REVA UNIVERSITY
Bengaluru, India

SCHOOL OF COMPUTING AND INFORMATION TECHNOLOGY

B. Tech.

in

Computer Science & Engineering

HANDBOOK

2018-22
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Rukmini Educational Charitable Trust

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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 ofthe 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 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. S. Y. Kulkarni
Vice-Chancellor, REVA University

Director's – Message

I congratulate and welcome all the students to the esteemed school of Computing and Information technology (C & 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, M.Tech and Ph.D programs offered in the school are designed to cater 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 B.Tech in Computer Science and Engineering program curriculum. The program is of 4 years duration and split into 8 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, such as, AI, Data Science, and Systems. Theoretical foundations of engineering, science, and computer science are taught in first two and half years. Later, advanced courses and recent technologies are introduced in subsequent semesters for pursuing specialization.

The important features of the BTech CSE are as follows: 1) Choice based course selection and teacher selection, 2) Studies in emerging areas like Machine Learning, Artificial Intelligence, Data Analytics, Cloud Computing, Python/R Programming, NLP, IoT and Cloud security, 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, IOT, AI, ML and DL, software engineering, computer networks, cognitive computing, etc.State of art laboratories are available for the purpose of academics and research.

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.

Prof. Dr. Sunilkumar S. Manvi,
Director, School of Computing and IT

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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 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 recognized 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 global challenges and become the top leaders of the country and the globe in different fields.

REVA University located in between Kempe Gowda 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 to preparing the scheme of instruction and detailed curricula for thisprogram. Greater emphasis on practice in respective areas and skill development to suit 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 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. 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 byforming 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 Intelligence, 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 andDean, 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 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 the entire faculty to adopt the new tools and implement their use. The division furtherworks 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 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 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 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 for 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 recognized 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 School Survey, ranked among Top 30 Best B Schools by Business World, India's Best Law Institution by Careers 360, to mention a few.

Vision (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 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 one undergraduate program: B Tech in Computer Science and Engineering. Three postgraduate programs offered in the school are: M Tech in Data Engineering and Cloud Computing and M Tech in Computer Science and Engineering (Both Full time and Part time). 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 create a pool of high-caliber technologists and researchers in computer science 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 and strong ethical values.

Mission

- Create a center of excellence where new ideas flourish and from which emerge tomorrow's researchers, scholars, leaders and innovators.
- Provide quality education in both theoretical and applied foundations of computer science, information technology and related inter-disciplinary areas and to train students to effectively apply the education to solve real-world problems.
- Amplify students' potential for life-long high-quality careers and give them a competitive advantage in the ever-changing and challenging global work environment of the 21st century.
- Forge research and academic collaboration with industries and top global universities in order to provide students with greater opportunities.
- Support the society by encouraging and participating in technology transfer.

Advisory Board

Sl.No	Name and Designation of the Members
1	Mr. Himesh Misra, Program Director, IBM Innovation Center, IBM India Private Limited Bengaluru
2	Dr. Rajkumar Buyya, Director, Cloud Computing and Distributed Systems Laboratory Department of Computing and Information Systems University of Melbourne, Australia
3	Mr. ChethanShivkumar, Founding Director, AIKAAN Labs, Bengaluru
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5	Dr. Sajal Das, Professor, Department of CS&E Missouri University of Science and Technology, USA
6	Dr. Heggere S. Ranganath, Professor and Chair, Computer Science Department University of Alabama in Huntsville Huntsville, USA
7	Mr. Mrityunjay Hiremath, Director, AMD Inc. USA, Bengaluru, India

MEMBERS OF BOARD OF STUDIES

Sl. No	Name and Affiliation	Role
1	Dr Sunil Kumar S Manvi, Professor and Director School of C & IT, REVA University	Chairman
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3	Dr Kiran Kumari Patil, Director UIIC REVA University	Member
4	Dr Mallikarjuna M Kodabagi, Professor and Deputy Director IQAC, REVA University	Member
5	Dr Ashwin Kumar U M, Associate Professor, School of C & IT, REVA University	Member
6	Dr Gopala Krishna Shyam, Associate Professor, School of C & IT, REVA University	Member
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10	Dr Sanjay, HoD Dept. of ISE, NITTE Meenakshi Institute of Technology, Bengaluru	Member
11	Dr Raghavendra Kulkarni, Director of Academics, M. S. Ramaiah University of Applied Sciences, Bengaluru	Member

