues pertaining to the chemical industry.

Course Content:

UNIT-I

Materials in Catalysis- Introduction: Basics of catalysis, Fundamental properties of the solid catalysts. Classification of solid catalysts, Metals and metallic alloys. Preparation of metallic catalysts. Structure. Specific features of metallic catalysts. Structure sensitivity of catalytic reactions. Structure of adsorbate layers; Stepped surfaces; Surface relaxation and reconstruction of surfaces; homogeneous and heterogeneous catalytic surfaces Supported metal catalysts. Metal-support interaction. Reaction mechanisms in catalysis on metals. Fundamentals of kinetics of heterogeneous catalytic reactions. Case study: the ammonia synthesis catalyst and the reaction mechanism involved. Noble metal catalysis

[7 hrs]

UNIT-II

Heterogeneous Catalysis and porous materials: Classification of solid catalysts, Adsorption of molecules at the solid surfaces, Adsorbed states of molecules on metals, potential-energy curves for adsorption, descriptive chemistry of chemisorption on metals, chemisorption and catalysis by metals quantitative aspects, catalysis by unsupported and supported bimetals, Adsorption and catalysis on semiconducting oxides, selective oxidation of hydrocarbons. Different types of reactors.

Zeolite Compounds and Heterogeneous Catalysis: Introduction to porous materials: Classification into micro-, meso- and macro porous materials, the origin of pores and its significance, distinction from condensed materials. **[8 hrs]**

UNIT-III

Semiconducting materials in electronics and energy devices, Semiconductors, Binary and ternary oxides and non-oxide semiconductors, their structure, properties, doping, band structure modification and working application in solar energy conversion, electronic components, semiconductor.

Materials for Sensors: Thermal, Gas, Biosensors types, sensors and applications.

Chemistry of silicates and Hard materials: Glass, alkali silicates, composition, manufacture, raw materials, properties. Ceramics: classification of ceramic products, manufacture of ceramics, clay, Oxide ceramics, aluminum oxide, zirconium oxide, beryllium oxide, uranium oxide and thorium oxide, other oxide ceramics, electro- and magneto-ceramics and their structure and properties.

[7 hrs]

UNIT-IV

Inorganic polymers, Surfactants, Biosensors, Pesticides: Chemistry of Inorganic polymers: Poly-(sulphur –nitrides), Polyphosphates, polysilicates, polysilicones, organo-metallic polymers, bonding, structure and properties, Inorganic fibers.

Surfactants: Classification with examples, Adsorption and micelle formation, Manufacture of anionic, cationic, zwitterionic and nonionic detergents, Applications as Foaming agent, Wetting agent, Dispersant, Solubilizers, Emulsifiers and Rheology modifiers, Detergent formulations, Detergent biodegradation, Biosurfactants.

Inorganic Pigments: white pigments, titanium dioxide pigments, zinc sulfide pigments, colored pigments.

Pesticides: Introduction, classification, synthesis of few common pesticides of chlorinated (DDT, BHC, Chlordane, Aldrin), organophosphorus and carbamate (parathion, Malathion, carbaryl) compounds family. **[7 hrs]**

References:

1. Chemical Process Industries, 4th Edition, Norris Shreve, R. and J.A. Brink Jr. McGrawHill, Tokyo, (1977).
2. Industrial Chemistry, Chakrabarty, B.N Oxford & IBH Publishing Co., New Delhi (1981).
3. Industrial Inorganic Chemistry, Karl Heinz Büchel, Hans-Heinrich Moretto, Dietmar Werner, 2nd Completely Revised Edition, Wiley – VCH, (2008).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS301	CO1	2	1	2			1			1	1	2		1
	CO2	1	1	1			1	1		1	1	2		1
	CO3	1		1		1	2	1	1	1	1	2		
	CO4	1	1	1		1	1	1	1	1	1	1		

SEMESTER-III: ORGANIC CHEMISTRY HARD CORE

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ307	ADVANCED ORGANIC CHEMISTRY-III.1	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. Enhance the knowledge on structure and reactivity of organic molecules with emphasis on reaction mechanisms.
ii. Examine the principles of bonding, stereochemistry, kinetics and thermodynamics in organic synthesis.
iii. Evaluate the logical disconnections to identify the synthons and choose the reactants and reagents.
iv. Explore the feasibility of a process in terms of cost, conditions and starting materials.

Course Outcomes:

By the completion of course student will be able to

CO1. Interpret the mechanisms of organic reactions and identify the synthons.
CO2. Develop a detailed understanding for appropriate disconnections and possible strategies.
CO3. Enhance the knowledge on various feasible reactions for synthesizing molecules.
CO4. Justify the regioselectivity, stereoselectivity and chemoselectivity of reactions.

Course Content:

UNIT – I

The Disconnection Approach, Basic Principles: Synthons and Reagents, Synthesis of Aromatic Compounds, Strategy I: The Order of Events, One-Group C-X Disconnections, Strategy II: Chemoselectivity, Two-Group C-X Disconnections, Strategy III: Reversal of Polarity, Cyclisations, Amine Synthesis, Strategy IV: Protecting Groups, One-Group C-C Disconnections I: Alcohols. **[15 hrs]**

UNIT – II

General Strategy A: Choosing a Disconnection, Strategy V:Stereoselectivity A, One-Group C-C Disconnections II: Carbonyl Compounds, Strategy VI: Regioselectivity, Alkene Synthesis, Strategy VII: Use of Acetylenes, Two- Group C-C Disconnections I: Diels-Alder Reactions, Strategy VIII: Introduction

to Carbonyl Condensations, Two-Group C-C Disconnections II: 1,3-Difunctionalised Compounds Strategy IX: Control in Carbonyl Condensations. **[15 hrs]**

UNIT – III

Two Group C-C Disconnections III:1,5-Difunctionalised Compounds, Michael Addition and Robinson Annelation, Strategy X: Aliphatic Nitro Compounds in Synthesis, Two-Group Disconnections IV: 1,2-Difuntionalised Compounds, Strategy XI: Radical Reactions in Synthesis, Two-Group Disconnections V: 1,4-Difunctionalised Compounds, Strategy XII: Reconnection, Two-Group C-C Disconnections VI: 1,6-Dicarbonyl Compounds, General Strategy B: Strategy of Carbonyl Disconnections, Strategy XIII: Introduction to Ring Synthesis: Saturated Heterocycles, Three- Membered Rings. **[15 hrs]**

UNIT – IV

Strategy XIV: Rearrangements in Synthesis, Four-Membered Rings: Photochemistry in Synthesis, Strategy XV: The Use of Ketenes in Synthesis, Five-Membered Rings, Strategy XVI: Pericyclic Reactions in Synthesis, Six-Membered Rings, General Strategy C: Strategy of Ring Synthesis, Strategy XVII: Stereoselectivity B, Aromatic Heterocycles, General Strategy D: Advanced Strategy. **[15 hrs]**

References:

1. Organic Synthesis: The Disconnection Approach, 2nd Edition, Stuart Warren, Paul Wyatt, Wiley, Chichester, (2008).
2. Organic Chemistry from Retrosynthesis to Asymmetric Synthesis, 1st Edition, Vitomir Šunjić, Vesna PetrovićPeroković, Springer, Switzerland, (2016).
3. Organic Mechanisms, 2nd Edition, Reinhard Bruckner, Springer-Verlag, Berlin, (2010).
4. Organic Chemistry, 2nd Edition, Jonathan Clayden, Nick Greeves, Stuart Warren, Oxford University Press, Oxford, (2012).
5. Modern Methods of Organic Synthesis, 4th Edition, William Carruthers and Iain Coldham, Cambridge University Press, Cambridge, (2004).
6. Name Reactions, 3rd Edition,Jie Jack Li, Springer-Verlag, Berlin, (2006).
7. Introduction to Strategies for Organic Synthesis, 1st Edition, Laurie S. Starkey, Wiley, New Jersey, (2012).
8. Organic Synthesis: Strategy and Control, 5th Edition, Paul Wyatt, Stuart Warren, Wiley, Chichester, (2007).
9. March's Advanced Organic Chemistry, 7th Edition, Michael B. Smith, Wiley, New Jersey, (2013).

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MZ307	CO1	3	1	2	1	2	3	1			1	2	1	2
	CO2	2	1	2	2	2	1	2			1	2	2	3
	CO3	2	2	1	1	3	2	3			1	3	1	2
	CO4	3	2	2	1	2	1	2			1	2	2	3

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ308	ADVANCED ORGANIC SYNTHESIS-III.2	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. The advanced lineup in organic synthesis provides a deeper understanding of the reactivity and properties of the organic compounds and emphasis on the applications of important reagents and reactions in organic synthesis.

ii. Expand a fundamental understanding of carbon-carbon single and double bond formation.

iii. Development of highly stereoselective reactions and their applications in complex synthesis. These reactions include stereoselective alkylation of carbonyl compounds, stereoselective aldol condensations, stereoselective oxidations, epoxidations and reductions.

iv. Discussion of newer methods for the stereoselective formation of carbon-carbon double bonds, and the modern application of the Diels Alder reaction, particularly its use in the control of stereochemistry in the synthesis of natural products.

v. Determine which strategic bond constructions can be used most effectively to obtain synthetic targets with high selectivity.

Course outcome:

By the completion of course student will be able to

CO1. Analyze Molecular Orbital (HOMO-LUMO) symmetry concepts and pericyclic reactions.

CO2. Differentiate the products by photochemical and thermal reactions.

CO3. Knowledge of name reactions in organic synthesis and their applications.

CO4. Utilize the principles behind enantioselectivity and Diastereoselective in organic synthesis.

Course Content:

UNIT-1

Pericyclic Reactions: Introduction, Classification of pericyclic reactions.Electrocyclic reactions: con rotation and dis rotation. Electrocyclic ring closure and opening in 4n and 4n+2 systems. Cycloaddition Reactions: Suprafacial and Antarafacial additions in 4n and 4n+2 cycloadditions. Sigmatropic reactions: [i-j] shifts- suprafacial and Antarafacial shifts, Cope and Claisen rearrangement reactions. Molecular orbitals: ethylene, 1,3-butadiene, 1-allyl cation. Frontier Molecular Orbital (HOMO-LUMO) approach-concept: Framing Woodward Hofmann selection rules for all the pericyclic reactions by Frontier Molecular Orbital

(FMO) approach. Conservation of orbital symmetry: (Correlation Diagrams) approach- for electrocyclic and cycloadditions. **[15 hrs]**

UNIT-2

Photochemistry: Introduction, Laws of photochemistry, Quantum yield, Photochemical equivalence Photochemistry of (n-π*) Transitions: Excited states of carbonyl compounds, homolytic cleavage of α-bond. Norrish type-I reactions in acyclic and cyclic ketones and strained cycloalkane ketones. Norrish type II reactions in ketones and esters. Paterno-Buchi reaction and Barton reaction.

Photochemistry of π-π* Transitions: Excited states of alkenes, cis-trans isomerization, and photo stationary state. Photochemistry of 1,3-butadiene. Electrocyclization and sigmatropic rearrangements, di-π methane rearrangement. Intermolecular reactions, photocycloadditions, photodimeriastion of simple and conjugated olefins. Addition of olefins to α, β-unsaturated carbonyl compounds. Photoisomerization of benzene.

[15 hrs]

UNIT-3

STEREOCHEMISTRY-II

Optical activity in the absence of chiral atoms: Atropisomerism, chirality in biphenyls, allenes, BINAP (2,2′-bis(diphenylphosphino)-1,1′-binaphthyl), adamantanes, ansa compounds, cyclophanes, *trans*-cyclooctene, catenanes, rotaxanes and helicenes. Assignment of R, S- configuration to these classes of compounds.

Optical activity due to the presence hetero atoms: Chirality of organic compounds due to the presence of silicon, nitrogen, phosphorous, arsenic and sulphur atoms. Determination of R,S-configuration of these compounds using CIP rules.

Determining absolute and relative configuration

i). Chemical correlation of configuration: Methods without involving the chiral centre. Chemicaltransformation involving the chiral centre. Chemical correlation involving diastereomers.

ii). Methods based on comparison of optical rotation: Distance rule, Rule of shift, Rule of optical superposition, Mill's rule, Method based on molecular rotation difference.

iii) The method of quasi-racemate.

iv). Use optical rotatory dispersion curves: α-axial haloketone rule and its applications, octant rule (application of these rules in the determination of absolute configuration of substituted cyclohexanones, decalones and cholestanones). **[15 hrs]**

UNIT-4

Asymmetric Synthesis: 'ee' and methods of determination of 'ee'.

Stereoselectivity: classification, terminology and principle. Asymmetric synthesis and asymmetric induction. Double diastereoselection and double asymmetric induction.

Acyclic stereoselection: Addition of nucleophiles to carbonyl compounds (1,2- 1,3- and 1,4-asymmetric induction). Asymmetric aldol condensation. Addition of allyl metal and allyl boranes to carbonyl group.

Diastereoselection in cyclic systems: Nucleophilic addition to cyclic ketones (formation of axial and equatorial alcohols, catalytic hydrogenation, alkylation, diastereoselective oxidations and stereoselective cyclization of poylenes).

Enantioselective synthesis: Reduction with chiral hydride donors [(S)-PBMgCl, (-)- $iBOAlCl_2$, alpine-borane, (S)-BINAL-H, (R,R)-DIOP, and (S,S)-CHIRAPHOS]. Enantioselective reactions: alkylation of ketones via hydrazones, alkylation with chiral PTC, Michael addition and intramolecular aldol condensation. Use of (+)- and (–)- DET in asymmetric epoxidation. Polymer-bound chiral catalysts in asymmetric induction. Asymmetric amplification. **[15 hrs]**

References:

1. Principles of Organic synthesis, 3rdedition,Richard O.C. Norman and James M Coxon, CRC Press, (1993).
2. Advanced organic chemistry, 4thEdition,J. March, John Wiley, 2008.Organic synthesis, R.E.Ireland, Prentice-hall India, New Delhi, (1975).
3. Understanding organic reaction mechanisms, A. Jacob, Cambridge Univ Press, (1997).
4. Introduction to organic chemistry, A. Streitweiser, Jr and C. H. Heathcock, Macmillan, (1985).
5. Physical and mechanistic organic chemistry, 1stEdition,R. A.Y. Jones, Cambridge Univ Press, (1979).
6. Modern synthetic reactions, 2ndEdition, H. O. House, W. A. Benjamin, California, (1972).
7. Some modern methods of organic synthesis, 2ndEdition, W. Carruthurs, Cambridge Univ. Press, London, (1978).
8. Mechanisms of molecular migration, Vols I & II, B. S. Thyagarajan, Pergamon Press, Oxford, (1979).
9. Comprehensive organic chemistry, D. Barton and W. D. Wallis, Pergamon Press, Oxford, (1983).
10. Organic chemistry,6thEdition,Vol. II, I. L. Finar Longman, (1992).
11. Organic reaction Mechanisms, 3rdEdition., V. K. Ahluwalia and R. K. Prashar, Narosa, New Delhi, (2005).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21SM Z308	CO1	3	3		1	3	1	2		1	2	3	2	2
	CO2	1	1	1	1	3	2	2		1	2	4	2	2
	CO3	1	2		2	3	1			1	2	1	2	2
	CO4	1	3		2	3	1	2		1	2	1	2	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ309	NATURAL PRODUCTS AND BIOORGANIC CHEMISTRY-III.3	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. To identify, extract and eventual modification of compounds that are of natural origin- plants, animals and bacteria for pharmaceutical use and other purposes
ii. To bring the awareness of the richness and diversity of plants and animals around them.
iii. To distinguish the naturally occurring compounds into different classes
iv. To formulate different reactions and their mechanism in the natural product synthesis.

Course Outcomes:

By the completion of course student will be able to

CO1. Acquire the knowledge of Identifying and characterizing various classes of natural products by their structure Appreciate the biogenesis of many natural products of importance.

CO2. Contribute the knowledge of natural products in drug design and development of new drugs with hemisynthetic routes or with total synthesis.

CO3. Discuss the use of natural products as starting materials for medicine.

CO4. Carry out independent investigations of plant materials and natural products.

Course Content:

UNIT-I

Terpenoids and Carotenoids: Classification, nomenclature, occurrence and isolation. Isoprene rules. Stereochemistry of citral, farnesol, limonene, 1,8-cineole, menthols and borneols. Correlation of configurations of terpenoids. Structure elucidation of camphene, -pinene, caryophyllene and santonin. Synthesis and biosynthesis of the following: Linalool, terpineol, fenchone, eudesmol, abietic acid. Commercial synthesis of camphor. Biosynthesis of squalene and cyclisation of squalene into lanosterol and friedelene.

Carotenoids: Methods of isolation. Structural relationship of α-, β- and γ-carotenes. Structure elucidation and synthesis of β-carotene. **[15 hrs]**

UNIT-II

Alkaloids: Definition, nomenclature, occurrence, isolation, classification, General methods of structure elucidation. Synthesis and biosynthesis of the following alkaloids: Ephedrine, hygrine, coniine and cocaine. Cinchona alkaloids: Cinchonine and quinine. Opioid alkaloids: Morphine, codeine, thebiene and heroin. Structure elucidation and synthesis of papaverine and ergotamine. Photochemical synthesis of nuciferine, coradyline and tylophorine. **[15 hrs]**

UNIT-III

Steroids: Occurrence, nomenclature, basic skeleton, Diels hydrocarbon and stereochemistry. Isolation, structure and structural elucidation of sterols and bile acids (determination of ring size, nature of side chain, position of angular methyl and stereochemistry of ring junctions). Sex hormones and corticosteroids. Synthesis of cholesterol, estrone, progesterone, androsterone, testosterone. Photo products of ergosterol-vitamins D. Barton reaction for the synthesis of aldosterone, epiandrosterone. Marker degradation.

Porphyrins and vitamin B12: Structure elucidation and synthesis of haemin and vitamin-B12 (synthesis of Vitamin-B12 from cobyric acid). **[15 hrs]**

UNIT-IV

Amino acids and Peptides: Synthesis of amino acids, Sanger and Edman methods of sequencing. Cleavage of peptide bond by chemical and enzymatic methods. Peptide synthesis- Protection of amino group (Boc-, Z- and Fmoc-) and carboxyl group as alkyl and aryl esters. Use of DCC, EEDQ, HATU, HOBt and active esters, acid halides, anhydrides in peptide bond formation reactions (introduction to new generation coupling agents like COMU, Oxyma, T3P). Deprotection and racemization in peptide synthesis. Solution and solid phase techniques. Synthesis of oxytocin and enkephalins. Peptidomimetics-Introduction and examples.

Insect pheromones: Introduction, classification. Pheromones in pest control. Syntheses of (one synthesis should be stereoselective synthesis) I) Grandisol (component of boll weevil pheromone) ii) Farenal (trail pheromone of pharaoh's ants) iii) Brevicomin (pheromone from Dendroitis brevicomis) iv) (+)-Disparlure (gypsy moth sex pheromone). v) 3,11-Dimethy1-2-nonacosanone (pheromone of German cockroaches). vi) Bombykol (sex pheromone of silkworm moth). vii) Multistriatin (Elm bark beetle sex pheromone).

[15 hrs]

References:

1. Natural products: Their chemistry and biological significance, J. Mann, R. S. Davidson, J. B. Hobbs, D. V. Banthorpe & J. B. Harborne, Longman, UK, (1994).
2. Terpenes, J. Verghese, Tata McGraw-Hill, New Delhi, (1982).
3. Chemistry of terpenes and terpenoids, A. Newman, Academic Press, London, (1975).

4. Handbook of naturally occurring compounds, Vol. II: Terpenes, T. K. Davon, A. I. Scott, Academic Press, NY, (1972).
5. Natural products chemistry, Vol. I & II, K. Nakanishi, T. Goso, S. Ito, S. Natori & S. Nozoe, Academic Press, NY, (1974).
6. Total synthesis of natural products, Vol. I & VI, Apsimon, John Wiley, NY, (1973-1981).
7. Organic chemistry, Vol.II, I. L. Finar, 6thEdition. Longman, (1992).
8. Chemistry of natural products, 6th Edition, Vol. I & II, O. P. Aggarwal, Goel Publishing House, (1982).
9. Total synthesis of natural products: The chiral approach, Vol.III, S. Hanessian Pergamon Press, (1983).
10. Total synthesis of steroids, Akhaun & Titov, Jerusalem, (1969).
11. Medicinal natural products: A biosynthetic approach, P. M. Dewick. John Wiley, Chichester, (1997).
12. The colours of life: An introduction to the chemistry of porphyrins and related compounds, L. R. Milgrom, Wiley Chichester, (1995).
13. Interpretation of the UV spectra of natural products, A.I. Scott, Pergamon Press, Oxford, (1964).
14. Spectral data of natural products Vol. I., K.Yamaguchi, Elsevier Publishing Co, London, (1970).
15. Chemistry of natural products: A unified approach, N. R. Krishnaswamy, University Press, India, (1999).
16. Amino Acids, Peptides and Proteins in Organic Chemistry, Edited by Andrew B. Hughes, Volume 4, Wiley-VCH Verlag GmbH & Co. KGaA, ISBN: 978-3-527-32103-2, (2011).
17. Principles of Peptide Synthesis, Bodanszky M, Springer, ISBN 978-3-642-96763-4, (1984).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MZ309	CO1	3	2		1	2				1	1	3	2	2
	CO2	3	2	3	3	2				1	1	3	2	2
	CO3	2	2	3	2	2				1	1	3	2	1
	CO4	2	2	2	2	3	2			1	1	3	2	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ310	ORGANOMETALLICS IN ORGANIC SYNTHESIS-III.4	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. Discuss the Complexation and De-Complexation Reactions of S and P- Bonded systems and use of Organo transition metal complexes as protecting and stabilizing groups.
ii. Illustrate the synthesis and applications of various organometallic reagents in organic synthesis.
iii. Explain the synthetic applications of tri methyl silyl chloride, Organo tin, Organo cerates, and Organo mercurial.
iv. Develop and design the catalytic cycle for the Homogeneous and Heterogeneous catalysis.

Course Outcomes:

By the completion of course student will be able to

CO1. Distinguish between Complexation and De complexation reactions of Organo transition metal complexes.
CO2. Apply the appropriate mechanistic steps in reactions involving organometallic compounds.
CO3. Apply organometallic reagents and reactions in organic synthesis.
CO4. Acquire the knowledge of fundamental organometallic reactions to construct catalytic cycle.

Course Content:

UNIT-I

Organometallic Compounds in Organic Synthesis-I: General introduction of Chemistry of Organo transition metal complexes, hapticity, types of Organometallic Compounds, 16 and 18 Electron rules. Synthesis, structure, bonding and reactivity of Carbene Complexes. Complexation and De-Complexation Reactions: σ-bonded systems and. π- bonded systems such as- olefins, acetylenes, allyl moieties, cyclobutadiene, cyclopenta dienyl moieties. Grubb's Ru Catalysts (metathesis). Use of Organo transition metal complexes as protecting and stabilizing groups: Protection of olefins, acetylenes. Stabilization of cyclobutadiene and norbornadienones. Organometallics as Electrophiles and nucleophiles: Nucleophilic addition to ή2, &ή5 complexes. Electrophilic addition to ή4, ή6 and Organometallics in coupling and cyclization reactions: Coupling and cyclization of organic nucleophiles with olefins (including Heck reaction) and coupling of olefins with acetylenes. **[15 hrs]**

UNIT-II

Organometallic Compounds in Organic Synthesis-II: Chemistry of Organometallic compounds: Synthesis and applications of Organo LiHMDS and LDA and Organo zincs: Preparation, reaction with compounds containing acidic protons, reaction with C-C multiple bonds, Simmons Smith, and Reformatsky reaction. Organo Copper Reagents: (Gilman reagents-lithium di alkyl cuprates): Preparation, reactions with alkyl, allyl, vinyl, benzyl and aryl halides, aldehydes, ketones (including a, b-unsaturated carbonyl compounds) and epoxides. Synthetic applications of Organo boranes: Preparation of Organo boranes viz hydroboration with BH3-THF, dicylohexyl borane, disiamyl borane, thexyl borane, 9-BBN and diisicamphenyl borne, functional group transformations of Organo Boranes-Oxidation. Formation of carbon-carbon-bonds viz Organo boranes carbonylation, and reaction of alkenyl boranes and tri alkenyl borates. **[15 hrs]**

UNIT-III

Organometallic Compounds in Organic Synthesis-III: Organo Silanes: Synthetic applications of tri methyl silyl chloride, silyl carbanion and β-silyl Carboniumions. Peterson olefination. Preparation and Synthetic applications of OrganoSamarium and Organo Chromium Compounds.Organo tin: Preparation and reactions of tri-n-butyl tin hydride, Barton decarboxylation and Barton- McCombie reaction.

Organo cerates: Preparation and reactions of Organo cerates, Organo mercurial: Preparation, Electrophilic substitution reactions, Solvomercuration-demercuration and cyclopropanation of alkenes. **[15 hrs]**

UNIT-IV

Homogeneous Catalysis: Introduction, properties of catalysis, types of reactions in homogeneous catalysis, hydrogenation of olefins, isomerization of olefins, Oxo-process, Wacker process, Monsanto acetic acid process, water gas shift reaction, carbonylation, alkene hydrosilylation.

Heterogeneous Catalysis: Introduction, Fischer-Tropsch reaction, Ziegler-Natta catalysis.

Fluxionality behavior in organometallic complexes: Fluxionality in complexes containing ή2 -Olefin, ή3- allyl and dienyl complexes. Applications of organometallic compounds in industry. **[15 hrs]**

References:

1. Organometallic Chemistry, R. C. Mehrotra and A. Singh, Wiley Eastern, (1991).
2. The Organometallic Chemistry of the transition metals, R. H. Crabtree, (1988).
3. Principles and application of the Organotrnsition metal chemistry, J. P. Collman, L. S. Hegedus, University Science books, (1980).
4. An introduction to Organometallic Chemistry, A.W. Parkinsand R.C.Poller, Macmillan, (1986).
5. Modern Synthetic Reactions, 2nd Edition, H. O. House, W.A. Benjamin, California, (1972).

6. Organometallics, Vol. 1 & 2, M. Bochmann, Oxford Chemistry primers, Oxford University Press, (1994).
7. Advanced Organic Chemistry, 4th Edition,J. March, John Wiley, (2008).
8. Organo-transition metal chemistry, S. G. Davies, Pergamon Press, Oxford, (1982).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MZ310	CO1	1		1	1	1		1	1			1	1	1
	CO2	2	1	2		3	1	2	2			2	2	2
	CO3	2	1	2		3	1	2	2			2	2	2
	CO4	2	1	1		2	1	1	2			2	1	1

SEMESTER-III: ORGANIC CHEMISTRY SOFT CORE

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS302	GREEN CHEMISTRY-III.5	DSEC/SC	2	0	0	2	2

Course objectives:

This course aims to provide the student to gain

i. Knowledge of green chemistry through various concepts
ii. Application of instrumental techniques for the synthesis of green materials or compounds
iii. Outline on the synthesis of green materials through various chemical routes
iv. Design the concept and discipline of green chemistry and place its growth and expansion in a historical context from.

Course outcome:

By the completion of course student will be able to

CO1. Employ alternate methods for material synthesis towards better sustainability.
CO2. Design reaction schemes for developing new green products.
CO3. Identify environmental friendly chemicals and techniques for materials synthesis.
CO4. Analyse materials for their applications based on their chemical properties.

Course Content:

UNIT-I

Introduction to green chemistry: Green chemistry: Relevance and goals, Anasta's, 12 principles of green chemistry -tools of Green chemistry:- Alternative starting materials, reagents, catalysts, solvents and processes with suitable examples

Use of ultrasound and Microwaves in Organic Synthesis

Use of ultrasound: Introduction, instrumentation, the phenomenon of cavitation. Sonochemical esterification, substitution, addition, alkylation, oxidation, reduction and coupling reactions.

Use of Microwaves: Introduction, concept, reaction vessel/medium, specific effects, atom efficiency (% atom utilization), advantages and limitations. N-alkylation and alkylation of active methylene compounds, condensation of active methylene compounds with aldehydes and amines. Diels-Alder reaction. Deprotection of esters and silyl ethers. **[8 hrs]**

UNIT-II

Ionic-liquids: Introduction, structure, synthesis and applications of some important ionic liquids in organic synthesis Polymer supported reagents in organic synthesis Introduction- properties of polymer support, advantages of polymer supported reagents and choice of polymers.

Applications: Substrate covalently bound to the support: Synthesis of oligosachcharides, Dieckmann cyclisation. Preparation of polymer bound aldehyde and application in aldol and Wittig reactions. Synthesis of polystyryl boronic acid and use in diol protection reaction. Reagent linked to a polymeric material: Preparation of sulfonazide polymer and application in diazotransfer reaction. Synthesis of polymer bound per acid and its applications. Polymer supported catalytic reactions: Preparation of polymer supported AlCl3 and application in etherification and acetal formation reactions. **[7 hrs]**

UNIT-III

Phase transfer catalysis and Crown ethers

Phase transfer catalysis: Introduction, definition, mechanism of phase transfer catalysis. Types of phase transfer catalysts and reactions and their Advantages.

Preparation of catalysts and their application in substitution, elimination, addition, alkylation, oxidation and reduction reactions.

Crown ethers: Introduction, nomenclature, features, nature of donor site. General synthesis of Crown ethers.

Synthetic applications: Alkylation, generation of carbenes, aromatic substitution and displacement reactions. Generation and application of superoxide anions. Cation deactivation reactions. **[8 hrs]**

UNIT-IV

Supported catalyst and Bio-catalyst for Green chemistry

Introduction-the concept of atom ecomnomy-supported metal catalsts-mesoporous silicas-the use of biocatalyst for green chemistry-modified biocatalyst-Fermentations and Biotransformations-fine chemicals bymicrobial fermentations- vitamins and amino acids -Baker's yeast mediated bio transformation-biocatalyst mediated Bayer-Villiger reactions -Microbial polyester synthesis.

Multi-component Reactions: Studies on the mechanistic aspects and use of the following reactions in organic synthesis: Passerini-Ugi; Hantsch; Biginelli; Doebner-Miller; Ritter; Jacobson; Betti; Robinson-Schopf; Barbier; Baylis-Hilmann; Ivanov and Suzuki coupling reaction. **[7 hrs]**

References:

1. Green Chemistry -Environmentally benign recations- V.K. Ahluwalia. Ane Books India (Publisher) (2006).
2. Green Chemistry-Designing Chemistry for the Environment- 2nd Edition, Edited by Paul T. Anastas & Tracy C. Willamson, (1998).
2. Green Chemistry-Frontiers in Benign Chemical synthesis and Processes- Edited by Paul T. Anastas & Tracy C. Willamson. Oxford Press (1998).
3. Organic Chemistry, R. E. Ireland Prentice-Hall India, New Delhi, (1975).
4. Some modern methods of Organic Synthesis, 2nd Edition, W. Caruthers, Cambridge Uni. Press London, (1998).
5. A textbook of organic chemistry, V. K. Ahluwalia and M. Goyal, Narosa Publishing House, New Delhi, (2000).
6. Organic synthesis: Special techniques, V. K. Ahluwalia and R. Aggarwal, Narosa, New Delhi, (2003).
7. Green Chemistry- environment friendly alternatives, R. Sanghi, M. M. Srivastava, Narosa, New Delhi, (2003).
8. Green Chemistry-an introduction text, Royal Society of Chemistry, UK, (2002).
9. Organic chemistry Vol. 2, 6th Edition, I. L. Finar, Longman, (1992).
10. Crownethers and cryptands, G.W.Gokel, Monograph, The Royal Society of Chemistry, (1991).
11. Macrocyclic Polyether Chemistry, G. W. Gokel, S. M. Korzeniowski, Vol 1 to 3, Wiley, NY, (1978, 1981, 1987).
12. Phase Transfer Catalysis in Organic Synthesis, W. B. Weber, G. W. Gokel, Springer, Berlin, (1977).
13. Phase Transfer Catalysis, 2nd Edition, E. V. Dehmlov, S. S. Dehmlov, Verlagchemie, Wienheim, (1983).
14. Polymers as aids in organic synthesis, N. K. Mathur, C. K. Narang, R. E. Williams, Academic Press, NY, (1980).

Mapping of Course Outcomes with programme Outcomes (sample)

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS302	CO1	2	2	1	2	1	2		1			2	2	1
	CO2	3	1	2	2	2	3		2			2	1	2
	CO3	2	3	2	1	2	2		2			1	2	3
	CO4	3	2	2	1	2	1		2			2	2	3

SEMESTER-III: PHYSICAL CHEMISTRYHARD CORE

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ313	PHOTO PHYSICAL PROCESSES AND APPLICATIONS-III	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. Principles and laws of photochemistry,
ii. Measurement of fluorescence and phosphorescence and lifetimes
iii. Fluorescence based sensors.

Course Outcomes:

By the completion of course student will be able to

CO1. Acquire knowledge on laws of photo chemistry, types of electronic transitions and their kinetics.
CO2. Study of various methods to understand fluorescence and phosphorescence processes.
CO3. Explain Fluorescence based sensors with relevant examples.
CO4. Describe principle of photovoltaics, various energy conversion devices and their applications.

Course Content:

UNIT – I

Principles and concepts: overview of: Laws of photochemistry, Beer-Lambert law, electronic energy levels, atomic and molecular term symbols, singlet-triplet state, intensity and strength of electronic transition, selection rules for electronic transition, singlet, triplet states, Jablonski diagram and photophysical processes, Franck-Condon principle, Quantum yield, Quenching. Different types of electronic transitions, Excited state lifetime, steady state and time resolved emission, factors affecting excited state energy: solvent effect, TICT. **[15 hrs]**

UNIT-II

Excited state kinetics, quantum yield expressions, excimer and exciplex, kinetics of luminescence quenching: static and dynamic, Stern-Volmer analysis, deviation from Stern-Volmer kinetics. Photoinduced electron transfer rates, free energy dependence of electron transfer on rate, Photoinduced energy transfer, FRET, rate and efficiency calculation of FRET. **[15 hrs]**

UNIT – III

Methods: Measurement of fluorescence and phosphorescence and lifetimes. Quantum yield, Introduction to time-resolved techniques for absorption and emission measurements, detection and kinetics of reactive intermediates. Examples of low temperature matrix isolation of reactive intermediates. **[15 hrs]**

UNIT – IV

Applications: Fluorescence based sensors – examples of molecular and supramolecular systems. Conversion of solar energy to chemical and other forms of energies, Principles of photovoltaics, Semiconductors, crystalline solid in Photoactive materials, solar photovoltaic cell, basic principle and design of the cell. Organic photovoltaics, Dye sensitized solar cells, Emission devices, Light emitting devices, LED, organic LED. **[15 hrs]**

References:

1. Physical Chemistry, 4th Edition, P.W. Atkins, ELBS, Oxford University Press (1990).
2. Elements of Physical Chemistry, S. Glasstone, MacMillan.
3. Modern Spectroscopy, 4th Edition, J. M. Hollas, John Wiley & Sons, (2004).
4. Modern Optical Spectroscopy, Student Edition, William W. Parson, Springer, (2009).
5. Fundamentals of Photochemistry, K. K. Rohatgi-Mukhejee, Wiley Eastern Ltd, (1992).
6. Principles of Fluorescence Spectroscopy, 3rd Edition, J. R. Lakowicz, Springer, (2006).
7. Laser Spectroscopy- Basic concepts and instrumentation, 3rd Edition, W. Demtroder, Springer,(2004).
8. Fundamentals of Photoinduced Electron Transfer, G. J. Kavarnos, VCH publishers Inc., New York, (1993).
9. Modern Molecular Photochemistry of Organic Molecules, N. J. Turro, V. Ramamurthy, J. C. Scaiano, University Science, Books, CA, (2010).
10. Photochemical Synthesis, I. Ninomiya, T. Naito, Academic Press, New York, (1989).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MZ313	CO1	2	2	1	1	1	2	2	1	1	2	2	2	1
	CO2	1	2	2	2	2	2	2	2	1	2	3	2	2
	CO3	2	1	2	3	2	1	3	2	2	2	2	1	1
	CO4	2	2	3	2	2	2	2	2	1	3	3	2	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Wk
M21SMZ314	FUNDAMENTALS OF ELECTROCHEMISTRY AND APPLICATIONS-III	HC	4	0	0	4	4

Course of Objective

This course aims to provide the student to

i. Explain the fundamental concept, principles and laws of electrochemistry,
ii. Discuss related to the types of electrodes and study of electrode reactions pathway.
iii. Explain the concept of spectro-electrochemical and spectroscopic techniques.
iv. Construction of electrode materials for various applications.

Course of Outcome

By the completion of course student will be able to:

CO1. Illustrate the electrochemical reactionand mechanism.
CO2. Development of electrode materials in various applications.
CO3. Apply the spectro-electrochemical and spectroscopic in better understanding structural feature and prospective of electrode materials.
CO4. Design the new electrode materials for various applications in the field of electrochemical sensors and electrochemical energy devices.

Course Content:

UNIT – I

Electrochemical cells, Electrical double layer theories, Electrolyte conduction process, different types of electrochemical cells, Mass transport, Linear diffusion, Fick's laws and diffusion coefficient, The charged interface, Potential step and potential sweep experiments, Reactions controlled by rate of electron transfer and activated complex theory, Role of electron tunneling. **[15 hrs]**

UNIT – II

Electrode Types and Study of Electrode Reactions: Carbon electrodes, Semiconductor film electrodes, Microelectrodes, Ultra-micro electrodes, Ion-selective electrodes, Porous electrodes and non uniform reaction rates, Hydrodynamic/Rotating disk electrodes, Semiconductor electrodes and electrical capacitance.

Cyclic voltammetry in reversible, quasi-reversible and irreversible systems, Study of reaction mechanisms, Surface modification in charge transfer and interfacial activity Electron transfer in DNA and biosystems, Potentiometry, coulometry, pulse techniques. **[15 hrs]**

UNIT-III

Spectro-Electrochemical and Spectroscopic Techniques: Impedance Spectroscopy, Scanning Electrochemical Microscopy, Electrochemical AFM and STM, Electrochemical Quartz Crystal Microbalance, Photoelectochemistry.

Electrode Materials and Sensors: Electroactive Fullerenes, Carbon Nanotubes, Biomolecules, Controlled Potential Techniques, Electrochemical synthesis of nanomaterials, nanowires and conducting polymers, Functional nanoparticles as catalysts and sensors, MOSFETS and ISFETS, Solid state molecular devices.

[15 hrs]

UNIT-IV

Electrochemical Energy Systems: Photo-electrochemistry, Monitoring photolytic intermediates, Electroluminescence and devices and sensors, Electro - chemiluminescence, Digital simulation of electrochemical problems, Sample BASIC programs.

Fuel cells: Electrode materials, Diagnostic tools in fuel cell research, Determination of injection efficiency and electron diffusion length under steady state condition, Small-amplitude time-resolved methods, Organic solar cells, DSSC, battery electrochemistry. **[15 hrs]**

References:

1. Electrochemical Methods: Fundamentals and Applications, 2nd Edition, Allen J. Bard, Larry R. Faulkner, John Wiley & Sons, (2001).
2. Electroanalytical Chemistry, Allen J. Bard (Ed, Vol.13, Plenum Press (1983).
3. Analytical Electrochemistry, 3rd Edition, Joseph Wang, John Wiley & Sons,(2006).
4. Electrochemistry of Functional Supramolecular Systems, Paola Ceroni, Alberto Credi and Margherita Venturi (Ed), John Wiley & Sons, (2010).
5. Electrochemistry in Non-aqueous Solutions, Kosuke Isutzu, Wiley – VCH Verlag GmbH & Co. (2002).
6. Dye-Sensitized Solar Cells, 1st Edition, K. Kalyanasundaram (Ed), EPFL Press, (2010).
7. Electrochemical Systems, 3rd Edition, J. Newman, Wiley-Interscience, (2004).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MZ310	CO1	2	2	3	3	3	3	1	1	1	2	3	3	3
	CO2	2	3	1	2	2	2	1	2	1	2	3	2	2
	CO3	3	3	1	2	3	1	1	2	1	2	2	2	2
	CO4	2	2	3	3	3	3	1	1	1	2	3	3	3

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ315	ADVANCED PHYSICAL CHEMISTRY-III	HC	4	0	0	4	4

Course objectives:

This course on physical chemistry provides students to enlighten the knowledge on topics like

i. This course intends to make the students to understand topics like quantum chemistry and its application is in molecular architecture.
ii. Bring awareness about the differences in Statistical Thermodynamics and non equilibrium thermodynamics and molecular motions.
iii. To develop the ideas pertaining to molecular interactions in quantum level.
iv. To build and utilize knowledge of macro molecules in the construction of new drug entities.

Course outcomes:

After completion of the course student will,

CO1. Analyze the quantum mechanical aspects in the molecular dynamics.

CO2. Acquire knowledge on Schrodinger equation, particle in box, Characteristics of many electron systems.

CO3. Understand the statistical thermodynamics, non equilibrium thermodynamics, Molecular forces, Electrical properties of molecules.

CO4. Construct ideas pertaining to the statistical thermodynamics and macro molecular interactions.

Course Content:

UNIT – I

Quantum Chemistry II: Solutions of Schrondinger equation for: free particle in 1D, finite and infinite potential wells, Particle in 3D box, Zero point energy significance, 1D Harmonic oscillator, selection rules in vibrational transitions, Many body problem, approximations, independent particle model, Perturbation method. Application to particle in 1D box of increasing potential, Helium atom, Self consistent field method, Hartee Equation and Hartee-Fock Equations. Pauli"s exclusion principle, Symmetry and antisymmetry wave functions.Spin orbit coupling, Term symbols and spectral lines.

Characteristics of many electron systems, Born-Oppenheimer approximation, Valence bond and Molecular orbital theory, Electron density distribution and stability of H_2^+ ion. **[15 hrs]**

UNIT – II

Statistical Thermodynamics and non equilibirium thermodynamics: Transitional, rotational, vibrational and electronic partition functions of diatomic molecules, Calculation of thermodynamic functions including chemical potential, equlibrium constant, salient features of Fermi-Dirac and Bose-Einstein statics.

Non equilibrium thermodynamics: Thermodynamic fluctuation around equilibrium, Entropy production, energy flux, thermodynamic flux, thermodynamic force, phenomenological laws and Onsagar reciprocity relations, Applications. **[15 hrs]**

UNIT – III

Molecular Interactions: Molecular forces, Electrical properties of molecules, electric dipole moments, Molar Polarization, Mosotti-Clausius and Debye-Langevin equation – their derivation, uses and limitations, Onsagar equation, Ferro-electricity, Intermolecular forces, London dispersion force, Lennard-Jones potential, Nature of binding interactions in supramolecular structures: ion-ion, ion-dipole, dipole-dipole, H-bonding, cation-p, anion-p, p-p, and van der Waals interactions., Crystal engineering: role of H-bonding and other weak interactions. Dielectric effects in absorption and emission spectra in solution, Lippert equation.Molecular interaction in liquids. **[15 hrs]**

UNIT – IV

Macromolecules: Introduction, Classification, Nomenclature, Different structures, Viscosity, Molecular weight determination, Flory-Huggins theory, Amorphous and semicrystalline states, glass transition and related theories, melt transition, viscoelasticity, Maxwell-Voight models, Rubber elasticity – thermodynamic theories. Macromolecule motion. Kinetics and mechanism of addition and condensation polymerisation, Biological macromolecules, Properties of macromolecules. **[15 hrs]**

References:

1. Quantum Chemistry, 2nd Edition, A.K. Chandra. Tata McGraw Hill Publishing Co. Ltd., (1983).
2. Quantum Chemistry, Eyring, Walter and Kimball. John Wiley and Sons, Inc., New York.
3. Quantum Chemistry, I.N. Levine. Pearson Education, New Delhi, (2000).
4. Theoretical Chemistry, S. Glasstone. East West Press, New Delhi, (1973).
2. Quantum Chemistry, R.K. Prasad, New Age International Publishers, (1996).
3. Statistical Thermodynamics, I.M. Klotz.
4. Introduction to Statistical Thermodynamics, M. Dole, Prantice Hall, (1962).
5. Statistical Themodynamics, B.C. Meclelland, Chapman and Hall, London (1973).
6. Physical Chemistry, P.W. Atkins, ELBS, 4thEdition, Oxford University Press (1990)
7. Elements of Physical Chemistry, S. Glasstone, MacMillan.