B Tech (Computer Science & Engineering) Program

Program Overview

Computer Science Engineering (CSE) encompasses a variety of topics that relate to computation, like development of algorithms, analysis of algorithms, programming languages, software design and computer hardware. Computer Science engineering has roots in electrical engineering, mathematics, and linguistics. In the past Computer Science was taught as part of mathematics or engineering departments and in the last 3 decades it has emerged as a separate engineering field. In the present information era (Knowledge era) computer science and engineering will see an exponential growth as the future machines work on artificial intelligence.

The oldest known complex computing device, called the Antikythera mechanism, dates back to 87 B.C., to calculate astronomical positions and help Greeks navigate through the seas. Computing took another leap in 1843, when English mathematician Ada Lovelace wrote the first computer algorithm, in collaboration with Charles Babbage, who devised a theory of the first programmable computer. But the modern computing- machine era began with Alan Turing's conception of the Turing Machine, and three Bell Labs scientists invention of the transistor, which made modern-style computing possible, and landed them the 1956 Nobel Prize in Physics. For decades, computing technology was exclusive to the government and the military; later, academic institutions came online, and Steve Wozniak built the circuit board for Apple-1, making home computing practicable. On the connectivity side, Tim Berners-Lee created the World Wide Web, and Marc Andreessen built a browser, and that's how we came to live in a world where our glasses can tell us what we're looking at. With wearable computers, embeddable chips, smart appliances, and other advances in progress and on the horizon, the journey towards building smarter, faster and more capable computers is clearly just beginning.

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.

The career opportunities for computer science and engineering graduates are plenty and growing. Programming and software development, information systems operation and management, telecommunications and networking, computer science research, web and Internet, graphics and multimedia, training and support, and computer industry specialists are some of the opportunities the graduates find.

The School of Computing and Information Technology at REVA UNIVERSITY offers B. Tech.in Computer Science and Engineering programme 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.

The B. Tech., in Computer Science and Engineering curriculum developed by the faculty at the School of Computing and Information Technology, 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

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 organizations as researchers.

The Program Educational Objectives (PEOs):

PEO-1	Have successful professional careers in industry, government, academia and military as innovative engineer in a team
PEO-2	Develop code and solutions to industry in a rapid changing technology environment and communicate with clients as an entrepreneur
PEO-3	Pursue higher studies and continue to learn by participating conferences, seminars etc

PROGRAM OUTCOMES

After undergoing this programme, a student will be able to:

PO1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals for the solution of complex problems in Computer Science and Engineering.

PO2. **Problem analysis**: Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.

PO3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **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.

PO6**. The engineer 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.

PO7**. 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.

PO8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PO9. **Individual and team work**: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO10. **Communication**: Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations and give **and receive clear instructions.**

PO11**. Project management and finance**: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

PO12. **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)

After successful completion of the programme, the graduates will be able to

1. Demonstrate the knowledge of Data structures and Algorithms, Operating Systems, Database Systems, Software Engineering, Programming Languages, Digital systems, Theoretical Computer Science, and Computer Networks

2. Solve latest problems and develop code to address the requirements of Industry through programming.

3. Use modern tools and techniques in the area of Computer Science and Engineering

Programme Regulations

Students will be provided with programme regulations which deals about credit structure, teaching and Learning processes, Assessment, Re-examination, Degree awarding requirements.

REVA UNIVERSITY
Bengaluru, India

Summary of REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Four Year Graduate Degree Programs-2018

1. Teaching and Learning Process:

The Teaching & Learning process under CBCS – CAGP of education in each course of study will have three components, namely**:** L:T:P.

(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.

2. Courses of Study and Credits

a. The study of various subjects in B Tech 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.
b. 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.
c. The total duration of a semester is 20 weeks inclusive of semester-end examination.
d. **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.
e. The total credits earned by a student at the end of the semester upon successfully completing the course are L + T + P.

3. Courses of Study

Different C**ourses of Study** are labeled and defined as follows:

a. Core Course:

A course which should compulsorily be studied by a candidate as a core-requirement is termed as a Corecourse. The CORE courses of Study are of THREE types, viz – (i) Foundation Course,

(ii) Hard Core Course, and (iii) Soft Core Course.

b. 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.

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 (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.**

f. 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. 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 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.**

3. *Scheme, Duration and Medium of Instructions:*

3.1 B Tech degree program is of 8 semesters - 4 years duration. A candidate can avail a maximum of 16 semesters - 8 years as per doubleduration norm, in onestretch 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 School when he/she resumes his/herstudies.

3.2 The medium of instruction shall be English

4. *Minimum Credits to be Earned*

4.1 **A candidate has to earn 192 credits for successful completion of B Tech degree** with the distribution of credits for different courses as prescribed by the university. A candidate can enroll for a maximum of 32 credits and a minimum of 20 credits per Semester. However he / she may not successfully earn a maximum of 32 credits per semester. This maximum of 32 credits does not include the credits of courses carried forward by a candidate.

4.2 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 192 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.

4.3. *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 192 credits for the B Tech Degree program.

4.3.1. *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 192 credits for the B Tech Degree program.

The A**dd on Proficiency Certification / Diploma** so issued to the candidate contains the courses studied and grades earned.

5. Scheme of Assessment and Evaluation

5.1. The Scheme of Assessment and Evaluation will have two parts, namely;

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

5.2. 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 40:60 marks respectively (i.e., 40 marks internal assessment; 60 marks semester end examination).

5.3. The 40 marks of internal assessment shall comprise of:

Internal Test = 30 marks

Assignments / Seminars / Model Making etc. = 10 marks

5.4. There shall be **three internal tests** conducted as per the schedule given below. **The students have to attend all the three tests compulsorily.**

- **1st test for 15 marks at the end of 6th week of the beginning of the semester;**
- 2nd test for 15 marks at the end of 13th week of the beginning of the semester; and
- 3rd test for 15 marks at the end of 16th week of the beginning of the semester.

5.5. The coverage of syllabus for the said three tests shall be as under:

- **For the 1st test syllabus shall be 1st unit and 1st half 2nd unit of the Course;**
- For the 2nd test it shall be 2nd half of 2nd unit and 3rd unit of the Course;
- For the 3rd test the syllabus will be 4th unit of the Course.

5.6. Out of 3 tests, the highest marks scored in **two tests** are automatically considered while assessing the performance of the students.

5.7. There shall be two Assignments / Seminars each carrying 5 marks ; whereas the number of model designs and the marks for each model design shall be decided by the School well in advance and should be announced before commencement of the Semester to avoid ambiguity and confusion among students and faculty members.

5.8. The Semester End Examination for 60 marks shall be held in the 19th and 20th week of the beginning of the semester and the syllabus for the semester end examination shall be entire 4 units.

5.9. The duration of the internal test shall be 75 minutes and for semester end examination the duration shall be 3 hours.

5.10. Summary of Internal Assessment and Evaluation Schedule is provided in the table given below.

Summary of Internal Assessment and Evaluation Schedule

Type of Assessment	Period	Syllabus	Marks	Activity
Allocation of Topics for Assignments / Seminars / Model making*	Beginning of 5th Week	First Unit and Second Unit		Instructional process and Continuous Assessment
First Internal Test	2nd Part of 6th Week	First Unit and 1st half of Second Unit	15	Consolidation of 1st Unit 1st half of 2nd Unit
Submission of Assignments / Conduct of Seminars / Presentation of Model Design*	8th Week	First Unit and Second Unit	5	Instructional process and Continuous Assessment
Second Internal Test	2nd Part of 13th Week	Second half of Second Unit and Third Unit	15	Consolidation of Second half of Second Unit and 3rd Unit
Allocation of Topics for Assignments / Seminars / Model making*	Beginning of 11th Week	Third Unit and Fourth Unit		Instructional process and Continuous Assessment
Submission of Assignments / Conduct of Seminars / Presentation of Model Design*	14th Week	Third Unit and Fourth Unit	5	Instructional process and Continuous Assessment
Third Test	2nd Part of 16th Week	Fourth Unit	15	Consolidation of Fourth Unit
Semester-end Practical Examination	17th & 18th Week	Entire syllabus	60	Conduct of Semester - end Exams
Preparation for Semester-end Theory Exam	17th & 18th Week	Entire Syllabus		Revision and preparation for semester–end exam
Semester End Theory Examination	19th & 20th Week	Entire Syllabus	60	Evaluation and Tabulation
	End of 21st Week			Notification of Final Grades