8. Thermodynamic Properties of Nonelectrolyte Solutions, Acree W.E., (Academic Press, (1984).
9. Chemical Thermodynamics: Advanced Applications, 1st Edition, J. Bevan Ott, Juliana Boerio-Goates, (Academic Press, (2000).
10. The Molecular Theory of Solutions, Prigogine, North Holland Publishing Co. Amsterdam (1957).
11. Molecular Theory of Solutions, Arieh Ben-Naim, Oxford University Press, USA, (2006).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MZ315	CO1	3	2	1	3	2	3	1	1	1	1	3	2	2
	CO2	3	2	1	1	2	2	1	1	1	1	3	2	2
	CO3	3	2	1	2	2	1	2	1	1	1	3	2	2
	CO4	3	2	3	1	1	1	1	2	1	1	3	2	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ316	POLYMER SCIENCE AND TECHNOLOGY-III	SC	4	0	0	4	4

Course Objectives:

i. Broad knowledge on polymer science and technology intends to make the students to understand basic concepts of polymers.
ii. Develop knowledge on thermodynamics of polymer solutions.
iii. Enhanced knowledge on classification, structure-property relation of polymers and different applications of polymers.
iv. Expert in mechanism of polymerization, instrumentation method of polymer characterization.

Course Outcomes:

After completion, of course student will be able to:

CO1. Demonstrate the knowledge of the basic concept of polymer, analysis of molecular weight of polymer.

CO2. Explore physical factors of polymers, analysis of glass transition temperature of polymer, Thermodynamic equation of polymer.

CO3. Create broad knowledge on polymer classification, mechanism of polymerization, instrumentation method of polymer characterization.

CO4. Acquire broad knowledge of polymers for medical, environmental, catalysis and device applications

Course Content:

UNIT – I

Basic concepts - classification, nomenclature, molecular weights, molecular weight distribution, glass transition, degree of crystallinity, morphology, and viscosity-molecular weight, mechanical property - molecular weight relationships. Molecular weights and Methods of determination, molecular weight distribution, size and shape of macromolecules. Intrinsic viscosity, Mark-Houwink relationship.

Chain structure and configuration, conformation, size of an ideal chain (freely jointed chain and other models), Real chains, Flory theory. **[15 hrs]**

UNIT – II

Thermodynamics of polymer solutions; Molecular motion (self-diffusion, hydrodynamic radius, Rouse Model, Zimm Model, entangled polymer dynamics and de Gennes reptation model).

Glass transition temperature – elementary theories and methods of determination. Variation of glass transition with structure.

Rubber elasticity - concepts, thermodynamic equation of state. Elementary theories of viscoelasticity (Maxwell, Voight). **[15 hrs]**

UNIT – III

Classification of polymers, Structure- property relationship, Mechanisms and Methods of Polymerization - Step (condensation) polymerization - Description - Reactivity Functional Groups - Kinetic and thermodynamic considerations - Molecular weight distribution. Chain polymerization, controlled radical polymerizations (INIFERTER, ATRP, RAFT, SET). Living Polymerizations. Ziegler-Natta and metathesis polymerizations. Kinetics and mechanism of addition and condensation polymerization, Moulding and fabrication of polymer. Introduction to Instrumental methods for characterization of polymers. **[15 hrs]**

UNIT – IV

Applications of Polymers: Electrically conductive polymers, Charge transport mechanism, Photoactive polymers, OLED, polymers energy conversion devices, corrsion prevetion, Thermal resistant polymers, catalysis, medical prothesis, Metallopolymers, metalloorganic frameworks, applications, biodegradable polymers, degradation pathways, environmental effects. **[7 hrs]**

References:

1. Polymer Structure, Properties and application, R.D. Deanin, American Chemical Society, (1974).
2. Relating Materials, Properties to Structure, Handbook and Software for Polymer calcilations and Materials Properties, D. J. David and Ashok Mishra, Technical Publishing Componey, Inc, (1999).
3. Properties of Polymer; Correlations with Chemical Structurees and their numerical Estimation and Predication from Additive Group Contribution van Krevelen, Elsevier Publication Company, (1990).
4. Relating Materials Properties to structure, D. J. David, Technical Publishing Company Inc, (1999).
5. Polymer Chemistry, C. E. Carrshar, Marcel Dakker Inc, (2003).
6. Physical chemistry of Polymers, A. Tager, Mir Publishers, (1978).
7. Polymer Association Structures M. A. EL-Nokally, American Chemical Society, (1989).

8. Polymer Solutions- Introduction to Physical Properties, Teraoka, Iwao, John Wiley and Sons. Inc, (2002).
9. Polymer Chemistry- An Introduction, M. P. Stevens, Oxford University Press, (1990).
10. Text book of Polymer Science, Billmeyer, John Wiley ans Sons,(1984).
11. Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons Inc (1965).
12. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons Inc (1988).
13. Polymer Chemistry, Malcolm P. Stevens, Oxford University Press, Inc, (1990).
14. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta, Wiley – Inter Science Publication, (1977).

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ Cos**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PS O1**	**PS O2**	**PS O3**
M21S MZ316	CO1	2	1	1	2	1	1	1	2	1	2	2	2	1
	CO2	2	2	2	2	1	2	1	2	1	2	2	2	2
	CO3	2	1	1	1	1	2	1	1	1	1	2	2	2
	CO4	2	1	2	1	1	1	1	1	1	2	2	2	1

SEMESTER-III: PHYSICAL CHEMISTRY SOFT CORE

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS303	ENERGY AND ENERGY CONVERSION SYSTEMS	SC	2	0	0	2	2

Course Objectives:

This course aims to provide the student to

i. Fundamental importance of energy and energy conservation required to have sustainable life.
ii. The present situation of the availability non-renewable energy resources and reason to shift over to renewable energy sources.
iii. The different renewable energy sources and how to make use of them for our day to day life.
iv. Methods involved in converting and storing of the renewable energy sources for the continuity supply of energy.

Course outcomes:

By the completion of course student will be able to

CO1. Explore the Renewable and non-renewable energies, their advantages and disadvantages, Environmental effects.

CO2. Analyse the status of the renewable and non-renewable sources in the world and discuss the importance of renewable sources

CO3. Acquire the knowledge of renewable sources and list out the different renewable sources to convert, store, and usage in daily life.

CO4. Evaluate the efficiencies of solar cells, electrochemical energy conversion (HER and OER), storage (batteries, and supercapacitors) and fuel cells with their examples.

Course Content:

UNIT – I

Energy systems - Available energy options, Renewable and non renewable, their advantages and disadvantages. Environmental effects, comparative evaluation of energy options and energy needs.

Fossil fuels: petroleum, natural gas and coal - Origin, processing and production of value added products - available current conversion technologies.

Nuclear Energy: Principles of Fission - Fission reactors, U enrichment and processing of spent fuels. Nuclear reactor kinetics and control - nuclear fusion - magnetic and other confinement - evaluation of the option of nuclear energy. **[8 hrs]**

UNIT – II

Electrochemical power sources - theoretical background on the basis of thermodynamic and kinetic considerations.

Primary cells - various types, especially magnesium and aluminum based cells - magnesium reserve batteries.

Secondary cells: classification based on electrolyte type, temperature of operation on the basis of electrodes - chemistry of the main secondary batteries - Batteries for electric vehicles - present status.

[8 hrs]

UNIT – III

Fuel cells - classification - chemistry of fuel cells - detailed description of hydrogen/oxygen fuel cells - methanol - molten carbonate, solid oxide fuel cells solid polymer electrolyte and biochemical fuel cells.

Hydrogen as a fuel - production (thermal, electrolysis, photolysis and photoelectrochemical) storage and applications of hydrogen storage.

Other methods of energy conversion: processes especially in the form of storage as chemical energy.

[7 hrs]

UNIT – IV

Semiconducting materials, Solar energy conversion devices, principle, Photoconversion processes - photovoltaic cells - photoelectrochemical cells - semiconductor electrolyte junctions photocatalytic modes for fuel conversion process - photobiochemical options. **[7 hrs]**

References:

1. Modern Batteries, C. A. Vincent Edward Arnold, (1984).
2. Chemical and Electrochemical energy systems, R. Narayanan, B. Viswanathan, Orient Longmans, (1997).
3. Basic Nuclear Engineering, K. Sriram, Wiley Eastern, (1990).
4. Fuel cell Hand Book, A. S. J. Appleby, F. K. Foulkes, Von Nostrand Reinhold, (1989).
5. Hand book of batteries and Fuel cells, D. Linden, McGraw Hill Book Company, (1984).
6. Solar Hydrogen energy systems, T. Ohta, Peragamon Press, (1979).
7. Energy Resources through photochemistry and catalysis, M. Gratzel, Academic Press, (1983).
8. Energy Technology, Sources, Systems and Frontiers conversions, T. Ohta, Pergamon, (1994).
9. The chemistry and technology of petroleum, J. G. Speight, Marcel Dekker Inc. (1980).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS303	CO1	2	1	2	1	1	2	1	1	2	1	2	1	2
	CO2	1	1	1	2	1	2	1	1	1		1	1	1
	CO3	3	1	2	1	2	1	1	1	1	1	1	1	1
	CO4	2	2	2	2	2	2	1	1	1	1	2	3	2

SEMESTER-III: ANALYTICAL CHEMISTRY HARD CORE

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ319	ADVANCED ANALYTICAL CHEMISTRY-III.1	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. To understand the separation and extraction of compounds by different methods.
ii. Exposure to the various analytical techniques for the detection of elements in the solution.
iii. Highlights and study of instrumental techniques such as Atomic and atomic Spectroscopy.
iv. Development of sensors, optical, biosensors and their type's correlation with basic instrument.

Course Outcomes:

By the completion of course student will be able to

CO1. Identification of the elements and their properties by using instrumental methods.
CO2. Explain the various extraction methods involved during the separation of the compounds.
CO3. Elaborate the principle, instrumentation and applications of various analytical and spectroscopic techniques.
CO4. Design the detectable concentration of a given specific analytes.

Course Content:

UNIT-I

Classical approach for aqueous extraction: Introduction, Liquid-Liquid extraction (LLE) (Theory of LLE, selection of solvents, solvent extraction, problems with LLE process), purge and trap for volatile organics in aqueous samples.

Solid Phase extraction (SPE): Introduction, Types of SPE media, SPE formats and apparatus, method for SPE operation, solvent selection, factors affecting SPE, selected methods of analysis for SPE, Automation and On-Line SPE. Microwave assisted extraction: Introduction, instrumentation, Applications.

Solid phase micro-extraction: Introduction, theoretical considerations, experimental, Methods of analysis: SPME-GC, SPME-HPLC-MS.**[15 hrs]**

UNIT-II

Atomic Spectroscopy: Theory, sources, burners, atomic emission spectra, atomic absorption spectra, effect of temperature on emission, absorption and fluorescence, electro thermal atomizers, Instrumentation for FES, radiation sources atomic absorption methods, instrumentation for AAS, spectral interferences, standard addition and internal standard method of analysis, comparison of atomic absorption and emission methods, inductively coupled plasma and direct current plasma emission spectroscopy, Cold vapor technique, Applications of AAS, AES and ICPAES, analysis of micronutrients like Mo, B, Cu, Zn essential towards the healthy growth of crops, fruits, determination of these micronutrients from soils, plants and fruits. **[15 hrs]**

UNIT-III

Atomic Mass Spectroscopy: Features of atomic mass spectroscopy, Atomic weight in mass spectroscopy, mass to charge ratio, Types of atomic mass spectroscopy, mass spectrometers, transducer for mass spectroscopy, qudrapole mass analyzer, time of flight mass analyzer, inductively coupled mass spectroscopy (ICPMS), Isotopic effect, HRMS to identify the isotopes, Instrumentation for ICPMS, Atomic mass spectra and interferences, Applications of ICPMS special reference to the inorganic complexes analysis

Atomic Fluorescence, Resonant Ionization and laser based-Enhanced Ionization:

Atomic Fluorescence Spectroscopy (AFS): Atomic fluorescence, apparatus for AFS, EMR source for AFS, LASERS, Cells for AFS, Plasmas, Wavelength selection for AFS, Detectors for AFS, Theory of AFS, Analysis with AFS, Interference With AFS. Resonanant Ionization Spectroscopy, Laser-enhanced ionization spectroscopy. **[15 hrs]**

UNIT-IV

Chemical Sensors: Introduction, definitions, Classification of chemical sensors, descriptions of chemical sensors (electrochemical sensors, potentiometric sensors, voltametric chemical sensors, sensors based on conducting properties), Optical sensors (light guides, the evanescent wave, design of fiber optic sensor, indicator mediated sensor), Calorimetric sensors (catalytic gas sensor, thermal conductivity sensor), mass sensor (piezoelectric quartz crystal resonator, surface acostic wave sensor).

Biosensors in analysis: Introduction, producing biological surface, Achievement of biotransduction (amperometric, potentiometric, optical).

Applications: Determination of glucose in blood, determination of copper (I) in water using anodic stripping voltammetry. **[15 hrs]**

Reference Books:

1. Instrumental methods of chemical analysis, H. Willard, L.Merrit, J.A. Dean and F.A. settle. Sixth Edition CBS (1986).
3. Principles of Instrumental Analysis, 6th Edition, Skoog, Holler, Nieman.
4. Extraction technique in analytical science, John R. Dean, Wiley (2009).
5. Quantitative Inorganic Analysis including Elementary Instrumental analysis, By A. I. Ed Vogel, 3, ELBS, (1964).
6. Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and T. A. Nieman, Harcourt College Pub.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MZ319	CO1	3	2		2	3		1	1	1	2	3	3	3
	CO2	2	2	1	3	3	2	1	1	1	2	3	2	3
	CO3	3	3		3	3	1	2	1	1	2	4	3	2
	CO4	4	3	1	3	3	1	2	1	1	2	4	4	3

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ320	ADVANCED MATERIALS, ANALYSIS AND ELECTRON SPECTROSCOPY-III.2	HC	4	0	0	4	4

Course Objective:

This course aims to provide the student to

i. Explain emerging trends in nanotechnology and scope of other materials like zeolites.
ii. Discuss the various techniques involved in synthesis of ceramics and nanomaterials.
iii. Make use of different spectroscopic techniques for chemical analysis.
iv. Analyse the applications of nanomaterials in various fields like agriculture, health, electronics, medical, food safety etc.

Course Outcome:

By the completion of course student will be able to

CO1. Discuss emerging trends in nanotechnology and scope of other materials like zeolites
CO2. Explain the various techniques involved in synthesis of ceramics and nanomaterials
CO3. Demonstrate the knowledge spectroscopic techniques for chemical analysis
CO4. Characterize the materials by different analytical techniques for various fields like agriculture, health, electronics, medical, food safety etc.

Course Content:

UNIT-I

Scope of materials science: Types of materials based on structure (i) layered materials (clays, MoS2, LDH) (ii) Porous materials: Microporous (zeolites), Mesoporous materials (MCM-41) (iii) Metal Organic Frameworks and dendrimers. (Structure and applications in each case need to be discussed) Introduction and definition of nanoparticles and nanomaterials, emergence of nanotechnology, Challenges of nanotechnology. Nanotechnology in relation to other branches of science. Structure of solids: crystalline and non-crystalline. Types of common materials and advanced materials inorganic, organic, biological. Types of nanomaterials depending upon their properties: electronic, semiconductors, superconductors, superionic, magnetic, optic, opto-electronic, spintronics, ceramics. **[15 hrs]**

UNIT-II

Preparation techniques: Principles of solid state synthesis-ceramic methods, solid solution and compound precursors, sol- gel, spray, pyrolysis, and combustion, hydrothermal, electrosynthesis. Preparation of nanoscale materials: Precipitation, mechanical milling, colloidal routes, self-assembly, chemical vapour deposition, sputtering, evaporation.

Overview of inorganic functional materials, their properties and applications. Crystal structure and amorphous materials. Defects and non-stoichiometric solid solutions. Band theory and electronic conductivity. Synthesis and processing of inorganic materials. Properties of inorganic materials: superconductivity, magnetic, dielectric and optical properties. **[15 hrs]**

UNIT-III

Electron spectroscopy: Introduction, principle of electron spectroscopy for chemical analysis(ESCA), ESCA satellite peaks, spectral splitting, ESCA chemical shifts, Apparatus used for ESCA, X-ray source, samples, Analyzers, Detectors, Chemical analysis using ESCA, Applications, Auger electron microscopy, Ultraviolet photoelectron spectroscopy**.**

X- ray Methods of Analysis: Principle, Theory- X-ray spectral lines, X-ray tube, X-ray emission, Absorptive apparatus: Sources, Collimation, sample handling, wavelength dispersive devices, Energy dispersive devices, detectors, readout device, Chemical analysis using X-ray absorption, X-ray Fluorescence- instrumentation and chemical analysis, X-ray Diffraction, Chemical analysis with X-ray diffraction, numerical problems. Single crystalline and polycrystalline XRD analysis

[15 hrs]

UNIT-IV

Materials Characterization techniques: Principle, technique and specific applications of Electron microscopy (TEM and SEM), Focussed Ion Beam Techniques, Atomic Force Microscopy, Scanning tunneling microscopy (STM),BET surface area, porosity, solid state NMR (introduction).

Basic principle, instrumentation and application of Wavelength and energy dispersive X-ray fluorescence spectroscopy (WDS and EDS); X-ray absorption spectroscopy (XANES and EXAFS); secondary ion mass spectrometry (SIMS); temperature programmed desorption (TPD); thermal desorption spectroscopy (TDS).

[15 hrs]

Reference:

1. Introduction to Scanning Tunneling Microscopy by C. J. Chen, Oxford University Press, New York, (1993).
2. Nanostructures and nanomaterials, G. Cao, Imperial College Press, University of Washington, USA, (2004).

3. Nanotechnology Fundamentals and applications, M. Karkare, I. K. international publishing house pvt. Ltd., Bangalore, (2008).
4. Springer Handbook of Nanotechnology, 3rd Edition, B. Bhusan, Springer-Verlag, (2009).
5. Principles of Fluorescence Spectroscopy, 3rdEdition, J. R. Lakowicz, Springer, (2006).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MZ320	CO1	3	3	1		2	1	1	2		2	2	4	3
	CO2	4	3	3	2	3	3	1	2	1	2	3	4	2
	CO3	2	1	3	3	3	2	1	1	1	2	3	4	3
	CO4	1	3	3	2	3	3	1		1	2	2	4	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ321	ELECTROCHEMISTRY AND ELECTROANALYTICAL TECHNIQUES –III.3	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to

i. Knowledge on Electrode/electrolyte interfaces, kinetics of electrochemical processes at metal/solution and SC/solution interface.
ii. Expose into the different coulometric and voltametric techniques to enhance the analysis knowledge of elelctrochemical reactions
iii. Further, exploring hydrodynamic processes and appreciate the importance of impedance spectroscopy in understanding and analysing the electrochemical process.
iv. Finally, expose them to different in-situ-spectroelectrochemical methods.

Course Outcomes:

By the completion of course student will be able to

CO1. Acquire the knowledge Mass transport, Linear diffusion, Fick's laws and diffusion coefficient, the charged interface, Potential step and potential sweep experiments.

CO2. Analyze the compounds by using the analytical techniques such as Chronocoulometry and potentiometery methods.

CO3. Analyze the hydrodynamic, voltametric techniques and impedance spectroscopy and extract the electrochemical reaction information.

CO4. Assessment of the electrochemical process using the different in-situ-spectro-electrochemical methods.

Course Content:

UNIT-I

Electrified interface and electrodics: Formation of electrified interfaces. Electrical double layer and different models. Introduction to three electrode electrochemical devices (arrangement of electrodes to get minimum resistance),iR compensation, electro transfer under an interfacial electric field, Butler-Volmer equation and its modifications and applications with electrochemical water splitting (HER), theory of the symmetry factor (beta). Thermodynamic treatment of the equilibrium state for charge transfer at the metal/solution interface. Mass transport and electrode processes: Faradaic and non-Faradaic processes,

Nernst-Planck equation, Nernstian and non-Nernstian behaviour, Fick's first and second law and their application in mass transport, kinetic and transport-controlled processes.

Electrode kinetics for semiconductor/solution interface: n-p junction, current-potential relation at the SC/electrolyte interface, effects of surface states, use of SC in thermal reactions, photo activity of SC electrodes. **[15 hrs]**

UNIT-II

Step techniques: Basic principles, potential excitation signals and response signals of chronoamperometry, chronocoulometry and chronopotentiometry (single and double potential steps). Use of Cottrell and Sand equations and applications. Evaluation of heterogeneous kinetic parameters and adsorption of species on the electrode surface.

Pulse and stripping techniques: Pulse techniques: fast, normal & differential pulse and square wave voltammetry (principle, comparative potential excitation signals and response signals), pulse width, diminution factor. Application and relative advantages of different pulse techniques. Some special pulse techniques: reverse pulse, differential normal pulse and double differential pulse voltammetry. Stripping techniques: different types of stripping techniques (anodic, cathodic, potentiometric, adsorptive and abrasive) and their comparative preconcentration and determination step, use of pre-concentration techniques at trace and ultra-trace level analysis, use of pre-concentration step for mercury film electrode in metal-ligand complex study. **[15Hrs]**

UNIT-III

Hydrodynamic voltammetry: Useful parameters (comparison of diffusion layer thickness: dynamic and static conditions, relation of hydrodynamic condition with Reynolds, Schmidt, Peclet and Sherwood numbers). Practical considerations: potentiostat and electrodes in hydrodynamic system, RDE and RRDE. Reversible and irreversible kinetics in hydrodynamic condition, use of Levich, Koutecky-Levich equations and Tafel plot and applications. Evaluation of kinetic control and diffusion control processes. Applications of hydrodynamic voltammetry.

Impedance spectroscopic techniques: Impedance, detection and measurements of impedance, equivalent circuit of an electrochemical cell, the Faradaic impedance and the total impedance of a simple electrode process, impedance plots for complex plane. Admittance and its use. Hydrodynamic electrodes and impedance. Transforms and impedance, application of impedance for characterization of corrosion and capacitors. **[15 Hrs]**

UNIT-IV

Spectro-electrochemistry and scanning electrochemical microscopy: Principles, electrochemical set-up and applications, electro-chemiluminescence, optical probing of electrode-solution interfaces. Approach

curves for scanning electrochemical microscopy, imaging surface topography, applications in homogeneous reaction kinetics and others. Electrochemical quartz crystal microbalance, Photo-electrochemical measurements, Spectroelectrochemistry: Electrochemical STM, Electrochemical AFM, Spectroelectrochemistry (insitu-UV-vis, IR, Raman), Sonoelectrochemistry.

[15 hrs]

References:

1. Electrochemical Methods: Fundamentals and Applications, 2nd Edition, Allen J. Bard and Larry R. Faulkner, John Wiley & Sons, (2001).
2. Electroanalytical Chemistry, Vol.13, Allen J. Bard (Ed), Plenum Press, (1983).
3. Analytical Electrochemistry, 3rd Edition, Joseph Wang, John Wiley & Sons, (2006).
4. Electrochemical Systems, 3rd Edition J. Newman, Wiley-Inter science, (2004)
5. Modern Electrochemistry 2B: Electrodics in Chemistry, 2nd Edition, J. O'M. Bockris& A. K. N. Reddy, Engineering, Biology and Environmental Science, Springer, (2001).
6. Electrochemistry: Principles, Methods and Applications, C. M. A. Brett & A. M. O. Brett, Oxford University Press, (1993).
7. Laboratory Techniques in Electroanalytical Chemistry, 2nd Edition, P. Kissinger & W. R. Heinemann, CRS Press, (1996).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21SM Z321	CO1	3	2	2	1	3	1	2	2	2	1	3	3	3
	CO2	2	1	2	2	3	1	2	2	2	2	2	2	3
	CO3	3	3	2	2	2	1	1	2	2	2	2	2	3
	CO4	3	3	1	2	3	1	1	3	3	2	3	3	3

Course Code	**Course Title**	**Type**	L	T	P	C	Hrs/Week
M21SMZ322	INSTRUMENTAL AND ANALYTICAL ANALYSIS TECHNIQUES-III.4	HC	4	0	0	4	4

Course Objectives:

This course aims to provide the student to:

i. Fundamental understanding of principles and their application of medical imaging techniques
ii. Understanding the optical microscopy and electron and ion beam microscopy
iii. To elucidate the chemical structure of molecules and compunds
iv. Developing the physical sensors for Specific applications

Course Outcomes:

By the completion of course student will be able to

CO1. Fundamental understanding of principles and their application of medical imaging Techniques.

CO2. Understanding the optical microscopy and electron and ion beam microscopy.

CO3. Understanding the structural elucidation by using different spectroscopic techniques.

CO4. Understanding and applications of different types of physical sensors.

Course Content:

UNIT-I

Advanced Imaging Techniques for Medical Applications

Basic principles, instrumentation and applications of different imaging techniques such as,Radio imaging, Ultrasound, Elastography, Radiography, Magnetic resonance imaging, Nuclear medicine, Photoacoustic imaging, Tomography, Echocardiography, IR imaging, Raman Imaging, X-ray imaging, CT Scan imaging, Magnetic resonance imaging. [8 **hrs]**

UNIT-II

Optical Microscopy- Basic principles, instrumentation and applications

Simple compound microspore, Fluorimetry, Confocal microscopy-multiphoton spectroscopy, single molecule spectroscopy

Electron microscopy- Basic principles, instrumentation and applications

Secondary electron microscopy, transmission electron microscopy, low energy electron diffraction (LEED), Focussed ion beam microscopy [7 hrs]

UNIT-III

Advanced Spectroscopy-Structural Elucidation

Spectroscopic methods for structure analysis using NMR (1H and 13C), Mass spectroscopy, IR, UV-Vis spectroscopy

1D NMR techniques: DEPT, Decoupling, magnetisation transfer, relaxation measurement, NOE difference spectra.

2D NMR techniques: Homo- and heteronuclear correlation (COSY, TOCSY, HMBC, HSQC,), measurement of the nuclear overhauser effect (NOESY, ROESY). **[7 hrs]**

UNIT-IV

Introduction to sensors, principle and uses of different transducers, Microelectromechanical systems (MEMS), nanoelectromechanical systems (NEMS).

Thermistor, thermocouple, resistance temperature detector, thermal imaging sensors, position sensor using Hall effect, proximity sensors: inductive & capacitive, accelerometer and vibration sensor, flow sensors, ultrasonic, laser sensors, touch sensors-capacitive and level sensors, actuators, piezoelectric sensors and piezoresistive actuators. Semiconductor gas sensors, electrochemical gas sensors, polymer gas sensors (Conductivity type) moisture sensor.

[8 hrs]

References:

1. Environmental Chemistry, Dr. H. Kaur, (2010).
2. Environmental pollution- monitoring and control, Khopkar. S. M, IIT Mumbai (2004).
3. Environmental Chemistry with Green Chemistry, Asim K. Das, (2010).
4. A text book of Soil Chemical Analysis, P. R. Hesse, (2002).
5. Environmental Chemistry, A. K. De, 7th Edition, Uttarpara West Bengal (2010).
6. Physico chemical examination of water, sewage and industrial effluents, 6th edition, N. Manivasakam, (2010).
7. Hand book of Analysis and Quality control for fruit and vegetable products, 2nd Edition, S Ranganna, Tata McGraw-Hill Publishing Co. Ltd.
8. Pharmaceutical Drug Analysis. AshutoshKar, New Age International Publishers.
9. Practical Clinical Biochemistry, 4th Edition, Harold Varley.
10. Food Analysis, A. G. Woodman, McGraw-Hill.
11. Principles of Medicinal Chemistry, Vol 1, Dr. S S, Kadam, Dr. K R Mahadic, Dr. K G Bothara, Niraliprakashan.
12. Modern Optical Spectroscopy, William W. Parson, Springer, Student Edn, (2009).

13. Principles of Fluorescence Spectroscopy, 3rd Edition, J. R. Lakowicz, Springer, (2006).
14. Laser Spectroscopy- Basic concepts and instrumentation – 3rd Edition, W. Demtroder, Springer, (2004).
15. Scanning Probe Microscopy and Spectroscopy, R. Wiesendanger, Cambridge University Press, (1994).
16. Handbook of instrumental techniques for analytical chemistry, Frank A. Settle, Prince Hall, New Jersey, (1997).
17. Physical chemistry of surfaces, Arthur W. Adamson (1990).
18. Introduction to Scanning Tunneling Microscopy, C. J. Chen, Oxford University Press, New York, (1993).
19. Gas Sensors, Principles, Operation and Developments, G. Sberveglieri, Springer, (1992).
20. Hand book of modern sensors, Physics, Designs, and Applications, Jacob Fraden, Springer, (2004).
21. Organic Spectroscopic Analysis, Editor: E W Abel, Rosaleen J. Anderson, David J. Bendell, Paul W. Groundwater, Royal Society of Chemistry, (2004).
22. Modern techniques of surface science, D.P. Woodruff, T.A. Delchar, Cambridge Univ. Press, (1994).
23. Introduction to Scanning Tunnelling Microscopy, C. J. Chen, Oxford University Press, New York, (1993).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MZ322	CO1	2	1		3	1						2	3	1
	CO2	3			3	1						3	3	1
	CO3	3			3	1						2	3	1
	CO4	3			3	1						2	3	1

SEMESTER-III: ANALYTICAL CHEMISTRY SOFT CORE

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS304	ENVIRONMENTAL CHEMISTRY AND APPLIED ANALYSIS-III.5	DSEC*/HC	2	0	0	2	2

Course Objectives:

This course aims to provide the student to

i. Demonstrate a knowledge and understanding of the basic facts and experimental basis of environmental chemistry.

ii. Develop an understanding of how chemists approach and attempt to solve environmental problems.

iii. Review the basic principles of analytical procedures to analyze food constituents and Evaluate quality control results and estimation of vitamins, lipids and other minerals.

iv. Describe the mechanism of drug molecules, principles and procedures of various tests performed in Clinical Chemistry laboratory.

Course Outcomes:

By the completion of course student will be able to

CO1. To create environmental awareness to understand the vulnerability and sensitivity of environment. To promote a sense of responsibility and proactive citizenship.

CO2. Recognize different types of toxic substances, their responses and analyze toxicological information and implement pollution monitoring techniques.

CO3. Illustrate the major chemical reactions occurring during processing and storage of food and method of analysis of various minerals in vitamins and also the estimation of lipids.

CO4. Construct the mechanism of drug interaction and interpretation of clinical data.

Course Content:

UNIT – I

Environmental Chemistry: Introduction: Environmental chemistry, environmental segments classification of environmental pollution.

Air Pollution: Introduction, Air pollutants, Primary pollutants, Sources (CO, NOx, HC, SO_2, and particulates). Particulates–Sources (Inorganicandorganicparticulate matters).

Effects on: Humans, materials, vegetationand animals. Air quality standards, Sampling, monitoring and analysis: CO by gas chromatography, NOx by Spectrophotometric method using sulphanilamide and

NEDA, SO_2 by pararosaniline (PRA), H_2S by colorimetric using ethylene blue, hydrocarbons by chemiluminescence, control of air pollution: Control of particulate matter and gaseous pollutants.

Radioactive Pollution: Introduction, Sources, Radiation from natural and manmade activities, radioactive effects on human and plants, Storage and disposal of radioactive waste, Detection and monitoring of radioactive pollutants. **[8 hrs]**

UNIT-II

Water Pollution: Introduction, Sources, Water pollutants classification: Organic pollutants –Pesticides, insecticides, detergents. Inorganic pollutants, Sediments, Radioactive materials and Thermal pollutants. Drinking water supplies, Trace elements in water. COD, BOD, TOC-definitions. Monitoring techniques and methods: Determination of pH, conductance, dissolved oxygen by Winkler's method, nitrate/nitrite by diazo coupling, chloride by Mohrs and Volhard's method, and fluoride by Alizarin Visual method, Water contamination with cyanide, sulfide, sulphate, phosphate and total hardness. Analysis of Arsenic by Atomic absorption spectroscopy (AAS), cadmium and mercury by dithizone method, chromium by diphenyl carbazide method, lead by polarographic method. Water pollution control and management.

Soil Analysis: Introduction, Origin and nature of soil, Sources of soil pollution and explanation in brief, Purpose of soil analysis, Techniques for the analysis of soil Lime Potentials: Moisture measurement by gravimetric method, pH using calomel glass electrode method, total nitrogen by kjeldhal method, determination of nitrate nitrogen by Bratton and Marshal method, determination of potassium and sodium by Flame photometry, calcium by EDTA titration ,organic matter by combustion, total sulphur by oxidation as sulphate. **[7 hrs]**

UNIT - III

Food Analysis: Sampling, Preparation and storage of samples, Estimation of moisture, ash, crude protein, crude fat, sugars, nitrogen, crude fibre, starch in food. Polyphenols: Extraction, detection and analysis, characterization and spectral identifications of anthocyanins and anthocyanidins. Estimation of Tannins.

Vitamins: Estimation of Vitamin-C (Ascorbic acid), Thiamine, Riboflavin, Folic acid Minerals: Preparation of sample, Estimation of calcium, Magnesium, phosphorus, iron, potassium, sodium, copper, tin, zinc, lead, arsenic, mercury.

Lipids: General composition of edible oils, Physical and chemical characteristics. Composition and structure of free fatty acids. Test for the presence of specific oils: Ground nut oil, Sesame oil, cottonseed oil, linseed oil, argemone oil, presence of mineral oil, Fatty acid analysis. Estimation of fatty acid composition, tests for stability of fats. **[8 hrs]**

UNIT-IV

Analysis of Drugs: Drug design: Characteristics of an ideal drug molecule, mechanism of drug interaction, Antibiotics, classification and structure, mode of action, Theory and assay of Aspirin(titrimetry), methyldopa (nonaqueous titrimetry), Analgin(iodimetry), chloral hydrate (argentiometry), cholesterol (gravimetry), hydrocortisone acetate (tetrazolium assay). Clinical Chemistry: Composition of blood, collection, and preservation of samples- anticoagulants, proteinprecipitants. Interpretationand Clinical analysis of Blood glucose (glucose oxidase methods), proteins, blood urea (Nesslerisation method). Lipids, Calcium, phosphorus, phosphatases, iodine, iron, copper, Sulfur, Magnesium, Chloride, sodium and potassium. **[7 hrs]**

References:

1. Environmental Chemistry, Dr. H. Kaur, (2010).
2. Environmental pollution- monitoring and control, Khopkar. S. M, IIT Mumbai, (2004).
2. Environmental Chemistry with Green Chemistry, Asim K. Das, (2010).
3. A text book of Soil Chemical Analysis, P. R. Hesse, (2002).
4. Environmental Chemistry, 7th Edition, A. K. De, Uttarpara West Bengal (2010).
5. Physico chemical examination of water - sewage and industrial effluents, 6th Edition, N. Manivasakam, (2010).
6. Hand book of Analysis and Quality control for fruit and vegetable products, 2nd Edition S Ranganna, Tata McGraw-Hill Publishing Co. Ltd.
7. Pharmaceutical Drug Analysis. AshutoshKar, New Age International Publishers.
8. Practical Clinical Biochemistry, 4th Edition, Harold Varley.
9. Food Analysis, A. G. Woodman, McGraw-Hill.
10. Principles of Medicinal Chemistry, Vol 1, Dr. S S, Kadam, Dr. K R Mahadic, Dr. K G Bothara, Niraliprakashan.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS304	**CO1**	3	3	1		1	3	3	1	1	3		1	
	CO2	1	3	2	2	1	1	1	1		1		1	1
	CO3	1	3	1	1	1	2	2			1	1	3	1
	CO4	1	2	3	3	3	1	1	1		1	2	3	2

OPEN ELECTIVE FOR PG STUDENTS OF DISCIPLINES OTHER THAN CHEMISTRY

(Offered to other Schools by Chemistry)

Course Code	**Course Title**	**Type**	L	T	P	C	Hrs/Week
M21SMO301	ADVANCED MATERIALS IN SEMICONDUCTOR DEVICE TECHNOLOGIES	OE	4	0	0	4	4

COURSE DETAILS: OE

Subject Nature: Theory

Prerequisites: Basics knowledge of Chemistry and Physics

COURSE OBJECTIVES:

This course enables the students to

1. Correlate the electronic properties of matter in device applications.
2. Provide insights on importance of selection of materials in device technologies
3. Understand the challenges of materials in energy and electronic devices.
4. Develop the knowledge and inspiration to look for new materials in advanced devices

COURSE OUTCOMES:

After the completion of the course, a student should be able to

1. Select materials for semiconductor devices.
2. Address the inherent challenges of semiconductor materials in device technologies.
3. Update with recent advances in semiconductors in device technologies
4. Apply the knowledge to extent and develop towards research on semiconductors

SYLLABUS

Unit 1: Electronic properties of matter: Electrons in matter, Band structure of solids, Energy bands, charge transport and ordering, Overview of materials preparation and fabrication techniques, solid-state electronics, emerging devices and crystalline materials: Atomic, molecular and polymeric systems

Unit 2: Advances of materials in Electronic and semiconductor devices: Semiconductor materials, Elements to compounds, Direct and indirect bandgap semiconductors, Materials challenges, Semiconductor devices,

Unit 3: Materials in photoconversion devices: Solar spectrum, solar energy conversion materials, inherent challenges, advanced materials, conversion efficiency, application, artificial photosynthesis, Photoelectrochemical devices, And Semiconductor/electrolyte charge transfer

Unit 4: Nanoelectronic and nanophotonic devices: Micro to nano devices transformation, Size effects, and nanoelectronic materials advances, Nanophotonics, Fabrications techniques, device challenges, device applications,

ESSENTIAL READING

1, Organic Electronics Materials and Devices, Springer Pub., S S Ogawa, 2015

2, Physical Chemsitry of Ionic materials, Wiley Pub. J Maier, 2004

3, Semiconductor devices: Physics and Technology, S. M Sze, M . K Lee, John Wiley and Sons, 2012

4.Photochemistry and photophysics: concepts, research and applications, Wiley Pub, V. Balzani, P. Ceroni, A. Juris, 2014

SUPPLEMENTARY READING

1. Journal reading, Nanoletters – ACS

2. Journal reading, Advanced materials – Wiley

3. Journal reading, Chemical Reviews - ACS

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
M21SMO301	CO1	2	2	1	2	1	2			1	1	2	3	1
	CO2	2		2	1	1	1			1	0	1	2	2
	CO3	1		2	1	2	1			1		1	2	2
	CO4	2	1		1	2	1			1	1	1	3	1

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMO302	BIODIESEL – AN ALTERNATE RENEWABLE ENERGY SOURCE	OE	4	0	0	4	4

Course Objectives: The open elective course aims to provide students about

1. Biodiesel as an alternate renewable energy source.
2. The chemistry concepts involved in understanding its fuel nature.
3. Raw materials and the constraints in their selection.
4. The analytical procedures and its engineering aspects.

Course Outcomes: After the completion of the course, students able to

CO1: Evaluate basic properties of oil/biodiesel labs.

CO2: Understand the experimental concepts, green techniques of biodiesel synthesis.

CO3: Realise the significance of spectroscopic techniques for sample characterisation.

CO4: Know correlation between biodiesel fuel properties and its engineering applications

Syllabus

Unit 1: Introduction to the basics

History of biodiesel, definition, basic structure of biodiesel molecule and its components, feedstocks-edible and non-edible, physical and chemical properties and their significance- acid value, free fatty acid, iodine value, peroxide value, saponification value, density, viscosity, cetane number (types), refractive index, fatty acid composition, structure of fatty acids and their chemistry, advantages and disadvantages of biodiesel, role of biotechnology, comparison of biodiesel with other alternate sources of energy, standard specifications (BSI, EN and ASTM).

Unit 2: Methods of synthesis

Methods of oil extraction- solvent extraction, mechanical, biodiesel synthesis- transesterification, pyrolysis, microwave technique, Ultrasonication and supercritical techniques, Experimental parameters; role catalyst– homogeneous (both acid & base), heterogeneous (both acid & base) catalysis, nature of alcohol and its effect (both advantages and disadvantages), chemistry of transesterification process, homogeneous and heterogeneous acid /base catalysis - reaction mechanism (some examples for homogeneous and heterogeneous catalysis)

Unit 3: Characterisation - Analytical techniques

Introduction to spectroscopic techniques of oil/biodiesel analysis; IR, NMR (IH and 13C) - basic principle, instrumentation and understanding of the chemistry of various functional groups, separation techniques of oil /biodiesel analysis; GC, HPLC - basic principle, instrumentation and chemistry involved in qualitative analysis and quantitative analysis.

Unit 4: Application of biodiesel as alternate fuel – engineering aspects

Basic concepts of CI engine, types of engines, combustion process in CI engine, engine performance parameters; BSFC, BP, BTE, and EGT, engine emission analysis of samples for CO_2, UHC, NOx, CO, PM, Soot and O_2 gases, and fuel-air ratio, alcohols as fuels; methanol, ethanol, and other higher alcohols, biodiesel as source of energy, role of blends as alternate fuels for CI engines (some examples), impact of FFA composition of fuel samples on engine performance and emission characteristics.

References

1. Biodiesel: A Realistic Fuel Alternative for Diesel Engines, Ayhan Demirbas, Springer Science & Business Media, 20-Dec-2007 - Technology & Engineering - 208 pages

2. Handbook of biofuels production: Processes and technologies, Rafael Luque, Juan Campelo, and JAMES Clark, Woodhead Publishing Limited, 2011

3. Biodiesel Handling and Use Guide *(Fifth Edition),* Teresa L. Alleman and Robert L. McCormick, US Department of Energy- Energy Efficiency and renewable energy

4. Biodiesel Production Technology, J. Van Gerpen, B. Shanks, and R. Pruszko, D. Clements, G. Knothe, National Renewable Energy Laboratory, Available electronically at http://www.osti.gov/bridge.

5. The Biodiesel Handbook- 2nd Edition, Gerhard Knothe Jürgen Krahl Jon Gerpen, Academic Press and AOCS Press, 1st May 2010

6. Introduction to Spectroscopy, Donald L Pavia, Gary M. Lampman, George S Kriz, Thomson Learning Academy resources

7. Fundamentals of molecular spectroscopy, Walter s. Struve, a wiley-interscience publication

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
M21S MO302	**CO1**	2	2				2		2			2	2	2
	CO2	2	2	3			3		3			2	2	3
	CO3	1	3				2		2			2	1	2
	CO4	2	2	3		2	3		3			2	2	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMO303	CHEMISTRY OF MATERIALS AND CHARACTERIZATION	OE	4		0	4	4

Course Objectives:

This course aims to provide the student to

i. Types of materials like layered materials and porous materials based on structure.
ii. The fundamentals of the chemistry of Nano materials its properties and applications.
iii. Synthesis the bulk materials by Precipitation methods, Sol – gel method, solid state synthesis and template technique.
iv. Characterize the samples by SEM, TEM, XPS and BET studies.