__Note:__ 1. **As per the model making is concerned, the School shall decide about the Marks and the Number of Model Designs and as well the schedule of allocation and presentation of model design(s). If the model design carries 5 marks, there shall be two model designs; and in case of 10 marks, there shall be one model design. However, the decision of the School should be announced in the beginning* *of the Semester for students to avoid ambiguity and confusion.*

2. Examination and Evaluation shall take place concurrently and Final Grades shall be announced latest by 5 day after completion of the examination.

3. Practical examination wherever applicable shall be conducted after 3rd test and before semester end examination. The calendar of practical examination shall be decided by the respective School Boards and communicated well in advance to the Registrar (Evaluation) who will notify the same immediately.

6. *Assessment of Performance in Practicals*

6.1. 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.

6.2. The 40 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	10 marks
	the mid-term test includes performance in the conduction of experiment and write up about the experiment.	
	Total	**40 marks**

63. The 60 marks meant for Semester End Examination (SEE), shall be allocated as under:

i	Conduction of semester end practical examination	40 marks
ii	Write up about the experiment / practical conducted	10 marks
iii	Viva Voce	10 marks
	Total	**60 marks**

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

7. *Evaluation of Minor Project / Major Project / Dissertation:*

7.1. 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	Results of Work and Draft Report (25%)
omponent– III	Final Evaluation and Viva-Voce (50%). Evaluation of the report is for 30% and the Viva-Voce examination is for 20%.

8. Provision for Appeal

If a candidate is not satisfied with the evaluation of Internal Assessment components (Mid-term Tests and Assignments), 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 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 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.

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

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

10. Requirements to Pass the Semester and to Carry Forward the Failed Subjects / Courses:

10.1 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 = 40 + SEE = 60) and have to secure a minimum of 40% to declare pass in the course. However, a candidate has to secure a minimum of 25% (15 marks) in Semester End Examination (SEE) which is compulsory.

11. *Provision to Carry Forward the Failed Subjects / Courses:*

The total number of "F" Grades that can be carried forward by a student at the end of any even semester shall not be more than four courses.

12. *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 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.

13. *Attendance Requirement:*

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

13.2. 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.

13.3. 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 as provided in 10.3.

13.4. 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 Semester end examination, and subsequently a notification pertaining to the above will be brought out by the Director of the School before the commencement of Semester end examination. A copy of this notification shall also be sent to the office of the Registrar & Registrar (Evaluation).

13.5. Absence during Internal Test:

In case a student has been absent from a internal tests 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 conducting a separate internal test. 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 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.

14. Grade Card and Grade Point

14.1. 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).

14.2. 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 Registrar (Evaluation).

14.3. 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	C
0-40	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.

12.3.1. 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**	**C**	**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**	**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**

14.4. Cumulative Grade Point Average (CGPA):

12.4.1. Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (192) 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. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

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	7.29	24 x 7.29 = 174.96
3	24	8.11	24 x 8.11 = 192.64
4	26	7.40	26 x 7.40 = 192.4
5	26	8.29	26 x 8.29 = 215.54
6	24	8.58	24 x 8.58 = 205.92
7	24	9.12	24 x 9.12 = 218.88
8	24	9.25	24 x 9.25 =222
Cumulative	196		1588.26

Thus, **CGPA** = $\frac{24x6.83+24x7.29+24x8.11+26x7.40+26x8.29+24x8.58+24x9.12+24x9.25}{196}$ = 8.10

12.4.2. *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

14.5. 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

*Overall percentage=10*CGPA*

15. 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 Registrar (Evaluation) within 10 days after the announcement of the results. **This challenge valuation is only for semester end examination.**

b. *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.*

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

Eligibility for Admission:

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

Sl. No.	Program	Duration	Eligibility
1	Bachelor of Technology (B Tech)	4 Years	Passed 10+2 examination with Physics and Mathematics as compulsory subjects along with one of the Chemistry Biotechnology / Biology / 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)	**(F)** Provided further that Students who completed successfully six Semesters in REVA University and have exited with Advanced Diploma in Engineering &Technology (ADET) shall be eligible for admission to the Fourth year B Tech degree courses subject to the vacancies. **(G)** 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.

School of Computing and Information Technology
B. Tech. in Computer Science and Engineering
Scheme 2018-2022

Scheme of Instruction

Sl. No	Course Code	Course Title	Course Type	Credit Pattern and Value					Weekly Contact Hours	Teaching School/ Dept.
				L	T	P	J	C		
First Semester:										
1	B18CS1010	Multivariable Calculus and Linear Algebra	HC	4	0	0	0	4	4	CIT/Mat
2	B18CS1020	Chemistry	HC	3	0	0	0	3	3	Chemistry
3	B18CS1030	Programming for Problem Solving	HC	3	0	1	0	4	5	CIT
4	B18CS1040	Basic Electrical and Electronics Engineering	HC	4	0	0	0	4	4	EE
5	B18CS1050	Environmental Science	HC	2	0	0	0	2	2	Chemistry
6	B18CS1060	Technical English-1	FC	0	0	2	0	2	4	Arts and Humanities
7	B18CS1070	Basic Electrical and Electronics Engineering Lab	HC	0	0	2	0	2	2	EEE
8	B18CS1080	Chemistry Lab	HC	0	0	2	0	2	2	Chemistry
9	B18CS1090	Skill Development-1	HC	0	0	0	0	1	2	UIIC/CIT

Total								**24**	**29**	

Note: Workshop tour to be conducted to introduce Mechanical Tools (One Day). Building construction tour to be conducted to introduce construction fundamentals and technologies (One day). Industrial visits will be organized for a day to Public/Private Sectors in Bengaluru.

Second Semester:

1	B18CS2010	Probability and Statistics	HC	4	0	0	0	4	4	CIT/Mat
2	B18CS2020	Physics	HC	3	0	0	0	3	3	Physics
3	B18CS2030	Object Oriented Programming	HC	3	0	0	0	3	3	CIT
4	B18CS2040	Technical English-2	FC	0	0	2	0	2	4	Arts & Humanities
5	B18CS2050	Indian Constitution and Professional Ethics	FC	2	0	0	0	2	2	Law
6	B18CS2060	Computer Aided Engineering Drawing Lab	HC	0	0	2	0	2	4	ME
7	B18CS2070	Object Oriented Programming Lab	HC	0	0	2	0	2	2	CIT
8	B18CS2080	Physics Lab	HC	0	0	2	0	2	2	Physics
9	B18CS2X10	Skill Development-2	HC	0	0	0	0	1	2	UIIC/CIT
10	B18CS2X20	Sports/Yoga/Music/ Dance/Theatre	RULO	0	0	2	0	2	2	Others
Total								**23**	**28**	

Note: Industrial visits will be organized for a day to Public/Private Sectors in Bengaluru. All students must participate in a mini project exhibition and Hackathon.

Third Semester :

1	B18CS3010	Digital Logic Design	HC	3	0	0	0	3	3	CIT
2	B18CS3020	Analog Electronic Circuits	HC	3	0	0	0	3	3	CIT/ECE
3	B18CS3030	Programming with Java	HC	3	0	1	0	4	4	CIT
4	B18CS3040	Data Structures	HC	3	0	0	0	3	3	CIT
5	B18CS3050	Discrete Mathematics	HC	3	0	0	0	3	3	CIT/Mat
6	B18CS3060	Software Engineering	HC	3	0	0	0	3	3	CIT