Course Outcomes:

By the completion of course student will be able to

CO1: Differentiate the Types of materials like layered materials and porous materials based on structure

CO2: Explainthe the fundamentals of the chemistry of Nano materials its properties and applications

CO3: Synthesize the bulk materials by Precipitation methods, Sol – gel method, solid state method and template technique.

CO4: Characterize the samples by SEM, TEM, XPS and BET studies.

Unit-I

Scope of materials science: Functional materials and their applications. Types of materials based on structure (i) layered materials (clays, MoS2, LDH) (ii) Porous materials: Microporous (zeolites), Mesoporous materials, (iii) Metal Organic Frameworks and dendrimers.

Unit-II

Nanomaterials: Introduction, properties of nanomaterials: (electronic, mechanical, superconducting, magnetic). Synthesis of nanomaterials: Top down methods (ball milling and exfoliation – thermal, solvent and interlayer modification) and bottom up methods (solution synthesis – La Mer principle, Ostwald ripening, role of capping agents, inverse micelle synthesis). Applications of Nanomaterials in medicine and biology – sensing and targeted drug delivery

Unit-III

Bulk materials: Bulk to nano transition - physical phenomena, Principle and applications, Synthesis methods (i) Precipitation methods (ii) Sol – gel method (iii) solid state synthesis (iv) template technique (v) Chemical vapor transport.

Unit-IV

Characterization techniques: Principle, technique and specific applications of Electron microscopy (TEM and SEM), Atomic Force Microscopy, Photoelectron spectroscopy (XPS and Auger spectroscopic techniques), BET surface area, porosity, solid state NMR (introduction).

Text Book Reference:

1. T. Pradeep, Nano: The Essentials Understanding nanoscience and nanotechnology, Tata McGrawHill Publishing Company Limited NEW DELHI, 2007.
2. Nanomaterials Synthesis, Properties and Applications Edited by A S Edelstein and R C Cammarata, IOP Publishing Ltd 1996.
3. Guozhong Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press 2004.
4. Handbook of Nanoceramics and their Based Nanodevices (Vol. 2) Edited by Tseung-Yuen Tseng and Hari Singh Nalwa, American Scientific Publishers.
5. Neelina H. Malsch (Ed.), Biomedical Nanotechnology, CRC Press (2005).
6. P. J. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead Publishing Limited, Cambridge, (2007).
7. W.N. Chang, Nanofibres fabrication, performance and applications, Nova Science Publishers Inc, (2009)

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
M21SMO303	CO1	2	2	1	2	1	2			1	1	2	3	1
	CO2	1		1	1	1	1			1	0	1	2	2
	CO3	1		2	1	2	1			1		2	2	2
	CO4	1	1		1	2	1			1	1	1	3	1

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMO304	CHEMISTRY OF FOOD AND BEVERAGES	OE	4	0	0	4	4

PREREQUISITES: Basics knowledge of Chemistry

COURSE OBJECTIVES:

This course enables the students to

1. Enhance the knowledge on the chemistry of food and beverages
2. Gather sufficient information about the resources and importance of diet
3. Assimilate the concepts of food processing
4. Develop the knowledge on bio-transformations and biochemical reactions

COURSE OUTCOMES:

After the completion of the course, a student should be able to

1. To acknowledge the dietary classifications and nutrients
2. Understand the significant aspects of food metabolism in the human body
3. Gain knowledge on the food quality and its impact on health
4. Realize the various aspects of food storage and preservation, toxins and contaminants.

SYLLABUS

Unit 1

Food, Types of nutrients, Food as a source of energy, Use of energy by the body, Energy requirements, Enzymes, Cell metabolism, Digestion, Deficiency diseases, Concept of a balanced diet, Diet and diseases of affluence, Concepts of health and food quality, Regulation of appetite and eating, Metabolism and the role of diet in regulation, Obesity, Anorexia nervosa, Food intolerance and allergy, Dietary reference values, Uses of dietary reference values, Coeliac disease, Oils and fats, Lipids in aqueous media: colloidal and emulsions, Lipids in the diet.

Unit 2

Milk and dairy products, Nutritional value, Sugars, Polysaccharides, Carbohydrates in the diet, Carbohydrates in the body, Sources of sugars, Sucrose, Cane sugar or beet sugar, Foodstuffs manufactured

from sugar, Sugars in the diet, Cereals, Amino acids, Peptides, Proteins, Meat, Fish, Eggs, Soya, Novel protein-rich foods.

Unit 3

Water, Non-alcoholic beverages, Alcoholic beverages, Major mineral elements, Other mineral elements, Fat-soluble vitamins, Water-soluble vitamins, Other bioactive food constituents, Plant polyphenols, Fruits, Nuts, Vegetables, Sensory qualities of fruits and vegetables, Bioactive compounds in fruits and vegetables.

Unit 4

Cooking, Methods of heat transfer, Transfer of mass, General effects of cooking, Changes occurring after cooking , Moist heat methods, Dry heat methods, Raising agents, The nature of diet, Establishing diet and health links, Dietary needs of special groups, Types of dietary intervention to improve health, Food spoilage, Food preservation, Food toxins, Food hygiene, Food contaminants, Food additives

ESSENTIAL READING

1. Food Chemistry, Belitz, H.-D., Werner Grosch, Peter Schieberle, Springer 2009
2. Principles of Food Chemistry, John M. deMan, Third Edition, Aspen Publication 1999
3. Introduction to Food Chemistry, Richard Owusu-Apenten, CRC Press, 2019

Food Science, Nutrition and Health, Michael E. J. Lean CRC Press 2006

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
M21SMO304	**CO1**	**2**	**1**	**2**	**2**	**2**	**1**	**1**	**0**	**0**	**1**	**3**	**1**	**2**
	CO2	**3**	**2**	**1**	**2**	**2**	**3**	**2**	**0**	**0**	**1**	**2**	**1**	**3**
	CO3	**2**	**3**	**2**	**3**	**3**	**2**	**1**	**0**	**0**	**1**	**3**	**1**	**2**
	CO4	**3**	**2**	**1**	**2**	**2**	**2**	**2**	**0**	**0**	**1**	**3**	**1**	**3**

Course Code	**Course Title**	**Type**	L	T	P	C	Hrs/Week
M21SMO305	NANOTECHNOLOGY	OE	2	0	0	2	2

This is the fundamental course in Nanotechnology. This course will provide the Nanotechnology needed to understand engineering applications. This course will be begun by covering the nanotechnology concepts necessary in the study of recent advancement technology. Next, it covers the concepts of smart materials for device applications. Fatherly, it discusses the concepts of fabrication of instruments. Then move on to nano characterization devices analyze the nano structures using the optical, X-ray and electron beam techniques. Finally, it covers the topics of nanofabrication devices, properties and nano characterizations.

Course Objectives:

This course aims to provide the student to:

This course enables graduating students to identify Nanotechnology requirements and to find efficient solutions in developing smart materials for device applications.

i. Learn on basic introduction to nanomaterials and their fabrications
ii. Classification of nanomaterials and their working principle.
iii. Discuss the preparation of nanomaterials.
iv. Gain the knowledge of nanomaterials and their applications.

Course Outcomes:

By the completion of course student will be able to

CO1: Understand the importance of nanotechnology and properties

CO2: Provide knowledge on fabrication of nanomaterials

CO3: Provide knowledge on Characterization of nanomaterial

CO4: Apply the nanotechnology and device for fabrication of smart devices and industrial applications.

Course Content:

UNIT-I

Introduction to nanotechnology: Nanomaterials, size dependent properties, nanotechnology**,** bottom up and top-down approaches for the synthesis of nanomaterials. Cleanroom and vacuum environment are necessary for creating nanotechnology products.

Properties of nanomaterials and devices applications: Photocatalytic, Thermal, Magnetic, Optical, Mechanical, and Electrical properties.

UNIT-II

Nanofabrication techniques: basics of nanofabrication, Powder Vapor Deposition (PVD), Chemical Vapor Deposition (CVD), Molecular beam epitaxy, Template based synthesis, Gas phase, Plasma-based synthesis, and Lithography.

Nanostructures and device applications: Carbon fullerenes, graphene, CNT, metal, metal oxides, semiconducting quantum dots, nanowires, and nanocomposites.

UNIT-III

Nanomaterials characterization devices and techniques: Principle, instrumentation, and structural analysis of scanning electron microscopy (SEM) and transmission electron microscopy (TEM), scanning probe microscopy: atomic force microscopy (AFM) and scanning tunneling microscopy (STM), and X-ray photoelectron spectroscopy.

UNIT-IV

Industrial Nanotechnology: Nanoelectronics devices, Nanorobotics in Surgery -Nanosensors in Diagnosis- Neuro-electronic Interfaces- Therapeutic applications, Polymer nanofibers – Nylon-6 nanocomposites from polymerization -Nano-filled polypropylene fibers – Nano finishing in textiles (UV resistant, antibacterial, hydrophilic, self-cleaning, flame retardant finishes). Nanomaterials composite for agricultures.

Text Book Reference:

1. T. Pradeep, Nano: The Essentials Understanding nanoscience and nanotechnology, Tata McGraw Hill Publishing Company Limited NEW DELHI, 2007.
2. Nanomaterials Synthesis, Properties and Applications Edited by A S Edelstein and R C Cammarata, IOP Publishing Ltd 1996.
3. Guozhong Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press 2004.
4. Nanomaterials, Nanotechnologies and Design: An Introduction to Engineers and Architects, D. Michael Ashby, Paulo Ferreira, Daniel L. Schodek, Butterworth-Heinemann, 2009.
5. Handbook of Nanoceramics and their Based Nanodevices (Vol. 2) Edited by Tseung-Yuen Tseng and Hari Singh Nalwa, American Scientific Publishers.
6. Neelina H. Malsch (Ed.), Biomedical Nanotechnology, CRC Press (2005).
7. P. J. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead Publishing Limited, Cambridge, (2007).
8. Y-W. Mai, Polymer Nano composites, Woodhead publishing, (2006).
9. W.N. Chang,Nanofibres fabrication, performance and applications, Nova Science Publishers Inc, (2009)

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MO305	CO1	2			1	1	1				1	1	1	2
	CO2	2			1	1	1				1	1	1	2
	CO3	2			1	1	1				1	1	1	2
	CO4	2			1	1	1				1	1	1	2

Course Code	Course Title	Type	L	T	P	C	CH
M21SMO306	**Sensor Technologies: Physical Sensors, Chemical Sensors, Biosensors, Gas Sensors and their Instrumentation**	**OE**	**4**	**0**	**0**	**4**	**4**

CoM21urse Objectives: This course aims to provide the student to

v. *Learn on basic introduction to Sensors and their fabrications*
vi. Classification of Physical Sensors and their working principle.
vii. Discuss the Chemical and Biosensors and their classifications.
viii. Gain the knowledge of gas sensors and their applications.

Course outcomes: After completion of this course student shall able to

1. Discuss the fabrication of sensors.
2. Explain the various typesPhysical Sensors and their working principle
3. Differentiate the Chemical and Biosensors and their classifications.
4. Construct the gas sensors and explain their applications.

Course Description:

Sensor course will provide students about comprehensive understanding of different types of sensors and their underlying principles. The basic knowledge of construction of sensors, selection of suitable sensor for particular application, calibration methods and their principles. Theory and application of various sensor technologies and their instrumentation.

Unit I **13 Hours**

Techniques of sensor fabrications

Basic construction of sensors.Thin Film Deposition Techniques: Physical Vapor Deposition Thermal Deposition, E-beam Evaporation, Sputtering (RF Sputtering), Pulsed Laser Deposition, Field effect Transistors. Chemical vapour deposition techniques. Basic understanding of Photolithography (Photolithography) for pattering layer. Chemical synthesis-solgel technique.

Etching methods for fabrication, Microfluidics design and sensor applications using PDMS technique. Patterning and lithography for nanoscale devices: Introduction to optical/UV, electron beam and X-ray Lithography systems and processes, Wet etching, dry (Plasma /reactive ion) etching, Etch resists-dip pen lithography.

Unit II **13 Hours**

Physical Sensors

Temperature Sensors: Thermistor, Thermocouple, Resistance temperature detector, thermal imaging sensors, position sensor using Hall effect, Proximity sensors: Inductive & Capacitive, accelerometer and vibration sensor, Flow Sensors, ultrasonic and laser sensors- Capacitive and level sensors. Working principles of Actuators, Piezoelectric and Piezoresistive actuators, MEMS, NEMS.

Unit III **13 Hours**

Chemical sensors and Biosensors

Basic principles of chemical and biosensors, different types of biosensors validation methods and their applications. Protein/enzyme based sensors, immobilization techniques, specificity of sensors, binding constants, kinetics and diffusion constants. Redox-enzymes in biosensors, amperometric methods and conductometric methods. Application of quartz crystal microbalance. Optical biosensors UV/Vis/IR, luminescence, fluorescence, fibre optic sensors, surface plasmon resonance sensors, Transducers-electrochemical and optical devices.

Unit IV **13 Hours**

Gas sensors, metal ion sensors, and their fabrication, sensor characteristics and failure mechanisms

Optical gas sensors, semiconductor gas sensors, electrochemical gas sensors, polymer gas sensors (Conductivity type) Moisture sensor.

Heavy metal ion sensors: Optical method of detection, electrochemical methods of detection and heavy metal ion remedies

Basics and fundamental Measurement: Classification of errors, Error analysis – Static and dynamic errors, Sensor Characterisation and Calibration: Static and Dynamic Characteristics of sensors, reliability, aging test, failure mechanisms, stability studies and their evaluation. Physics and chemistry of nanotechnology process of sensors.

References

8. Nanofabrication towards biomedical applications, C.S.S.R. Kumar, J.Hormes, C.Leuschner, Wiley –VCH Verlag GmbH & Co, Weinheim, (2004).
9. Nano Electronics and information Technology, W. Rainer, Wiley, (2003).
10. Transducers and Instrumentation, D.V.S. Murty, 2nd edition, (2012)
11. Measurement, Instrumentation, and Sensors Handbook, John G. Webster, HalitEren, CRC Press, (2018)
12. Handbook of Modern Sensors, Fraden, Jacob, Springer-Verlag New York (2010).

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
M21SMO306	CO1	3	1	1	2	1	1	0	0	1	1	2	3	1
	CO2	1	0	1	1	1	1	0	0	1	0	1	2	2
	CO3	1	0	1	1	1	1	0	0	1	0	1	2	2
	CO4	1	1	1	1	1	1	0	0	1	1	1	3	1

SEMESTER-III

INTERNSHIP / SKILL DEVELOPMENT

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SMM321	INTERNSHIP / SKILL DEVELOPMENT	RULO	0	0	2	0	4

Note: The students will have to undergo Skill Development course being conducted by Training and Placement cell of the University.

SEMESTER-III: INORGANIC CHEMISTRY PRACTICAL-1

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ305	INORGANIC CHEMISTRY PRACTICALS-III.1	SC	0	0	2	2	4

Course Objectives:

This course aims to provide the student to

i. The practical course on Inorganic chemistry intends to provide the students scientific skills in qualitative and preparative techniques.

ii. Appreciate the importance of being systematic in life.

iii. It also helps to develop honesty, punctuality, analytical reasoning, questioning, critical evaluation and thinking among students.

Course Outcomes:

By the completion of course student will be able to

CO1. Apply the practical knowledge in determination of strength of analyte.

CO2. Identify individual functional groups present in mixture of salt.

CO3. Detect the ions present in the sample by different techniques.

CO4. Estimate the amount of ions by volumetric and gravimetric methods.

Course Content:

PART – I

1. Simultaneous spectrophotometric determination of chromium and manganese in a steel solution.
2. Quantitative analysis of copper (II) and iron (II) in a mixture:
    i. Copper gravimetrically as CuSCN and
    ii. Iron volumetrically using cerium (IV) solution
3. Flame photometric determination of the following metal ions from different samples:
    a) Sodium
    b) Potassium
    c) Calcium
    d) Lithium and
    d) Sodium and potassium in a mixture.
4. Quantitative determination of nickel using dithizone and 1, 10-phenanthroline by synergistic extraction.

5. Spectrophotometric determination of the pKa value of methyl red.

6. Micro-titrimetric estimation of: a) Iron using cerium (IV), b) Calcium and magnesium using EDTA

7. Quantitative estimation of copper (II), calcium (II) and chloride in a mixture.

COMPLEX ANALYSIS

1. Estimation of cobalt present in Chloropentamminecobalt (III) chloride complex.
2. Estimation of nickel present in Hexamine nickle(II)chloride complex

ORE ANALYSIS

1. Estimation of calcium carbonate in limestone by oxalate method.
2. Estimation of MnO_2 present in the given pyrolusite ore.
3. Estimation of Chromium and manganese in steel sample.
4. Estimation of Iron in pharmaceutical samples.

PART – II

COMPLEX PREPARATIONS

1. Preparation of Mercury tetrathiocyanato cobaltate (II) complex.

2. Preparation of Chloropentammine cobalt (III) chloride complex.

3. Preparation of Bisoxalato cuprate (II) di hydrate complex.

4. Preparation of Tris-oxalato ferrate (III) complex.

5. Preparation of Sulphato tristhiourea zinc (II) complex.

6. Preparation of Tristhiourea copper (I) sulphate complex

7. Cis and Trans Diaquadioxalato chromate (III) complex.

8. Preparation of Hexamine nickle (II) chloride complex.

9. Demonstration Experiments:

    (a) Interpretation of IR and NMR spectra of complexes.

    (b) DNA interaction with metal complexes by UV-visible absorption and viscosity methods.

    (c) Preparation of Metal oxide-conducting polymer composite

10. Characterization of any one inorganic metal complexes: conductance method, cryoscopy, IR spectroscopy, EPS, QPS, X-ray diffraction, Dipole moment, NMR spectroscopy, Chemical methods, Mossbauer spectra.

11. Characterization of any one inorganic compounds by XRD, IR, UV-Vis, SEM, TEM, AFM, STM, XANS, LEED, AAS, ICP-AES, TDS, SIMS, and Chromatographic analysis.

References:

1. Advanced Physico-Chemical Experiments, J. Rose.
2. Instrumental Analysis Manual - Modern Experiments for Laboratory, G. G. Guilbault and L. G. Hargis.
3. A Text Book of Quantitative Inorganic Analysis, A.I. Vogel, 5th edition.
4. Experimental Inorganic Chemistry, G. Palmer.
5. Inorganic Synthesis, O. Glemser.
6. Experimental Inorganic/ Physical Chemistry, Mounir A. Malati.
7. Quantitative Chemical Analysis, 7th Edition,Daniel C. Harris, (2006).
8. Spectrophotometric Determination of Elements, Z. Marczenko.
9. College practical Chemistry, Ahulwalia.
10. Analytical Chemistry, G. D. Christian.
11. Practical Inorganic Chemistry, K. Somashekara Rao.
12. Principles of Inorganic Chemistry, Puri, Sharma, Khalia.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21SM Z305	CO1	3	2	2	2	3	2	2		1	2	3	2	2
	CO2	3	2	2	2	2	2	2	2	1	2	3	2	2
	CO3	2	2	2	3	2	1	2	2	2	2	2	2	2
	CO4	2	3	3	2	2	2	2	2	1	2	2	3	3

SEMESTER-III: ORGANIC CHEMISTRY PRACTICAL-1

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ311	ORGANIC CHEMISTRY PRACTICAL –III.1	DSEC/SC	0	0	2	2	4

Course Objectives:

This course aims to provide the student to

i. Practical knowledge on organic chemistry and scientific skills in qualitative and preparative techniques.
ii. Acquire the experience of handling the chemicals and their identification through chemical analysis.
iii. Appreciate the importance of being systematic in life.
iv. Helps to develop punctuality, analytical reasoning, questioning, critical evaluation and thinking.

Course Outcomes:

By the completion of course student will be able to

CO1. Acquire skill to perform chemical reaction, common laboratory techniques, including reflux, distillation, steam distillation, re-crystallization, vacuum filtration and aqueous extraction.

CO2. Calculate the limiting reagent and percent yield.

CO3. Evaluate data collected to determine the identity, purity, and yield of products, and to characterize organic molecules by physical methods such as melting point and boiling point.

CO4. Predict the outcome and mechanism of some simple organic reactions, using a basic understanding of the relative reactivity of functional groups.

Course Content:

Organic Chemistry Practicals - II

Qualitative analysis Systematic analysis and identification of organic compounds.

References:

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, Austin R. Tatchell, Longman Scientific and Technical, (1989).

2. Some modern methods of Organic Synthesis, 2nd Edition,W. Caruthers, Cambridge Uni. Press London, (1998).
3. Organic synthesis: Special techniques, K. Ahluwalia and R. Aggarwal, Narosa, New Delhi, (2003).
4. Spectrometric Identification of Organic Compounds, R. M. Silverstein and W. P. Webster, Wiley & Sons, (1999).
5. Introduction to Spectroscopy, 3rd Edition, Pavia, Lampman and Kriz, Thomson.

Mapping of Course Outcomes with programme Outcomes (sample)

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MZ311	CO1	3	2	1	3	2		3			1	3	3	2
	CO2	2	2	1	3	1	1	1		3	1	3	2	2
	CO3	2	2	2	3	2	2	2		2	1	3	2	2
	CO4	2	2	1	1	2	1				1	3	2	1

SEMESTER-III: ANALYTICAL CHEMISTRY PRACTICAL-1

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ323	ANALYTICAL CHEMISTRY PRACTICAL –III.2	SC	0	0	2	2	4

Course Objectives:

The practical course on Analytical chemistry intends to provide the students to,

i. Impart training in operating different instruments used in the analysis of chemical constituents.
ii. Analyze different chemical constituents using various analyticalmethods.
iii. Explain diverse analytical problems in an efficient and quantitative way that conveys the importance of accuracy and precision of the analytical results.
iv. Provide a basic knowledge and understanding of essential chemical and physical principles for analytical chemistry.

Course Out comes:

On successful completion of the practical course students shall be able to:

CO1. Demonstrate practical skills in analysing different constituents using instrumental methods.
CO2. Employ a variety of analytical and instrumental methods to prepare, separate and quantify Samples.
CO3. Describe and compare a range of electroanalytical methods and explain the underlying Theoretical principles.
CO4. Defend the experimental results with validation.

Course Content:

1. Estimation of acetyl salicylic acid in the given aspirin tablet by titrating against 0.1N alcoholic KOH potentiometrically.
2. Determination of strength of acetic acid (commercial vinegar) by Conductometric method.
3. Determination of purity of commercial HCl, H_2SO_4, H_3PO_4 and CH_3COOH and using pH metric end point.
4. Estimation of sulphate as benzidine sulphate by potentimetric method.
5. Estimation of metal acetates using perchloric acid in glacial acetic acid medium.

6. Estimation of copper using salicylaldoxime.
7. Estimation of Iron III by solvent Extraction.
8. Synthesis of inorganic polymer and measurement of surface acidity and basicity.
9. Analysis of chrome steel: Estimation of iron by volumetry and Cr by colorimetry.
10. Determination of pKa of a weak organic acid or a base using UV-Vis spectrophotometry.
11. Analysis of Portland cement: Estimation of insoluble residue by gravimetry.
12. Standardizing cyclic voltammetry using ferrocyanide—ferriccyanide system.

References:

1. Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, J. Mendham, R. C. Denney, J. D. Barnes and M. J. K. Thomas, Third Indian Reprint, Pearson Education Pvt. Ltd., New Delhi, (2003).
2. Analytical Chemistry Principles, 2nd Edition, John H. Kennedy, Saunders College Publishing, California, (1990).
3. Analytical Chemistry: An introduction Skoog, West, Holler and Crouch; 7th Edition Saunders College Publishing, (1999).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21SM Z323	CO1	3	3	3	3	3	2	1	1	1	2	2	3	2
	CO2	3	3	2	3	3	2	1	2	1	2	2	2	2
	CO3	2	3	2	2	3	2	1	1	1	2	3	2	3
	CO4	2	2	2	2	2	2	2	1	1	2	2	2	2

SEMESTER-III: INORGANIC CHEMISTRY PRACTICAL-2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ306	ADVANCED INORGANIC CHEMISTRY PRACTICALS-III.2	SC	0	1	2	2	4

Course Objectives:

The practical course on Inorganic chemistry intends to provide the students scientific skills in qualitative and preparative techniques.

i. Appreciate the importance of being systematic in life.

ii. It also helps to develop honesty, punctuality, analytical reasoning, questioning, critical evaluation and thinking among students.

Course Outcomes:

On successful completion of course students will be able to:

CO1. Apply the practical knowledge in determination of strength of analyte.

CO2. Identify individual functional groups present in mixture of salt.

CO3. Detect the ions present in the sample by different techniques.

CO4. Estimate the amount of ions by volumetric and gravimetric methods.

Course Content:

PART-I

COMPLEX ANALYSIS

1. Determination of CFSE. for select transition metal complexes
2. Rate of isomerization of trans-potassium dioxalatodiaquachromate(I1I) to the cis isomer
3. Preparation of Iodine pentoxide,
4. Preparation of potassium trioxalatomanganate (III) from higher oxidation state. Preparation of potassium manganate from Potassium permanganate
5. Solvent effect in UV-Vis spectra on transition metal complexes
6. IR spectra of Coordinationcomplexes
7. Kinetics of Malachite green or dye discoloration
8. Preparation and spectral characterizationof,

NiO, Nickel ferrite, trans-$[Co(en)_2Cl_2]Cl$, $K_3[Cr(ox)_3]$ $(NH_4)_3[Cr(ox)_3]$ $[Cu(acac)_3]Mn(acac)_3]$ $[Cu(thiourea)_3]_2SO_4$, Copper phthalocyanine, copper-1,10-phenanthroline

9. Stabiliation of oxidation states in copper (I) chloride, copper(I) tetraiodomercurate(II), tris(thiourea)copper(I) sulphate, tetrapyridinesilver(II) peroxodisulphate

PART-II

COMPLEX PREPARATIONS

1. Preparation of Sulphatotristhioureazinc (II) complex.
2. Cis and Trans Diaquadioxalatochromate (III) complex.
3. Estimation of nickel present in Hexamine nickle (II) chloride complex

ORE ANALYSIS

1. Estimation of calcium carbonate in limestone by oxalate method.
2. Estimation of MnO_2 present in the given pyrolusite ore.

COMMERCIAL SAMPLE ANALYSIS

1. Estimation of Chromium and manganese in steel sample.
2. Estimation of Iron in pharmaceutical samples.

LAB ASSIGNMENTS

1. Characterization of any one inorganic metal complexes: conductance method, cryoscopy, IR spectroscopy, EPS, QPS, X-ray diffraction, Dipole moment, NMR spectroscopy, Chemical methods, Mossbauer spectra.
2. Characterization of any one inorganic compounds by XRD, IR, UV-Vis, SEM, TEM, AFM, STM, XANS, LEED, AAS, ICP-AES, TDS, SIMS, and Chromatographic analysis.

References:

1. Vogel's Textbook of Quantitative analysis, 6th Edition, J Mendham, R.C. Denney, J. D. Barnes M. J. K. Thomas.
2. College practical Chemistry, Ahulwalia.
4. Analytical Chemistry, G.D. Christian.
5. Practical Inorganic Chemistry, K. Somashekara Rao.
6. Principles of Inorganic Chemistry, Puri, Sharma, Khalia.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21SM Z306	CO1	3	2	2	2	3	2	2		1	2	1	2	2
	CO2	3	2	2	2	2	2	2	2	1	2	2	3	2
	CO3	2	2	2	3	2	1	2	2	2	2	2	2	3
	CO4	2	3	3	2	2	2	2	2	1	2	2	2	2

SEMESTER-III: ORGANIC CHEMISTRY PRACTICAL-2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ312	ADVANCED ORGANIC CHEMISTRY PRACTICAL –III.2	DSEC/SC	0	1	2	2	4

Course Objectives:

This course aims to provide the student with

i. Practical knowledge on protection and deprotection.
ii. Ability to choose feasible reactions and optimize the yield.
iii. Experience on Reagent control and functional group transformation.
iv. Awareness on ecofriendly conditions and chemical waste management.

Course Outcomes:

By the completion of course student will be able to

CO1. Explore the suitable reactions for carbon-carbon and carbon-heteroatom bond formation.
CO2. Protect and deprotect the functional groups that interfere with the reaction conditions.
CO3. Incorporate chemoselectivity and regioselectivity controls in chemical synthesis.
CO4. Devise economical and highly efficient linear or convergent synthesis, and multicomponent reactions.

Course Content:

Organic Chemistry Practicals - III

1. Green synthesis and reactions.
2. Protection and deprotection reactions of organic multiple functional groups.
3. Multiple step synthesis involving functional group transformations.
4. Isolation and purifications of organic compounds-TLC, Column Chromatography and using Rotatory evaporators.
5. Spectral characterisation of organic compounds.

References:

1. Green Chemistry-Environmentally benign recations, V.K Ahluwalia. Ane Books India (Publisher) (2006).
2. Green Chemistry-Designing Chemistry for the Environment, 2nd Edition, Edited by Paul T. Anastas & Tracy C. Willamson (1998).
3. Some modern methods of Organic Synthesis, 2nd Edition,W. Caruthers, Cambridge Uni. Press London, (1998).
4. Organic synthesis: Special techniques, V. K. Ahluwalia and R. Aggarwal, Narosa, New Delhi, (2003).
5. Spectrometric Identification of Organic Compounds, R.M. Silverstein and W.P. Webster, Wiley & Sons, (1999).
6. Introduction to Spectroscopy,3rd Edition, Pavia, Lampman and Kriz, Thomson.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MZ312	CO1	1	3		3	3						2	3	2
	CO2	3	1	3		3	3						1	3
	CO3	2	2		3	3						3	3	2
	CO4	3	3	2	2	2						1	1	1

SEMESTER-III: ANALYTICAL CHEMISTRY PRACTICAL-2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMZ324	ANALYTICAL CHEMISTRY PRACTICAL –III.2	SC	0	0	2	2	4

Course Objectives:

The practical course on Analytical chemistry intends to provide the students to,

i. Learn different electro analytical techniques for sample analysis.
ii. Impart training in practical experience in selected instrumental methods of analysis.
iii. Able to synthesize materials, characterization and chemical analysis.
iv. Understanding the theoretical principles and practical applications of different chromatographic techniques.

Course Out comes:

On successful completion of the practical course students shall be able to:

CO1. Interpret the results of quantitative experiments and interpret the data in meaningful ways.

CO2. Analyze the chemical methods employed for compound analysis.

CO3. Illustrate the experimental skills on different instrumental analysis of the given compounds.

CO4. Discuss the fundamentals, critical thinking and analytical reasoning as applied to scientific problems.

Course Content:

1. Determination of fluoride in drinking water by Spectrophotometry (Zr-Alizarin method).
2. Estimation of caffeine in a given sample using UV Spectrophotometer.
3. Spectrophotometric determination of pKa value of an indicator (the acid dissociation constant of methyl red).
4. Separation and identification of metal ions in a mixture by paper chromatography/TLC.
5. Synthesis of CaO and MgO composites and their characterization by XRD studies.
6. Preparation of Hexamine nickel (II) chloride complex and its characterization by IR Spectroscopy.
7. Synthesis of dipeptide and its characterization by IR Spectroscopy.
8. Preparation of Aspirin and its characterization by NMR Spectroscopy.
9. To determine the percentage of ascorbic acid in a given sample using HPLC.

References:

1. Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, J. Mendham, R. C. Denney, J. D. Barnes and M. J. K. Thomas, Third Indian Reprint, Pearson Education Pvt. Ltd., New Delhi,(2003).
2. Analytical Chemistry: An introduction Skoog, 7th Edition, West, Holler and Crouch, Saunders College Publishing (1999).
3. Chromatography, C. G. Sharma.

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ Cos**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PS O1**	**PS O2**	**PS O3**
M21SM Z324	CO1	2	3	3	3	3	3	3	3	1	2	2	3	3
	CO2	2	3	3	3	2	2	3	1	2	2	2	3	3
	CO3	2	2	2	2	3	3	2	2	1	1	2	3	3
	CO4	3	3	3	3	2	2	1	2	1	3	2	3	3

SEMESTER-IV: HARDCORE

Course Code	Course Title	Type	L	T	P	C	Hrs./
M21SM0401	MAJOR PROJECT	HC	0	0	8	8	16

Course Objective:

To carry out the research under the guidance of R&D supervisor/Industry/R&D Institution and in the process learn the techniques of research.

Course Outcomes:

On successful completion of the project, the student shall be able to:

- **CO1.** Familiarize with literature search
- **CO2.** Conduct the experiments related to research and formulate computational techniques.
- **CO3.** Interpret the scientific data
- **CO4.** Write report and defend the research findings.

Course Content:

Project:

This project will be based on preliminary research-oriented topics both in theory and experiment. The teachers who will act as supervisors for the projects will float projects and any one of them will be allocated to the student. The research projects floated should be completed in 18 weeks. After the completion of the project the student shall submit project report in the form of dissertation on a specified date by the School. The details of assessment of project are explained under the heading “Evaluation of Minor Project / Major Project / Dissertation” in this handbook.

SEMESTER-IV: SOFT CORE

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS401	FUNCTIONAL INORGANIC MATERIALS	SC	2	0	0	2	2

Course of Objective:

This course aims to provide the student to

i. Explain the basic concept the inorganic based metal complexes.
ii. Elaborate the synthesis, reaction, properties and applications of magnetic materials.
iii. Discuss the crystalline inorganic metal oxide for the structural correlation with properties.
iv. Explain the various superconductors for the device application.

Course of Outcome:

By the completion of course student will be able to

CO1. Build the knowledge on inorganic based metal complexes.
CO2. Importance of magnetic materials and their application in various sector.
CO3. Interpretation of metal oxide with the help of structure-property correlations and potential applications.
CO4. Design the superconducting materials based on the device application.

Course Content:

UNIT -I

Macrocyclic inorganic complexes, supramolecular organometallic compounds, Metalloorganic frameworks and metallopolymers. **[12 hrs]**

UNIT -II

Metallomesogens – synthesis, properties, applications, Molecular Magnetic materials, GMR materials, Compounds intercalation and redox reactions. **[12 hrs]**

UNIT -III

Synthesis, structure, properties, structure-property correlations and potential applications of crystalline inorganic solid state materials. Functional oxides, mixed metal oxides.

[12 hrs]

UNIT -IV

Superconductors –(Ba,K)BiO3, Cuprates, MgB2, , Ferroelectric materials, Piezoelectric materials, ionic conductors, Spintronics Materials – Principle, Synthesis – Gas storage materials, Photoluminescent materials. **[12 hrs]**

References:

1. Principles of Inorganic Materials Design,J. N. Lalena, D.A. Cleary, Wiley, New York, (2010).
2. Physical Chemistry of Ionic Materials: Ions and Electrons in Solids, Maier, J. Wiley, New York, (2004).
3. Solid-state Chemistry of Inorganic Materials VI (Symposium QQ at 2006 MRS Fall Meeting), Curran Associates, Inc., (2007).
4. Supramolecular Chemistry,P. D. Beer, P. A. Gale, D. K. Smith, Oxford University Press, (1999).
5. Supramolecular Chemistry, J. W. Steed, J. L. AtwoodWiley, (2000).

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ Cos**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PS O1**	**PS O2**	**PS O3**
M21S MS401	CO1	2	3	1	2	3				1	2	3	2	3
	CO2	3	3	1	2	3	2			1	2	3	3	3
	CO3	3	3		2	2				1	2	3	3	3
	CO4	3	2	1	2	3	1			1	2	3	4	3

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS402	ADVANCED FUNCTIONAL ORGANIC MATERIALS	DSEC/SC	2	0	0	2	2

Course Objectives:

This course aims to provide the student to

i. To develop the knowledge of functional organic materials, organic optical devices.
ii. Apply the synthetic organic chemistry knowledge in making MOF's and organic electronic devices, solar devices.
iii. To understand the application of organic materials in the area of organic electronics, metal organic frameworks, optical materials and in solar cells.
iv. To construct the materials based on their requirement like solar cells, OLEDs, energy storage devices etc.

Course Outcomes:

By the completion of course student will be able to

CO1. Acquire knowledge on functional organic materials as molecular spintronic.
CO2. Understand the applications of MOFs as energy materials etc.
CO3. Categorize the optical materials for OLED´s.
CO4. Application of organic materials for solar cells.

Course Content:

UNIT-I

Functional organic materials: Introduction to material science. Classification and examples of application of functional (in) organic molecules.

Organic electronics: Electron transport in organic mat erials. (A) Chiral organic (supra) conductors. Molecular spintronics–classification, concepts, materials and applications. **[7 hrs]**

UNIT-II

Metal-organic frameworks: Definition, nomenclature and classification of metal-organic frameworks (MOF´s). Synthesis, physico-chemical properties and catalytic applications. Molecules encapsulation in MOF´s and its applications – molecular gas cylinders (hydrogen, methane, acetylene), drug carriers (ibuprofen). Nanotechnologies based on MOF´s. **[8 hrs]**

UNIT-III

Non-linear optical materials: Principles of fluorescence and phosphorescence. Organoluminescence – classification, chemistry and applications. Organic light-emitting diodes (OLED´s). Polymeric opto-elektronic materials. Electroluminescence, mechanochromic fluorescence and piezofluorochromism – concepts, materials and future applications. **[8 hrs]**

UNIT-IV

Solar cells: Photoelectric effect. Basic principles of organic solar cells. Dye-sensitised solar cells (DSSC) – classification, concepts, chemistry and applications. Organic photovoltaics. Chemistry of personalized solar energy. [7 **hrs]**

References:

1. Functional organic materials: synthesis, strategies and applications, Thomas J. J Muller, Wiley-VCH (2007).
2. The chemistry of metal-organic frameworks synthesis, characterization and applications, Edited by Stefan Kaskel, Wiley-VCH, (2016).
3. Organic photovoltaics-mechanisms, materials and devices, Sam-Shajing sun. Niyai serdar Sariciftci, March 29, CRC press, (2005).
4. Research articles and reviews published in reputed journals.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS402	CO1	3		1	2							3	2	2
	CO2	1	1	2			3					3	2	1
	CO3	2		2	2		2			2		2	2	2
	CO4	3	1	3	3	2	2			2		2	3	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS403	ADVANCED SPECTROSCOPY AND APPLICATIONS IN STRUCTURAL ANALYSIS	SC	2	0	0	2	2

Course Objectives:

The practical course on Analytical chemistry intends to provide the students to,

i. Acquire knowledge about the widely used analytical Instruments
ii. Provide experience in some scientific methods employed in analytical chemistry.
iii. Understand the chemical methods employed for elemental and compound analysis.
iv. This course provides students to analyse the compounds using spectroscopic data of UV-Vis spectra, IR, NMR, EPR, XRD, MASS etc.

Course Out comes:

On successful completion of the practical course students shall be able to:

CO1. Understand the working principle, theory and application of various instrumental method.

CO2. Acquire the analytical skills on various analytical instrumental techniques used to identify and solve the problem.

CO3. Interpret the chemical composition and structure of the compound using spectral data.

CO4. Design an analytical work-flow to acquire data and achieve the research objectives of their project.

Course Content:

UNIT-I: Powder Diffraction Methods and calibration techniques: The modern Automated diffractometer, Applications of the Powder Method, Qualitative phase analysis, Crystallography and space group analysis, Indexing and lattice parameter determination, refinement and identification, Powder pattern calculation, Crystal structure determination -The Rietveld method.

Single Crystal Methods: Quantitative X-ray Diffraction, Interaction of X-rays with matter, absorption and EXAFS (time?), X-ray reflectometry analysis, Small Angle scattering, Patterson Function, Pair correlation functions and linkage to structure function, Application to spherical, elliptical and needle shape inclusions.

[10 hrs]

UNIT-II: Particle size measurement: Basic principle of particle analysis, equivalent sphere model, D[1,0], D[3,2] and D[4,3] representations, conversion between length and volume/mass means, mean, median and mode statistics; Methods of measurement of particle size, XRD, optical and laser scattering techniques; surface area and porosity; definition and meaning, measurement using BET method , adsorption isotherms, DC polarization, AC impedance measurements. **[10 hrs]**

UNIT – III: EPR: hyperfine splitting in various systems, factors affecting the magnitude of g-value, Anisotropy in the hyperfine coupling constants, zero-field splitting and Kramers' degeneracy, nuclear quadrupole interactions. Applications.

NQR: Basic theory, effect of magnetic field in the spectra, relationship between 'q' and molecular structure. Structural information from NQR spectra, Applications.

Mossbauer: Gamma ray emission and absorption by nuclei, Mossbauer effect-conditions, nuclear recoil, Doppler effect, instrumentation, chemical shift examples, quadrupole effect, effect of magnetic field, effect of simultaneous electric and magnetic fields, Use of Mossbauer spectra in chemical analysis, typical spectra of iron and tin compounds. **[10 hrs]**

UNIT-IV:Spectral analysis: Application of combined spectroscopic techniques in structural analysis of organic and inorganic compounds using UV-Vis, FTIR, NMR (^{1}H-NMR, C-13 NMR, F-19 NMR, P-31 NMR), MASS, ESR, NQR, Mossbauer spectroscopic techniques. **[10 hrs]**

References:

1. Elements of Modern X-ray Physics, 2nd Edition, Jens Als-Nielsen and Des Mc Morrow, Wiley & Sons (2011).
2. Modern Powder, Diffraction Reviews in Mineralogy, D. L. Bish and J. E. Post Vol. 20, Mineralogical Society of America, (1989).
3. Fundamentals of Analytical Chemistry. 7th Edition, D. A. Skoog, D. M. West and F. J. Holler, Saunders College Publishing (1996).
4. Instrumental methods of Analysis. H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Set, CBS Publishers (1996).
5. Introduction to Spectroscopy, 4th Edition, Donald L. Pavia.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21SM S403	CO1	3	2	1	1	1	2	3	2	2	2	2		2
	CO2	1	2	1	1	3	2	2	2	2	2	2		2
	CO3	2	2		1	2	2	2	1	2	2	2		2
	CO4	1	2	1		2	2	2	2	2	1	1		2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS404	ADVANCED ELECTROANALYTICAL TECHNIQUES	DSEC/SC	2	0	0	2	2

Course Objectives:

This course aims to provide the student to

i. Knowledge on Electrode types, electrochemical characterization techniques, Electrochemical STM, Electrochemical AFM, Sensors.

ii. Skilled in problem solving, critical thinking and Analytical reasoning as applied to scientific Problems

iii. Conclude Fundamental Concepts in Analytical Electrochemistry- Mass transport, Linear diffusion, Fick's laws and diffusion coefficient.

iv. Design and carryout scientific experiments as well as accurately record and analyze the results of such experiments

Course Outcomes:

By the completion of course student will be able to

CO5. Acquire the knowledge Mass transport, Linear diffusion, Fick's laws and diffusion coefficient, the charged interface, Potential step and potential sweep experiments.

CO6. Analyze the compounds by using the analytical techniques.

CO7. Explain the Advanced analytical techniques (Sensors) which are useful to analyse the compounds.

CO8. Students will be able to function as a member of an interdisciplinary problem solving.

Course Content:

UNIT- I

Fundamental Concepts in Analytical Electrochemistry: Mass transport, Linear diffusion, Fick's laws and diffusion coefficient, The charged interface, Potential step and potential sweep experiments, Reactions controlled by rate of electron transfer and activated complex theory and Electrode reactions.