	B18CS3070	Data Structures Lab	HC	0	0	2	0	2	2	CIT
8	B18CS3080	Logic Design anAnalog Circuits Lab	HC	0	0	2	0	2	2	CIT
9	B18CS3090	Skill Development-3	HC	0	0	0	1	1	2	UIIC/CIT
10	B18CS3X10	Soft Skills-1	HC	0	0	2	0	2	2	Placement
Total								**26**	**27**	
Note: Awareness workshop on free and open source tools and commercial tools for computer science and engineering application development has to be conducted. Industrial visits will be organized for a day to Public/Private Sectors in Bengaluru.										
Fourth semester:										
1	B18CS4010	Design and Analysis of Algorithms	HC	3	0	1	0	4	5	CIT/Mat
2	B18CS4020	Graph Theory	HC	3	0	0	0	3	3	CIT/Mat
3	B18CS4030	Database Management System	HC	3	0	0	0	3	3	CIT
4	B18CS4040	Computer Organization and Architecture	HC	3	0	0	0	3	3	CIT
5	B18CS4051/5	Softcore -1 (SC-1)	SC	-	-	-	-	3	3	CIT
6	B18CS4060	Database Management System Lab	HC	0	0	2	0	2	2	CIT
7	B18CS4070	ARM Microcontroller and IoT Lab	HC	0	0	2	0	2	2	CIT
8	B18CS4080	Skill Development-4	HC	0	0	0	1	1	2	UIIC/CIT
9	B18CS4090	Soft Skills-2	HC	0	0	2	0	2	2	Placement
Total								23	25	
Note: All students must participate in a miniproject exhibition and Hackathon. Industrial visits will be organized for a day to Public/Private Sectors in Bengaluru.										
Fifth Semester :										
1	B18CS5010	Finite Automata and Formal Languages	HC	3	0	0	0	3	3	CIT
2	B18CS5020	Python for Data Analysis	HC	2	0	1	0	3	3	CIT
3	B18CS5030	Computer Networks	HC	3	0	0	0	3	3	CIT

4	B18CS5040	Operating Systems	HC	3	0	1	0	4	5	CIT
5	B18CS5051/5	Softcore - 2 (SC-2)	SC	-	-	-	-	3	3	CIT
6	B18CS5061/5	Softcore - 3 (SC-3)	SC	-	-	-	-	3	3	CIT
7	B18CS5070	Statistical Data Analysis Lab	HC	0	0	2	0	2	2	CIT
8	B18CS5080	Computer Networks lab	HC	0	0	2	0	2	2	CIT
9	B18CS5090	Skill Development -5	HC	0	0	0	1	1	2	UIIC/CIT
10	B18CS5X10	Soft Skills-3	HC	0	0	2	0	2	2	Placement
Total								26	28	
Note: Industrial visits will be organized for a day to Public/Private Sectors in Bengaluru.										
Sixth Semester :										
1	B18CS6010	Machine Learning for Data Analytics	HC	3	0	1	0	4	5	CIT
2	B18CS6020	Cloud Computing and Big Data	HC	3	0	0	0	3	3	CIT
3	B18CS6031/5	Softcore - 4 (SC-4)	SC	-	-	-	-	3	3	CIT
4	B18CS6041/5	Softcore -5 (SC-5)	SC	-	-	-	-	3	3	CIT
5	B18CS6051/4	Softcore - 6 (SC-6)	SC	-	-	-	-	3	3	CIT
6	B18CS6061/4	Softcore-7 (SC-7)	SC	-	-	-	-	3	3	CIT
7	B18CS6070	Cloud Computing Lab	HC	0	0	2	0	2	2	CIT
8	B18CS6080	Skill Development-6	HC	0	0	0	1	1	2	UIIC/CIT
9	B18CS6090	Soft Skills-4	HC	0	0	2	0	2	2	Placement
Total								24	26	
Note: All students must participate in a miniproject exhibition and Hackhathon. Industrial visits will be organized for a day to Public/Private Sectors in Bengaluru.										