[8 hrs]

UNIT -II

Electrode types, Electrochemical characterization techniques – Cyclic voltammetry, Potentiostatic and galvanostatic methods, Pulse methods, RRDE, impedance analysis. **[7 hrs]**

UNIT -III

Photoelectrochemical measurements, I-V measurements, IPCE, Efficiency, Spectroelectrochemistry, Electrochemical STM, Electrochemical AFM. **[8 hrs]**

UNIT -IV

Electrochemical sensing, Electrochemical biosensors, Electron transfer in DNA and biosystems, Photoelectrochemical sensing. **[7 hrs]**

References:

1. Electrochemical Methods: Fundamentals and Applications, 2nd Edition, Allen J. Bard, Larry R. Faulkner, John Wiley & Sons, (2001).
2. Electroanalytical Chemistry, Vol.13, Plenum Press Allen J. Bard (Ed) (1983).
3. Analytical Electrochemistry, 3rd Edition, Joseph Wang, John Wiley & Sons, (2006).
4. Electrochemical Systems, 3rd Edition, J. Newman, Wiley-Inter science, (2004).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS404	CO1	3	1		3	2		2	2		2	2	2	1
	CO2	2	2	2	3	3		1	2	2	3		2	2
	CO3	3	2	2	2	2	1	2	2	2	2	1	1	2
	CO4	2	3	2	1	2	2	2	2	2	3	2	1	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS405	ADVANCES IN SURFACE, INTERFACE AND CATALYSIS	DSEC/SC	2	0	0	2	2

Course Objectives:

This course aims to provide the student to

i. Intends to enlighten the students in Suface forces, surface energy, Electrostatic forces, Electrical double layer, Solid surfaces, structures, Thermodynamics of Adsorption processes.

ii. This course provides students to get knowledge on Fundamental processes in catalysis, Structures, Kinetic aspects Heterogenous catalysts, Synthesis of metal oxide catalysts, catalysis by porous materials.

iii. Students are able to understand the fundamental of metal oxide and catalysis.

iv. Build research knowledge on photocatalysis, electrocatalysis, devices and their application.

Course Outcomes:

By the completion of course student will be able to

CO1. Acquire the knowledge of suface forces, surface energy, Electrostatic forces, Electrical double layer, Solid surfaces and structures.

CO2. Explain the Fundamental processes in catalysis, Structures, Kinetic aspects Heterogenous catalysts, Bio enzyme catalysis.

CO3. Synthesize the metal oxide catalysts, catalysis by porous materials.

CO4. Identify the Photocatalysts, Electro catalysts.

Course Content:

UNIT - I

Sufaces: Suface forces, surface energy, Electrostatic forces, Electrical double layer, Solid surfaces, structures, Thermodynamics of Adsorption processes, Colloidal systems, stability, -coagulation, charged colloids, thin liquid films, emulsions Application of colloids. **[8 hrs]**

UNIT- II

Interface: Solid-liquid interface, Liquid-liquid interface, Surface analysis – scanning probe microscopy, EELS, BET- Surface area analysis, Microscopic analysis, Thermal analysis. **[7 hrs]**

UNIT -III

Catalysis: Fundamental processes in catalysis, Structures, Kinetic aspects Heterogenous catalysts, Synthesis of metal oxide catalysts, catalysis by porous materials. **[7 hrs]**

UNIT IV

Catalysis for sustainable energy: Photocatalysts, Electrocatalysts, device application, Catalysis in industrial processes, Bio enzyme catalysis. **[8 hrs]**

References:

1. Physical chemistry of surfaces, Arthur W. Adamson (1990).
2. Surface Science: Foundations of Catalysis and Nanoscience, K.W. Kolasinski, Wiley, (2002).
3. Modern techniques of surface science, D.P. Woodruff, T. A. Delchar, Cambridge Univ. Press, (1994).
4. Principles and Practice of Heterogeneous Catalysis, M. Thomas, W.J. Thomas, Wiley-VCH, (1997).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS405	CO1	3	3	1		2	1				2	2	4	3
	CO2	4	3	3	2	3	3			1	2	3	4	2
	CO3	2	1	3	3	3	2			1	2	3	4	3
	CO4	1	3	3	2	3	3			1	2	2	4	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS406	ADVANCED MATERIALS IN ENERGY STORAGE AND CONVERSION DEVICES	SC	2	0	0	2	2

Course Objectives:

This course aims to provide the student to

1. Intends to enlighten the students in charge transfer process, electrochemical energy conversion device processes.
2. This course provides students to get knowledge Electro catalysis in fuel cells, semiconducting materials.

Course Outcomes:

By the completion of course student will be able to

1. Acquire the knowledge of charge transfer processes, electrochemical energy conversion device processes in the cells.
2. Construct the different types of Batteries.
3. Identify the Electrode and Electrolyte materials used in the different batteries.
4. Explain the solar cells, water splitting and photo electrochemical cells.

Course Content:

UNIT- I

Electrochemistry: fundamental processes, charge transfer process, Electrochemical energy conversion device processes, Fundamental thermodynamic and kinetic consideration, Available energy resources, Ragone plot. **[8 hrs]**

UNIT -II

Different battery systems Electrode materials for Lithium-ion batteries, Sodium ion batteries, Li-S batteries, Cathode materials, anode materials, high power supercapacitors. **[7 hrs]**

UNIT -III

Electrocatalysis in fuel cells, HOR, ORR Noble metals, non-noble metal and other electrocatalysic systems, Different types of fuel cells, acid, alkaline, molten carbonate, solid oxide fuel cells solid polymer electrolyte, methanol, biochemical fuel cells and Photoelectrocatalysis. **[8 hrs]**

UNIT -IV

Fundamentals of semiconducting materials – solar energy conversion, Photoelectrochemical cells, Organoelectronics, Hydrogen a clean fuel, water splitting and photoelectrochemical cells hydrogen storage materials. **[7 hrs]**

References:

1. Chemical and Electrochemical energy systems, R. Narayanan and B. Viswanathan, Orient Longmans, (1997).
2. Basic Nuclear Engineering, K. Sriram, Wiley Eastern, (1990).
3. Fuel Cell Hand Book, A. S. J. Appleby, F. K. Foulkes, Von Nostrand Reinhold, (1989).
4. Hand book of batteries and Fuel cells, D. Linden, McGraw Hill Book Company, (1984).
5. Solar Hydrogen energy systems, T. Ohta, Peragamon Press, (1979).
6. Energy Resources through photochemistry and catalysis, M. Gratzel, Academic Press, (1983).
7. Energy Technology, Sources, Systems and Frontiers conversions, T. Ohta, Pergamon, (1994).
8. Electrochemistry, Bockris and Reddy.

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ Cos**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PS O1**	**PS O2**	**PS O3**
M21S MS406	CO1	3	2	2	2	1	3	2	1	2	1	3	2	2
	CO2	2	2	3	2	2	2	2	2	2	2	3	3	2
	CO3	2	3	2	3	3	1	2	2	2	2	2	2	3
	CO4	3	1	1	2	2	2	2	2	3	3	2	3	2

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS407	ADVANCES IN POLYMER SCIENCE AND TECHNOLOGY	SC	2	1	0	3	4

Course objectives:

This course aims to provide the student to

i. Demonstrate the knowledge of the basic concept of polymer, analysis of molecular weight of polymer.

ii. Explore physical factors of polymers, analysis of glass transition temperature of polymer, Thermodynamic equation of polymer.

iii. Create broad knowledge on polymer classification, mechanism of polymerization, instrumentation method of polymer characterization.

iv. Acquire broad knowledge of polymers for medical, environmental, catalysis and device applications.

Course Outcomes:

By the completion of course student will be able to

CO1. Basic of polymer, analysis.

CO2. Physical factors, analysis, equations.

CO3. Classification, mechanism, techniques.

CO4. Applications, environmental.

Course Content:

UNIT- I

Introduction to polymer science, Molecular weights and Methods of determination, molecular weight distribution, size and shape of macromolecules, Mark-Houwink relationship, chain structure and configuration, conformation, size of an ideal chain (freely jointed chain and other models), Real chains, Thermodynamics of polymer solutions; Molecular motion (self-diffusion, hydrodynamic radius, Rouse Model).Glass transition temperature – elementary theories and methods of determination. Variation of glass transition with structure. **[8 hrs]**

UNIT -II

Membrane technology for separation: Basic principle, Types of membranes/classification, synthesis of membrane; polymer membranes, structural analysis, factors affecting membrane separation, comprehensive applications. Ionically conducting membranes and Applications. **[7 hrs]**

UNIT -III

Polymer characterisation: Transport mechanism in membranes, characterisation of ionic membranes, porous and nonporous systems, Microscopic techniques, Gas adsorption-desorption, Thermoporemetry Inorganic membranes: Introduction, types, membrane synthesis, glass membranes and Applications.

[8 hrs]

UNIT- IV

Applications of Polymers: Conducting polymers, Organic Photovoltaics, polymer electronics energy conversion devices, Corrosion protection, Thermal resistant polymers, catalysis, Metallopolymers, Biocompatible polymers, Biodegradable polymers. **[7 hrs]**

References:

1. Textbook of Polymer Science, 3rdEdition, F. W. Billmeyer, John Wiley, 1994.
2. Polymer Science, V. R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, New Age International (P) Ltd, (2005).
3. Principles of Polymerization, 4th Edition, G. Odian, Wiley-Interscience, (2004).
4. Basic principles of Membrane technology, Marcel Mulder, Springer, (1996).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS407	CO1	2	1		2	1						2	2	1
	CO2	2			2	1						2	2	1
	CO3	2	1		1	1						2	2	1
	CO4	2		2			1					2	2	1

SEMESTER-IV

MOOC/SWAYAM/HARVARD/Edx/INTERNSHIP

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SMON41	MOOC/SWAYAM/HARVARD/EDX/ INTERNSHIP/ATTENDING CONFERENCES/WEBINARS/INDUSTRIAL VISIT/ IN-HOUSE R&D, ETC. (ALL SEMESTER)	RULO	4	0	0	4	4

Course Objectives:

To carry out the research or internship at Industry/R&D Institution and in the process learn the techniques of research or Self learning related courses from MOOC/SWAYAM/HARVARD/Edx.

Course Outcomes:

By the completion of course student will be able to

CO1. Familiarize with R&D culture.

CO2. Conduct the experiments related to research and formulate computational techniques

CO3. Interpret the scientific data and Write report and defend the research findings.

CO4. Apply the self-learning capabilities

Internship: Minimum of four weeks duration internship should be carried out by the student either in industry or in an R&D organization, including educational institutes with excellent research culture. In case, if a student is unable to secure internship either in industry or in an R&D organization, a project may be carried out within the university. The student is expected to submit a formal report at the end of the internship programme. The student shall be awarded the marks for internship based on the (a) presentation and (b) comprehensive viva by the panel of examiners constituted by the school.

MOOC/ SWAYAM: Globally, MOOC (Massive Open Online Course) platforms are gaining much popularity. Considering the popularity and relevance of MOOCs, Government of India has also launched an indigenous platform, SWAYAM. SWAYAM (Study Webs of Active Learning for Young Aspiring Minds) is basically an integrated MOOCs platform for distance education that is aimed at offering all the courses from school level (Class IX) to post-graduation level. The platform has been developed collaboratively by

MHRD (Ministry of Human Resource Development) and AICTE (All India Council for Technical Education) with the help of Microsoft and is capable of hosting 2,000 courses.

A student shall register and successfully complete any of the courses available on SWAYAM.

Student shall inform the MOOC/SWAYAM coordinator of the school about the course to which he/she has enrolled. The minimum duration of the course shall be not less than 40 hours and of 4 credits. The student should submit the certificate issued by the SWAYAM to the MOOC/SWAYAM coordinator of the school, the grades obtained in the course shall be forwarded to concerned authority of the University.

SEMESTER IV – ADVANCED ORGANIC CHEMISTRY PRACTICALS

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS408	ADVANCED ORGANIC CHEMISTRY LAB-IV.1	SC	0	0	3	3	5

Course Objectives:

This course on ADVANCED ORGANIC CHEMISTRY LAB provides students to enlighten the knowledge on topics like

i. Synthesis, separation, purification, characterization and property measurements of Organic compounds with an emphasis on different techniques of reaction set-up.
ii. Exposure to various spectroscopic characterization techniques.
iii. Formulate the scheme for an organic chemical reaction and record the systematic procedure.
iv. Analyze the spectral data to obtain the structure of the organic compound.

Course Outcomes:

By the completion of course student will be able to,

CO1. Apply the knowledge on Synthesis, separation, purification, characterization.
CO2. Acquire knowledge on various spectroscopic characterization techniques.
CO3. Design and research problems in organic synthesis.
CO4. Solve the analytical data obtained and interpret the structure of the organic compound.

.

Course Description:

1. Synthesis, separation, purification, characterization and property measurements of Organic compounds with an emphasis on different techniques of reaction set-up.
2. Exposure to various spectroscopic characterization techniques.
3. Carryout protection and deprotection reactions for the functional groups-NH_2, -COOH, -OH etc.,
4. Independently carry out the synthesis of amide bonds using different coupling agents-DCC, EDC, HATU, HOBT etc, purify the organic compounds through column chromatographic techniques and characterize the final amide derivatives.

References:

1. Vogel's Textbook of Practical Organic Chemistry, 5th Edition,Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, Austin R. Tatchell, Longman Scientific and Technical, (1989).
2. Some modern methods of Organic Synthesis, 2nd Edition.W. Caruthers, Cambridge University. Press London, (1998).
3. Organic synthesis: Special Techniques, K. Ahluwalia and R. Aggarwal, Narosa, New Delhi, (2003).
4. Spectrometric Identification of Organic Compounds, R.M. Silverstein and W.P. Webster, Wiley & Sons, (1999).
5. Introduction to Spectroscopy, 3rd Edition, Pavia, Lampman and Kriz, Thomson.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS408	CO1	3	2	2	2	2	2		1	1	1	3	3	3
	CO2	3	2		3	2	1				1	3	3	2
	CO3	3	3	3	2	3	1			1	1	3	2	2
	CO4	3	2		2	2	2			1	1	3	3	3

SEMESTER IV – ADVANCED INORGANIC CHEMISTRY PRACTICALS

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS409	ADVANCED INORGANIC CHEMISTRY LAB-IV.2	SC	0	0	3	3	5

Course Objectives:

This course aims to provide the student to

i. Synthesis, characterization and property measurements of inorganic compounds with an emphasis on different techniques of reaction set-up, conducting polymers.
ii. Exposure to various spectroscopic characterization techniques.
iii. To use electroanalytical techniques in synthesis and characterization.
iv. To analyse coordination complexes and conducting polymers and metal oxides.

Course Outcomes:

By the completion of course student will be able to

CO1. Apply the experimental knowledge to synthesis new compounds by environmental benign routes and interpret their properties

CO2. Devise the methodology in synthesis and optimize the condition for preparation new experiments

CO3. Analyze the spectral data and evaluate the electronic properties and bond vibrations and bond strengths

CO4. Interpret the data obtained through various electrochemical and solution synthesis techniques of chemical compounds and their characterization

Course contents:

Part-I: Preparation of nanostructured materials by chemical and electrochemical methods

1. Preparation of MnO_2 by ethylene glycol as a reducing agent.
2. In-situ preparation of polyaniline-MnO_2 composites.
3. In-situ preparation of Polypyrrole-MnO_2 composites.
1. Preparation of Ag nano particles using $NaBH_4$ and their spectral studies.
2. Electrochemical synthesis of Manganese dioxide films.
3. Preparation of polyaniline thin films by electropolymerization of aniline.
4. Preparation of polypyrrole thin films by electropolymerization of pyrrole.
5. Electrodeposition of zinc, nickel, copper and verification of Faradays's law.

6. Electrochemical anodization of copper and zinc.

Part-II: Chemical, Electrochemical and spectral analysis

1. Preparation of Ag/AgCl reference electrode.
2. Redox behaviour of potassium ferricyanide, cobalt complexes using cyclic voltametry technique.
3. Construction and Supercapacitor behaviour of electrical double layer capacitor and Pseudocapacitor.
4. Construction and super capacitor studies of Hybrid electrode material (metal oxide-polymer).
5. Estimation of Chloride ions in copper ammonium complex.
6. Estimation of Chloride ions in cobalt ammonium complex.
7. Spectral studies of metal complexes and their CFSE interpretation.
8. Cu, Ni, and Co ammonium complexes: ligand displacement reaction with different concentration of ammonia monitored by UV-VIS spectra.

References:

1. Electrochemical Methods: Fundamentals and Applications, 2nd Edition, Allen J. Bard, Larry R. Faulkner.
2. Energy Resources through photochemistry and catalysis, M. Gratzel, Academic Press, (1983).
3. T. Ohta, Energy Technology, Sources, Systems and Frontiers conversions, Pergamon, (1994).
4. Electrochemistry, Bockris, Reddy.
5. Standard Potentials in Aqueous Solution, Allen J. Bard, Larry R. Faulkner.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M21S MS409	CO1	2	1	2	2	2	1			1	1	2	2	2
	CO2	2	1	1	2	2	1			1	2	2	1	3
	CO3	2	1	2	2	2	1			2	2	2	2	2
	CO4	3	1	2	2	2	2			1	2	3	2	3

SEMESTER IV – ANALYTICAL CHEMISTRY PRACTICALS

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M21SMS411	ANALYTICAL CHEMISTRY LAB-IV.3	SC	0	0	3	3	5

Course Objectives:

The practical course on Analytical chemistry intends to provide the students to,

i. Learn different electro analytical techniques for sample analysis.
ii. Impart training in practical experience in selected instrumental methods of analysis.
iii. Able to synthesize materials, characterization and chemical analysis.
iv. Understanding the theoretical principles and practical applications of different chromatographic techniques.

Course Outcomes:

By the completion of course student will be able to

CO1. Interpret the results of quantitative experiments and interpret the data in meaningful ways.

CO2. Analyze the chemical methods employed for compound analysis.

CO3. Illustrate the experimental skills on different instrumental analysis of the given compounds.

CO4. Discuss the fundamentals, critical thinking and analytical reasoning as applied to scientific problems.

Course contents:

1. Determination of fluoride in drinking water by Spectrophotometry (Zr-Alizarin method).
2. Estimation of caffeine in a given sample using UV Spectrophotometer.
3. Spectrophotometric determination of pKa value of an indicator (the acid dissociation constant of methyl red).
4. Separation and identification of metal ions in a mixture by paper chromatography/TLC.
5. Synthesis of metal oxides and their characterization by XRD technique.
6. Preparation of Hexamine Nickel (II) chloride complex and its characterization by IR Spectroscopy.
7. Investigate the autocatalytic activity between potassium permanganate and oxalic acid.
8. Spectral analysis of alcohols and amines by NMR Spectroscopy.
9. To determine the percentage of ascorbic acid in a given sample using HPLC.
10. Titrate potentiometrically Zn (II) by Potassium Ferrocynanide and verify the composition of the complex.

References:

1. Vogel's Textbook of Quantitative Chemical Analysis, 6thEdition, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, Third Indian Reprint, Pearson Education Pvt. Ltd., New Delhi, (2003).
2. Analytical Chemistry: An introduction Skoog, West, Holler and Crouch; 7th edition Saunders College Publishing (1999).
3. Chromatography, C. G. Sharma.

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ Cos**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PS O1**	**PS O2**	**PS O3**
M21S MS411	CO1	2	3	3	3	3	3	3	3	1	2	2	3	3
	CO2	2	3	3	3	2	2	3	1	2	2	2	3	3
	CO3	2	2	2	2	3	3	2	2	1	1	2	3	3
	CO4	3	3	3	3	2	2	1	2	1	3	2	3	3

INORGANIC CHEMISTRY

Course Outcomes:

1. During the study of this course the students will acquire a deeper knowledge about basics in inorganic chemistry periodic properties, solvents, nuclear chemistry etc.
2. After studying this subject student is able to understand how nanomaterials are completely different from that of bulk materials, its approaches for synthesis and its applications.
3. During the study of this course the students will acquire a deeper knowledge complexes, metal ligand interactions about chemistry.
4. Student is able to understand various principles of bioinorganic chemistry, Bioenergetics, biophysical chemistry, bioorganic chemistry etc.
5. The students are expected to acquire knowledge about inorganic reaction mechanisms and organometallic chemistry.
6. After the completion student is able to understand about energy for chemical industry, surfactants, explosives, pesticides their effect to the environment. Importance of industrial materials like cement, polymers, glass, paint, fertilizes etc can be understood here.
7. Student is able to understand different types of solids, its reactions, electronic properties and band theory and gets an information regarding advanced electronic materials.
8. Student will be familiar with various spectroscopies like electron spectroscopy, Mossbauer spectroscopy, destructive techniques and non-destructive techniques, SAM, SPM, TEM, LEED etc.
9. Students will understand the principles in inorganic photochemistry, metal complexes in drugs, medicinal bioinorganic chemistry and advance nuclear chemistry.

ORGANIC CHEMISTRY

Course Outcomes:

The students will acquire knowledge of:

1. The structure, nature of bonding in the molecules and reaction mechanism.
2. Conformational analysis of cycloalkanes, reactivity, chirality, interconversion, resolution and asymmetric synthesis.
3. Organization and working of various components present in living cell.
4. Nomenclature of different heterocyclic compounds.
5. Synthesis and reactivity five, six and seven membered monocycles and the fused heterocyclic compounds.

6. Molecular structure of proteins, DNA, RNA and vitamins, organization and working of various components present in living cell.
7. Mechanistic aspects of nucleophilic, electrophilic substitution and elimination reactions.
8. Molecular orbital symmetry and possibility of thermally and photochemically pericyclic reactions.
9. Conversion of different functional groups via rearrangement reactions.
10. Molecular recognition and nature of binding involved in biological systems.
11. Structure of supramolecules of various types in solution, solids and their applications in miniaturization of molecular devices.
12. Drug designing, development, mode of action of different drugs and role of drugs to inhibit particular enzymes and treatment of disease.
13. Mechanistic pathway of organic reactions.
14. Retrosynthetic approach of planning organic synthesis
15. Conversion of different functional groups via reactions.
16. Mechanism of major chemical reactions.
17. Utilizing reagents in organic transformations.
18. The principles behind Enantio-selectivity and Diastero-selectivity, analyze how stereochemical outcome of the reaction can be predicted.
19. Identifying and characterizing various classes of natural products by their structure.
20. Appreciate the biogenesis of many natural products of importance.
21. The contribution of natural products in drug design and development of new drugs with hemisynthetic routes or with total synthesis.

PHYSICAL CHEMISTRY

Course Outcomes:

After completion, of course students will:

1. Acquire knowledge about basics of thermodynamics, chemical kinetics and electrochemistry.
2. Understand the Thermodynamic laws, concepts of entropy and free energy, partial molar properties, fugacity of gases, thermodynamics of dilute solutions, statistical thermodynamics.
3. Get knowledge on kinetics of complex reactions, Parallel, consecutive and reversible reactions.
4. Acquire knowledge on theories of electrolytes and irreversible electrode processes, cyclic voltammetry, Impedance Spectroscopy, Scanning Electrochemical Microscopy, Electrochemical AFM and STM, electrochemical sensors and energy systems.
5. Able to analyze the kinetics of the different types of reactions
6. Understand Surface phenomena of solids, solid-liquid interfaces, Homogenous and Heterogeneous Catalysis.

7. Analyze the instrumental methods of catalyst characterization.
8. Enlighten the knowledge on Quantum chemistry, molecular symmetry, group theory: representation and applications, various spectroscopic techniques like microwave, vibrational, electronic, Raman, EPR and NMR.
9. Understand the principles and laws of photochemistry, measurement of fluorescence and phosphorescence and lifetimes and Fluorescence based sensors.
10. Get knowledge on topics like energy systems: renewable and non-renewable, nuclear energy, electro chemical power sources, chemistry of fuel cells and semi conducting materials.
11. Understand topics like quantum chemistry, Statistical Thermodynamics and non-equilibrium thermodynamics, molecular interactions and macro molecules.
12. Understand topics like quantum chemistry, Statistical Thermodynamics and non-equilibrium thermodynamics, molecular interactions and macro molecules.
13. Understand basic concepts of polymers, thermodynamics of polymer solutions, classification, structure-property relation of polymers and different applications of polymers.

ANALYTICAL CHEMISTRY

Course Outcomes:

After completion, of course students will:

1. Acquire knowledge of Data handling/ statistical treatment of data.
2. Acquire knowledge of Potentiometric, Coulometric, and Voltametric methods of analysis, Chromatographic Techniques and applications.
3. Identify and describe the steps that are included in a complete analytical procedure
4. Learn the basic analytical and technical skills to work effectively in the various fields of chemistry.
5. To know and understand the issues of safety regulations in the use of chemicals in their laboratory work.
6. Students can define and calculate theretention factor, R f, and describe how TLC and column chromatography can be used for separation and qualitative analysis.
7. This study is useful to furnish students with the advanced technical skills and knowledge base
8. That is required in the field of instrumental analysis and which will enable them to pursue ca-reers as analysts in the chemical and/or pharmaceutical industry.
9. The fundamental analytical techniques, Mass spectrometry, NMR spectroscopy and electron spectroscopy.
10. Other general characterisation techniques (IR & UV spectroscopy, mass and NMR spec-troscopy).
11. About spectroscopy and its application in studying the structure of organic molecules.

12. Gain knowledge and understand the principle of Separation techniques, analysis by using spectroscopic techniques.
13. Demonstrate the Chromatographic Techniques and applications.
14. In this practical course the students acquire practical skills related to analytical chemis-try in analysis of constituents present in different samples.
15. The students will acquire knowledge of development of experimental skills on conductivity meter, potentiometer, pH meter and voltammeter for different applications
16. Different concepts of atmosphere, stratospheric and tropospheric chemistry, photochemical smog, acid rain, atmospheric aerosols, global climate.
17. Chemistry of colloids with reference to environment.
18. Air pollution, water pollution, soil pollution and its control.
19. Analysis of various components in food and drug analysis.
20. Concepts and applications of Green Chemistry.
21. Concepts of types of materials, properties of nanomaterials and various preparation methods and characterization techniques like XRD, SEM, TEM, NMR, XPS and applications
22. Concepts of water pollution and water analysis methods.

CAREER DEVELOPMENT AND PLACEMENT

Having a degree will open doors to the world of opportunities for you. But Employers are looking for much more than just a degree. They want graduates who stand out from the crowd and exhibit real life skills that can be applied to their organizations. Examples of such popular skills employers look for include:

1. Willingness to learn
2. Self motivation
3. Team work
4. Communication skills and application of these skills to real scenarios
5. Requirement of gathering, design and analysis, development and testing skills
6. Analytical and Technical skills
7. Computer skills
8. Internet searching skills
9. Information consolidation and presentation skills
10. Role play
11. Group discussion, and so on

REVA University therefore, has given utmost importance to develop these skills through variety of training programs and such other activities that induce the said skills among all students. A full-fledged Career Counseling and Placement division, namely Career Development Center (CDC) headed by well experienced senior Professor and Dean and supported by dynamic trainers, counselors and placement officers and other efficient supportive team does handle all aspects of Internships and placements for the students of REVA University. The prime objective of the CDC is to liaison between REVA graduating students and industries by providing a common platform where the prospective employer companies can identify suitable candidates for placement in their respective organization. The CDC organizes pre-placement training by professionals and also arranges expert talks to our students. It facilitates students to career guidance and improve their employability. In addition, CDC forms teams to perform mock interviews. It makes you to enjoy working with such teams and learn many things apart from working together in a team. It also makes you to participate in various student clubs which helps in developing team culture, variety of job skills and overall personality.

The need of the hour in the field of Chemistry is not only knowledge in the subject, but also the skills to do the job proficiently, team spirit and a flavour of innovation. This kept in focus, the CDC has designed the training process, which will commence from second semester along with the curriculum. Special coaching in personality development, career building, English proficiency, reasoning, puzzles, and communication

skills to every student of REVA University is given with utmost care. The process involves continuous training and monitoring the students to develop their soft skills including interpersonal skills that will fetch them a job of repute in the area of his / her interest and March forward to make better career. The School of Applied Sciences also has emphasised subject based skill training through lab practice, internship, project work, industry interaction and many such skilling techniques. The students during their day to day studies are made to practice these skill techniques as these are inbuilt in the course curriculum. Concerned teachers also continuously guide and monitor the progress of students.

The University has also established University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director to facilitate skill related training to REVA students and other unemployed students around REVA campus. The center conducts variety of skill development programs to students to suite to their career opportunities. Through this skill development centre the students shall compulsorily complete at least two skill / certification based programs before the completion of their degree. The University has collaborations with Industries, Corporate training organizations, research institutions and Government agencies like NSDC (National Skill Development Corporation) to conduct certification programs. REVA University has been recognised as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana.

The University has also signed MOU's with Multi-National Companies, research institutions, and universities abroad to facilitate greater opportunities of employability, students' exchange programs for higher learning and for conducting certification programs.

LIST OF FACULTY MEMBERS

Sl. No	Faculty Name	Designation	Email.Id	Mobile No
1	Dr. Madhusudana Reddy M. B.	Professor &Assistant Director	madhusudana.mb@reva.edu.in	9480224757
2	Dr. Sakthivel Kandaiah	Associate Professor	sakthivel.k@reva.edu.in	9742585588
3	Dr. LakshmiB.	Associate Professor	lakshmib@reva.edu.in	9902632762
4	Dr. Ramakrishna Reddy K.	Associate Professor	k.ramakrishnareddy@reva.edu.in	9885057117
5	Dr. Vipin A.Nair	Associate Professor	vipina.nair@reva.edu.in	9417251206
6	Dr. Nagaraju D. H.	Associate Professor	nagaraju.dh@reva.edu.in	9900634435
7	Dr. Shivakumara S.	Assistant Professor	s.shivakumara@reva.edu.in	9972599779
8	Dr. Nagarajaiah H.	Assistant Professor	nagarajaiah.h@reva.edu.in	9964076373
9	Dr. Nagendra G.	Assistant Professor	nagendra.g@reva.edu.in	9844722805
10	Dr. Sathish Reddy	Assistant Professor	sathish.reddy@reva.edu.in	9353808562
11	Dr. Srinivas M.	Assistant Professor	srinivas.m@reva.edu.in	9900447889
12	Dr. Shivanna M.	Assistant Professor	shivanna.m@reva.edu.in	9964556195
13	Prof. Sreekanth R.	Assistant Professor	sreekanth.r@reva.edu.in	9986769845
14	Prof. Mamatha Mohan	Assistant Professor	mamatha.mohan@reva.edu.in	9980555788
15	Prof. Pushpalatha R.	Assistant Professor	pushpalatha.r@reva.edu.in	8095755650
16	Prof. Shwetha K. R.	Assistant Professor	shwetha.kr@reva.edu.in	9900404059
17	Prof. Mubeena A.	Assistant Professor	mubeen.a@reva.edu.in	8553643347
18	Mr.Chandrashekar P.	Teaching Associate	chandrashekar.p@reva.edu.in	9880206742
19	Mr. Umesh P. V.	Lab Instructor	umesh.pv@reva.edu.in	9742924366

REVA UNIVERSITY
Bengaluru, India

(School of Allied Health Sciences)

B. Sc. Nutrition and Dietetics

HAND BOOK

2021

Rukmini Knowledge Park
Kattigenahalli, Yelahanka, Bengaluru – 560064
Phone No: +91-080-46966966, Fax: 080-28478539
www.reva.edu.in

Chancellor's Message

"Education is the most powerful weapon which you can use to change the world."
- Nelson Mandela

There was a time when survival depended on just the realization of physiological needs. We are indeed privileged to exist in a time when 'intellectual gratification' has become indispensable. Information is easily attainable for the soul that is curious enough to go look for it. Technological boons enable information availability anywhere anytime. The difference, however, lies between those who look for information and those who look for knowledge.

It is deemed virtuous to serve seekers of knowledge and as educators it is in the ethos at REVA University to empower every learner who chooses to enter our portals. Driven by our founding philosophy of 'Knowledge is Power', we believe in building a community of perpetual learners by enabling them to look beyond their abilities and achieve what they assumed impossible.

India has always been beheld as a brewing pot of unbelievable talent, acute intellect and immense potential. All it takes to turn those qualities into power is a spark of opportunity. Being at a University is an exciting and rewarding experience with opportunities to nurture abilities, challenge cognizance and gain competence.

For any University, the structure of excellence lies in the transitional abilities of its faculty and its facility. I'm always in awe of the efforts that our academic board puts in to develop the team of subject matter experts at REVA. My faculty colleagues understand our core vision of empowering our future generation to be ethically, morally and intellectually elite. They practice the art of teaching with a student-centered and transformational approach. The excellent infrastructure at the University, both educational and extra-curricular, magnificently demonstrates the importance of ambience in facilitating focused learning for our students.

A famous British politician and author from the 19th century - Benjamin Disraeli, once said 'A University should be a place of light, of liberty and of learning'. Centuries later this dictum still inspires me and I believe, it takes team-work to build successful institutions. I welcome you to REVA University to join hands in laying the foundation of your future with values, wisdom and knowledge.

Dr. P. Shyama Raju

The Founder and Hon'ble Chancellor, REVA University

Vice-Chancellor's Message

The last two decades have seen a remarkable growth in higher education in India and across the globe. The move towards inter-disciplinary studies and interactive learning have opened up several options as well as created multiple challenges. India is at a juncture where a huge population of young crowd is opting for higher education. With the tremendous growth of privatization of education in India, the major focus is on creating a platform for quality in knowledge enhancement and bridging the gap between academia and industry.

A strong believer and practitioner of the dictum "Knowledge is Power", REVA University has been on the path of delivering quality education by developing the young human resources on the foundation of ethical and moral values, while boosting their leadership qualities, research culture and innovative skills. Built on a sprawling 45 acres of green campus, this 'temple of learning' has excellent and state-of-the-art infrastructure facilities conducive to higher teaching-learning environment and research. The main objective of the University is to provide higher education of global standards and hence, all the programs are designed to meet international standards. Highly experienced and qualified faculty members, continuously engaged in the maintenance and enhancement of student-centric learning environment through innovative pedagogy, form the backbone of the University.

All the programs offered by REVA University follow the Choice Based Credit System (CBCS) with Outcome Based Approach. The flexibility in the curriculum has been designed with industry-specific goals in mind and the educator enjoys complete freedom to appropriate the syllabus by incorporating the latest knowledge and stimulating the creative minds of the students. Bench marked with the course of studies of various institutions of repute, our curriculum is extremely contemporary and is a culmination of efforts of great think-tanks - a large number of faculty members, experts from industries and research level organizations. The evaluation mechanism employs continuous assessment with grade point averages. We believe sincerely that it will meet the aspirations of all stakeholders – students, parents and the employers of the graduates and postgraduates of REVA University.

At REVA University, research, consultancy and innovation are regarded as our pillars of success. Most of the faculty members of the University are involved in research by attracting funded projects from various research level organizations like DST, VGST, DBT, DRDO, AICTE and industries. The outcome of the research is passed on to students through live projects from industries. The entrepreneurial zeal of the students is encouraged and nurtured through EDPs and EACs.

REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students. REVA University has entered into collaboration with many

prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students become skilled

with relevant to industry requirements. Structured training programs on soft-skills and preparatory training for competitive exams are offered here to make students more employable. 100% placement of eligible students speaks the effectiveness of these programs. The entrepreneurship development activities and establishment of "Technology Incubation Centers" in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise.

With firm faith in the saying, "Intelligence plus character –that is the goal of education" (Martin Luther King, Jr.), I strongly believe REVA University is marching ahead in the right direction, providing a holistic education to the future generation and playing a positive role in nation building. We reiterate our endeavor to provide premium quality education accessible to all and an environment for the growth of over-all personality development leading to generating "GLOBAL PROFESSIONALS".

Welcome to the portals of REVA University!

Dr. Dhanamjaya M
Vice-Chancellor, REVA University

MESSAGE FROM THE DIRECTOR

Nutrition and Dietetics is Allied Health Sciences program assimilates in itself a number of disciplines and as such hasgrown rapidly. B Sc in Nutrition and Dietetics offered by REVA University aims to provide the required skills and knowledge necessary to pursue a successful career in Nutrition and Dietetics. This program imparts need based, practical education in contemporary world to develop global competence among students. It strives to prepare students to become leaders in the field of Health Sciences in general and Nutrition and Dietetics in particular by encouraging them to inculcate scientific thinking coupled with creative and innovative ideas.

The program provides hands- on training and practical skills in the field of Health Sciences like Biochemistry, Human Nutrition & Family Meal Management, Microbiology, Instrumentation and Food analysis, Community and Public Health Nutrition, Quality Food Service and Physical Facilities, Bakery Science and Nutrition Counseling in the Allied Health field.

As far as employment is concerned Nutrition and Dietetics has become one of the fast-growing sectors. Employment record shows that Nutrition and Dietetics has a great scope in future. Medical laboratory technician can find careers with Hospitals, Sports Academy and Health care and Food Industries.

The curriculum caters to and has relevance to local, regional, national, global developmental needs. Maximum numbers of courses are integrated with crosscutting issues with relevant to professional ethics, gender, human values, environment & sustainability.

This handy document containing brief information about B.Sc. Nutrition and Dietetics program, scheme of instruction and detailed course content will serve as a guiding path to you to move forward in a right direction.

Dr. Jayashree S
Director
School of Allied Health Sciences

Preface

Higher education across the globe is opening doors of its academic disciplines to the real-world experiences. The disciplinary legitimacy is under critical review. Trans-border mobility and practice learning are being fore-grounded as guiding principles. Interactive learning, bridging disciplines and facilitating learners to gain different competencies through judicious management of time is viewed as one of
the greatest and fascinating priorities and challenges today.

Indian economy is experiencing an upward growth right from the beginning of 21st century necessitating well qualified science graduates to work as scientists, teachers, algorithm developers, computer programmers, professionals and often administrators. At present more than 400 million youth are below 18 years of age and government is committed to increase the GER to 30% by 2020, further necessitating more number of teachers and professors to work in schools and colleges. Research has also been given equal importance. Pivate sector and Corporates are also looking for smart science graduaes in a big way. The B.Sc. Nutrition and Dietetics degree program of REVA University is designed to prepare Biotechnologist, Biochemists, Nutrition & Dietitian, Genetists, Scientists, Teachers, Professionals & Administrators who are motivated, enthuastics & creative thinkers to meet the challenges of growing economy as well as to fulfill the growing aspirations of the youth.

The program has been developed with an emphasis on knowledge assimilation, application, national and international job market and its social relevance. The outcomebased curriculum designed and followed imbibes required theoretical concepts and practical skills in the domain. By undergoing this program, you will develop critical, analytical thinking and problem solving abilities for a smooth transition from academic to real-life work environment. The L: T: P structure of teaching and learning under Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) would certainly help our students learn and build competencies needed in this knowledge based society.

I am sure you will enjoy the curriculum, teaching and learning environment, the vast infrastructure and the experienced teachers involvement and guidance. We will strive to provide all needed comfort and congenial environment for your studies. I wish you and all students' pleasant stay in REVA and grand success in your career.

Dr. Jayashree S.
Professor & Head,
School of Allied Health Science

CONTENTS

Sl.No.	Particulars	Page No.
1	Message from the Honorable Chancellor	**2**
2	Message from the Vice-Chancellor	3-4
3	Director's Message	5
4	Preface	6
5	Rukmini Educational Charitable Trust	8
6	About REVA University	9-12
7	About School of Allied Health Sciences - Vision - Mission - Values - Advisory Board Members	13-14
8	**B. Sc Nutrition and Dietetics** Program Overview Program Educational Objectives Program Outcomes Program Specific Outcomes Mapping programme outcomes with Programme Educational Objectives - Mapping of Course Outcomes with programme Outcomes	15-33
9	Regulations Governing School of Allied Health Sciences Programmes	
10	**B. Sc Nutrition and Dietetics** Scheme of Instructions ➢ Detailed Syllabus - Course Overview - Course Objective - Course Outcomes - Course Contents (Unit-1,2,3,4) - Skill development activity, if any - Text books - Reference books	33
11	Career Development and Placement	97-98
12	List of Faculty Members	99

RUKMINI EDUCATIONAL CHARITABLE TRUST

It was the dream of late Smt. Rukmini Shyama Raju to impart education to millions of underprivileged children as she knew the importance of education in the contemporary society. The dream of Smt. Rukmini Shyama Raju came true with the establishment of Rukmini Educational Charitable Trust (RECT), in the year 2002. Rukmini Educational Charitable Trust (RECT) is a Public Charitable Trust, set up in 2002 with the objective of promoting, establishing and conducting academic activities in the fields of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology, among others. In furtherance of these objectives, the Trust has set up the REVA Group of Educational Institutions comprising of REVA Institute of Technology & Management (RITM), REVA Institute of Science and Management (RISM), REVA Institute of Management Studies (RIMS), REVA Institute of Education (RIE), REVA First Grade College (RFGC), REVA Independent PU College at Kattigenahalli, Ganganagar and Sanjaynagar and now REVA University. Through these institutions, the Trust seeks to fulfill its vision of providing world class education and create abundant opportunities for the youth of this nation to excel in the areas of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology.

Every great human enterprise is powered by the vision of one or more extraordinary individuals and is sustained by the people who derive their motivation from the founders. The Chairman of the Trust is Dr. P. Shyama Raju, a developer and builder of repute, a captain of the industry in his own right and the Chairman and Managing Director of the DivyaSree Group of companies. The idea of creating these top notched educational institutions was born of the philanthropic instincts of Dr. P. Shyama Raju to do public good, quite in keeping with his support to other socially relevant charities such as maintaining the Richmond road park, building and donating a police station, gifting assets to organizations providing accident and trauma care, to name a few.

The Rukmini Educational Charitable Trust drives with the main aim to help students who are in pursuit of quality education for life. REVA is today a family of ten institutions providing education from PU to Post Graduation and Research leading to PhD degrees. REVA has well qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 11,000 students study various courses across REVA's three campuses equipped with exemplary state-of-the-art infrastructure and conductive environment for the knowledge driven community.

ABOUT REVA UNIVERSITY

REVA University has been established under the REVA University Act, 2012 of Government of Karnataka and notified in Karnataka State Gazette dated 7thFebruary, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

REVA University located in between Kempegowda International Airport and Bangalore city, has a sprawling green campus spread over 45 acres of land and equipped with state-of-the-art infrastructure that provide conducive environment for higher learning and research. The REVA campus has well equipped laboratories, custom-built teaching facilities, fully air-conditioned library and central computer centre, the well planned sports facility with cricket ground, running track & variety of indoor and outdoor sports activities, facilities for cultural programs. The unique feature of REVA campus is the largest residential facility for students, faculty members and supportive staff.

The University is presently offering 23 Post Graduate Degree programs, 20 Degree and PG Degree programs in various branches of studies and has 15000+ students studying in various branches of knowledge at graduate and post graduate level and 410 Scholars pursuing research leading to PhD in 18 disciplines. It has 800+ well qualified, experienced and committed faculty members of whom majority are doctorates in their respective areas and most of them are guiding students pursuing research leading to PhD.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed universities / institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The system also allows students to move forward under the fast track for those who have the capabilities to surpass others. These programs are taught by well experienced qualified faculty supported by the experts from industries, business sectors and such other organizations. REVA University has also initiated many supportive measures such as bridge courses, special coaching, remedial classes, etc., for slow learners so as to give them the needed input and build in them confidence and courage to move forward and accomplish success in their career. The University has
also entered into MOUs with many industries, business firms and other institutions seeking their help in imparting quality education through practice, internship and also assisting students' placements.
REVA University recognizing the fact that research, development and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology and other areas of study. The interdisciplinary-multidisciplinary research is given the top most priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image

Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano- Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nano Tribology, Fuel Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

The REVA University has also given utmost importance to develop the much required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) department with world class infrastructure, headed by a dynamic experienced Professor & Dean, and supported by well experienced Trainers, Counselors and Placement Officers. The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognized as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana. The Centre conducts several add-on courses in challenging areas of development. It is always active in facilitating student's variety of Skill Development Training programs.

The University has collaborations with Industries, universities abroad, research institutions, corporate training organizations, and Government agencies such as Florida International University, Okalahoma State University, Western Connecticut University, University of Alabama, Huntsville, Oracle India Ltd, Texas Instruments, Nokia University Relations, EMC^2, VMware, SAP, Apollo etc, to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreignuniversities also facilitates students to study some of the programs partly in REVA University and partly in foreign university, viz, M.S in Computer Science one year in REVA University and the next year in the University of Alabama, Huntsville, USA.

The University has also given greater importance to quality in education, research, administration and all activities of the university. Therefore, it has established an independent Internal Quality division headed by a senior professor as Dean of Internal Quality. The division works on planning, designing and developing different quality tools, implementing them and monitoring the implementation of these quality tools. It concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat Ratna Prof. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr. Balaram, Former Director I.I.Sc., and noted Scientist, Dr. V S Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of Defence Dr. Sathish Reddy, Scientific Advisor, Ministry of Defence, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

As a part of our effort in motivating and inspiring youth of today, REVA University also has instituted awards and prizes to recognize the services of teachers, researchers, scientists, entrepreneurs, social workers and such others who have contributed richly for the development of the society and progress of the country. One of such award instituted by REVA University is **'Life Time Achievement Award'** to be awarded to successful personalities who have made mark in their field of work. This award is presented on occasion of the **"Founders' Day Celebration"** of REVA University on 6th January of every year in presence of dignitaries, faculty members and students gathering. The first "REVA Life Time Achievement Award" for the year 2015 has been awarded to Shri. Kiran Kumar, Chairman ISRO, followed by Shri. Shekhar Gupta, renowned Journalist for the year 2016, Dr K J Yesudas, renowned play back singer for the year 2017. REVA also introduced "**REVA Award of Excellence"** in the year 2017 and the first Awardee of this prestigious award is Shri Ramesh Aravind, Actor, Producer, Director, Screen Writer and Speaker.

REVA organizes various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVAMP conducted every year. The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions and variety of cultural events. Another important event is Shubha Vidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and wonmedals and prizes in academic, cultural and sports activities are also recognized by distributing awards and prizes. The founders have also instituted medals and prizes for sports achievers every year. The physical education department conducts regular yoga classes everyday to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around. Recognizing the fast growth of the university and its quality in imparting higher education, the BERG (Business Excellence and Research Group), Singapore has awarded BERG Education Award 2015 to REVA University under Private Universities category. The University has also been honored with many more such honors and recognitions.

Vision

REVA University aspires to become an innovative university by developing excellent human resources with leadership qualities, ethical and moral values, research culture and innovative skills through higher education of global standards.

Misson

- To create excellent infrastructure facilities and state-of-the-art laboratories and incubation centers
- To provide student-centric learning environment through innovative pedagogy and education reforms
- To encourage research and entrepreneurship through collaborations and extension activities
- To promote industry-institute partnerships and share knowledge for innovation and development
- To organize society development programs for knowledge enhancement in thrust areas
- To enhance leadership qualities among the youth and enrich personality traits, promote patriotism and moral values.

Objectives

- Creation, preservation and dissemination of knowledge and attainment of excellence in different disciplines
- Smooth transition from teacher - centric focus to learner - centric processes and activities
- Performing all the functions of interest to its major constituents like faculty, staff, students and the society to reach leadership position
- Developing a sense of ethics in the University and Community, making it conscious of its obligations to the society and the nation
- Accepting the challenges of globalization to offer high quality education and other services in a competitive manner

ABOUT SCHOOL OF ALLIED HEALTH SCIENCES

The School of Allied Sciences offers graduate programs in Medical Laboratory Technology, Medical Radiology and Diagnostic Imaging, also Nutrition and Dietetics which are incredibly fascinating. It aims to attract talented youth and train them to acquire knowledge and skills useful to industrial sectors, research laboratories, and educational institutions. The school presently offers BSc Medical Radiology and Diagnostic Imaging, BSc Medical Laboratory Technology, BSc Nutrition and Dietetics and Diploma in Medial Laboratory Technology.
The School of Allied Health Sciences is shouldered by well qualified, experienced and highly committed faculty. The state-of-the-art infrastructure digital classrooms, well equipped laboratories, conference rooms and the serene academic atmosphere at REVA University will enhance the transfer as well as creation of knowledge. The school provides an interactive, collaborative peer tutoring environment that encourages students to break down complex problems and develop strategies for finding solutions across a variety of situations and disciplines. The school aims to develop a learning community of critical thinkers who serves as models of innovative problems solving in the university environment to enrich their academic and professional careers.

Vision

To nurture intellect, creativity, character and professionalism among students and impart contemporary knowledge in various branches of Biological and Allied health Sciences that are socially relevant and transform them to become global paramedical citizens.

Mission

1. Committed to provide students with well-equipped advanced laboratory and research facilities.
2. To provide highest quality learning environment, teaching methods, programme specific curriculum, and the changing patterns of skills that is demanded by modern health care.
3. To impart knowledge and skill-based training to create cadre of globally competent Biochemistry and Allied Health Care professionals.
4. To provide an opportunity to expose students to intellectual environment and a specialized body of knowledge
5. To develop their proficiency in laboratory techniques in collaboration with leading Heath sectors and Industries.
6. To improve the quality of life and society by teaching moral values and enhancing leadership qualities.

Values

- Excellence in all our academic and research endeavours
- Dedication and service to our stakeholders
- Leadership through innovation
- Accountability and transparency
- Creating conducive academic environment with service motto
- Integrity and intellectual honesty
- Ethical and moral behaviour
- Freedom of thought and expression
- Adaptability to the change
- Team-work.

"The constant questioning of our valuesand achievements is a challenge without which neither science nor society can remain healthy" **— Aage Niels Bohr**

Advisory Board

Sl.No.	Name of the Member	Designation
1	**Dr. Jayashree S** Professor & Head School of Biochemistry, REVA University jayashree.s@reva.edu.in 9880241577	Chairperson
2	**Dr. Sangeeta Pandey** Associate Professor Food Science & Nutrition Mount Carmel College, Bengaluru. pandey.sangeeta@yahoo.com 9535708708	External Member
3	**Dr. C S Vivek Babu** Principal Scientist, CFTRI, Mysore vivekbabu.cs@cftri.res.in 9448581704	External Member
4	**Dr. Keshamma E,** Assistant Professor of Biochemistry, Maharani Cluster University, Palace Road, Bangalore keshamma76@gmail.com 8660688950.	External Member
5	**Dr. Veera Raghavan** Professor School of Allied Health Sciences, REVA University veera.raghavan@reva.edu.in 9880241577	Internal Member
6	**Dr. Sharadamma N** Assistant Professor School of Allied Health Sciences, REVA University sharadamma.n@reva.edu.in 9502639348	Internal Member
7	**Prof. Pooja R Karkera** Assistant Professor School of Allied Health Sciences, REVA University poojar.karkera@reva.edu.in 9741224361	Internal Member

B. Sc Nutrition and Dietetics

Programme Overview

Nutrition science is the study of nutrients that are essential for growth, development and maintenance of good health throughout life. In the present scenario, society needs the awareness regarding their diet and also, people are becoming more nutrition conscious. The common man is gradually switching towards nutrition scientists and dietitians for scientifically proved information on Nutrition and Dietetics. Nutrition-related chronic diseases, are the most common cause of death in the world and present a great burden for society, particularly diseases such as obesity, diabetes, cardiovascular disease, cancer, dental disease, and osteoporosis. Making improvements in terms of diet and physical activity can help reduce the risk of these chronic diseases.

Currently food industry is focusing more on nutrient composition of the products such as calories, percentage of macronutrients, nutraceutical properties etc. Hence it is essential that Nutrition and Dietetics is offered at various levels of education in general and masters in particular. Here the student learns both the rudimentary and application aspects, which includes the investigation and analysis of the requirement along with the skills in dietetics. Job opportunities are wide in the field of nutrition both in public and private sector. Professionals can work at hospitals, fitness centers, food industries, self-employment (small scale industries), entrepreneurship, research and development etc.

Programme Educational Objectives (PEOs)

- To develop knowledge and skilled professionals to perform food and nutrition analysis using various anlytical tools at multi-centric facilities in India and abroad.
- To pursue successful industrial, academic and research careers in specialized fields of food technology.
- To edify students with necessary skills to perform various nutritional procedures in the domain of food and nutrition.
- To inculcate a problem-solving mindset of the students through healthcare and industrial exposure of real-world problems.
- To equip students with good laboratory practices pertaining to nutritional analysis procedures.

The Programme Educational Objectives are to prepare the students:

- State the importance of nutrition and dietics plays important role in health and treatment of the patient.
- Add new procedures and duties to his/her repertoire with ease using the basic knowledge acquired in the nutrition and dietics program and will demonstrate the ability to read and understand a procedure manual in order to perform analysis and testing.
- Utilize quality control methods and standards in maintaining accuracy and precision. Perform some basic preventative maintenance of equipment and instruments.
- Evaluate new methods and procedures with minimal assistance by applying knowledge of principles, procedures, and techniques.
- Recognize a problem and identify the cause; apply the problem-solving approach to situations including making decisions concerning the results of quality control and quality assurance measures.
- Communicate ideas and data and exhibit professional conduct through interpersonal skills with public, patients, and other healthcare professionals, Recognize the need to be responsible for his/her work and to respond to constructive criticism in a positive manner.
- Exhibit compassion and respect for the public and allied health care personnel.
-

- Attend continuing educational programs to establish and maintain continuing education as a function of growth and maintenance of professional competence. Follow established safety procedures in the performance of his/her duties in order to maintain a safe working environment for himself/herself and other employees.

Programme Educational Objectives (PEOs)

The programme educational objectives of the B.Sc Nutrition and Dietetics course is to prepare graduates to

PEO-1	Demonstrate problem solving skills in Performing routine in Nutrition and Dietetics Procedures by communicating effectively either leading a team or as a team member.
PEO-2	Express oral and written interpersonal skills as part of the team to understand, learn and advance their careers through research developments and seeking higher learning.
PEO-3	Understand the professional, ethical and social responsibilities through lifelong learning skills
PEO-4	Acquire higher degree of work in academics and research.

Programme Outcomes (POs)

PO1. Science Knowledge: Apply the knowledge of nutrition and dietetics for the solutions to the problems in various domains particularly for health care and food industries.

PO2. Problem analysis: Identify formulate and analyze problems related to food and nutrition domains of clinically relevant.

PO3. Conduct investigations of relevant problems: Comprehend, analyze, model and solve complex problems in the areas of malnutrition, geriatric nutrition and sports nutrition**.**

PO4. Modern tool usage: Utilize modern tools and modalities in the arena of food technology for better outcomes.

PO5: Environment and sustainability: Understand and appreciate the role of food and nutrition in the development of healthy society

PO6: Individual and team work: Recognize the need to expertise in the areas of nutrition and dietetics by self up gradation through life long learning.

PO7.Communication: Communicate with clarity and coherence, both written and verbally.

PO8. Ethics: Exibit professional responsibility in conducting standardized food analysis.

PO9. Project management and finance: Encourage collaborative learning and analyze the impact of radio diagnostic practices in a global, economic, environmental, and societal context

P10. Life long learning: Use latest computer techniques and tools to carry out scientific investigations and develop new solutions to solve nutritional problems related to society.

Programme Specific Outcomes (PSOs)

After successful completion of the programme, the graduates shall be able to

PSO1. Demonistrate the knowledge Nutrition and Dietics

PSO2. Apply the concepts in the design, development and implementation of application-oriented Nutrition and Dietetics solutions.

PSO3. Comprehend the fundamentals of Nutrition and Dietetics skills and undertake advanced level of knowledge to analyse and create techniques to solve real life problems.

REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Science Graduate Degree Programs, 2020

(Framed as per the provisions under Section 35 (ii), Section 7 (x) and Section 8 (xvi) & (xxi) of the REVA University Act, 2012)

1. Title and Commencement:

1.1. These Regulations shall be called the **"REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Under Graduate Degree Programs- 2020".**

1.2. These Regulations shall come into force from the date of assent of the Chancellor.

2. The Programs:

The following programs and all Graduate Degree programs to be instituted and introduced in REVA University in coming years shall follow these regulations.

B. Sc in:

Nutrition and Dietetics
Medical Radiology and Diagnostic Imaging
Medical Laboratory Technology

3. Definitions:

Course: Every course offered will have three components associated with the teaching-learning process of the course, namely:

- L= Lecture (ii) T= Tutorial (iii) P=Practice; where:

L stands for **Lecture** session consisting of classroom instruction.

T stands for **Tutorial** session consisting participatory discussion / self-study/ desk work/ brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes.

P stands for **Practice** session and it consists of Hands on Experience / Laboratory Experiments / Field Studies / Case Studies that equip students to acquire the much required skill component.

4. Courses of study and Credits

4.1. The study of various subjects in B.Sc., degree program are grouped under various courses. Each of these course carries credits which are based on the number of hours of teaching and learning.

4.1.1. In terms of credits, every **one hour session of L amounts to 1 credit per Semester.**
In terms of credits, every **one hour session of L amounts to 1 credit per Semester** and a minimum of **two hour session of T or P amounts to 1 credit per Semester** over a period of one Semester of 16 weeks for teaching-learning process.

4.1.2. **The total duration of a semester is 20 weeks inclusive of semester-end examination.**

4.1.3. **A course shall have either or all the four components.** That means a course may have only lecture component, or only practical component or combination of any two or all the three components.

4.1.4. The concerned BoS will assign Credit Pattern for every course based on the requirement. However, generally, courses can be assigned with 1-4 Credits depending on the size of the course.

4.1.5. Different **Courses of Study** are labelled and defined as follows:

Core Course:

A course which should compulsorily be studied by a candidate as a core-requirement is termed as a Core course. The CORE courses of Study are of THREE types, viz – (i) Foundation Course (ii) Hard Core Course, and (iiI) Soft Core Course.

a. **Foundation Course (FC)**
b. Foundation Courses are four courses including language study which are mandatory in nature prescribed by the University and should be completed successfully as part of Graduate Degree Program irrespective of the branch of study.
c. **Hard Core Course (HC):**

The **Hard Core Course** is a Core Course in the main branch of study and related branch (es) of study, if any that the candidates have to complete compulsorily.

d. **Soft Core Course (SC):**

A Core course may be a **Soft Core** if there is a choice or an option for the candidate to choose a course from a pool of courses from the main branch of study or from a sister/related branch of study which supports the main branch of study.

e. **Open Elective Course:**

An elective course chosen generally from other discipline / subject, with an intention to seek exposure to the basics of subjects other than the main discipline the student is studying is called an O**pen Elective Course.**

f. **Clinical Postings /Internship/:**

Clinical Postings /Internship is a special course involving application of knowledge in solving / analysing /exploring a real life situation / difficult problem. An internship carrying **EIGHT** credits and Clinical postings with 2 to 4 credits on each semester. **Project work /Internship may be a hard core or a Soft Core as decided by the BoS / concerned.**

5. Eligibility for Admission:

Pass in PUC/10+2 examination with life science/Biology as compulsory subjects with minimum 45% marks (40% in case of candidate belonging to SC/ST category) in the above subjects taken together of any Board recognized by the respective State Government /Central Government/Union Territories or any other qualification recognized as equivalent thereto.

6. Scheme, Duration and Medium of Instructions:

6.1 The Three Year degree program is of 6 semesters (3 years) duration. A candidate can avail a maximum of 12 semesters (6 years) as per double duration norm, in one stretch to complete the ThreeYear Degree, including blank semesters, if any. Whenever a candidate opts fo blank semester, he/she has to study the prevailing courses offered by the School when he/she resumes his/her studies.

6.2. The medium of instruction shall be English.

7. Credits and Credit Distribution

7.1. A candidate has to earn 120 credits for successful completion of Three Year Degree B.Sc

Nutrition and Dietetics with a distribution of credits as given in Table - 1 below:

Table-1

Credits and Credit Distribution for ThreeYear degree programs

Course Type	**Credits for Three Year Degree (6 semesters)**
Hard Core Course	48
Core Courses	36
Ability Enhancement Course	4
Core Lab	30
RULO	2
Total	120

7.2. The concerned BOS based on the credits distribution pattern given above shall prescribe the credits to various types of courses and shall assign title to every course including project work, practical work, and field work, self-study elective, as **Foundation Course (FC), Hard Core (HC) or Open Elective (OE)**.

7.3. Every course including project work, practical work, Clinical Postings, self-study elective should be entitled as Foundation Course (FC), Hard Core (HC) or Soft Core (SC) or Open Elective (OE) by the BoS concerned.

However, following shall be the

RULO (REVA Unique Learning Offerings) courses with credits mentioned against them, common to all branches of study. However, the BOS of respective program/ discipline shall decide about the total credits for RULO courses.

RULO Courses		
Sl. No.	Course Title	Number of Credits
1	Sports, Yoga, Music, Dance, Theatre	2
2	Internship	0
3	Soft Skill Training	0
4	Skill Development Course	0
	Total	2

7.4. The concerned BOS shall specify the desired Program Objectives, Program Educational Objectives, Program Specific Outcomes and Course Outcomes while preparing the curriculum of a particular program.

7.5. A candidate can enrol for a maximum of 27 credits and a minimum of 21 credits per Semester. However, he / she may not successfully earn a maximum of 27 credits per semester. This maximum of 27 credits does not include the credits of courses carried forward by a candidate.

7.6. Only such full time candidates who register for a minimum prescribed number of credits in each semester from I semester to VI semester and complete successfully 144 credits in 6 successive semesters shall be considered for declaration of Ranks, Medals, Prizes and are eligible to apply for Student Fellowship, Scholarship, Free ships, and such other rewards / advantages which could be applicable for all full time students and for hostel facilities.

8. Add-on Proficiency Certification / Diploma:

8.1 Add- on Proficiency Certification:

To acquire Add on Proficiency Certification a candidate can opt to complete a minimum of 2 extra credits either in the same discipline /subject or in different discipline / subject in excess to 144 credits for the Three Year Graduate degree programs.

8.2 Add on Proficiency Diploma:

To acquire Add on Proficiency Diploma, a candidate can opt to complete a minimum of 2 extra credits either in the same discipline /subject or in different discipline / subject in excess to 144 credits for the Three Year Graduate degree programs.

The Add on Proficiency Certification / Diploma so issued to the candidate contains the courses studied and grades earned.

9. Assessment and Evaluation

a) Each course is assessed for a total weight of 100%. Out of the total 100% weight; 50% weight is for Continuous Internal Assessment (CIA or IA) and the remaining 50% for the Semester End Examination (SEE). This is applicable for theory, laboratory, workshop, studio and any such courses.

b) Out of 50% weight earmarked for Internal Assessment (IA)- 15% for test-1, 15% for test-2 and 20% for Assignments and this is applicable for theory based courses

c) The tests and assignments are conducted as per the semester academic calendar provided by the University.

The details as given in the table

Component	**Description**	**Conduction**	**Weight Percentage**
C1	**Test-1: IA1**	**6th week from the starting date of semester**	**15**
	Test-2: IA2	**12th week from the starting date of semester**	**15**
C2	**1 Assignment 1**	**7th week**	**10**
	2 Assignment 2	**13th week**	**10**
C3	**SEE including practical & Clinical Postings Report**	**between 17th Week-20th Week**	**50**
Results to be Announced			**By the end of 21st Week**

Note: IA or CIA includes C1 and C2

Each test must be conducted for a duration of 60 minutes, setting the test question paper for a maximum of 30 marks. The final examination must be conducted for a duration of 3 hours and the question paper must be set for a maximum of 100 marks.

d) Students are required to complete courses like technical skills, placement related courses, Open electives and any such value addition or specialized courses through online platforms like SWAYAM/NPTEL/Any other reputed online education aggregator. Students are required to choose the courses on the advice of their course coordinator/Director and required to submit the course completion certificate along with percentage of marks/grade scored in the assessment

e) conducted by the online education aggregator. If the online education aggregator has issued a certificate along with the grade or marks scored to students, such courses will be considered for SGPA calculations, in case the aggregator has issued only a certificate and not marks scored, then such courses will be graded through an examination by concerned School, in case, if grading is not possible, students will be given a pass grade and award the credit and the credits will not be considered for SGPA calculations. The Online/MOOCs courses will not have continuous internal assessment component.

Such of those students who would like to discontinue with the open elective course that they have already registered for earning required credits can do so, however, they need to complete the required credits by choosing an alternative open elective course.

Setting question paper and evaluation of answer scripts.

i. For SEE, three sets of question papers shall be set for each theory course out of which two sets will be by the internal examiners and one set will be by an external examiner. In subsequent years by carrying forward the unused question papers, an overall three sets of question papers should be managed and depending on the consumption of question papers either internal or external examiner be called for setting the question paper to maintain an overall tally of 3 papers with the conditioned mentioned earlier. The internal examiner who sets the question paper should have been course tutor

ii. The Chairman of BoE shall get the question papers set by internal and external examiners.

iii. The Board of Examiners shall scrutinize and approve the question papers and scheme of valuation. It is the responsibility of the BoE to see that all questions contained in the question paper are within the prescribed syllabus of the concerned course.

iv. There shall be single valuation for all theory papers by internal examiners. However, there shall be moderation by the external examiner who has the subject background. In case no external examiner with subject background is available, a senior faculty member within the discipline shall be appointed as moderator.

v. The SEE examination for Practical work / Field work / Project work/Internship will be conducted jointly by internal and external examiners as detailed below: However, the BoE on its discretion can also permit two internal examiners.

vi. If a course is fully of (L=0):T:(P=0) type or a course is partly P type i.e, (L=3): (T=0) (P=1), then the examination for SEE component will be as decided by the BoS concerned.

10. Evaluation of Practical's and Minor Project / Major Project / Dissertation /Clinical Postings

10.3.1. A practical examination shall be assessed on the basis of:

a) Knowledge of relevant processes;

b) Skills and operations involved;

c) Results / products including calculation and reporting.

10.3.2. In case a course is fully of P type (L=0:T=0:P=4), the performance of a candidate shall be assessed for a maximum of 100 marks as explained below:

a) Continuous Internal assessment (CIA) = 50 marks

b) Semester end practical examination (SEE) = 50 marks.

The 25 marks for continuous assessment shall further be allocated as under (IA or CIA):

I	Conduction of regular practical throughout the semester	20 marks
Ii	Maintenance of lab records /industry reports	15 marks
Iii	Laboratory test and viva	15 marks
	Total	50 marks

The 50 marks meant for Semester End Examination, shall be allocated as under:

I	Conduction of semester end practical examination	30 marks
Ii	Write up about the experiment / practical conducted	10 marks
Iii	Viva Voce	10 marks
	Total	50 marks

10.3.3. The SEE for Practical work will be conducted jointly by internal and external examiners. However, if external examiner does not turn up, then both the examiners will be internal examiners.

10.3.4. In case a course is partly P type i.e, (L=3): (T=0) (P=1), then the examination for SEE component will be as decided by the BoS concerned.

10.3.5. The duration for semester-end practical examination shall be decided by the concerned School Board.

10.4. Evaluation of Internship/Clinical Postings:

Right from the initial stage of defining the problem, the candidate has to submit the progress reports periodically and also present his/her progress in the form of seminars in addition to the regular discussion with the supervisor. At the end of the semester, the candidate has to submit final report of the project / dissertation, as the case may be, for final evaluation. The components of evaluation are as follows:

1	Intership/Clinical Postings	Should be done a semester before the project semester	Weightage: 0%
2	Intership/Clinical Postings	7^{th} week from the start date of project semester	Weightage: 25%
3	Intership/Clinical Postings	14^{th} Week from the start date of project semester	Weightage: 25%
4	Intership/Clinical Postings	17^{th} -20^{th} Week of project Semester	Weightage: 30% for Dissertation Weightage : 20% for Final Viva Voce

11. Provision for Appeal

If a candidate is not satisfied with the evaluation of C1,C2 components, he/she can approach the grievance cell with the written submission together with all facts, the assignments, test papers etc, which were evaluated. He/she can do so before the commencement of semester-end examination. The grievance cell is empowered to revise the marks if the case is genuine and is also empowered

to levy penalty as prescribed by the university on the candidate if his/her submission is found to be baseless and unduly motivated. This cell may recommend taking disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the grievance cell is final.

For every program there will be one grievance cell. The composition of the grievance cell is as follows:-

- The Registrar (Evaluation) - Ex-officio Chairman / Convener
- One Senior Faculty Member (other than those concerned with the evaluation of the course concerned) drawn from the school / department/discipline and/or from the sister schools / departments/sister disciplines – Member.
- One Senior Faculty Members / Subject Experts drawn from outside the University school / department – Member.

12. Eligibility to Appear Semester End Examination (SEE)

12.1. Only those students who fulfil a minimum of 75% attendance in aggregate of all the courses including practical courses / field visits etc, as part of the course(s), as provided in the succeeding sections, shall be eligible to appear for SEE examination.

12.2. Requirements to Pass a Course

Students are required to score a total minimum of 40% (Continuous Internal assessment and SEE) in each course offered by the University/ Department for a pass (other than online courses) with a minimum of 25% (12) marks in final examination.

13. Requirements to Pass the Semester

To pass the semester, a candidate has to secure minimum of 40% marks in each subject / course of the study prescribed in that semester.

13.1 Provision to Carry Forward the Failed Subjects / Courses:

A student who has failed in a given number of courses in odd and even semesters of first year shall move to third semester of second and final year of the study. However, he / she shall have to clear all courses of all semesters within the double duration, i. e., within sixyears of admission of the first semester failing which the student has to re-register to the entire program.

13.2. Provision to Withdraw Course:

A candidate can withdraw any course within ten days from the date of notification of final results. Whenever a candidate withdraws a course, he/she has to register for the same course in case it is hard core course, the same course or an alternate course if it is Soft Core Course or Open Elective Course. A DROPPED course is automatically considered as a course withdrawn.

13.3. **Re-Registration and Re-Admission:**

a) In case a candidate's class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University, such a candidate is considered as dropped the semester and is not allowed to appear for end semester examination (C3) and he / she shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

b) In such case where in a candidate drops all the courses in a semester due to personal reasons, it is considered that the candidate has dropped the semester and he / she shall seek re-admission to such dropped semester.

14. Attendance Requirement:

14.1 All students must attend every lecture, tutorial and practical classes, clinical postings.

14.2 In case a student is on approved leave of absence (e g:- representing the university in sports,

games or athletics, placement activities, NCC, NSS activities and such others) and / or any

other such contingencies like medical emergencies, the attendance requirement shall be minimum of 75% of the classes taught.

a) Any student with less than 75% of attendance in aggregate of all the courses including practical courses / field visits etc, during a semester shall not be permitted to appear to the end semester (C4) examination and such student shall seek re-admission as provided in 7.8.4.

b) Teachers offering the courses will place the above details in the School Board meeting during the last week of the semester, before the commencement of C3, and subsequently a notification pertaining to the above will be brought out by the Director of the School before the commencement of C3 examination. A copy of this notification shall also be sent to the office of the Registrar & Registrar (Evaluation).

15. Absence during Mid Semester Examination:

In case a student has been absent from a mid-semester (C1, C2) examination due to the illness or other contingencies he / she may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Head of the School, for make-up examination. The Head of the School may consider such request depending on the merit of the case and after consultation with course instructor and class teacher, and arrange to conduct a special test for such candidate(s) well in advance before the C3 examination of that respective semester. Under no circumstances C1, C2 test shall be held after C3 examination.

16. Grade Card and Grade Point

16.1. Provisional Grade Card: The tentative / provisional grade card will be issued by the Registrar (Evaluation) at the end of every semester indicating the courses completed successfully. The provisional grade card provides **Semester Grade Point Average** (SGPA).

16.2. Final Grade Card: Upon successful completion of M.Sc., Degree a Final Grade card consisting of grades of all courses successfully completed by the candidate will be issued by the Registrar (Evaluation).

16.3. The Grade and the Grade Point: The Grade and the Grade Point earned by the candidate in the subject will be as given below.

Marks P	Grade G	Grade Point (GP=V x G)	Letter Grade
90 >100	10	v*10	O
80 > 90	9	v*9	A+
70 > 80	8	v*8	A
60 > 70	7	v*7	B+
55 > 60	6	v*6	B
50 > 55	5.5	V*5.5	C +
40 > 50	5	v*5	P
0-40	0	v*0	F
ABSENT			AB

O - Outstanding; A-Excellent; B-Very Good; C-Good; D-Fair; E-Satisfactory; F – Fail

Here, P is the percentage of marks (P=[C1+C2+C3]) secured by a candidate in a course which is

rounded to nearest integer. V is the credit value of course. G is the grade and GP is the grade point.

16.3.1. Computation of SGPA and CGPA

The Following procedure to compute the Semester Grade Point Average (SGPA)

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student in a given semester, i.e:

SGPA (Si) = ∑(Ci x Gi) / ∑Ci where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

Illustration for Computation of SGPA and CGPA

Illustration No. 1

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit x Grade)
Course 1	4	A+	9	4X9=36
Course 2	4	A	8	4X8=32
Course 3	3	B+	7	3X7=21
Course 4	3	O	10	3X10=30
Course 5	3	P	5	3X5=15
Course 6	3	B	6	3X6=18
Course 7	2	O	10	2X10=20
Course 8	2	A	8	2X8=16
	24			188

Thus, **SGPA = 188 ÷ 24 = 7.83**

Illustration No. 2

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade point)
Course 1	4	A	8	4X8=32
Course 2	4	B+	7	4X7=28
Course 3	3	A+	9	3X9=27
Course 4	3	B+	7	3X7=21
Course 5	3	B	6	3X6=18
Course 6	3	P	5	3X5=15
Course 7	2	B+	7	2X7=21
Course 8	2	O	10	2X10=20
	24			175

Thus, **SGPA = 175 ÷ 24 = 7.29**

Illustration No.3

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit x Grade point)
Course 1	4	O	10	4 x 10 = 40
Course 2	4	A+	9	4 x 9 = 36
Course 3	3	B+	7	3 x 7 = 21
Course 4	3	B	6	3 x 6 = 18
Course 5	3	A+	9	3 x 9 = 27
Course 6	3	B+	7	3 x 7 = 21
Course 7	2	A+	9	2 x 9 = 18
Course 8	2	A+	9	2 x 9 = 18
	24			199

Thus**, SGPA = 199 ÷ 24 = 8.29**

Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (96) for Two year Post Graduate degree program is calculated taking into account all the courses undergone by a student over all the semesters of a program i. e.,

$CGPA = \sum(Ci \times Si) / \sum Ci$

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration: No.1

CGPA after Final Semester

Semester (ith)	No. of Credits (Ci)	SGPA (Si)	Credits x SGPA (Ci X Si)
1	24	6.83	24 x 6.83 = 163.92
2	24	7.71	24 x 7.71 = 185.04
3	24	8.68	24 x 8.68 = 208.32
4	24	9.20	24 x 9.20 = 220.80
Cumulative	96		778.08

Thus, CGPA = 24x6.83+24x7.13+24x8.68+24x9.20 = 8.11

16.3.2. CONVERSION OF GRADES INTO PERCENTAGE:

Conversion formula for the conversion of CGPA into Percentage is:

Percentage of marks scored = CGPA Earned x 10

Illustration: CGPA Earned 8.10 x 10=81.0

16.3.3. Classification of Results

The final grade point (FGP) to be awarded to the student is based on CGPA secured by the candidate and is given as follows.

CGPA	Grade (Numerical Index) G	Letter Grade	Performance	FGP Qualitative Index
9 >= CGPA 10	10	O	Outstanding	Distinction
8 >= CGPA < 9	9	A+	Excellent	
7 >= CGPA < 8	8	A	Very Good	First Class
6 >= CGPA < 7	7	B+	Good	
5.5> = CGPA < 6	6	B	Above average	Second Class
> 5 CGPA < 5.5	5.5	C	Average	
> 4 CGPA <5	5	P	Pass	Satisfactory

Overall percentage=10*CGPA

17. Challenge Valuation

a. A student who desires to apply for challenge valuation shall obtain a photo copy of the answer script by paying the prescribed fee within 10 days after the announcement of the results. He / She can challenge the grade awarded to him/her by surrendering the grade card and by submitting an application along with the prescribed fee to the Registrar (Evaluation) within 10 days after the announcement of the results. This challenge valuation is only for SEE.

The answer scripts for which challenge valuation is sought for shall be evaluated by the external examiner who has not involved in the first evaluation. The higher of two marks from first valuation and challenge valuation shall be the final.

b. With regard to any specific case of ambiguity and unsolved problem, the decision of the Vice-Chancellor shall be final.

Mapping of PEOS with Respect to Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
PE01	√	√	√	√	√	√	√	√	√	√
PE02	√	√	√	√	√	√	√	√	√	√
PE03	√	√	√	√	√	√	√	√	√	√
PE04	√	√	√	√	√	√	√	√	√	√

Attainment of CO (Course Outcome)

CO Attainment	Value
0.4 - 0.6	1
0.6 – 0.75	2
> 0.75	3

Mapping of Course Outcomes with programme Outcomes

Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3

B21AHE102	CO1	3	2	3	3	3	2	2	2			2	1	1
	CO2	2	3	1	3	1	3	2	2			1	1	1
	CO3	1	2	2	3	1	3	3	3			2	1	2
	CO4	3	3	2	3	1	3	2	3			1		2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0101	CO1	2	3	3	3	1	2	2	3			2	1	2
	CO2	3	2	3	3	1	2	2	3			2	2	1
	CO3	2	2	3	3	2	1	3	3			1	1	2
	CO4	3	3	2	3	1	1	3	2			2	1	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0102	CO1	2	3	2	3	1	3	1	1			1	2	2
	CO2	2	3	3	3	1	1	2	3			2	2	2
	CO3	3	3	3	2	1	1	2	1			1	2	1
	CO4	3	2	1	3	1	3	2	3			1	1	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0103	CO1	3	1	3	3	2	1	3	2			1	1	1
	CO2	3	3	2	3	1	1	2	3			1	2	2
	CO3	2	3	2	3	2	1	2	3			2	1	1
	CO4	1	3	2	3	2	3	2	3			2	2	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0104	CO1	3	3	1	2	1	1	2	---			1	1	1
	CO2	2	2	1	--	--	--	1	--			1	1	2
	CO3	3	2	1	2	--	1	1	--			2	2	2
	CO4	3	3	2	3	--	1	1	--			2	1	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0105	CO1	1	1	3	3	1	1	--	--	--	1	3	1	1
	CO2	2	1	3	3	1	3	2	--	--	--	3	1	1
	CO3	2	1	3	3	1	2	2	3	--	--	3	1	1
	CO4	2	1	3	3	2	2	1	3	--	--	3	1	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0106	CO1	1	1	3	3	1	1	--	--	--	1	3	1	2
	CO2	3	1	2	3	1	2	2	--	--	--	3	2	3
	CO3	2	1	3	2	1	2	1	2	--	--	3	2	2
	CO4	2	1	2	3	1	3	2	3	--	--	3	1	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0107	CO1	1	1	3	3	1	1	--	2	--	1	3	2	2
	CO2	2	1	3	3	1	3	2	--	--	--	3	3	2
	CO3	2	2	3	3	1	3	2	2	--	--	3	3	3
	CO4	2	1	2	3	2	2	1	3	--	--	3	2	3
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21LHM201	CO1	2	2	3	3	1	2	3	1			1	1	2
	CO2	3	2	2	3	3	2	2	2			2		1

	CO3	2	3	3	3	3	2	3	3			2	1	2
	CO4	1	3	3	3	2	2	3	3			1		2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0201	CO1	3	2	3	3	2	1	1	2			1	1	2
	CO2	2	3	2	3	1	1	3	2			2	1	2
	CO3	2	2	3	3	1	2	3	2			2	2	2
	CO4	2	3	3	3	2	3	3	3			2	1	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0202	CO1	3	2	2	2	1	1	2	3			2	1	2
	CO2	3	3	2	3	2	1	2	3			1	2	2
	CO3	2	3	2	3	1	2	2	2			1	1	2
	CO4	2	2	2	3	2	3	2	3			1	2	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0203	CO1	3	1	1	3	1	2	2	1			2	1	1
	CO2	3	1	1	3	1	2	2	1			1	1	2
	CO3	3	1	1	3	1	2	3	1			1	1	1
	CO4	3	1	1	3	1	2	2	1			2	2	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0204	CO1	3	2	1	3	1	1	2	2			2	2	1
	CO2	3	2	2	3	1	1	2	2			1	2	2
	CO3	3	3	3	2	2	2	3	3			1	2	2
	CO4	2	3	3	3	2	2	3	3			2	2	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0205	CO1	1	2	3	3	1	1	1	--	--	1	3	1	1
	CO2	2	1	3	3	1	3	2	--	--	--	3	1	1
	CO3	2	2	3	1	1	2	2	2	--	--	3	1	1
	CO4	2	1	3	3	2	2	1	3	--	--	3	1	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0206	CO1	1	1	3	3	1	1	1	--	--	1	3	1	2
	CO2	3	1	2	2	1	2	2	--	--	--	3	2	3
	CO3	2	2	3	2	1	2	1	2	--	--	3	2	2
	CO4	2	1	2	3	1	3	2	3	--	--	3	1	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0207	CO1	1	1	3	3	1	1	1	2	--	1	3	2	2
	CO2	2	2	3	2	1	3	2	1	--	--	3	3	2
	CO3	2	2	3	3	1	3	2	2	--	--	3	3	3
	CO4	2	1	2	3	2	2	1	3	--	--	3	2	3
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0301	CO1	3	1	2	2	--	1	1	--			1	1	2
	CO2	3	2	2	3	--	1	2	--			1	2	1
	CO3	3	3	2	1	--	1	2	--			2	1	2
	CO4	3	3	2	3	--	1	2	--			1	1	2

Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0302	CO1	1	3	2	2	3	2	3	3			1	1	2
	CO2	1	3	3	3	1	1	3	3			2	2	1
	CO3	1	3	3	3	1	2	2	3			1	1	2
	CO4	2	3	2	3	1	2	2	2			2	2	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0303	CO1	3	3	2	3	1	1	2	3			1		2
	CO2	3	3	2	3	1	1	2	3			2	1	2
	CO3	3	3	2	3	1	1	2	3			2	1	1
	CO4	3	3	2	3	1	1	2	3			1	1	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0304	CO1	3	3	2	3	3	2	1	2			1	2	2
	CO2	3	3	2	3	3	2	1	2			2	2	2
	CO3	3	3	2	3	2	3	1	2			2	1	1
	CO4	3	3	2	3	2	3	1	2			2	2	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0305	CO1	3	1	1	1	1	1	1	--			1	1	2
	CO2	3	1	1	2	1	1	2	--			2	2	1
	CO3	2	3	2	2	--	1	2	--			1	1	2
	CO4	1	3	3	3	--	1	2	--			2	1	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0306	CO1	1	2	3	3	1	1	1	1	1	1	3	1	1
	CO2	2	1	3	3	1	3	2	1	1	--	3	1	1
	CO3	2	2	3	1	1	2	2	2	1	--	3	1	1
	CO4	2	1	3	3	2	2	1	3	--	1	3	1	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0307	CO1	1	1	3	3	1	1	1	1	--	1	3	1	2
	CO2	3	1	2	2	1	2	2	1	--	1	3	2	3
	CO3	2	2	3	2	1	2	1	2	1	--	3	2	2
	CO4	2	1	2	3	1	3	2	3	--	--	3	1	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0308	CO1	1	1	2	3	1	1	1	2	1	1	3	2	2
	CO2	2	2	3	2	2	3	2	1	--	--	3	3	2
	CO3	2	2	3	3	1	3	2	2	1	1	3	3	3
	CO4	2	1	2	2	3	2	1	3	--	1	3	2	3
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HS0401	CO1	2	1	1	1				2			2	1	1
	CO2	2	1	2	1	2			2			2	2	2
	CO3	3	2	1	1		1					2	2	2
	CO4	2	1	2	1	2			1			2	1	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3

B21HC0401	CO1	3	3	3	3	1	1	3	2			2	1	1
	CO2	3	2	1	3	1	3	1	3			2	1	2
	CO3	3	1	1	3	1	3	1	2			2	2	1
	CO4	3	3	3	3	1	3	2	3			1	1	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0402	CO1	3	3	2	2	1	2	2	2			2	2	1
	CO2	3	3	2	2	1	3	2	2			1	1	2
	CO3	3	3	1	2	1	2	3	3			2	1	2
	CO4	3	3	1	2	1	3	3	3			2	1	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0403	CO1	1	3	2	2	--	1	2	--			2	1	1
	CO2	1	3	3	2	--	--	1	--			2	2	1
	CO3	2	3	2	3	--	--	--	--			1	1	2
	CO4	2	3	2	3	--	--	--	--			1	1	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0404	CO1	3	3	2	3	1	2	2	3			1	1	2
	CO2	3	3	2	3	1	2	2	3			2	2	1
	CO3	3	3	1	3	1	1	2	2			1	1	2
	CO4	3	3	1	3	1	1	2	2			2	2	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0405	CO1	1	2	3	3	1	1	1	1	1	1	3	1	1
	CO2	2	1	3	3	1	3	2	2	2	1	2	1	1
	CO3	2	2	3	1	1	2	2	2	1	--	3	1	1
	CO4	2	1	3	3	2	2	1	3	1	1	3	1	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0406	CO1	1	1	3	3	1	1	1	1	--	1	3	1	2
	CO2	3	1	2	2	1	2	2	1	1	1	3	2	3
	CO3	2	2	3	2	1	2	1	2	1	--	1	2	2
	CO4	2	1	2	3	1	3	2	3	--	--	3	1	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0407	CO1	1	1	2	3	2	1	1	2	1	1	2	2	2
	CO2	2	2	3	2	2	3	2	1	1	--	3	3	2
	CO3	2	2	1	3	1	2	2	2	1	1	3	3	3
	CO4	2	1	2	2	3	2	1	3	1	1	3	2	3
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0501	CO1	3	2	3	3	1	1	2	3			1	1	2
	CO2	2	3	2	3	1	1	2	3			2	2	1
	CO3	3	3	2	2	1	1	2	3			1	1	2
	CO4	2	3	1	3	1	1	2	3			1	2	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0502	CO1	3	2	2	1	--	1	--	--			1	2	2
	CO2	2	2	2	2	--	--	--	--			2	2	1

	CO3	3	1	1	2	--	1	1	--			1	1	2
	CO4	2	3	3	1	--	1	--	--			1	2	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0503	CO1	3	3	2	1	1	1	2	3			1	2	2
	CO2	2	3	3	2	1	1	2	2			1	1	2
	CO3	3	2	3	1	1	2	3	2			1	1	1
	CO4	2	3	2	1	1	1	2	2			2		1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0504	CO1	3	3	1	3	1	2	3	1			1	2	1
	CO2	3	3	1	3	1	2	3	1			1	1	2
	CO3	3	3	1	3	1	2	3	1			1	2	2
	CO4	3	3	1	3	1	2	3	1			1	1	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0505	CO1	1	3	2	2	--	--	1	--			2	2	2
	CO2	1	3	3	2	--	--	1	--			1	2	1
	CO3	2	2	2	2	--	1	1	--			2		1
	CO4	1	2	2	1	--	--	1	--			1	2	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0506	CO1	1	1	3	3	1	1	--	--	--	1	3	1	1
	CO2	2	1	3	3	1	3	2	--	--	--	3	1	1
	CO3	2	1	3	3	1	2	2	3	--	--	3	1	1
	CO4	2	1	3	3	2	2	1	3	--	--	3	1	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0507	CO1	1	1	3	3	1	1	--	--	--	1	3	1	2
	CO2	3	1	2	3	1	2	2	--	--	--	3	2	3
	CO3	2	1	3	2	1	2	1	2	--	--	3	2	2
	CO4	2	1	2	3	1	3	2	3	--	--	3	1	2
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0508	CO1	1	1	3	3	1	1	--	2	--	1	3	2	2
	CO2	2	1	3	3	1	3	2	--	--	--	3	3	2
	CO3	2	2	3	3	1	3	2	2	--	--	3	3	3
	CO4	2	1	2	3	2	2	1	3	--	--	3	2	3
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0601	CO1	3	1	1	3	1	2	2	1			2	1	2
	CO2	3	1	1	3	1	2	2	1			2		1
	CO3	3	1	1	3	1	2	2	1			2	2	1
	CO4	3	2	3	3	1	1	2	3			2	1	1
Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0602	CO1	3	2	2	3	1	2	3	3			1	1	1
	CO2	2	3	3	3	1	3	2	2			1	1	2
	CO3	3	2	3	3	1	2	2	3			2	1	1
	CO4	2	3	3	3	1	2	2	3			2	1	1

Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0603	CO1	3	1	1	1	--	--	--	--			1	1	2
	CO2	2	3	2	2	1	--	1	--			2	1	1
	CO3	3	3	2	2	--	--	--	--			2	1	1
	CO4	3	1	1	2	--	--	--	--			2	2	1
Course Code	POs/ Cos	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0604	CO1	1					3	2	2			2	1	1
	CO2						2		2			2		1
	CO3	1					3	2	2			2	1	1
	CO4						2		2			2		1

Mapping of PEOs with Respect to POs

	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PSO1	PSO2	PSO3
PEO1	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO2	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO3	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO4	√	√	√	√	√	√	√	√	√	√	√	√	√

B. Sc (Nutrition and Dietetics)

Scheme of Instruction and Detailed Syllabus

(Effective from the Academic Year 2021-24)

CC = Core Course; SEC= Skill Enhancement Course; HC = Hard Course

CL=Core Lab; AEC = Ability Enhancement Course

Scheme of Instruction **Duration: 6 Semesters (3 Years)**

FIRST SEMESTER

SL.	Course Code	Title of the Course	CC/FC/ HC/SC	Credit Pattern				Hours
				L	T	P	Total	
1	B21AHE102	Communicative English	FC	2	0	0	2	3
2	B21HC0101	Introduction to Food and nutrition	CC	2	1	0	3	4
3	B21HC0102	Human physiology-I	CC	2	1	0	3	4
4	B21HC0103	Instrumentation and Food analysis	HC	2	1	0	3	4
5	B21HC0104	Fundamentals of Food Science	HC	2	1	0	3	4

		Practicals						
6	B21HC0105	Human Physiology -I	HC	0	0	2	2	3
7	B21HC0106	Nutritional biochemistry-I	HC	0	0	2	2	3
8	B21HC0107	Fundamentals of Food Science	HC	0	0	2	2	3
Total Credits				**10**	**4**	**6**	**20**	**28**
SECOND SEMESTER								
1	B21LHM201	Constitution of India & Professional Ethics	MC	0	0	0	0	3
2	B21HC0201	Human Nutrition & Family Meal Management	HC	3	1	0	4	4
3	B21HC0202	Fundamentals of Nutritional biochemistry	HC	2	1	0	3	4
4	B21HC0203	Human physiology -II	CC	2	1	0	3	4
5	B21HC0204	Food Sanitation	HC	3	1	0	4	4
		Practicals						
6	B21HC0205	Nutritional biochemistry - II	CL	0	0	2	2	3
7	B21HC0206	Human Nutrition & Family Meal Management	CL	0	0	2	2	3
8	B21HC0207	Food sanitation	CL	0	0	2	2	3
Total Credits				**10**	**4**	**6**	**20**	**28**
THIRD SEMESTER								
1	B21HC0301	Nutrition and health education	SEC	2	0	0	2	3
2	B21HC0302	Nutraceutical and functional food	HC	2	1	0	3	4
3	B21HC0303	Food Microbiology	HC	2	1	0	3	4
4	B21HC0304	Community and Public Health Nutrition	CC	2	1	0	3	4
5	B21HC0305	Clinical Nutrition -I	CC	2	1	0	3	4
		Practicals						

6	B21HC0306	Food Microbiology	HC	0	0	2	2	3
7	B21HC0307	Community and Public Health Nutrition	HC	0	0	2	2	3
8	B21HC0308	Clinical Nutrition-I	HC	0	0	2	2	3
Total Credits				**10**	**4**	**6**	**20**	**28**
FOURTH SEMESTER								
1	B21HS0401	Environmental Science and Health	SEC	2	0	0	2	3
2	B21HC0401	Food Service Management	CC	2	1	0	3	4
3	B21HC0402	Food Product Development and Quality control	CC	2	1	0	3	4
4	B21HC0403	Bakery Science	HC	2	1	0	3	4
5	B21HC0404	Food Packaging	HC	2	1	0	3	4
		Practicals						
6	B21HC0405	Bakery Science	HC	0	0	2	2	3
7	B21HC0406	Food Product Development	HC	0	0	2	2	3
8	B21HC0407	Food Service Management	HC	0	0	2	2	3
Total Credits				**10**	**4**	**6**	**20**	**28**
FIFTH SEMESTER								
1	B21HC0501	Nutrition for Sports and Exercise	CC	2	0	0	2	4
2	B21HC0502	Food Processing	CC	2	0	0	2	4
3	B21HC0503	Basics of Bio Informatics	HC	2	0	0	2	4
4	B21HC0504	Quality Food Service and Physical Facilities	HC	2	1	0	3	4
5	B21HC0505	Clinical Nutrition - II	HC	2	1	0	3	3
6	B21HCON01	SWAYAM/ MOOC	SEC	2	0	0	2	4
		Practicals						
7	B21HC0506	Assesment of Food Quality	HC	0	0	2	2	3

8	B21HC0507	Clinical Nutrition - II	HC	0	0	2	2	3
9	B21HC0508	Nutrition for Sports and Exercise	HC	0	0	2	2	3
Total Credits				**10**	**4**	**6**	**20**	**32**
SIXTH SEMESTER								
1	B21HC0601	Nutrition Counseling	CC	2	1	0	3	4
2	B21HC0602	Entrepreneurship development	CC	2	0	0	2	3
3	B21HC0603	Project work	HC	0	0	10	10	15
4	B21HC0604	Internship	HC	0	0	5	5	6
Total Credits				**4**	**1**	**15**	**20**	**28**
Total Credits of all Semesters							**120**	**172**

DETAILED SYLLABUS
SEMESTER I:

B21AHE102	**Communicative English**	**L**	**T**	**P**	**C**
Duration: 3hrs/wk		**2**	**0**	**0**	**2**

Prerequisites:

Knowledge of intermediate English Grammar and LSRW skills

Course objectives:

1. To develop basic communication skills in English for the learners of Bachelor of Science.
2. To prioritize listening and reading skills among the learners.
3. To simplify writing skills needed for academic as well as workplace context.
4. To examine that the learners use the electronic media such as internet and supplement the learning materials used in the classroom.

Course outcome: On completion of the course, students will be able to:

On completion of the course, students will be able to:

CO1. Interpret audio files and comprehend different spoken discourses/ excerpts in different accents (Listening Skills).

CO2. Demonstrate speaking ability with clarity, confidence and comprehension and communicate with one or many listeners using appropriate communicative strategies (Speaking Skills).

CO3. Make use of reading different genres of texts adopting various reading strategies (Reading Skills).

CO4. Develop the ability to write cohesively, coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic (Writing Skills).

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
B21AHE102	CO1	3	2	3	3	3	2	2	2			2	1	1
	CO2	2	3	1	3	1	3	2	2			1	1	1
	CO3	1	2	2	3	1	3	3	3			2	1	2
	CO4	3	3	2	3	1	3	2	3			1		2

Course Content: **Total Hours: 26 hrs**

Unit-I: Functional English

7 Hours

Remedial Grammar: Past Simple; Past Continuous; Irregular Verbs
Writing Skills: Paragraph Writing
Activities: Conversations; Leaving Phone Messages
Literature: Chief Seattle – The End of Leaving and Beginning of Survival

Unit-II: Interpersonal Skills

6 Hours

Remedial Grammar: Present Simple & Present Continuous; Activity & State Verbs
Writing Skills: Official Letters
Activities: Making Apologies; Invitations & Making Arrangements
Literature: Ruskin Bond – Tiger in the Tunnel

Unit-III: Multitasking Skills

6 Hours

Remedial Grammar: Present Perfect; For, Since & How Long; -ed & -ing adjectives; Prefix Opposites of Adjectives
Writing Skills: Note Making
Activities: Agreeing & Disagreeing with Opinions
Literature: Jesse Owens - My Greatest Olympic Prize

Unit-IV: Communication Skills

6 Hours

Remedial Grammar: Collocations; Prepositions
Writing Skills: Precise Writing
Activities: Offers, Suggestions & Requests
Literature: Avijit Pathak – Onscreen Magic

Reference Books:

1. Green, David. *Contemporary English Grammar Structures and Composition*. New Delhi: MacMillan Publishers, 2010.
2. Thorpe, Edgar and Showick Thorpe. *Basic Vocabulary*. Pearson Education India, 2012.
3. Leech, Geoffrey and Jan Svartvik. *A Communicative Grammar of English*. Longman, 2003.
4. Murphy, Raymond. *Murphy's English Grammar with CD*. Cambridge University Press, 2004.

5. Rizvi, M. Ashraf. *Effective Technical Communication*. New Delhi: Tata McGraw-Hill, 2005.
6. Riordan, Daniel. Technical Communication. New Delhi: Cengage Publications, 2011.
7. Sen et al. Communication and Language Skills. Cambridge University Press, 2015.

B21HC0101	Introduction to Food and Nutrition	L	T	P	C
Duration: 3 hrs/wk		2	1	0	3

Prerequisites:
Knowledge of basic concept of food, Nutrients and Nutrition

Course objectives:
1. To understand the functions and role of nutrients, their requirements and the effect of deficiency and excess (in brief)
2. To understand the concept of an adequate diet and the importance of nutrients in recommended Dietary Allowances, Estimated Average Requirement (EAR)

Course outcome: On completion of the course, students will be able to:
CO1 . understand the functions and role of different nutrients, their role in making foods choices and obtaining an adequate diet.
CO2 . able to apply basic nutrition knowledge on macronutrients, their requirements and the effect of deficiency and excess
CO3 . gain knowledge about energy requirements and the Recommended Dietary Allowances.
CO4 . able to learn the importance of various vitamins & minerals in maintaining health.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
B21HC0101	CO1	2	3	3	3	1	2	2	3			2	1	2
	CO2	3	2	3	3	1	2	2	3			2	2	1
	CO3	2	2	3	3	2	1	3	3			1	1	2
	CO4	3	3	2	3	1	1	3	2			2	1	1

Course Content: **Total Hours: 48 hrs**

UNIT-I **12 Hrs**

Science of Nutrition, Concept of Nutrition- Definition of nutrition, health, nutritional status and Malnutrition. Food Adulteration, Food Laws, Food Guide, RDA- Definition, factors affecting RDA and methods used for deriving RDA, concept of EAR and my plate.

Carbohydrates - Definition, composition, functions, maintenance of blood sugar levels, requirement, sources, digestion and absorption; Dietary fiber- Definition, classification, physiological effects and sources.

UNIT-II **12 Hrs**

Proteins- Definition, composition, nutritional classification of proteins and amino acids, functions, sources, requirements, digestion and absorption. Evaluation of protein quality: PER, BV, NPU and Chemical score.
Lipids- Definition, composition, functions, sources, requirements, digestion and absorption. Essential fatty acids – Definition, functions, sources and effects of deficiency.

UNIT- III **12 Hrs**

Energy- Definition, units of measurement, direct and indirect calorimetry; Determination of energy value of food, Total Energy requirement, Factors affecting physical activity, Factors affecting Basal Metabolic Rate, factors affecting Thermic effect of food, Recommended Dietary Allowances and Sources

UNIT- IV **12 Hrs**

Macro Minerals- Calcium and Phosphorous: Functions, requirements, sources and effects of deficiency. Micro minerals- Iron, Iodine, Copper, Fluorine and Zinc: Functions, sources, requirements and effects of deficiency. Sodium and Potassium: Functions, sources, requirements and effects of imbalances.
Fat soluble Vitamins – Vitamin A, D, E and K: Functions, requirements, sources and effects of deficiency. Water Soluble Vitamins – Thiamine, riboflavin, niacin, ascorbic acid, folic acid, vitamin B6 and vitamin B12: Functions, requirements, sources and effects of deficiency.

REFERENCES:

1. Sumathi R. Mudambi, Rajagopal, M.V., Fundametals of Foods and Nutrition, New Age International (P) Ltd, Publishers, Third edition, 1997.
2. Srilakshmi B., Nutrition Science, New Age International (P) Ltd, Publishers, Fifth multi colour edition, 2016.
3. Mangala Kango, Normal Nutrition, Curing diseases through diet, CBS Publications, First edition, 2005.
4. Paul.S., Text Book of Bio-Nutrition, Fundamental and Management, RBSA Publishers, 2003.
5. Sue Rodwell Williams, Nutrition and Diet Therapy, C.V. Melskey Co., 6th edition, 2000.
6. Mahtab. S.Bamji, Kamala Krishnaswamy and G.N.V Brahmam, Text Book of Human Nutrition, Oxford and IBH Publishing Company, Third Edition. 2009.
7. ICMR short report on RDA and EAR 2020.

B21HC0102	**Human Physiology - I**	L	T	P	C
Duration: 3 hrs/wk		**2**	**1**	**0**	**3**

Prerequisites:

Knowledge of basic concept of human organs and system

Course Objective:

1. To understand the structure and functions of cell

2. To understand the structure and functions of different organ systems and their influence on nutrition

Course Outcome: On completion of the course, students will be able to:

CO1. learn about structures and function of basic unit of life: cell, components of blood cell, blood component, lymphatic system and related lab technique. Able to understand cardiovascular system, cardiac cycle, blood pressure & heart rate

CO2. Achieve knowledge about Nervous system, It's various part and their function. It's complex mode of action, synapse, reflex

CO3. will acquire active knowledge of muscle and bones and their components.

CO4. Able to understand the physiology and working principle of excretory system.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0102	CO1	2	3	2	3	1	3	1	1			1	2	2
	CO2	2	3	3	3	1	1	2	3			2	2	2
	CO3	3	3	3	2	1	1	2	1			1	2	1
	CO4	3	2	1	3	1	3	2	3			1	1	2

Course Content: **Total Hours: 48 hrs**

UNIT- I **12 Hours**

Unit of Life: Structure and functions of cell with special reference to Plasma membrane (Fluid Mosaic Model), Mitochondria, Ribosome, Endoplasmic reticulum. Nucleus (nuclear membrane, nuclear chromatin and nucleolus). Nucleotide, Homeostasis, Positive and negative feedback, classification and functions of basic tissues

Blood & Circulatory system: Composition, Functions, Hemopoiesis, Erythropoiesis, Anemia, Haemostasis, Blood groups. Circulatory System: Functional anatomy of the heart, Properties of cardiac muscles, Conducting system of the heart, Pressure changes during cardiac cycles, , Arterial and venous blood pressure. Hypertension: Definition & types

UNIT- II **12 Hours**

Nervous System:

Structure of Neuron, Nerve Impulse, Myelinated & non-Myelinated nerve, CNS & PNS. Brief account of resting, Membrane Potential, Action Potential & conduction of Nerve impulse,

Neurotransmitters- definition, classification, synapse: chemical Synapse (Excitatory, Inhibitory), Electrical Synapse, Concept on sympathetic and parasympathetic nervous system

UNIT- III **12 Hours**

Muscular System:

Muscle Types, Gross structure, Functional differences with reference to Properties, Muscular Contraction and Relaxation, Energy sources, Neuromuscular junction, Sarcotubular system, smooth Muscle, Mechanism of Contraction. Formation and functions of muscles, Mechanism of muscle contraction, isometric and isotonic muscle contraction

UNIT -IV **12 Hours**

Excretory System: Structure and functional unit of kidney, kidney hormones, regulation of acid-base balance, electrolyte and water balance. Mechanism of urine formation and composition of urine. Urine analysis for abnormal constituents, tubular function tests. Nephritis and nephrosis. Dialysis

REFERENCES:

1. Ross & Wilson, (2014),Anatomy & Physiology in health & illness,11th edition, ElsevierPublications
2. Sujit Chaudhury,(2011),Concise Medical Physiology,6th edition,NCBA
3. Sembulingam k,(2012),Essentials of Medical Physiology,6th edition, Jaypee Publications
4. GuytonandHall,(2011)TextbookofMedicalPhysiology,12th Edition,Saunder/Elsevier
    a. Gerard J. Tortora and Bryan H.Derrickson,(Principles of Anatomy andPhysiology, 14th edition, Wileypublications
5. Textbook of Medical Physiology by G.K.Pal.

B21HC0103	Instrumentation and Food Analysis	L	T	P	C
Duration: 3 hrs/wk		2	1	0	3

Prerequisites:
Knowledge of basic physical chemistry

Course objective:
1. The objective of the course is to understand the principle, instrumentation and application of various analytical techniques used for biochemical characterizations.
2. To understand working Principle and theory of analytical chemistry applied in food science & Nuritional Biochemistry

Course Outcomes: After completing the course the student shall be able to:
CO1. Learn Principle, working, care & maintenance and calibration of different instruments required for food chemistry
CO2. gain knownledge on chemistry of solution, P^H, Buffers, indicators

CO3. learn about theory and principles of Proximate analysis of food

CO4. Get knowledge on working principle of qualitative and quantitative analysis of Macronutrients, elementary knowledge of food pigments and analysis of enzymes

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0103	CO1	3	1	3	3	2	1	3	2			1	1	1
	CO2	3	3	2	3	1	1	2	3			1	2	2
	CO3	2	3	2	3	2	1	2	3			2	1	1
	CO4	1	3	2	3	2	3	2	3			2	2	1

Course Content: **Total Hours: 48 hrs**

UNIT-I **12 Hours**

Instruments (Theory and demonstration): Principle, working, care & maintenance and calibration of Weighing balance, Hotplate, Magnetic stirrer, Centrifuges, Lyophilizer Incubator, Hot air oven, Colorimeter, Spectrophotometer, Water distillation plant, Deionizers, pH paper, pH meter, method of pH measurement. Types of electrodes, salt bridge solution. Use, care and maintenance of electrodes.

UNIT-II **12 Hours**

Preparation of solution and reagents, normal solution, molar solutions, percent solution, dilutions, w/v, v/v, standard solution. Body fluid dilutions. Units of measurement: SI unit, reference range, units for measurement of enzymes, protein, drugs, hormones, vitamins. Concepts of acid base, hydrogen ion concentration. Ionization of water. Buffers, types, Henderson Hassel back Equation, pH value of a solution, preparation of buffer solutions. Indicators and its types.

Quality control: Accuracy, Precision, Specificity, Sensitivity.

UNIT-III **12Hrs**

Methods of determining Moisture, Definition of water in food, Structure of water and ice, Types of water, Role of water activity, determination of ash, Analysis of Lipids- solubility test, emulsification test, saponification test, iodine value test, acrolein test. Chemical deterioration of fats and oils (auto oxidation, rancidity, lipolysis,)

UNIT-IV **12 Hours**

Analysis of Proteins: qualitative analysis of protein and amino acids: Ninhydrin test, Xanthoproteic acid test, sakaguchi test, biuret test**,** Physicochemical and functional properties of proteins, Carbohydrates Classification, Structure and Chemical reactions of carbohydrates, qualitative analysis of carbohydrates, Vitamins Types (Water soluble vitamins and Fat soluble vitamins); Analysis of Enzyme - Introduction, classification, General characteristics, Important enzymes in food processing, Introduction to food pigments: Natural pigments, synthetic food colour, Analysis of Pigments.

REFERENCES:

1. D M Vasudevan, (2011), Text book of Medical Biochemistry,6th edition Jaypee Publishers
2. M N Chatterjee & Rana Shinde, (2012), A Text book of Medical Biochemistry, 8th edition, Jayppe Publications
3. Singh & Sahni, (2008),Introductory Practical Biochemistry,2nd edition, Alpha Science
4. Lehninger, (2013), Principles of Biochemistry,6th edition, W HFreeman.
5. U Satyanarayan ,(2008), Essentials of Biochemistry,2nd edition, Standard Publishers
6. Medical laboratory Procedure Manual (T-M) by K.L. Mukerjee 1987, Vol.I, II & III Tata McGraw HillPublication.
7. Text book of Medical Biochemistry byRamakrishna
8. Text Book of Clinical chemistry by Norbert Teitz 4. Principles and Techniques of Practical Biochemistry by Wilson andWalker.
9. Clinical Chemistry - Principle and techniques by Rj Henry, Harper & Row Publishers.
10. Schaum's Outline of Biochemistry.Philip W. Kuchel, Ph.D, Simon Easterbrook-Smith, Vanessa Gysbers, J. MitchellGuss
11. Wilson and Walker's Principles and Techniques of Biochemistry andMolecular Biology
12. Pearson's Biochemistry.Christopher K. Mathews, Kensal E. van Holde, DeanR. Appling, Spencer J.Anthony-Cahill
13. Biochemistry. Donald Voet, Judith G. Voet
14. Samson Wrights AppliedPhysiology.
15. Text book of Medical physiology by A.B. Das Mahapatra.

B21HC0104	**Fundamentals of Food Scienece**	L	T	P	C
Duration: 3 hrs/wk		2	1	0	3

Prerequisites:
basic knowledge of food, Nutrients, cooking

Course objective:
1. To know the basic concept of Different food groups and methods and principles involved in cooking.
2. To know the chief nutritionial profile of each category of foodgroups.

Course Outcomes: After completing the course the student shall be able to:
CO1. Know Definition, functional classification and groups of food, cooking methods and their application, different beverages and types
CO2. Learn Structure, composition and nutritive value of cereals, pulses, sugar and their related products
CO3. Get idea on Composition and nutritive value of milk; Milk cookery, Meat structure, Meat cookery, eggs, fish poutry cookery,
CO4. Conceptualise Composition and nutritive value of vegetables, fruits, spices, oil and their related products, their role and application in Food science

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0104	CO1	3	3	1	2	1	1	2	---			1	1	1
	CO2	2	2	1	--	--	--	1	--			1	1	2
	CO3	3	2	1	2	--	1	1	--			2	2	2
	CO4	3	3	2	3	--	1	1	--			2	1	1

Course Content: **Total Hours: 48 hrs**

UNIT-I

12 Hours

Food: Definition, functional classification, groups (4, 5, 7 and 11), food pyramid.

Cooking: Definition and objectives; Methods- Moist heat methods, dry heat methods, combination of both and micro wave cooking; Effect of cooking on nutrients.

Beverages: Classification; Coffee beverage- Constituents and method of preparation; Tea-Types, preparation; Cocoa- Composition, nutritive value and preparation of cocoa beverage; Fruit beverages - Types; Introduction to vegetable juices, milk-based beverages, malted beverages, carbonated non alcoholic beverages and alcoholic beverages.

UNIT-II

12 Hours

Cereals and millets: Structure, composition and nutritive value of rice, wheat and oats; Nutritive value of maize, jowar, ragi and bajra. Cereal cookery: Effect of moist heat- Hydrolysis, Gelatinisation and factors affecting gelatinization, gel formation, retrogradation and syneresis; Effect of dry heat; Role of cereals in cookery.

Pulses: Composition, nutritive value, toxic constituents; Pulse cookery- Effect of cooking, factors affecting cooking quality, role of pulses in cookery, germination and its advantages.

Sugar and related products: Nutritive value, characteristics and uses of various types of sugars; Sugar Cookery- Crystallization and factors affecting crystallization; Stages of sugar cookery; Role of sugar in cookery.

UNIT-III

12 Hours

Milk and milk products: Composition and nutritive value of milk; Milk cookery- Effect of heat, effect of acid and effect of enzymes; Milk products- Non fermented and fermented products (does not include preparation); Role of milk in cookery.

Egg: Structure, composition, nutritive value; Egg cookery- Effect of heat, factors affecting coagulation of egg proteins and effect of other ingredients on egg protein; Role of egg in cookery; Home scale method for detecting egg quality.

Meat: Classification, composition, nutritive value, rigor mortis, ageing and tenderizing; Meat cookery-Changes during cooking.

Poultry: Classification, composition and nutritive value.
Fish: Classification, composition, nutritive value, selection and principles of fish cookery.

UNIT-IV

12 Hours

Vegetables: Classification (nutritional), composition, nutritive value; Pigments in vegetables- Water soluble and water insoluble; Enzymes, flavor compounds and bitter compounds; Vegetable cookery- Preliminary preparation, changes during cooking, loss of nutrients during cooking, effect of cooking on pigments, role of vegetables in cookery.

Fruits: Classification, composition, nutritive value, ripening of fruits; Browning- Types and preventive measures.

Spices: General functions, role in cookery; Medicinal value of commonly used spices.

Fats and oils: Composition and nutritive value, basic knowledge about commonly used fats and oils (lard,Ghee,butter, margarine, ground nut oil, coconut oil, soya bean oil, olive oil, rice bran oil, , mustard oil); Spoilage of fat- Types and prevention; Effect of heating, role of fats and oils in cookery.

REFERENCES:

1. Srilakshmi. B. Food Science, New Age International (P) Ltd. Publishers, Sixth edition.2016.
2. Manay Shakunthala, N and Shadaksharaswamy M. Food Facts and Principles, New Age International (P) Ltd Publishers, Reprint 2005.
3. Swaminathan M., Food Science, Chemistry and Experimental foods, Bappo Publishers company Ltd, 1997.
4. Usha Chandrasekar, Food Science in Indian Cookery, Phoenix publishers House Private Limited, 2002.

Practicals

B21HC0105	**Human Physiology -1 Practicals**	**L**	**T**	**P**	**C**
Duration: 3 hrs/wk		**0**	**0**	**2**	**2**

Prerequisites:
Clear theoretical concept of circulatory system, cells etc.

Course objective:
1. To measure clotting time, bleeding time and blood pressure, haemoglobinometry, and determination of blood group.
2. To study components and structures of pre-prepared slides of different tissues.

Course Outcomes: After completing the course the student shall be able to:
CO1. identify components and structures of pre-prepared slides of different tissues
CO2. learn individual clotting time, bleeding time and blood pressure
CO3. handle the haemoglobinometry and detrmination of blood group
CO4. determine hematocrit, separation of blood components through centrifugation

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0105	CO1	1	1	3	3	1	1	--	--	--	1	3	1	1
	CO2	2	1	3	3	1	3	2	--	--	--	3	1	1
	CO3	2	1	3	3	1	2	2	3	--	--	3	1	1
	CO4	2	1	3	3	2	2	1	3	--	--	3	1	1

Course Content: **Total Hours: 3 hours/ week**

Experiments: -

1. Microscopic study of tissues- epithelial, connective and muscular.
2. Determination of Clotting Time, Bleeding Time
3. Blood pressure Recording
4. Determination of Blood Groups (ABO)
5. Identification of blood cells.
6. Collection of blood sample- Capillary blood from finger tips and venous blood.
7. Separation of blood components (Centrifugation).

B21HC0106	Nutritional Biochemistry -1 Practical	L	T	P	C
Duration: 3 hrs/wk		0	0	2	2

Prerequisites:
Elementory knowledge of biochemical reactions of macro & micro nutrients.

Course objective:
1. To perform Qualitative estimation of macro nutrients.
2. To determine of proximate analysis of food.

Course Outcomes: After completing the course the student shall be able to
CO1. perform qualitative analysis of sugar and amino acids.
CO2. estimate urinary phosphorus, urea, blood glucose and cholesterol using suitable biochemical methods.
CO3. perform proximate analysis of food.
CO4. determine quantitative estimation of protein content of given food sample

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0106	CO1	1	1	3	3	1	1	--	--	--	1	3	1	2
	CO2	3	1	2	3	1	2	2	--	--	--	3	2	3
	CO3	2	1	3	2	1	2	1	2	--	--	3	2	2
	CO4	2	1	2	3	1	3	2	3	--	--	3	1	2

Course Content: **Total Hours: 3 hours/ week**

Experiments: -

1. Qualitative analysis of Carbohydrates
2. Qualitative analysis of amino acids
3. Estimation of Serum Glucose.

4. Determination of moisture & ash content in wheat flour
5. Estimation of ascorbic acid in food.
6. Estimation of protein in milk by biuret method.

B21HC0107	Fundamentals of Food Science Practicals	L	T	P	C
Duration: 3 hrs/wk		0	0	2	2

Prerequisites:
Theoritical knowledge and principles of food science.

Course objective:

1. to study the physical, chemical, and biochemical nature of foods and the principles of food processing**.**
2. To know basic sciences and application of different food groups and their properties in relation to food Science

Course Outcomes: After completing the course the student shall be able to
CO1. Identify different rheological and chemical properties of Food groups like cereals, pulses
CO2. Identify effect of external factors on different components of food
CO3. Demonstrate and identify enzymatic browning in vegetables & fruits
CO4. Determination of smoking point of oils & Stages of Sugar cookery

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0107	CO1	1	1	3	3	1	1	--	2	--	1	3	2	2
	CO2	2	1	3	3	1	3	2	--	--	--	3	3	2
	CO3	2	2	3	3	1	3	2	2	--	--	3	3	3
	CO4	2	1	2	3	2	2	1	3	--	--	3	2	3

Course Content: **Total Hours: 3 hours/ week**

Experiments: -

1. Study the effect of temperature, time of heating, concentration, addition of sugar and acid on gelatinization of starch.
2. Prepare recipe using principle of gluten formation
3. Demonstrate the effect of soaking, hard water and sodium bi carbonate on cooking quality of pulses.
4. Prepare recipes using whole gram, dhal, pulse flours, sprouted pulses and cereal pulse combination.

5. Demonstrate the factors affecting coagulation of milk protein and prepare milk products.
6. Demonstrate the formation of ferrous sulphide in boiling egg and its preventive measures.
7. Prepare recipes where egg acts as – thickening agent, binding agent, emulsifying agent

8. Demonstrate the effect of acid, alkali and over cooking on vegetables containing different pigments.
9. Demonstrate enzymatic browning in vegetables and fruits and any two methods of preventing it.
10. Determination of Smoking point of 3 edible oils
11. Demonstrate the stages of sugar cookery

12. SEMESTER: II

B21LHM201	Constitution of India & Professional Ethics	L	T	P	C
Duration: 3 hrs/wk		2	0	0	2

Prerequisites:
Basic knowledge of Indian history.

Course Objective: After completing the course the student shall be able to
1. To gain knowledge on Constitution of India and to understand about the fundamental rights, duties and other rights which is been given by our law.
2. To prepare students in the understanding of Constitution perspective and make them face the world as a bonafidecitizen.

Course Outcomes: After completing the course the student shall be able to
CO1: Analyze the Fundamental Rights, Duties and other Rights protected under Indian Constitution
CO2: Demonstrate the practicality of Constitution perspective.
CO3: Make the students face the world as a bonafide citizen.
CO4: Understand different union and state policies and their effect on industrialization in India.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21LHM201	CO1	2	2	3	3	1	2	3	1			1	1	2
	CO2	3	2	2	3	3	2	2	2			2		1
	CO3	2	3	3	3	3	2	3	3			2	1	2
	CO4	1	3	3	3	2	2	3	3			1		2

Course Content: **Total Hours: 48 hrs**

UNIT-1

12 Hrs

Introduction to Constitution of India. Role of Public Sector Undertakings in economic development... Public policy making in India and influence of new globalised world order. I.T. Law in India - Section 4-10 of I.T Act: Cyber laws in India - Section 43-47 of I.T Act -Section 65-78 of I.T Act. E-Governance and role of engineers in E-Governance. Socialist policy of India and its

relevance. Fundamental Duties of the Citizen, Significance and Characteristics. Elements of National Significance; National Flag, National Anthem, National Emblem.

UNIT-II

12 Hrs

Role of Planning Commission in economic development. Finance Commission and centre-State relations. Fundamental Rights and Fundamental Duties. Directive Principles of State Policy. Politics of Industrialization in India and the policy of Liberalization Privatization and Globalization (LPG) Need for reformed engineering serving at the Union and State level. Role of I.T. professionals in Judiciary. Problem of Alienation and Secessionism in few states creating hurdles in Industrial development.

UNIT-III **12Hrs**

Judiciary: Supreme Court of Indian, High Court, Right to Information Act 2005, Consumer Protection-Consumer Rights- Caveat Emptor and Caveat Venditor.

Unit-IV **12 Hrs**

Professional Ethics: Definition Scope and need of ethics for professional, Personal Ethics and Business Ethics, Ethical Standards, Duties of Employers and Employees. Due Care theory, Environmental Ethics, Ethical Code of Conduct in ethics. Best Ethical Companiesin India and Abroad; Corporate Social Responsibilities, Code of Conduct and Ethical Excellence

References:

1. An Introduction to the Constitution of India by: Brij Kishore Sharma
2. Relevant document related Government of India Policy.
3. Cyber Law by Dr. Gupta and Agarwal.
4. www.indiancourts.nic.in
5. Public Administration by Awasthi and Maheshwari.
6. M V Pylee, An introduction to Constitution ofIndia

B21HC0201	Human Nutrition & Family Meal Management	L	T	P	C
Duration: 4 hrs/wk		3	1	0	4

Prerequisites:

Basic knowledge of Food, Nutrient, RDA, EAR

Course Objective:

1. To learn different nutritional requirements at different stages of lifecycle.
2. To discuss, contrast and evaluate the roles of nutrition within the complex processes of pregnancy, lactation, child development and ageing.

Course Outcomes: After completing the course the student shall be able to

CO1. learn and apply the latest in research-based nutrient needs of pregnant and lactating females and will gain knowledge on changing nutritional needs of an infant and about complementary feeding**.**

CO2. relate nutrient needs to developmental stages and plan diets which will adequately meet nutritional needs during childhood, school going- age

CO3: learn the impact of growth and development in arriving at the nutritional needs of adolescents, adults and old age

CO4: gain competence on meeting nutrition needs and establishing dietary patterns to promote optimum health and reducing the impact of chronic diseases through effective meal Planning

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0201	CO1	3	2	3	3	2	1	1	2			1	1	2
	CO2	2	3	2	3	1	1	3	2			2	1	2
	CO3	2	2	3	3	1	2	3	2			2	2	2
	CO4	2	3	3	3	2	3	3	3			2	1	1

Course Content: **Total Hours: 48 hrs**

Unit- I

12 Hours

Nutrition during Pregnancy and lactation:

a) Physiological stages of pregnancy b) Effect of Nutritional status on Pregnancy outcome c) Nutritional Requirements d) Guide for eating during pregnancy, Complications of pregnancy and their dietary Implications.

b) **Nutrition during Lactation**: Physiology, Nutritional requirement, lactogauge

c) **Nutrition for Infants**-Composition of human and cow's milk, formulas d) Complimentary foods weaning pattern, composition, general principles in feeding infants, special feeding problems. Characteristics of low-birth weight Infant, small for date babies, pre-term babies

Unit- II

12 Hours

Nutrition during early childhood (Toddler/Preschool) - Growth & nutrient need, nutrition related problems, feeding patterns

Nutrition during School going age a) Growth and Development b) Nutritional Requirement's c) Factors influencing food intake d) Nutritional Concerns e) importance of snacks, school lunch.

Unit -III **12 Hours**

Nutrition for Adolescence: a) Growth and Development-Physiologic changes b) Nutritional Requirements c) Situations with special needs

Nutrition for adults: a) nutrient needs modifications for different activity levels and different income groups.

Nutrition for old Age: a) Process of Aging, b) Nutrient Requirements, Nutrition Related problems of old Age, Nutrition and Bone health in brief) c) Degenerative diseases, d) Health care of elderly and concepts of the use of supplements.

Unit -IV

12 Hours

Introduction to meal management - balanced diet, food groups & balanced diet planning. Food guides for selecting adequate diet.

Meal planning for the family, Indian meal patterns – vegetarian and non-vegetarian. Food faddism and the faulty food habits, Nutritive value of common Indian recepies.

REFERENCES:

1. Guthrie H.A. & Others, "Introductory Nutrition", 1986, 6th ed. Times Mirror/Mosby College Pub Louis.
2. Anderson L. et al, "Nutrition in Health and Disease', 1982, 17th ed, J.B Lippincott Co Philadelphia.
3. Whitney E.N., Hamilton E.N. & Raffes S.R., "Understanding Nutrition", 5th ed. West Pub. Co. New York.
4. Recommended Dietary Intakes for Indians, I.C.M.R. 2020 report
5. Mudambi, S.R. & M.N. Rajagopal - "Fundamentals of Food and Nutrition", 3rd ed. Wiley Eastern Ltc New Delhi-19.
6. Guthrie, H.A,, "Introductory Nutrition", 6th ed., Times Mirror/Mosby College Publ. - St Louis 1989.
7. Worthington Roberts, Bonnie S & others - "Nutrition in Pregnancy & Lactation", 3rd ed. Times Mirror Mosby College, St. Louis, 1985.

B21HC0202	**Fundamental Nutritional Biochemistry**	L	T	P	C
Duration: 3 hrs/wk		**2**	**1**	**0**	**3**

Prerequisites:
Knowledge of chemical Properties of Macro and Micro nutrients and their utilization

Course Objective:
1. To know the principles of biochemistry as applicable to human nutrition.
2. To understand the biological process and systems as applicable to human nutritions.

Course Outcomes: After completing the course the student shall be able to
CO1. Gain knowledge on digestion, Absorption, transport & utilization of macro nutrients and fiber.
CO2. Learn about metabolic and energy pathways utilizing carbohydrate and lipid.
CO3. Learn about metabolic pathways of protein and nucleic acid.
CO4. Understand utilization of energy and micro nutrients through biochemical pathways

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0202	CO1	3	2	2	2	1	1	2	3			2	1	2
	CO2	3	3	2	3	2	1	2	3			1	2	2
	CO3	2	3	2	3	1	2	2	2			1	1	2
	CO4	2	2	2	3	2	3	2	3			1	2	2

Course Content: **Total Hours: 48 hrs**

UNIT- I

12 Hours

Use of food in body - Digestion, Absorption, transport & utilization. Role of fibres in human nutrition.
Carbohydrates: Functions, classification, Digestion, Absorption, utilization, storage in body.
Protein: Functions, classification, Digestion, Absorption, utilization, storage in body
Fats & oils: composition, saturated and unsaturated fatty acids, classification, function, Digestion, Absorption, utilization, storage in body

UNIT -II

12 Hours

Introduction to metabolism- significance of anabolic and catabolic process in body,
Brief concept of Carbohydrate Metabolism: glycolysis, glycogenesis, TCA cycle, gluconeogenesis, HMP shunt, blood glucose regulation, Significance of carbohydrate metabolism in disease.
Lipids- Beta oxidation of fatty acids and the energetics, synthesis of ketone bodies, ketosis, Nutritional significance of ketosis in relation to diseases. Cholesterol & its clinical significance, Lipoproteins in the blood composition & their functions in brief, Atherosclerosis

UNIT- III

12 Hours

Protein Metabolism- amino acids, composition and function, general reactions of amino acid metabolism, synthesis of non essential amino acids, urea cycle
Nucleic acid- composition, functions, classification, structure and properties of DNA, RNA, replication and transcription, translation, genetic code and their biological importance

UNIT IV

12 Hours

Energy metabolism- biological oxidation-citric acid cycle and Electron transport chain, oxidative phosphorylation, energy conservation, high energy phosphate bond;
Vitamins- (water & fat soluble) - definition, classification & functions. Effect of cooking & heat processing on the vitamins of foods.
Acid base balance- concepts & disorders - pH, Buffers, Acidosis, Alkalosis

REFERENCES:

1. Bamji et al. 1996. Text Book of Human Nutrition. New Delhi, Oxford and IBH Publishing Co. Pvt. Ltd.

2. Devlin. T.M.. 1997. Text book of Clinical Biochemistry. New York, John Wiley and Sons.
3. Harper. H.A.. 1997. Review of Physiological Chemistry. 21st edition. Los Angeles, Lange Medical Publications.
4. Leninger. A. L.. 1992. The molecular basic of cell structure and functions. New Delhi, Kalyani Publishers.
5. Ramakrishnan. S. and Venkat Rao.. 1995. Nutritional Biochemistry. Chennai, T.R. Publications.
6. Shils et al. 1994. Modern Nutrition in Health and Disease. Vol. I and II. New York, Lea and Febiger.
7,. U Satyanarayan, (2008), ,2nd edition, Standard Publishers, Essentials of Biochemistry.

B21HC0203	**Human Physiology-II**	L	T	P	C
Duration: 3 hrs/wk		2	1	0	3

Prerequisites:
Knowledge of basic concept of human organs and system

Course Objective:
1. To understand the structure and functions of different vital systems of a human body.
2. To understand the physiology of different organ systems and their influence on nutrition.

Course Outcome: After completing the course the student shall be able to
CO1: learn about structures and function of Gastrointestinal system of human body
CO2: Achieve knowledge about endocrine and exocrine and understand different endocrine systems and their functions.
CO3: Know about the physiology and working principle of the sense organs and will be ready to understand respiratory system, transport of oxygen and carbon dioxide and respiratory disease,
CO4: Understand human reproductive system along with the organs and specific physiological condition like conception, lactation and menopause

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0203	CO1	3	1	1	3	1	2	2	1			2	1	1
	CO2	3	1	1	3	1	2	2	1			1	1	2
	CO3	3	1	1	3	1	2	3	1			1	1	1
	CO4	3	1	1	3	1	2	2	1			2	2	1

Course Content: **Total Hours: 48 hrs**

UNIT- I **12 Hours**

Gastro intestinal Sysytem: Organs of GIT and their structure & function. Gastric secretion, Pancreatic secretion, Gastric motility-digestive peristalsis, gastrointestinal hormones. Structure & function of liver, spleen, gall bladder & pancreas. Jaundice, Cirrhosis & Pancreatitis, Digestion and absorption of food

UNIT-II

12 Hours

Endocrine system: Endocrine Glands: Types of different endocrine glands, Structure, secretion and functions of pituitary, thyroid, parathyroid and adrenal gland, pancreas, Hypo and Hyper secretions, various hormonal disorders (Diabetes Mellitus, Diabetes insipidus, Hyper and Hypothyroidism, dwarfism & gigantism)

UNIT-III

12 Hours

Respiratory System: Parts of Respiratory System, Mechanism of breathing, Ventilation, Regulation of respiration, Transport of gases, Hypoxia, Artificial ventilation, non-respiratory functions of the lungs.

Physiology of sense organs: Structure and functions of Sense organs: Eye, Ear, Nose, Skin and Tongue, Disease of Ear and Eye (in brief)

UNIT- IV

12Hours

Reproductive System: Male & Female reproductive organs, Reproductive cycle in female Menstrual cycle, sex hormones, secondary sexual characteristics, puberty, brief process of spermatogenesis, oogenesis, pregnancy, parturition, lactation and menopause, different contraceptive measures.

REFERENCES:

1. Ross & Wilson,(2014),Anatomy & Physiology in health & illness,11th edition, ElsevierPublications
2. Sujit Chaudhury,(2011),Concise Medical Physiology,6th edition,NCBA
3. Sembulingam k,(2012),Essentials of Medical Physiology,6th edition, Jaypee Publications
4. Guyton and Hall,(2011)TextbookofMedicalPhysiology,12th Edition,Saunder/Elsevier
5. Gerard J. Tortora and Bryan H.Derrickson,(Principles of Anatomy andPhysiology, 14th edition, Wileypublications
6. Textbook of Medical Physiology by G.K.Pal.

B21HC0204	**Food Sanitation**	**L**	**T**	**P**	**C**
Duration: 4 hrs/wk		**3**	**1**	**0**	**4**

Prerequisites:

Prior knowledge on personal hygiene and safe food.

Course Objective:

1. To know the importance of sanitation and hygiene in food catering.
2. To understand personal hygiene, cleaning procedures and pest control in food catering.

Course Outcomes:

CO1. To identify and conceptualise Sanitation, Food hygiene, related terminologies

CO2. Learn basics of food production chain from Farm to fork

CO3. Gain knowledge of Personal Hygiene and sanitation, food contamination

CO4.know cleaning procedures, different sanitisers, importance of pest control in Food service areas

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0204	CO1	3	3	2	3	1	2	2	3			1	1	2
	CO2	3	3	2	3	1	2	2	3			2	2	1

	CO3	3	3	1	3	1	1	2	2			1	1	2
	CO4	3	3	1	3	1	1	2	2			2	2	1

Course Content: **Total Hours: 48Hrs**

UNIT-I **12 hours**

Sanitation: Definition and meaning, deteriorative effects of micro organisms- physical and chemical changes; methods of killing micro organism- heat, chemicals and radiation; methods of inhibiting microbial growth- refrigeration, chemicals, dehydration and fermentation

Food Sanitation terminologies-sanitation, hygiene, food contamination, Danger zone, Significance of sanitation in food catering industry

Unit -II **12 hours**

Hygiene in purchase and storage of food-receiving, food storage, general guidelines for storage, dry food storage, refrigerated storage, freezer storage. Hygiene in preparing, holding, serving and display if food, Hygienic procedures in food preparation, hot holding of food, safe use of leftover food, hygiene in food service, protective display of food

Unit -III **12 hours**

Personal hygiene-importance, sanitary habits and practices, protective clothing.

Storage and disposal of waste-classification of waste, solid waste (collection and storage of garbage), methods of disposal of garbage. Contamination of food products: Contamination of red meat, poultry and sea food during processing, contamination of dairy products and other food; contamination of ingredients; other sources of contamination- equipment, employees, air and water, sewage, insects and rodents; protection against contamination- protection against environment, protection during storage, protection against contamination from litter and garbage, protection against toxic substances

Unit-IV **12 hours**

Cleaning procedures-cleaning and sanitising, significance of cleaning programme, cleaning agents and compounds: Characteristics of good cleaning compound, classification- alkaline cleaning compound and acid cleaning compound, synthetic detergents, soaps, solvent cleaners; detergent auxiliaries - protection and cleaning auxiliaries; scouring compounds; selection of effective cleaning compound.

Sanitizers: Meaning, Types: thermal sanitizing, radiation sanitizing and chemical sanitizing types of cleaning equipment-manual, mechanical, post cleaning storage.

Pest control- importance, control of housefly, cockroaches, rodents.

REFERENCES: -

1. Norman G. Marriott, Principles of sanitation, Van Nostrand Reinhold company, Newyork. 1985.
2. Mario Stanga, Sanitation: Cleaning and Disinfection in the Food Industry, Wiley, 2010.
3. Y. H. Hui, L. Bernard Bruinsma, J. Richard Gorham, Wai-Kit Nip, Phillip S. Tong, Phil
4. Ventresca, Food plant sanitation, CRC Press, 2002.
5. Y. H. Hui, Plant sanitation for food processing and food service, CRC Press, 2014.
6. Food Sanitation and Hygiene (Latest Edition) by Sunetra Roday
7. Frazier W.C. and Westhoff D.C., Food Microbiology, 4th Ed., 1988 New York

B21HC0205	Nutritional Biochemistry -II Practical	L	T	P	C
Duration: 3 hrs/wk		0	0	2	2

Prerequisites:
Elementory knowledge of biochemical methods & instruments

Course objective:
1. To perform Qualitative estimation of macro nutrients.
2. To Determine biochemical parameters considered as Nutritional biomarkers from blood smaple

Course Outcomes: After completing the course the student shall be able to
CO1. perform qualitative analysis of Lipids and fats
CO2. study general properties of the enzyme Urease & Achromatic time of salivary amylase.
CO3. Perform suitable test to determine normal & abnormal constituents of urine
CO4. determine quantitative estimation Cholesterol from blood & Glucose from Urine

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0205	CO1	1	2	3	3	1	1	1	--	--	1	3	1	1
	CO2	2	1	3	3	1	3	2	--	--	--	3	1	1
	CO3	2	2	3	1	1	2	2	2	--	--	3	1	1
	CO4	2	1	3	3	2	2	1	3	--	--	3	1	1

Course Content: **Total Hours: 3 hrs/ Wk**

Experiments:
1. Preparation of phosphate and citrate buffer
2. Estimation of acid value, iodine value, Saponification value of fats
3. Estimation of Calcium in milk
4. Estimation of glucose in urine by Benedict's methods
5. Estimation of Fiber content in food
6. Estimation of blood cholesterol

B21HC0206	Human Nutrition & Family meal Management Practical	L	T	P	C
Duration: 3 hrs/wk		0	0	2	2

Prerequisites:
Elementary knowledge of RDA, EAR, meal planning

Course Objective:

1. To apply knowledge on different nutritional requirements at different stages of lifecycle.
2. To apply knowledge in planning, preparation and calculation of meals suitable for pregnancy, lactation, child development and ageing.

Course Outcomes: After completing the course the student shall be able to

CO1. Learn and apply the latest in research-based nutrient needs of pregnant and lactating females and will gain knowledge on changing nutritional needs of an infant and about complementary feeding**.**

CO2. Relate nutrient needs to developmental stages and plan diets which will adequately meet nutritional needs during childhood, school going- age

CO3: Learn and apply knowledge for planning, preparing and calculating a day's diet for adolescents, adults and old age

CO4: Gain competence on meeting nutrition needs and using it for designing appropriate meals for day-to-day life.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
B21HC0206	CO1	1	1	3	3	1	1	1	--	--	1	3	1	2
	CO2	3	1	2	2	1	2	2	--	--	--	3	2	3
	CO3	2	2	3	2	1	2	1	2	--	--	3	2	2
	CO4	2	1	2	3	1	3	2	3	--	--	3	1	2

Course Content: **Total Hours: 3 hrs/ Wk**

Experiments:

1. Measurement of food materials using standard measuring cups, spoons and weighing.
2. Preparing a recipe by Moist heat & dry heat method (Pressure cooking, Grilling)
3. Preparing a recipe by frying (deep & shallow fat frying)
4. Planning, Preparation and calculation of Nutrient dense food (Energy, iron, calcium, Protein)
5. Preparation and calculation of nutritive values of common recipes: Pulao, chapathi, vegetable sandwich, sambhar, thick soup, ragi konjee, fruit salad, rice kheer, fruit juice
6. Planning and Preparation and calculation of weaning food
7. Planning and Preparation and calculation of attractive snacks for Preschoolers, Schoolgoing child.
8. Planning and Preparation and calculation of day's diet for Pregnant woman Lactating woman, Adolescent girl and boy
9. Planning and Preparation and calculation of day's diet for adult man and woman

B21HC0207	Practicals	L	T	P	C
Duration: 16 weeks	**Food Sanitation Practical**	0	0	2	2

Prerequisites:

Prior knowledge on personal hygiene and safe food.

Course Objective:

1. To know the importance of sanitation and hygiene in food catering.
2. To understand personal hygiene, cleaning procedures and pest control in food catering.

Course Outcomes:

CO1. To identify and conceptualise Sanitation, Food hygiene, related terminologies
CO2. Learn basics of food production chain from Farm to fork
CO3. Gain knowledge of Personal Hygiene and sanitation, food contamination
CO4.know cleaning procedures, different sanitisers, importance of pest control in Food service areas

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0207	CO1	1	1	3	3	1	1	1	1	--	1	3	1	2
	CO2	3	1	2	2	1	2	2	1	1	1	3	2	3
	CO3	2	2	3	2	1	2	1	2	1	--	1	2	2
	CO4	2	1	2	3	1	3	2	3	--	--	3	1	2

Course Content: **Total Hours: 3Hrs/ wk**

Experiments:

1. Market survey of cleaning and sanitising agents
2. Hand washing technique
3. Visit to food catering unit to study hygiene and sanitary practices
4. Use of food sanitation checklist-food preparation and handling practices, personal practices, service.
5. Preparation of different module and training of group-D staff in hygiene and sanitation.

SEMESTER: III

B21HC0301	NUTRITION AND HEALTH EDUCATION	L	T	P	C
Duration: 2 hrs/wk		2	0	0	2

1. Concept, objectives and importance of nutrition and health education
2. Principles of health education.
3. Nutrition and health education communication process.
4. Steps in planning health and nutrition education.
5. Methods involved in nutrition and health education
6. Evaluation of nutrition and health education programmes.

CO1: Gain the knowledge and skills on different modes of teaching.
CO2: Gain knowledge on the mass media communication and computers used in health education.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
	CO1	1	3	2	2	3	2	3	3			1	1	2

B21HC0301	CO2	1	3	3	3	1	1	3	3			2	2	1

Course Content: **Total Hours: 2Hrs/ wk**

Unit-I **12 h**

Methods used in nutrition education: Lecture method, group discussion method, role play or dram method, story - telling, demonstration, brainstorming.

Teaching aids used in nutrition education: Direct and indirect methods, Traditional media methods.
Computers as a tool in Clinical Care: Communication in patient care, Nutritional assessment and support services, Nutritional therapy, Nutrition survey. Nutritional counselling. Patient education and consumer education.

Unit-II 12 h

Diet in Health:

Importance of food in health: Healthy eating during stress, Eating disorders, Super foods, Mindful nutrition, BP diet, Role of nutrients in allergy.

Health education in specific condition:

Need for health education to the following age group – infants, pre-school, school going, adolescents, old age.

Importance of nutrition education on the following specific condition - pregnancy and lactation, surgical conditions.

B21HC0302	**Neutraceutical and Functional Food**	L	T	P	C
Duration: 2 hrs/wk		2	1	0	3

Prerequisites:
Basic Knowledge in Food & Nutrition
Course Objectives:
1. To be aware of the growing importance of functional foods and neutraceuticals & to understand recent trends of food fortification in the market.
2. To know current guidelines and regulations of Nutraceuticals, functional foods in Indian context
Course Outcomes: After completing the course the student shall be able to
CO1: Recognize the growing importance of functional foods and neutraceuticals.
CO2: Gain knowledge of Probiotics & Prebiotics the related recent trends in the market.
CO3: Know implications Effects of processing conditions and storage of functional foods
CO4: Learn about Food Fortification, Need, Objectives, Rationale, Vehicles used for fortification, methods employed.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3

B21HC0302	CO1	1	3	2	2	3	2	3	3			1	1	2
	CO2	1	3	3	3	1	1	3	3			2	2	1
	CO3	1	3	3	3	1	2	2	3			1	1	2
	CO4	2	3	2	3	1	2	2	2			2	2	1

Course Content: **Total Hours: 48 Hrs**

UNIT-I

12 Hrs

Nutraceuticals and functional Foods –Definition, concept. Classification of nutraceuticals and functional foods.

Significance and relevance of nutraceuticals and functional foods in the management of diseases and disorder. Natural occurrence of certain phytochemicals- Antioxidants and flavonoids: omega – 3 fatty acids, carotenoids, dietary fiber, phytoestrogens

UNIT-II

12 Hrs

Prebiotics, probiotics and synbiotics-

Probiotics: Definition, types and relevance; Usefulness in gastro intestinal health and other health benefits; development of a probiotic products; recent advances in probiotics; Challenges and regulatory issues related to probiotic products.

Prebiotics: Prebiotic ingredients in foods; types of prebiotics and their effects on gut microbes; health benefits of prebiotics; recent development in prebiotics, Synbiotics.

UNIT-III:

12 Hrs

Functional foods - Definition, development of functional foods, use of bioactive compounds inappropriate form with protective substances and activators; Effect of environmental condition and food matrix; Effects of processing conditions and storage; Development of biomarkers to indicate efficacy of functional ingredients; Texteured vegetable protein.

UNIT – IV

12 Hrs

Food Fortification and enrichment. Need, Objectives, Rationale, Vehicles used for fortification & enrichment.

Methods employed, Advantages and Disadvantages of fortification, Biofortification – Definition, Need and methodology used, Micronutrients in biofortification – Zinc, Iron and carotene. Applications of neutraceuticals & functional foods. FSSAI regulation on neutraceuticals and functional foods.

REFERENCES: -

1. Wildman, R.E.C. (2007) Handbook of Nutraceuticals and Functional Foods, second edition. CRC Press.
2. Gibson GR & William CM. Functional Foods - Concept to Product. 2000.
3. Goldberg I. Functional Foods: Designer Foods, Pharma Foods. 2004.
4. Brigelius-Flohé, J & Joost HG. Nutritional Genomics: Impact on Health and Disease. Wiley VCH. 2006.
5. Cupp J & Tracy TS. Dietary Supplements: Toxicology and Clinical Pharmacology. Humana Press. 2003.
6. Chaudry, Qasim, Laurence, Watkins, Richard Nanotechnologies in food — 1st edition., 2010.

B21HC0303	Food Microbiology	L	T	P	C
Duration: 2 hrs/wk		2	1	0	3

Prerequisites:

Elementary knowledge of Microbes, Food & Nutrition

Objectives:

1. To provide a working knowledge of the important concepts in food microbiology
2. To gain idea and application of Microbiology in food industry, food sanitation and public health research**.**

Course Outcomes: After completing the course the student shall be able to

CO1. List the important microorganisms involved in food &describe the intrinsic and extrinsic factors affecting the growth of micro-organisms in food, various sources of contamination and principles of food spoilage

CO2. Spoilage of cereals, sugar products, vegetables, fruits, meat and meat product, milk and milk products, fish and sea food, spoilage of canned foods).

CO3. Describe the principles and methods of food preservation.

CO4. Explain the pathogenicity of bacteria involved in food borne infections. significance of Mycotoxins: aflatoxins, various health hazards of food in relation to health and sanitation (Food control agencies and their regulation).

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
B21HC0303	CO1	3	3	2	3	1	1	2	3			1		2
	CO2	3	3	2	3	1	1	2	3			2	1	2
	CO3	3	3	2	3	1	1	2	3			2	1	1
	CO4	3	3	2	3	1	1	2	3			1	1	2

Course Content: **Total Hours: 48 hrs**

UNIT-I

12 Hrs

Importantance of Microorganisms in food microbiology – Mold, Fungi, Algae, Bacteria and Virus – general characteristics. Contamination of foods – green plants and fruits, animals, sewage, soil, water, air during handling and processing. Spoilage – cause, classification, factors affecting kinds and numbers of microorganisms in food.

UNIT-II

12 Hrs

Spoilage of different groups of foods – cereal and cereal products, vegetables and fruits, meats and meat products, fish and other sea foods, eggs, poultry, milk and milk products and canned foods.
Bacterial agents of food borne illness – Clostridium botulinum, Escherichia coli, Salmonella, Shigella and Staphylococcus - The organism, pathogenesis and clinical features and association with foods.

UNIT III

12 Hrs

Food preservation – Methods and principles of food preservation, delay of microbial decomposition, prevention of microbial decomposition, removal of micro-organisms.

Preservation by use of high temperatures – Factors affecting heat resistance of microorganisms, commercial heat preservation methods –sterilization, canning, pasteurization, blanching.
Preservation by use of low temperatures – Growth of microorganisms at low temperatures, low temperatures storage – cellar, chilling and frozen.

UNIT IV

12 Hrs

Preservation by drying - Methods of drying, factors in control of drying, treatments of foods before and after drying. Preservation by chemicals.
Preservation by Irradiation – Microware radiation, Ultraviolet radiation and ionizing radiation.
Food borne Illness – Food hazards, significance of food borne disease, incidence of food borne illness, risk factors associated with food borne illness.
Bacterial agents of food borne illness – Clostridium botulinum, Escherichia coli, Salmonella, Shigella and Staphylococcus- The organism, pathogenesis and clinical features and association with foods. Significance of HACCP

REFERENCES:-

1. Adams M.R., Moss M.O., Food Microbiology, New age international publishers, New Delhi, 2015.
2. William C Frazier., Dennis C Westhoff., Food Microbiology, McGraw Hill education private limited, New delhi, 2014.
3. Sivasankar., Food Processing and Preservation, PHI Learning private limited New delhi, 2015.
4. Branen A.L. and Davidson, P.M. Antimicrobials in Foods. Marcel Dekker, New Delhi, 1983.
5. Jay J.M., Modern Food Microbiology. 3rd Edn. VNR, New York.utta. 1980 9th Edition, Prism Books Pvt. Ltd.,1986.

B21HC0304	Community & Public health Nutrition	L	T	P	C
Duration: 2 hrs/wk		2	1	0	3

Prerequisites:

Basic Knowlegde of Nutrition, Macro & Micro nutrients

Course Objective:

1. To study the basic concept of community nutrition and to learn the major nutritional problems, their prevention and control.
2. To know the nutrition program and policies working towards interests for public health nutrition in India and foreign countries

Course Outcomes: After completing the course the student shall be able to

CO1. Understanding the health status of population and methods of health promotion and disease prevention.

CO2. Gain knowledge on status of malnutrition, communicable and non-communicable diseases and their pathology**.**

CO3. Learn methods of communication and outreach to community.

CO4. To understand the concept of food and nutrition security.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0304	CO1	3	3	2	3	3	2	1	2			1	2	2
	CO2	3	3	2	3	3	2	1	2			2	2	2
	CO3	3	3	2	3	2	3	1	2			2	1	1
	CO4	3	3	2	3	2	3	1	2			2	2	1

Course Content: **Total Hours: 48 Hrs**

Unit -I **12 Hours**

Introduction: Meaning and scope of public health nutrition, multidisciplinary approach of public health nutrition, concept of food security, nutrition monitoring nutrition surveillance, health economics, Assessment of nutritional status in the community setting: methods: anthropometric methods, biochemical methods, clinical methods: dietary methods.

Unit- II **12 Hours**

Malnutrition: Etiology, prevalence, vicious cycle of malnutrition, economics of malnutrition, Major nutritional problems: prevalence at national and international level, epidemiological factors, prevention and control of IDA, Vitamin A deficiency (VAD), IDD, Coronary heart disease,and obesity. Hypertension, Diabetes Mellitus, Diarrhoea, Prevalence of Zn and Cu deficiency

Unit -III **12 Hours**

Communication to reach community: concept of communication, elements of communication, channels of communication, functions of communication, methods of communication: demonstration, exhibition, preparation of audio-visual aids, concept of IEC (Information, Education and Communication) and BCC (Behaviour Change Communication)

Unit -IV **12 Hours**

Food Security: Nutrition Security, determinants of food security, different levels (national, household and individual), Major factors of food access (Population, food policies and national economy). Role of Government in maintaining Food security.

National Nutrition Programme- objectives and functions of NNP, ICDS, NIDDCP, SFP, Vitamin A Prophyaxis programme, **Organisation to combat Malnutrition**: Objectives abd functions of National agencies- ICMR, NIN, CFTRI, DFRI and International agencies- FAO, WHO, UNICEF

Nutrition monitoring- Objectives and components: Population and key indicators, Objectives and function of NNMB, NFHS, NSSO. **Nutrition surveillance**- Objectives and uses of Nutrition Surveillance system (NSS)

REFERENCES: -

- Park and Park (2015), Preventive and Social Medicine 23rd Edition Bhanot Publisher
- Shubhangini A Joshi (2011), Nutrition and Dietetics, with Indian Case Studies, 3rd Edition Tata McGraw Hill Publication, New Delhi
- Edited by Michael J. Gibney, Barrie M.Margetts, John M. Kearney, Lenore Arab (2004), Public Health Nutrition, Wiley-Blackwell publication.

B21HC0305	Clinical Nutrition-1	L	T	P	C
Duration: 3 hrs/wk		2	1	0	3

Prerequisites:

Elementary knowledge of RDA, EAR, meal planning

Course Objective:

1. To understand the basics of clinical nutrition.
2. To know the diet therapy for infection, fever, gastro-intestinal disorders, cardiovascular disorders, liver disease, burn & weight management.

Course Outcome: After completing the course the student shall be able to

CO1: Learn basic concepts of diet therapy and planning of therapeutic diets.

CO2: Gain knowledge about dietary modifications in various disease conditions.

CO3: To understand nutritional requiremtns and dietary modifications in weight management and surgical condition.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0301	CO1	3	2	1	3	1	1	2	2			2	2	1
	CO2	3	2	2	3	1	1	2	2			1	2	2
	CO3	3	3	3	2	2	2	3	3			1	2	2
	CO4	2	3	3	3	2	2	3	3			2	2	1

Course Content: **Total Hours: 48 hrs**

UNIT – I

12 Hours

Nutritional assessment in clinical conditions:

Introduction, definition, objectives, basic concepts of diet therapy, factors to be considered in planning therapeutic diets

Nutritional assessment in clinical setting, planning of therapeutic diets, the dietitian: Role of dietitian: The hospital & community, code of ethics, responsibilities, the dietitians in India, Indian dietetic Association, Nutrition & diet clinics - Patient's checkup and dietary counseling, educating the patient and follow up. Routine hospital diets – Modifications of Regular diet- Liquid diet (clear liquid & full liquid), soft diet, bland diet, Tube feeding: composition, osmolarity, types of formula, mode of feeding, Parenteral nutrition: PPN, TPN

UNIT – II

12 Hour

Modification of diet in Infections – A. Nutrition during Febrile Disorders: a) Classification of fevers b) Metabolism c) General Dietary Considerations d) Acute & chronic fevers -Typhoid & Tuberculosis **Diet for gastro intestinal disorders-** General Dietary Considerations for healthy gut **Peptic Ulcer Disease –** Etiology, Symptoms, Dietary Management **Intestinal Diseases –** irritable bowel syndrome (IBS), Constipation, Diarrhea.

Diseases of the Small Intestine – Celiac Disease – Gluten Sensitive Enteropathy, Tropical Sprue, Lactose Intolerance, Inflammatory Bowel Disease - Crohn's Disease, Ulcerative Colitis,

Anaemias: General concept, aetiology, classification, and dietary management of Nutritional anaemia.

UNIT – III

12 Hours

Diet for weight management: Assessment of obesity – BMI, Waist Hip-Ratios, Skin folds Thickness, Etiology – Genetic Factors, Physiological Factors, Behavioral factor, complications of obesity, Treatment – Dietary Management, Fad diets and their consequences, Underweight – Etiology, Health hazards, Treatments.

Nutritional problems in infants - Preterm baby- nutritional requirement, feeding problems, management. Problems related to weaning: obesity, underweight, food allergy, refusal to take new foods, choking, diarrhoea, and nutritional problems in old age-osteoporosis, neurological disorders, anaemia, constipation, nutritional problems of adolesecents- eating disorders - Addictive behaviour in annorexia, nervosa, bulimia & alcoholism. Nutritional problems during pregnancy- Anaemia, constipation, oedema, Pica, pregnancy induced Hypertension, Gestational diabetes.

UNIT – IV

12 Hours

Diet for liver disease: Hepatitis: Types, Etiology, Symptoms, treatment, Cirrhosis: Etiology, Clinical Symptoms, Treatment, Hepatic Encephalopathy: Etiology, Clinical Symptoms, Treatment, Diseases of the Gall Bladder: (brief) Cholecystitis and Cholelithiasis,

Nutrition in burns: classification, stages, dietary management in flow phase and anabolic phase

surgical conditions-Pre and post operative conditions, special nutritional requirements**,**

REFERENCES:

1. Antia, F.P. (2005): Clinical Nutrition and Dietetics, Oxford University Press, Delhi
2. Mahan, L.K., Arlin, M.T. (2000): Krause's Food, Nutrition and Diet therapy, 11th edition, W.B.Saunders Company, London.
3.
4. Robinson,C.H;Lawler,M.R.Chenoweth,W.L;and Garwick,A.E(1986):Normal and Therapeutic Nutrition,17th Ed., Mac Millan Publishing Co
5. Shubhangini A Joshi (2002): Nutrition and Dietetics2nd edition, Tata Mc Graw-Hill Publishing Company Limited, New Delhi.
6. Srilakshmi,B.(2005):Dietetics,5th edition, New Age International(P) Limited Publishers, New Delhi
7. Williams's (1989): Nutrition and diet Therapy.6th edition. Times Mirror/Mosby College Publishing, St.Louis.

B21HC0306	**Food Microbiology**	L	T	P	C
Duration: 2 hrs/wk	**Practicals**	0	0	2	2

Prerequisites:

Elementary knowledge of Microbes, Food & Nutrition

Objectives:

1. To provide a working knowledge of the important concepts in food microbiology
2. To gain idea and application of Microbiology in food industry, food sanitation and public health research**.**

Course Outcomes: After completing the course the student shall be able to

CO1. Identify and use techniques of microbial growth, factors affecting the growth of micro-organisms in food, various sources of contamination and principles of food spoilage

CO2. Prepare special and nurients media suitable for growth of different microbes

CO3. Explain the different techniques used for microbial examination of food

CO4. Identify & describe the principles and methods of food preservation.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0306	CO1	1	2	3	3	1	1	1	1	1	1	3	1	1
	CO2	2	1	3	3	1	3	2	1	1	--	3	1	1
	CO3	2	2	3	1	1	2	2	2	1	--	3	1	1
	CO4	2	1	3	3	2	2	1	3	--	1	3	1	1

Course Content: **Total Hours: 3Hrs/Wk**

Experiments: -

1. Study of equipments in a microbiology lab.
2. Basic microbiological techniques.
   a. Cleaning and sterilization of glassware.

b. Preparation of nutrient media, cultivation of bacteria, yeasts and moulds.

c. Plating techniques, isolation of micro-organisms by std. plate count.

3. Staining of bacteria: gram-staining.

4. Microbial analysis of food samples-water, milk and its product, fruits and vegetables, canned foods etc

5. Demonstration of available rapid methods and diagnostic kits used in identification of microorganisms or their products.

6. Visits to one food processing units or any other organization dealing with advanced methods in food microbiology.

B21HC0307	Community & Public Health Nutrition Practical	L	T	P	C
Duration: 2 hrs/wk		0	0	2	2

Prerequisites:

Basic Knowlegde of Nutrition, Macro & Micro nutrients

Course Objective:

3. To study the basic concept of community nutrition and to learn the major nutritional problems, their prevention and control.
4. To know the nnutrition program and policies working towards interests for public health nutrition in India and foreign countries

Course Outcomes: After completing the course the student shall be able to

CO1. Preparing and demonstrating of audio-visual aids contributing to health promotion and disease prevention using clinical, dietary, anthropometric and biochemical measures.

CO2. describe the major causes, impact, Prevention and treatment of Malnutrition, communicable and non-communicable diseases and their pathology**.** and clear understanding about the concept of health care delivery at different levels in a community.

CO3.familiar with concept, elements, channels, functions, methods of communication: demonstration, exhibition in a community

CO4.identify, assess, monitor and evaluate the impact of public health programs through visit to a Community setting working to combat Nutrition related Problems(school/ anganwadi/old age home)

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0307	CO1	1	1	3	3	1	1	1	1	--	1	3	1	2
	CO2	3	1	2	2	1	2	2	1	--	1	3	2	3
	CO3	2	2	3	2	1	2	1	2	1	--	3	2	2
	CO4	2	1	2	3	1	3	2	3	--	--	3	1	2

Course Content: **Total Hours: 3Hrs/Wk**

Experments:

1. Preparation and demonstration of audio-visual aids: poster, bar diagram, pie diagram, flash card, flip chart, pull chart, tree chart, power point presentation etc.
2. Assessment of nutritional status by anthropometric methods.
3. Assessment of nutritional status by dietary methods.
4. Planning and preparation of indigenous low cost, nutritious recipe suitable for various vulnerable group
5. Planning and organizing a demonstration/exhibition
6. Visit to community setting working to combat nutrition related Problems: school/ anganwadi/ old age home

B21HC0308	Clinical Nutrition-I Practical	L	T	P	C
Duration: 3 hrs/wk		0	0	2	2

Prerequisites:
Elementary knowledge on RDA, EAR, basic dietary principles of different disease conditions.

Course Objective:

3. To understand the basics of clinical nutrition.
4. To know the diet therapy for infection, fever, gastro-intestinal disorders, cardiovascular disorders, liver disease, burn & weight management.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0308	CO1	1	1	3	3	1	1	1	2	--	1	3	2	2
	CO2	2	2	3	2	1	3	2	1	--	--	3	3	2
	CO3	2	2	3	3	1	3	2	2	--	--	3	3	3
	CO4	2	1	2	3	2	2	1	3	--	--	3	2	3

Course Content: **Total Hours: 3 hrs/ Wk**

Experiments: -

1. Planning and preparation of following diets:
    a. Regular diet.
    b. clear Liquid diet
    c. full liquid diet
    d. soft diet
    e. High and low caloric diet
    f. Low Fibre & residue diet

2. Planning, preparation and calculation of day's diet for following conditions
    a. acute and chronic febrile condition

    b. obesity & underweight,
    c. Peptic ulcer
    d. diarrhoea, constipation

3. Planning, preparation and calculation of day's diet for following conditions
    a. Hypertension and Atherosclerosis
    b. Viral hepatitis and cirrhosis

4. Planning, preparation and calculation of day's diet for following conditions
a. Low-cost diet for P.E.M

b. Anemia
c. vitamin A deficiency

SEMESTER IV

Course Code	Duration	Course Title	L	T	P	C
B21HS0401	16 weeks	**Environmental Science & health**	2	0	0	2

Prerequisite:

Basic knowledge of Environmental Science studied at higher secondary & school level.

Course Objectives:

1. Influence the new patterns of behaviors of individuals, groups and society as a whole towards theenvironment

2. List the knowledge values, attitudes, commitment and skills needed to protect and improve the environment

Course Outcomes: After completeing this course, the student will be able to**:**

CO1. Discuss Foster clear awareness and concern about economic, social, political and ecological interdependence in urban and ruralarea Adapt the environmental conditions and protectit

CO2. Estimate the role of individual, government and NGO in environmentalprotection**.**

CO3. Interpret the new renewable energy resources with high efficiency throughactive research. throughactive research.

CO4. Analyze the ecological imbalances and protectit

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HS0401	CO1	2	1	1	1				2			2	1	1
	CO2	2	1	2	1	2			2			2	2	2
	CO3	3	2	1	1		1					2	2	2
	CO4	2	1	2	1	2			1			2	1	2

Course Content: **Total Hours: 48Hrs**

Unit-I: **12 hrs**

Linkages Between Environment and Health: Understanding linkages between Environment and Public Health Effect of quality of air, water and soil on health. Perspective on Individual health: Nutritional, socio –cultural and developmental aspects, Dietary diversity for good health; Human developmental indices for public health.

Unit-II: **12 hrs**

Climate Change and Implications on Public Health: Global warming – Agricultural practices (chemical agriculture) and Industrial technologies (use of non-biodegradable materials like plastics, aerosols, refrigerants, pesticides): Manifestations of Climate change on Public Health-Burning of Fossil fuels, automobile emissions and Acid rain. *Environmental Management Policies* and *Practices.* Municipal solid waste management: Definition, sources, characterization

collection and transportation and disposal methods. Solid waste management system in urban and rural areas. Municipal Solid waste rules.

Policies and practices with respect to Environmental Protection Act, Forest Conservation Act,Wild life protection Act, Water and Air Act, Industrial, Biomedical and E waste disposal rules.

Unit-III: **12hrs**

Diseases in Contemporary Society: Definition – need for good health- factors affecting health. Types of diseases – deficiency, infection, pollution diseases-allergies, respiratory, cardiovascular, and cancer Personal hygiene-food – balanced diet. Food habits and cleanliness, food adulterants, avoiding smoking, drugs and alcohol.

Communicable diseases: Mode of transmission –epidemic and endemic diseases. Management of hygiene in public places – Railway stations, Bus stands and other public places. Infectious diseases:

Role of sanitation and poverty case studies on TB, diarrhea, malaria, viral diseases. Non-communicable diseases: Role of Lifestyle and built environment. Diabetes and Hypertension.

Unit-IV: **12 hrs**

Perspectives and Interventions in Public Health: Epidemiological perspective – Disease burden and surveillance; Alternative systems of medicine – Ayurveda, Yoga, Unani, Siddha and Homeopathy (AYUSH); Universal Immunization Programme (UIP); Reproductive health-Youth Unite for Victory on AIDS (YUVA) programme of Government of India. Occupational health hazards-physical-chemical and biological, Occupational diseases-prevention and control.

REFERENCES:-

1. Bridge, J. & Demicco, R. 2008. Earth Surface Processes, Landforms and Sediment deposits. Cambridge University Press.
2. Duff, P. M. D. and Duff, D. (Eds.). 1993. Holmes' Principles of Physical Geology. Taylor & Francis.
3. Gupta, A. K., Anderson, D. M., & Overpeck, J. T. 2003. Abrupt changes in the Asian southwest monsoon during the Holocene and their links to the North Atlantic Ocean. Nature 421: 354-357.
4. Gupta, A. K., Anderson, D. M., Pandey, D. N., & Singhvi, A. K. 2006. Adaptation and human migration, and evidence of agriculture coincident with changes in the Indian summer monsoon during the Holocene. Current Science 90: 1082-1090.
5. Leeder, M., & Arlucea, M.P. 2005. Physical Processes in Earth and Environmental Sciences.Blackwell Publishing.
6. Pelletier, J. D. 2008. Quantitative Modeling of Earth Surface Processes (Vol. 304). Cambridge: Cambridge University Press. Chicago.

B21HC0402	**Food Service Management**	L	T	P	C
Duration: 2 hrs/wk		2	1	0	3

Prerequisites:

Basic knowledge of management

Course Objective:

1. To develop knowledge in the areas of institutionl food service management.
2. To understand the process of planning, organizing and controlling the management of food and other resources in food service institutions.

Course Outcomes: After completing the course the student shall be able to

CO1. Understand concept of management food service industry, welfare and transport industry.
CO2. Acquire knowledge on Layout of kitchens and types of kitchens.
CO3. Learn about Quantity food service, equipments and menu planning
CO4. Get a concept of Resource management, Personnel management, Sanitation and safety

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0404	CO1	3	1	1	1	1	1	1	--			1	1	2
	CO2	3	1	1	2	1	1	2	--			2	2	1
	CO3	2	3	2	2	--	1	2	--			1	1	2
	CO4	1	3	3	3	--	1	2	--			2	1	1

Course Content: **Total Hours: 48 Hrs**

UNIT- I

12Hrs

Management-Definition, function, principles, tools of Management- Tangible tools(organization chart, job specification, work schedule, job analysis, budget), Intangible tools(Personality, experiences, decision making and quality of working life) TQM(concept of qulity assurance

Food service industry: Definition – types of catering Formal, semi formal, non formal- Hotel, Motel, Restaurant, Cafeteria and chain hotels.

Welfare – Hospital, School lunch, Residential establishment and Industrial catering.

Transport – Air, Rail, Sea and Space, Miscellaneous – Contract and outdoor.

UNIT – II:

12Hrs

Physical plant and food purchase

Layout of kitchens, types of kitchens – Planning of Receiving preparation, storage and service area with relevant too spacing. Catering equipments, classification based on mode of operation,

Food purchase- Procedures and Factors involved in the selection of food.

Costing- concept of cost, components Material, employee, overhead,)behaviour of cost(fixed, semi fixed, variables), concept of break- even and cost benefit ratio, cost control- food, labour, overhead, hidden cost, pricing of dishes

UNIT – III:

12Hrs

Quantity food service and equipments

Quantity food service: Definition, objectives, styles of service- waiter service, self – service, vending. Mechanics of waiter service.

Equipment: Classification, factors involved in selection, use and care of major equipments, traditional and modern equipment.

Menu planning: Origin of menu, importance of menu planning. Types of menu- table d'hote menu, a la carte, Dujour, theme, static, cycle. French classical menu, food served in kiosk, use of menu, construction of menus, Menu Design, Factors affecting menu planning. Standardisation of Recipes and portion control.

UNIT – IV

12Hrs

Management- Definition, principles, Functions and tools of management, qualities of a good leader, styles of leadership.

Resource management – Money, Time, Energy, Computer applications in menu planning.

Personnel management- Recruitment, selection and induction. Financial management- Cost control- methods of food cost control, Book- keeping; advantages of the double entry system.

Sanitation and safety – Sanitation of Plant and Kitchen Hygiene, Personal Hygiene, First aid principles and practice, Health and Safety at at work. Use of fire extinguishers.

REFERENCES :-

1. Kaufman, R. Mega planning- Practical tools for Organisational Success, Sage Publications Inc, 2000.
2. Shring Y, P. Effective Food Service Management, Anmol publications Pvt Ltd,New Delhi, 2001. 3. Stephen, B, Williams, S, R, "Bill Jardine, and Richard, J, N, Introduction to Catering,
3. Ingredients for Success, Delmar- Thomson learning, 2001.
4. Yadav, C, P. Management of Hotel and Catering Industry, Anmol publications Pvt
5. Ltd and Institute of sustainable development, Lucknow, New Delhi, 2001
6. Mohini Sethi and Surjeet Malham, "Catering Management – an integrated approach", 2nd edition, Wiley Eastern Limited, New Delhi, Reprint 2007.

Course Code	Duration	Course Title	L	T	P	C
B21HC0403	**16 weeks**	**Food Product Development and Quality control**	2	1	0	3

Prerequisite:

Basic knowledge on Food Product and ways to improvise them

Course objectives:

1. To Demonstrate knowledge of principles of menu planning through creating an appropriate menu for institutional feeding to meet needs of target population

Standardized Recipes

1. Discuss need for Quantity Food Production Techniques, Terminology, and Equipment, to apply the principles of sanitation and safety to foodservice, and recognize the impact on consumers

Course outcomes: After completing the course the student shall be able to

CO1. Demonstrate the ability to plan nutritient enhanced products.

CO2. Understand the development of new food product and organoleptic testing panels.

CO3. To gain knowledge on Sensory Evaluation Tests.

CO4. Gain market acceptance factors Regulations in quality control.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0403	CO1	1	3	2	2	--	1	2	--			2	1	1
	CO2	1	3	3	2	--	--	1	--			2	2	1

	CO3	2	3	2	3	--	--	--	--			1	1	2
	CO4	2	3	2	3	--	--	--	--			1	1	2

Course Content: **Total Hours: 48Hrs**

UNIT-I **12 hours**

New food product- Definition, Food needs and consumer preference: need for new products, factors shaping new product development- social concern, health concern, impact of market place influence and technology. Information required prior to launching a new product. Designing new products -- new food product development process and activities; Planning stages, Prerequisites of a successful product development, the concept of added value

UNIT-II **12 hours**

Food product development tool: Organoleptic testing panels- export profile panels, primary sensory panels and secondary sensory panels; Research guidance panels- purpose, panel organization, utility of results. Product Development and Quality Evaluation -- Standardization of food products (laboratory level, Scaling up, Understand sale and profit margin), Shelf life studies – chemical and microbiological parameters

UNIT-III **12 hours**

Sensory Characteristics of Food and Selection of Panel -- Colour, Texture, Consistency, Taste and odor; Effect of temperature on sensory characteristics of foods; Panels for Sensory Evaluation Types of panels, Training the panel members, Number of panel members for different tests); Types of Sensory Evaluation Tests -- Discriminative / Difference Test, Quality Test, Rating Test, Food Samples for Evaluation, Quality control: Need, role of government and industry in quality control, design of company quality assurance program, objectives of quality assurance activity, raw material quality assurance, in-process quality assurance and finished product quality assurance,

UNIT-IV **12 hours**

Advertisement and Marketing -- product performance testing; market positioning, marketing; developing test market strategies, various tools and methodologies to evaluate consumer attitudes, preferences and market acceptance factors Regulations in quality control: FAO/WHO Codex Alimentarious commission, PFA, AGMARK, BIS, FPO, CPA, fair average quality (FAQ) specifications for food grains, ISO 9000 series; HACCPbackground, principles, benefits and limitations; FSSAI

REFERENCES :-

1. Norman W. Desroisier, James N. Desrosier, The Technology of Food Preservation, fourth edition, CBS Publishers and distributors, Delhi.
2. Mark Clute, Food Industry Quality Control Systems, CRC Press, 2008.
3. Inteaz Alli, Food Quality Assurance: Principles and Practices, CRC Press, 2003.

Course Code	Duration	Course Title	L	T	P	C
B21HC0404	16 weeks	**Bakery Science**	2	1	0	3

Prerequisite:
Basic knowledge of Food Science Principles

Course objectives:

1. To Demonstrate knowledge of food science principles in baking industry to meet needs of target population using Standardized Recipes
2. Discuss need for developing Bakery products using advanced relevant technology

Course outcomes: After completing the course the student shall be able to

CO1. Know types of baked and confectionary products and equipments used in it.

CO2. Understand principles involved in the yeast product preparation and pastries.

CO3. Learn about Principles involved in the preparation of cake, Types and Preparation Methods Butter cream – royal icing, American frosting, preparation Methodsof Pastries

CO4. Gain knowledge on preparation, methods for mixing of cookies, types, faults and remedies in baked biscuits and cookies.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0402	CO1	3	3	2	2	1	2	2	2			2	2	1
	CO2	3	3	2	2	1	3	2	2			1	1	2
	CO3	3	3	1	2	1	2	3	3			2	1	2
	CO4	3	3	1	2	1	3	3	3			2	1	1

Course Content: **Total Hours: 48Hrs**

UNIT- I **12 hours**

Introduction of bakery–definition, principles, types of baked and confectionary products. Major and minor equipment – required to start a small bakery unit. Major and minor ingredient in baking
a) Major ingredients – flour, fat, sugar and leavening agent – types, role in bakery
b) Minor ingredients – milk, water, salt – types, role in bakery

UNIT -II **12 hours**

BREAD: a) Principles involved in the yeast products preparation, methods – straight dough method, salt delayed method, no dough time method, sponge and dough method, ferment and dough method.
b) Processing – flying fermentation, bulk fermentation, knock back, dividing and rounding, intermediate proofing, molding and panning, final proofing, baking, depanning, cooling, slicing, packaging.
c) Faults and remedies in baked bread, types of bread improvers.

UNIT- III **12 hours**

CAKE: a) Principles involved in the preparation of cake, sponge cake – types (fatless sponge, Genoese sponge, plain sponge, gel sponge).

b) Methods – sugar batter method, flour batter method, blending method, boiling method, sugar water method, all-in process method (slow speed, medium speed, fast speed), foaming method.

c) Faults and remedies in baked cakes

ICING –Types and Preparation Methods Butter cream – royal icing - almonds paste (or) marzipau – fondant icing – gum paste (or) pastillage – American frosting – water icing (or) glace icing.

PASTRIES and preparation Methods Pastries – types, short crust pastry – puff pastry – flaky pastry – philo (or) filo pastry – choure pastry – punish pastry – faults and their causes in making pastry

UNIT- IV **12 hours**

BISCUITS AND COOKIES: a) Principles involved in cookies preparation, methods for mixing cookies – single or one stage method, creaming or sugar batter method, blending or rub in method, foaming method, flour batter method.

b) Types – sheeted types, piped types, bar types, dropped types, rolled types

i. Different between biscuits and cookies

ii. Faults and remedies in baked biscuits and cookies

REFERENCES: -

1. Wayne Gisslen, The Professional Baking, Sixth Edition, Publishers John Wiley & Sons (2012).
2. Pat Sinclair, Basic Baking, Publisher Agate (2006).
3. John Kingslee, Professional Text to Bakery and Confectionary, First Edition, New Age International (P) Limited Publishers (2006).
4. Yogambal Ashokkumar Theory of Bakery and Confectionery, Fifth Edition, PHI Learning Private Limited, New Delhi (2009).

Course Code	Duration	Course Title	L	T	P	C
B21HC0405	**16 weeks**	**Food Packageing**	2	1	0	3

Prerequisite:

Basic knowledge of Nutrition

Course objectives:

1. To Demonstrate knowledge of principles of Food packaging
2. Discuss need for Quality Food Packaging Techniques, Terminology, and Equipment, to apply the principles of Packaging to foodservice, and recognize the impact on consumers

Course outcomes: After completing the course the student shall be able to

CO1. Learn the functions of packaging and usage of various packaging materials.

CO2. Understand the usage of Plastic, Papers, Aseptic packaging.

CO3. To know the types of packaging**.**

CO4. Understand the applications of nanotechnology in food packaging and its benefits.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0401	CO1	3	3	3	3	1	1	3	2			2	1	1
	CO2	3	2	1	3	1	3	1	3			2	1	2
	CO3	3	1	1	3	1	3	1	2			2	2	1
	CO4	3	3	3	3	1	3	2	3			1	1	2

Course Content: **Total Hours: 48Hrs**

UNIT-I

12Hrs

Food packaging- Definition, functions and levels of packaging.

Packaging materials: Introduction, purpose, requirements and characteristics of packaging materials. Packaging materials for processed foods: Metal cans- Types and their recommended uses. Glass containers- Characteristics, advantages and surface treatments.

UNIT-II

12Hrs

Plastics: General properties, pack requirements, applications, types of packaging plastics- PET, HDPE, PVC, LDPE, PP and PS; plastic films- types and applications; advantages of usage of plastic in food packaging; shrink and stretch films- properties, advantages and disadvantages.

Papers: Types, uses in packaging; corrugated board and solid fiber board- introduction.

Aseptic packaging: Introduction and heating systems involved

UNIT-III

12Hrs

Modified atmosphere packaging (MAP): Definition, gases used in MAP, types and active packaging. Microwave enable packages: Meaning and advantages.

Retortable packages: Types and advantages. Packaging of cereals: Storage of wheat, rice, breakfast cereals and pasta. Packaging of dairy products: Packaging materials used in dairy industries.

Packaging of fruits and vegetables: Packaging of fresh produce and packaging of minimally processed fruits and vegetables. Packaging of meat: Packaging of fresh meat, poultry and eggs

UNIT-IV

12Hrs

Application of nanotechnology in food packaging and its benefits. Future of food packaging: Smart packaging and activated packaging; RFID tags in packaging, intelligent packaging, self heating and

self chilling packages. Labeling: Definition, purpose, types, materials used, regulations, recent trends, thermo chromic labeling.

REFERENCES

1. NIIR Board of consultants and engineers, Food packaging technology, Hand book, NIIR, Delhi.
2. Neelam Khetarpaul and Darshan Punia, Food Packaging, Daya publishing house, New Delhi. 2012.
3. Vijaya Khader, Text book of food science and technology, Indian council of agricultural research, New Delhi, 2001.

Course Code	Duration	Practicals	L	T	P	C
B21HC0405	16 weeks	**Bakery Science Practical**	0	0	2	2

Prerequisite:
Basic knowledge of Food Science Principles

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
B21HC0405	CO1	1	2	3	3	1	1	1	1	1	1	3	1	1
	CO2	2	1	3	3	1	3	2	2	2	1	2	1	1
	CO3	2	2	3	1	1	2	2	2	1	--	3	1	1
	CO4	2	1	3	3	2	2	1	3	1	1	3	1	1

Course Content: **Total Hours: 3Hrs/ wk**
Experiments:

1. Preparation of pizza base and assessment of its quality
2. Preparation of bread and assessment of its quality
3. Preparation of buns and assessment of quality
4. Preparation of butter cake and assessment of its quality.
5. Preparation of sponge cake with icing and assessment of its quality.
6. Preparation of biscuit and assessment of quality.

Course Code	Duration	Practicals	L	T	P	C
B21HC0406	16 weeks	**Food Product Development Practical**	0	0	2	2

Prerequisite:
Basic knowledge on Food Product and ways to improvise them

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
B21HC0406	CO1	1	1	2	3	2	1	1	2	1	1	2	2	2

	CO2	2	2	3	2	2	3	2	1	1	--	3	3	2
	CO3	2	2	1	3	1	2	2	2	1	1	3	3	3
	CO4	2	1	2	2	3	2	1	3	1	1	3	2	3

Course Content: **Total Hours: 3Hrs/ wk**

Experiments:

1. Market survey to identify the concepts of new products based on special dietary requirements, functionality, convenience and improvisation of existing traditional Indian foods.
2. Development of new product and Standardization of formulation process.
3. Proximate Analysis of New Product
4. Training of sensory panel to perform sensitivity tests for four basic tastes
5. sensory evaluation of new Product
6. Packaging, labeling and shelf-life studies
7. Cost analysis and Final Project Report

B21HC0407	**Food Service Management**	L	T	P	C
Duration: 2 hrs/wk	**Practicals**	**0**	**0**	**2**	**2**

Prerequisites:

Basic knowledge of management

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0407	CO1	1	1	2	3	1	1	1	2	1	1	3	2	2
	CO2	2	2	3	2	2	3	2	1	--	--	3	3	2
	CO3	2	2	3	3	1	3	2	2	1	1	3	3	3
	CO4	2	1	2	2	3	2	1	3	--	1	3	2	3

Course Content: **Total Hours: 3Hrs/Wk**

Experiments: -

1. Visit to a food service institution (Commercial and Charitable) and Preparation of a report on that
2. Survey on types of equipments used in food production and service area
3. Plan a menu for hospital food service for patients (Waiter service)
4. Plan a menu for Industrial canteen (Table de Hote Menu)
5. Plan a menu for Five star hotel (A -la -carte Menu)
6. Plan a menu for College hostel (A week's cyclic menu)
7. Plan a menu for Preparation of Market list, cost and selling price calculation of a given lunch
8. Practice and demonstrate any four types of serviettes folding

9. Plan a menu for Table setting and formal service for
10. Plan a menu for Indian Lunch/ dinner of North India cuisine & South India cuisine.

SEMESTER V

Course Code	Duration	Course Title	L	T	P	C
B21HC0501	**16 weeks**	**Nutrition for Sports and Exercise**	2	0	0	2

Prerequisites:

Prior knowledge of Nutrition, Sports types

Course Objectives:

To learn the relationship between Physical fitness & Nutrition

To study the nutritional requirement of Athletes & Fitness enthusiasts

Course Outcomes: After completing the course the student shall be able to

CO1. Learn different Physical activity, Body composition and their relation to Nutrition

CO2. Gain Knowledge on Utilisation of Carbohydrates & Protein in different phase of Sports Specific preparatory phase, Competition phase, Transition phase, Injury and rehabilitation phase - Pre-competition - Post competition condition.

CO3. Acquire ideas on Role of Lipids & Electrolytes in Sports Performance

CO4. Learn about ergogenic aids, Fluid replacement, requirements of female athletes, sports related complications

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
B21HC0501	CO1	3	2	3	3	1	1	2	3			1	1	2
	CO2	2	3	2	3	1	1	2	3			2	2	1
	CO3	3	3	2	2	1	1	2	3			1	1	2
	CO4	2	3	1	3	1	1	2	3			1	2	2

Course Content: **Total Hours: 48Hrs**

Unit I

12hrs

Definition of physical fitness, Benefits of Fitness, Body's response to physical activity- Weight training, cardiorespiratory conditioning, muscle conditioning, Physical activity pyramid. Balanced fitness program. Energy cost of various physical activities including sports and exercise. Human Body Composition: Significance of studying body composition. Two

compartment and multiple compartment models. Methods of Assessment: Nutritional Anthropometry, BOD POD, Bioelectric impedance, DEXA, Whole body K counter. Factors affecting body composition: Age, Body weight, physical activity. Energy intake and energy expenditure - thermogenesis - SDA of foods - Pre competition Nutrition - Post competition nutrition

Unit II **12hrs**

Carbohydrates types - Simple sugars - complex carbohydrates - Glycemic index - Glycemic load - food sources - Muscle glycogen & performance - Consumption of carb (what, when & how much?) – carb loading - Carbohydrates in sports: - during training, during different phases of Preparation, General preparatory phase, Specific preparatory phase, Competition phase, Transition phase, Injury and rehabilitation phase - Pre competition Nutrition - Post competition nutrition. Protein - Amino acids, essential, non-essential - Types and quality of protein - Protein intake and performance - Daily protein requirement - Type of exercise and Protein requirements in sport - different type of sports and their protein requirement - Protein sparing - Protein intake (what, when and how much) - Protein in sports :- during training, during different phases of Preparation, General preparatory phase, Specific preparatory phase, Competition phase, Transition phase , Injury and rehabilitation phase - Pre competition Nutrition - Post competition nutrition

Unit III

12 hrs

Fat - types, Saturated and Unsaturated fats, Trans fatty acids - Essential Fats - Fat Intake (what, when and how much) - Cholesterol - Fats in sports :- during training, during different phases of Preparation, General preparatory phase, Specific preparatory phase, Competition phase, Transition phase , Injury and rehabilitation phase. Hydration - Pre competition Hydration, The Week before, the day before, on the day. Homeostasis: Fluid & Electrolyte Fluid loss - Sweat - Thermoregulation Core & Shell temperature - Effect of Climate & Environment - Dehydration & Performance - Assessing Fluid loss - Proper Pre-Hydration, Rehydration / fluid replacement (what, when & how much) - Electrolytes - Role of electrolytes in Muscular contraction- Electrolyte loss & exercise - Maintaining / Restoring electrolyte Balance - Sports &Energy drinks - Osmolality &osmolarity - Hypotonic, Isotonic, Hypertonic

Unit IV

12 hrs

Micronutrients- vitamins and minerals, Antioxidants, electrolytes - Definition of vitamins, Minerals - Fat soluble, Water soluble vitamins - Role of Vitamins - RDA - Deficiency - Vitamins and Performance - Minerals - Iron, calcium - RDA - Minerals role in Performance - deficiency - Iron deficiency - role of electrolytes in Sport & performance - Antioxidants - free radicals & exercise – Ergogenic aids: Definition of Ergogenic aids - Popular and famous Ergogenic aids Nutritional supplementation for performance enhancement Actions & side effects of steroids – Nutrition for female athlete - female athlete triad - eating disorders – athletic amenorrhea, Sports anemia, Weight imbalance - nutrition for preventing weight gain - nutrition for preventing muscle loss - nutrition for weight gain.

REFERENCES

1. Gordan.M. Wardlaw, Perspectives in Nutrition, fourth edition, Mc. Graw Hill companies. 1999.
2. Antia. F.P. and Philip Abraham, Clinical dietetics and Nutrition, fourth edition, Oxford University Press. 2002.
3. L. Kathleen Mahan, Sylvia Escott-stump, Krause's Food, Nutrition and Diet therapy, ninth edition, W.B. Saunders company., 1996.
4. Don Benordot, Advanced sports nutrition, second edition, Human Kinetics, 2012.
5. William D. McArdle, FrankL.Katch, Victor L. Katch: Exercise Physiology, Seventh edition-Nutrition, Energy and Human Performance 2010.
6. Heather Hedrick Fink, Lisa A. Burgoon, Alan E. Mikesky: Practical Applications in Sports Nutrition, 2nd edition 2009
7. Edward, H and Terjuny R.: Exercise Nutrition and Energy Metabolism, McMillan Pub.Co,1988.
8. Shils.M.E, Olson and Shike: Modern Nutrition in Health and Disease.

Course Code	Duration	Course Title	L	T	P	C
B21HC0502	16 weeks	**Food Processing**	2	1	0	3

Prerequisite:

Basic knowledge on Food chemistry & microbiology

Course objectives:

1. To gather knowledge in preveniting food contamination, food storage & transportation
2. To gain knowledge about turning food materials into attractive, commercial products, avoid food adulteration

Course outcomes: After completing the course the student shall be able to

CO1. Know about Scope and importance of food processing. Cereal Processing, Potato processing, Fish processing

CO2. understand Decortication processing of legumes, effect of processing of legumes on their nutrient composition and quantity and quality

CO3. Learn about Processing of oil seeds, packing and storage of fats and oils, change during storage of oils, Oil speciality products, processing oil seeds for food use

CO4. develop knowledge on processing of fruits and vegetables juice concentrates and powders, Processing of milk, Poultry and egg powder

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0502	CO1	3	2	2	1	--	1	--	--			1	2	2

	CO2	2	2	2	2	--	--	--	--			2	2	1
	CO3	3	1	1	2	--	1	1	--			1	1	2
	CO4	2	3	3	1	--	1	--	--			1	2	2

Course Content: **Total Hours: 48Hrs**

UNIT-I **12 hours**

Scope and importance of food processing. Cereal – processing of raw and parboiled rice and rice products- Puffing and flaking. Wheat and corn processing, Products of wheat and corn, Potato processing – potato chip, flakes and powder. Fish processing –canning, freezing, drying, salting, smoking and curing, uses of by-products

UNIT-II **12 hours**

Decortication processing of legumes, effect of processing of legumes on their nutrient composition and quantity and quality, quick cooking legumes, instant legume powders, legume protein concentrates, legume processing and storage of legumes.Meat processing - curing and smoking

UNIT III **12 hours**

Processing of oil seeds, packing and storage of fats and oils, change during storage of oils. Oil speciality products-margarine, mayonnaise, salad dressing and fat substitutes, Nutritional food mixes from oilseeds – processing oil seeds for food use, protein enriched foods

UNIT IV **12 hours**

Storage and handling of fresh fruits and vegetables, processing of fruits and vegetables juice concentrates and powders, by- products from fruits and vegetables waste. Canning process of fruits and vegetables. Cultivation of mushroom and its processed products.

Processing of milk, manufacture of butter, paneer and cheese., Poultry and egg powder – processing and storage.

REFERENCES:-

1. Norman N. P. and Joseph H.H, Food science, CBS Publishing New Delhi, 1997.
2. Stadelman W.J., Olson V.M, Shemwell G.A and Parch S., Egg and poultry meat processing, Elliwood Ltd, 1998.
3. Subbulakshmi G., Shobha A. Udipi, Food processing and preservation, New age international Publisher, New Delhi, 2008.
4. Sivasankar B., Food Processing and Preservation, PHI Learning private limited, New Delhi, 2015.
5. Sumati R. Mudambi, M.V. Rajagopal., Fundamental of food, nutrition and diet therapy. New age international publishers, New Delhi, 2015.

Course Code	Duration	Course Title	L	T	P	C

B21HC0503	16 weeks	Basics of Bioinformatics	2	1	0	3

Pre-requisites:
basic knowledge of computers and mathematics.

Course Objective:
1. To understand the importance of computer science in Nutrition sciences.
2. To understand the tools, databases and softwares used in Nutrition data understanding and interpretation.

Course Outcomes: After completing the course the student shall be able to

CO1. Understand fundamental knowledge, features of computers and their application in Nutrition data processing, computer memory

CO2. Acquire knowledge on Computer hardware, software, Nutritional Indian database & its application

CO3. Learn about An overview of MS WORD, MS EXCEL and MS POWERPOINT. Elements of BASIC programming. Simple illustrations

CO4. Application aspects of bioinformatics, search engines and softwares used in Diet calculations and its application, Use of e- audiovisual aids and its application in nutrirtion education.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
B21HC0503	CO1	3	3	2	1	1	1	2	3			1	2	2
	CO2	2	3	3	2	1	1	2	2			1	1	2
	CO3	3	2	3	1	1	2	3	2			1	1	1
	CO4	2	3	2	1	1	1	2	2			2		1

Course Content: **Total Hours: 48Hrs**

UNIT – I **12 hours**

General features of a Computer. Generation of computers. Personal Computer, workstation, Mainframe Computer and super Computers. Computer applications – data processing, information processing, commercial, office automation, industry and engineering, healthcare, education, graphics and multimedia.

Computer organization. Central processing unit. Computer memory primary memory and secondary memory. Secondary storage devices – magnetic and optical media. Input and output units. OMR, OCR, MICR, scanner, mouse. Modem.

UNIT-II **12 hours**

Computer hardware and software. Machine language and high-level language. Application software. Computer program. Operating system. Computer virus, antivirus and Computer security. Elements of MS DOS and Windows OS. Computer arithmetic. Binary, octal and hexadecimal number systems. Algorithm and flowcharts. Illustrations. Elements of database and its applications.

UNIT – II **12 hours**

Word processing and electronic spread sheet. An overview of MS WORD, MS EXCEL and MS POWERPOINT. Elements of BASIC programming. Simple illustrations. Network of computers. Types of networks. LAN, Intranet and Internet. Internet applications. World Wide Web. E-mail, browsing and searching. Search engines. Multimedia applications.

UNIT-IV **12 hours**

Introduction and history of bioinformatics. Database browsers and search engines, Pathway Databases, Entry formats. Application aspects of bioinformatics, search engines and softwares used in Diet calculations and its application, Use of e- audiovisual aids and its application in nutrirtion education.

REFERENCES: -

1. Alexis Leon and Mathews Leon (1999): Fundamentals of information technology, Leon Techworld Pub.
2. Jain, S.K. (1999): Information Technology "O" level made simple, BPB Pub.
3. Jain, V.K. (2000): "O" Level Personal Computer Software, BPB Pub.
4. Rajaraman, V. (1999): Fundamentals of Computers, Prentice Hall India.
5. Hamacher, Computer Organisation, Mc Graw.
6. Sinha, Computer Fundamentals, BPB Pub.

Course Code	Duration	Course Title	L	T	P	C
B21HC0504	**16 weeks**	**Quality Food Service and physical facilities**	2	1	0	3

Prerequisite:

Basic knowledge on Food service and nutrition

Course objectives:

1. To Demonstrate knowledge of principles of menu planning through creating an appropriate menu for institutional feeding to meet needs of target population

Standardized Recipes

3. Discuss need for Quantity Food Production Techniques, Terminology, and Equipment, to apply the principles of sanitation and safety to foodservice, and recognize the impact on consumers

Course outcomes: After completing the course the student shall be able to

CO1. demonstrate the ability to plan nutritious, appealing food combinations and menu patterns that meet the needs of the defined clientele within economic and physical limitations of a food service facility.

CO2. understand the use of Space organization and storage of foods in limited sourse of equipments available

CO3. Learn about food distribution systems and the role of marketing and merchandising in the business of food service**.** learn the biological, physical, and chemical changes which occur when food is cooked and stored

CO4. develop knowledge of Menu planning, standardization of recipes and different food service system

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0504	CO1	3	3	1	3	1	2	3	1			1	2	1
	CO2	3	3	1	3	1	2	3	1			1	1	2
	CO3	3	3	1	3	1	2	3	1			1	2	2
	CO4	3	3	1	3	1	2	3	1			1	1	1

Course Content: **Total Hours: 48 Hrs**

UNIT-I **12 Hrs**

Quality food service: Meaning and evolution.

Classification of food service institutions according to

a. Function: Profit oriented, service oriented and public health facility oriented.

b. Processing method: Conventional system, commissary system and fast-food service systems.

c. Service of food: Self service, tray service and waiter-waitress service.

UNIT-II **12 Hrs**

Space organization: Kitchen- Size and type; developing kitchen plan; work simplification- work area, worker's area of reach, work space, equipment materials and supplies and movement at work; features to be considered in designing kitchen; kitchen lay out.

Storage space: Location, planning, lay out, safety and security. Service area: Location, planning, dimensions and decor.

Equipments: Classification, selection, design, installation, operation, care and maintenance of commonly used equipments

UNIT-III **12 Hrs**

Food purchasing: Food buyer- Knowledge, quality and functions of a food buyer; methods of buying food.

Receiving and storage of food: Delivery methods, delivery procedure; Receiving; Storage- organization of storages, general procedure for storage; Store keeping- store records, order form and goods received book.

UNIT-IV **12 Hrs**

Menu planning: Menu- Definition, functions, need for and factors to be considered in menu planning, procedure for writing menu, types and construction of menu, menu display.

Standardization of recipe: Definition, methods of standardization, standard recipe format and uses.

Standard portion sizes: Definition, portioning equipments and portion control.

Food production: Meaning, types of food production system, process of food production (Briefly), large quantity cooking techniques, use of leftover food and holding techniques.

Food service: Meaning, styles- waiter service, self service and vending.

REFERENCES:-

1. Mohini Sethi and Surjeet Malhan, Catering management- An integrated approach, Third edition, New Age International publishers. 2015.

2. Mohini Sethi, Institutional food management, Second edition, New Age International publishers.2016.

3. Kinton, R and Cesarani, V., The Theory of Catering ELBS, VII Edition, 1992.
4. Lillicap, D.R and Cousins, J.A. Food and Beverage Service, ELBS, IV Edition, 1994.
5. Fellow, P., Food Processing Technology – Principles and Practices, 2nd Edition, CRC Press Woodland Publishers, England, 2000.
6. Sommers, C.H. and Xveteng Fan, Food Irradiation Research and Technology, Blackwell Publishing, 2006.

Course Code	Duration	Course Title	L	T	P	C
B21HC0505	16 weeks	**Clinical Nutrition-II**	2	1	0	3

Prerequisites:

Theoretical knowledge of general Principles of Meal planning, RDA, EAR

Course Objective:

1. To understand the basics of clinical nutrition.
2. To know the diet therapy for diabetes mellitus, renal, metabolic and genetic disorders, cancer and HIV

Course Outcome: After completing the course the student shall be able to

CO1: Understand about dietary modifications on for patients suffering from diabetes mellitus and renal disorders.

CO2: Achieve knowledge about specific food allergies and how to overcome them. Also know about dietary modifications for genetic and metabolic disorders.

CO3: Learn about dietary modifications on cancer and HIV/AIDS patients. Also know about nutrient drug interations.

CO4: Know about Nutritional problems in infants - Preterm baby- nutritional requirement, feeding problems, management.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
B21HC0505	CO1	1	3	2	2	--	--	1	--			2	2	2
	CO2	1	3	3	2	--	--	1	--			1	2	1
	CO3	2	2	2	2	--	1	1	--			2		1
	CO4	1	2	2	1	--	--	1	--			1	2	2

Course Content: **Total Hours: 3Hrs/ wk**

UNIT – I **12 hours**

Diet in Diabetes Mellitus: Definition, prevalence, types (IDDM, NIDDM, GDM, MRDM), etiology, symptoms, Factors Influencing, Risk Factors – Clinical Characteristics, Metabolic changes in Diabetes, Diagnosis of Diabetes Mellitus (1) Blood Glucose Levels, a) Glycosuria , b) Ketonuria

(2)Oral Glucose Tolerance Test (3) Glycosylated Hemoglobin, (4)SBGM, Complications of Diabetes-Hypoglycemia, DKA, Fasting Hyperglycemia

Long term Complications-Macro vascular and Micro vascular, Diseases, Management - Principles of Nutritional Therapy-i) Care of Insulin Dependent Diabetes Mellitus, (ii) Insulin Therapy
Care of Non-Insulin Dependent Diabetes, food exchange, glycaemic index of food, glycaemic load, carbohydrate counting, OHA, insulin- types and uses.
Diet in Renal Disorders: Renal Function in Disease, Etiology, Clinical Symptoms and Course of Disease, Treatment – Dietary Management, Feeding Pattern for (i) Glomerulonephritis, (ii) Nephrotic Syndrome, (iii) Chronic Kidney disease, (iv) Kidney Dialysis and (v) Transplantation (brief)
Renal Calculi: type, nutritional requirement, complications and management.

UNIT – II **12 hours**

Food sensitivity (food allergy): types of reaction, Foods involved in sensitivity, differences between food allergy and food intolerances, Lactose intolerance, gluten intolerances- symptoms, diagnosis, dietary management (elimination diet),
Diet in genetic disorders (Inborn error of metabolism): Phenylketoneurea, galactosemia, fructosuria
Diet in Metabolic disorders- Gout-etiology, Symptoms, treatment

UNIT – III **12 hours**
Diet in cancer: Pathophysiology, Causes, Types, Treatment-Nutrition and Medical management, Role of Antioxidants, Nutritional problems in cancer treatment, **Nutrition in Immune system dysfunction HIV/AIDS:** definition, stages, Nutritional requirements, dietary management
Nutrients – drug interaction: effect of drugs on Food intake, digestion, absorption, transportation and excretion

UNIT – IV **12 hours**
Diet for cardio vascular disease: Dyslipademia- Introduction, Etiology, Multiple Risk Factors, Treatment, Diet and Feeding Pattern, Food to be avoided and included ,Atherosclerosis – Introduction, Etiology, Multiple Risk Factors, Treatment, Diet and Feeding Pattern, Food to be avoided and included, Hypertension – Classification, Risk Factors, Symptoms, Dietary Management; Acute and chronic Cardiovascular Disease – MI – Dietary Management

REFERENCES :-

1. Antia, F.P. (2005): Clinical Nutrition and Dietetics, Oxford University Press, Delhi
2. Mahan, L.K., Arlin, M.T. (2000): Krause's Food, Nutrition and Diet therapy, 11th edition, W.B.Saunders Company, London.
3. Robinson,C.H;Lawler,M.R.Chenoweth,W.L;and Garwick,A.E(1986):Normal and Therapeutic Nutrition,17th Ed., Mac Millan Publishing Co
4. Shubhangini A Joshi (2002): Nutrition and Dietetics2nd edition, Tata Mc Graw-Hill Publishing Company Limited, New Delhi.

5. Srilakshmi,B.(2005):Dietetics,5th edition, New Age International(P) Limited Publishers, New Delhi
6. Williams's (1989): Nutrition and diet Therapy.6th edition. Times Mirror/Mosby College Publishing, St.Louis

Course Code	Duration	Practicals	L	T	P	C
B21HC0506	16 weeks	Assesment of Food Quality Practical	0	0	2	2

Prerequisite:

Basic knowledge on Food Product and ways to improvise them

Course objectives:

1. To Demonstrate knowledge of principles Proximate analysis, gluten content, pectin content
2. To learn Morphology and structural features of various bacteria and fungi commonly associated with Foods

Course outcomes: After completing the course the student shall be able to

CO1. demonstrate the ability to estimate titrable acidity, pectin content of foods and lactose.

CO2. understand the use of pecific gravity of milk using lactometer.

CO3. Learn about Proximate analysis of foods, Tests for identification of adulterants present in commonly used foods.

CO4. Gain Further knowledge on Isolation of microorganisms by Pure Culture Technique and Microbial count by Standard Plate Count Method

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0506	CO1	1	1	3	3	1	1	--	--	--	1	3	1	1
	CO2	2	1	3	3	1	3	2	--	--	--	3	1	1
	CO3	2	1	3	3	1	2	2	3	--	--	3	1	1
	CO4	2	1	3	3	2	2	1	3	--	--	3	1	1

Course Content: **Total Hours: 3Hrs/ wk**

Experiments:

1. Estimation of titrable acidity, pectin content of foods and lactose.
2. Estimation of specific gravity of milk using lactometer.
3. Determination of gluten content.
4. Determination of sugar concentration of food products using refractometer.
5. Isolation of microorganisms by Pure Culture Technique and Microbial count by Standard Plate Count Method.
6. Morphology and structural features of various bacteria and fungi commonly associated with Foods.
   1. Tests for identification of adulterants present in commonly used foods.

Course Code	Duration	Practicals	L	T	P	C
B21HC0507	16 weeks	Clinical Nutrition-II Practical	0	0	2	2

Prerequisites:
Elementary knowledge on RDA, EAR, basic dietary principles of different disease conditions.

Course Objective:

1.To understand the basics of clinical nutrition.

2.To know the diet therapy for infection, fever, gastro-intestinal disorders, cardiovascular disorders, liver disease, burn & weight management.

Course Outcome: After completing the course the student shall be able to

CO1: Learn about definition, objectives, basic concepts of diet therapy, factors to be considered in planning therapeutic diets for Diabetes

CO2: Achieve knowledge about dietary modifications on specific disese condition like Renal disorders in different age group

CO3: Achieve knowledge about dietary modifications on Gluten Sensitivity, Lactose intolerance

CO4: Know about the nutritional requiremtns and dietary modifications for constipation in old age

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0507	CO1	1	1	3	3	1	1	--	--	--	1	3	1	2
	CO2	3	1	2	3	1	2	2	--	--	--	3	2	3
	CO3	2	1	3	2	1	2	1	2	--	--	3	2	2
	CO4	2	1	2	3	1	3	2	3	--	--	3	1	2

Course Content: **Total Hours: 3Hrs/ wk**

Experiments:

1. Planning, preparation and calculation of day's diet for non-insulin dependent Diabetes mellitus,
2. Planning of snacks. deserts and beverages for diabetes.
3. Planning, preparations and calculation of diet in nephrotic syndrome and Chronic renal failure
4. Planning, preparations and calculation of diet in Cancer
5. Planning, preparations and calculation of day's diet for anaemic Pregnant mother
6. Planning, preparations and calculation of day's diet for constipation in geriatrics
7. Planning, preparations and calculation of day's diet for an adult with gluten sensitivity
8. Planning, preparations and calculation of day's diet for an adult with Lactose intolerance

Course Code	Duration	Practicals	L	T	P	C
B21HC0508	16 weeks	Nutrition for Sports & Exercise Practical	0	0	2	2

Prerequisites:

Prior knowledge of Nutrition, Sports types

Course Objectives:

1. To learn the relationship between Physical fitness & Nutrition.
2. To study the nutritional requirement of Athletes & Fitness enthusiasts

Course Outcomes: After completing the course the student shall be able to

CO1. Learn different Physical activity, Body composition and their relation to Nutrition

CO2. Gain Knowledge on Utilisation of Carbohydrates & Protein in different phase of Sports Specific preparatory phase, Competition phase, Transition phase, Injury and rehabilitation phase - Pre-competition - Post competition condition.

CO3. Acquire ideas on Role of Lipids & Electrolytes in Sports Performance

CO4. Learn about ergogenic aids, Fluid replacement, requirements of female athletes, sports related complications

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
B21HC0508	CO1	1	1	3	3	1	1	--	2	--	1	3	2	2
	CO2	2	1	3	3	1	3	2	--	--	--	3	3	2
	CO3	2	2	3	3	1	3	2	2	--	--	3	3	3
	CO4	2	1	2	3	2	2	1	3	--	--	3	2	3

Course Content: **Total Hours: 3Hrs/ wk**

Experiments:

1. An online survey on types of Exercise including Aerobics, spinning, tai chi, Yoga, Power yoga, Pilates, weight training, strength training, circuit training, etc.
2. Determination of Physiological age of a person.
3. Visit to a fitness center and conducting study of equipments commonly used in fitness industry, their advantages and limitations.
4. Plan and prepare and calculate a day's diet, pre-game and post-game for a female athlete.
5. Plan energy bar/ sports drink for a sports person to be consumed during the game.
6. To study body composition of obese and person with Normal BMI
7. Anthropometric measurement of one male & female individual: Weight, Height, Fat%, WHR

SEMESTER VI

Course Code	Duration	Course Title	L	T	P	C

B21HC0601	16 weeks	Nutrition counseling	2	1	0	3

Prerequisites:
Basic knowledge of therapeutic & clinical nutrition

Course Objective:
1. To learn basic concept of Diet counselling skills

2. To demonstrate effective counselling skill to individual/ group of clientelle

Course Outcomes: After completing the course the student shall be able to
CO1. Learn about Basics of nutrition counseling, models for behavioural change, trans theoretical model of behaviour change, Motivational interview with clients
CO2. Know about verbal, nonverbal communication skills, counseling skills for resistance behaviour, ABCDE approach
CO3. Gain knowledge of Nutrition Care plan, basics, define goals design goals design plan of action, Assessment
CO4. Learn about Components of counseling process**,** Strategies to promote change-food management tools, behaviour change strategy, cognitive restructuring, education during counseling**,** Making behaviour change

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO1	P02	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO10	PSO1	PSO2	PSO3
B21HC0601	CO1	3	1	1	3	1	2	2	1			2	1	2
	CO2	3	1	1	3	1	2	2	1			2		1
	CO3	3	1	1	3	1	2	2	1			2	2	1
	CO4	3	2	3	3	1	1	2	3			2	1	1

Course Content: **Total Hours: 48Hrs**

Unit- I **12 Hours**

Basic Concepts of Counseling -Definition of Nutrition counseling, models for behavioural change, trans theoretical model of behaviour change.
Motivational interview: principles, motivational intervention model Fundamentals of food behaviour, assessment of readiness to change, client counsellor
Relationship.

Unit -II **12 Hours**

Communication skills-Objectives, verbal, nonverbal communication skills
Skills – listening, response, action process, sharing response, observing, paraphrasing & reflecting
Behaviour change: counseling skills for resistance behaviour
Cultural competence in counseling – ABCDE approach

Unit -III **12 Hours**

Nutritional Care Plan (NCP) - Introduction, goal setting: basics, define goals design, plan of action Dietary assessment-Food intake data collection, data analysis, interpretation, Energy Determination-Determination of REE, physical activity factor (PA), determination of Total Energy Expenditure (TEE). Physical assessment, healthy weight standrads, weight for height tables, BMI and waist

Circumference Documentation-SOAP format.

UNIT-IV **12 Hours**

Components of counseling process-Strategies to promote change-food management tools, behaviour change strategy, cognitive restructuring, education during counseling**,** Making behaviour change last-social network, stress management, relapse prevention,counseling evaluation,

understanding psychology of clients and adopting appropriate intervention: Not ready to change, unsure about change, ready to change, skill development for OARS (open end questions, affirmations, reflective listening, summary statements, Client rights**)**

Evaluation - Measuring the success of performance of client and evaluating the counseling process.

REFERENCES:

1. Bauer Kathleen D, Sokolik Carol, Loiu Doreen, Nutrition Counseling and Education Skill Development, Wadsworth Thomson Learning 2002.
2. Bauer Kathleen D, Sokolik Carol, Basic nutrition counseling skill development, Wadsworth Thomson Learning, 2002
3. Gail Morrison & Lisa Hark, Medical Nutrition & Disease, Blackwell Science Inc
4. Herrin M, Nutrition Counseling in the Treatment of Eating Disorders, New York, NY, Brunner-Routledge, 2003
5. King Kathy, Klawitter Bridget, Nutrition Therapy: Advanced Counseling Skills, Lippincott Williams & Wilkin, 2007.
6. Snetsellar, Linda G, Nutrition Counseling skills for the nutrition care process, 4th Edition Jones & Bartlett Publishers, 2009.
7. Rollnick S, Miller WR, Butler CC, Guilford press, 2008, Motivational Interviewing in Health Care: Helping Patients Change Behaviour (Applications of Motivational Interviewing).

Course Code	Duration	Course Title	L	T	P	C
B21HC0602	**16 weeks**	**Entrepreneurship Development**	2	0	0	2

Prerequisites:

Prior knowledge of Nutrition counselling, management, diet therapy

Course Objective:

1. To understand various dimesnsions of entrepreneurship and using them in field of nutrition

2. To enable student to acquire knowledge to become self dependent

Course Outcomes: After completing the course the student shall be able to

CO1. Define Entreprenurship, Skills required in an entrepreneur, Get an idea of SWOT analysis

CO2. Know about Business plan for small enterprises: Importance of business plan, purpose, contents and benefits of business plan; business plan creation process.

CO3. Conceptualise Meaning, process of conducting market survey, points to be considered for effective market research; steps to register a company; regulatory requirements.

CO4. Learn about Concept of marketing, market assessment, market regulation, market targeting, marketing mix, promotional strategies and tips for successful marketing, Finance management.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0602	CO1	3	2	2	3	1	2	3	3			1	1	1
	CO2	2	3	3	3	1	3	2	2			1	1	2
	CO3	3	2	3	3	1	2	2	3			2	1	1
	CO4	2	3	3	3	1	2	2	3			2	1	1

Course Content: **Total Hours: 48Hrs**

UNIT-I **12 hours**

Entrepreneur: Definition, qualities and essential skills of an entrepreneur, communication and presentation skill; innovativeness; idea generation and SWOT analysis. Steps to start a small enterprise, learning journey of a successful entrepreneur.

UNIT-II **12 hours**

Business plan for small enterprises: Importance of business plan, purpose, contents and benefits of business plan; business plan creation process, preparation of sample business plan. Business ethics and etiquettes

UNIT-III **12 hours**

Market survey: Meaning, process of conducting market survey, points to be considered for effective market research; steps to register a company; regulatory requirements

UNIT-IV **12 hours**

Management process and policies: Importance of policy creation, corporate governance, management process, management functions- production and operation management, marketing management, financial management and human resource management. Pricing policy and methods of pricing.

Marketing management- Concept of marketing, market assessment, market regulation, market targeting, marketing mix, promotional strategies and tips for successful marketing.

Financial needs: Types of financial needs- fixed and working capital; methods of raising capital, working capital management, working capital cycle.

REFERENCES:

1. Entrepreneurship development- Your gateway to the journey of entrepreneurship, ICT Academy of Tamil Nadu, Chennai. 2015.
2. S.S. Khanka, Entrepreneurial development, S. Chand Publications, 2007.
3. Vasant Desai, Entrepreneurial development, Vol-1, Himalaya Publishing House, 2009.

Course Code	Duration	Course Title	L	T	P	C
B21HC0603	**16 weeks**	**Project work**	0	0	10	10

Prerequisites:

Advance knowledge of different courses of Nutrition and Dietitics

Course Objective:

1. To apply knowledge gained during three years of study into real life scenarios.
2. To prepare the student for his/her higher studies

Course Outcomes: After completing the course the student shall be able to

CO1. Carry out an independent research project work in any stream of his / her choice from the field of Nutrition

CO2. Know about application and Use of Nutrition related to Human requirements

CO3. discover unknown facts and principles of Food & Nutrition

CO4. Formulate and device new concepts and hypothesis related to field of Nutrition & dietetics

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0603	CO1	3	1	1	1	--	--	--	--			1	1	2
	CO2	2	3	2	2	1	--	1	--			2	1	1
	CO3	3	3	2	2	--	--	--	--			2	1	1
	CO4	3	1	1	2	--	--	--	--			2	2	1

Course Content: **Total Hours: 16 wk**

1. An independent research project work undertaken by student under the guidance of a teacher, can either be a survey or Laboratory oriented research. The research should be submitted at the end of session in the form of a dissertation. The project work can be undertaken at university department, affiliated research institutions, quality control laboratories, food industries or other institutions with prior approval.
2. The student should appear before examiners board and the dissertation shall be evaluated by means of presentation and viva - voce

Course Code	Duration	Course Title	L	T	P	C
B21HC0604	**16 weeks**	**Internship**	0	0	5	5

Prerequisites: Prior knowledge of Nutrition counselling, management, diet therapy

Course Objective:

1. To apply knowledge gained during three years of study into real life scenarios.
2. To prepare the student for effective Practice in clinic/ hospital/ industry setting

Course Outcomes: After completing the course the student shall be able to

CO1: Develop counseling competencies in professional practice, nutrition care and management in Dietetic Education and Practice
CO2: Familiarize, identify, understand and practice components of counseling in the practice of dietetics
CO3: Apply nutrition care process to make appropriate nutrition interventions
CO4: Demonstrate counseling techniques to facilitate nutrition behavior change for individuals and groups.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	PO1 0	PSO 1	PSO 2	PSO 3
B21HC0604	CO1	1					3	2	2			2	1	1
	CO2						2		2			2		1
	CO3	1					3	2	2			2	1	1
	CO4						2		2			2		1

Course Content: **Total Hours: 16 wk**

1.Internship Training in superspeciality hospital/ foods service institution for 8-12 weeks depending on availability & convenience
2. Report Preparation - Students are required to perform internship in Multispeciality hospitals and they have to submit a
report on the internship training during examination. Evaluation of internship shall be made on the basis of report and viva-voce examination.

CAREER DEVELOPMENT AND PLACEMENT

Having a degree will open doors to the world of opportunities for you. But Employers are looking for much more than just a degree. They want graduates who stand out from the crowd and exhibit real life skills that can be applied to their organizations. Examples of such popular skills employers look for include:

1. Willingness to learn
2. Self motivation
3. Team work
4. Communication skills and application of these skills to real scenarios
5. Requirement of gathering, design and analysis, development and testing skills
6. Analytical and Technical skills
7. Computer skills
8. Internet searching skills
9. Information consolidation and presentation skills
10. Role play
11. Group discussion, and so on

REVA University therefore, has given utmost importance to develop these skills through variety of training programs and such other activities that induce the said skills among all students. A full-fledged Career Counseling and Placement division, namely Career Development Center (CDC) headed by well experienced senior Professor and Dean and supported by dynamic trainers, counselors and placement officers and other efficient supportive team does handle all aspects of Internships and placements for the students of REVA University. The prime objective of the CDC is to liaison between REVA graduating students and industries by providing a common platform where the prospective employer companies can identify suitable candidates for placement in their respective organization. The CDC organizes pre-placement training by professionals and also arranges expert talks to our students. It facilitates students to career guidance and improve their employability. In addition, CDC forms teams to perform mock interviews. It makes you to enjoy working with such teams and learn many things apart from working together in a team. It also makes you to participate in various student clubs which helps in developing team culture, variety of job skills and overall personality.

The need of the hour in the field of Biotechnology, Biochemistry, Genetics isnot only the knowledge in the subject, but also the skill to do the job proficiently, team spirit and a flavour of innovation. This kept in focus, the CDC has designed the training process, which will commence from second semester along with the curriculum. Special coaching in personality development, career building, English proficiency, reasoning, puzzles, and communication skills to every student of REVA University is given with utmost care. The process involves continuous training and monitoring the students to develop their soft skills including interpersonal

skills that will fetch them a job of repute in the area of his / her interest and march forward to make better career. The School of Applied sciences also has emphasised subject based skill training through lab practice, internship, project work, industry interaction and many such skilling techniques. The students during their day-to-day studies are made to practice these skill techniques as these are inbuilt in the course curriculum. Concerned teachers also continuously guide and monitor the progress of students.

The University has also established University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director to facilitate skill related training to REVA students and other unemployed students around REVA campus. The center conducts variety of skill development programs to students to suite to their career opportunities. Through this skill development centre, the students shall compulsorily

complete at least two skills/certifications based programs before the completion of their degree. The University has collaborations with Industries, Corporate training organizations, research institutions and Government agencies like NSDC (National Skill Development Corporation) to conduct certification programs. REVA University has been recognised as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana.

The University has also signed MOU's with Multi-National Companies, research institutions, and universities abroad to facilitate greater opportunities of employability, students' exchange programs for higher learning and for conducting certification programs.

LIST OF FACULTY MEMBERS

Sl No.	Name of the Teacher	Designation	Contact No.	E-mail
1	Dr. Jayashree S	Professor	8610123372	Jayashree.s@reva.edu.in
2	Dr. Veeraraghavan V	Professor		veera.raghavan@reva.edu.in
3	Dr. Karthi N	Associate Professor	9884210099	karthi.n@reva.edu.in
4	Dr. Sikandar Mulla	Assistant Professor	7483072566	sikandar.mulla@reva.edu.in
5	Dr. Ramesh Kumar K	Assistant Professor	8004425060	rameshkumar.k@reva.edu.in
6	Dr. Sharadamma N	Assistant Proffesor	9739438693	sharadamma.n@reva.edu.in
8	Mrs. Deepa HN	Assistant Professor	9739355443	deepa.hn@reva.edu.in
9	Mrs. Pooja Karkera	Assistant Professor	9741224361	poojar.karkera@reva.edu.in

Rukmini Educational
Charitable Trust

Rukmini Knowledge Park
Kattigenahalli, Yelahanka, Bengaluru – 560064
Phone No: +91-080-46966966, Fax: 080-28478539
www.reva.edu.in