Sl. No	Course Code	Course Title	Course Type	Credit Pattern and Value					Weekly Contact Hours	Teaching Dept.
				L	T	P	J	C		
Seventh Semester										
1	B18CS7010	Web Application Development	HC	3	0	1	0	4	5	CIT
2	B18CS7020	Cryptography and Network Security	HC	3	0	0	0	3	3	CIT
3	B18CS7031	Internet Computing & Applications	OE	3	-	-	-	3	3	CIT
4	B18CS7032	Data Structures	OE							
5	B18CS7041/4	Softcore - 8 (SC-8)	SC	3	-	-	-	3	3	CIT
6	B18CS7051/4	Softcore - 9 (SC-9)	SC	3	-	-	-	3	3	CIT
7	B18CS7061/4	Softcore - 10 (SC-10)	SC	3	-	-	-	3	3	CIT
8	B18CS7071/4	Softcore - 11 (SC-11)	SC	3	-	-	-	3	3	CIT
9	B18CS7080	Project Work and Dissertation Phase 1	HC				1	1	2	CIT
		Total						**23**	**25**	

Note:1 **The project work phase-1** of project dissertation of 8th semester will begin in 7th semester, where student has to form a project group and perform literature survey and define the problem tools and technologies to be used. Options for 8th semester must be selected in 7th semester.

2. **Open Electives,** namely '**Internet Computing & Applications'** and '**Data Structures'** are offered for students belonging to Schools other than Computing and Information Technology. The students of B.Tech in Computer Science and Engineering shall have to choose one of the **Open Electives** offered by any other School.

Sl. No	Course Code	Course Title	Course Type	Credit Pattern and Value					Weekly Contact Hours	Teaching Dept.
				L	T	P	J	C		
	Eighth Semester									
1	B18CS8010	Internship/Skill Development / Global Certification Program	HC	-	-	-	-	6	6	CIT/others
2	B18CS8020	MOOC	HC	-	-	-	-	4	4	Others
3	B18CS8031/5	Softcore-12 (SC-12)	SC	3				3	3	CIT

4	B18CS8040	Project Work and Dissertation Phase-2	HC	-	-	-	10	10	10	CIT
Total								**23**	**23**	
Total Credits for all Eight Semesters:							**192**			

Note: Internship must be for atleast 2 months to be considered for 6 credits. Internships abroad must be for atleast 3 to 4 weeks to be considered for the credits. Global certification program students must obtain a certificate to attain 85 to 100% marks based on relative performance. If not eligible for certificate, they will have to undergo examination at school level for 80% marks, and marks will be awarded based on examination performance. Such a program will be considered as Skill Development Program.

Total Credits = 192

Code for the representation of the Softcore /Specialization Groups

A: Data Engineering, B: System Design & Computing, C: Robotics, D: Communication/Networking

E: Software Systems, F: Others

Sl.No.	Course Code	Name of the Course	L	T	P	J	C	Specialization Group
		Semester – IV (SC-1)						
1	B18CS4051	Signals and Systems	2	1	0	0	3	F
2	B18CS4052	System Software	3	0	0	0	3	F
3	B18CS4053	Embedded System Design	2	1	0	0	3	B
4	B18CS4054	Operation Research	2	1	0	0	3	B
5	B18CS4055	Numerical Techniques	2	1	0	0	3	B
		Semester – V (SC-2)						
1	B18CS5051	Object Oriented Analysis and Design	3	0	0	0	3	B
2	B18CS5052	IoT Programming and Applications	2	0	0	1	3	B
3	B18CS5053	Software Testing	2	0	1	0	3	E
4	B18CS5054	Digital Communication	3	0	0	0	3	D
5	B18CS5055	Microprocessors and Interfacing	3	0	0	0	3	F
		(SC-3)						
1	B18CS5061	Unix System Programming	2	0	1	0	3	E
2	B18CS5062	Advanced DBMS	2	0	0	1	3	A
3	B18CS5063	Introduction to Robotics	3	0	0	0	3	C
4	B18CS5064	High Performance Computing	3	0	0	0	3	B
5	B18CS5065	Differential and Difference equations	3	0	0	0	3	F

		Semester – VI (SC-4)						
1	B18CS6031	Signal Processing with SCIILAB	2	0	1	0	3	B
2	B18CS6032	Principles of Programming languages	3	0	0	0	3	A
3	B18CS6033	Compiler Design	3	0	0	0	3	B
4	B18CS6034	Artificial Intelligence	3	0	0	0	3	B
5	B18CS6035	Computer Design with Verilog	3	0	0	0	3	B
		(SC-5)						
1	B18CS6041	Digital Image Processing	3	0	0	0	3	C
2	B18CS6042	Advanced Java Programming	2	0	0	1	3	A
3	B18CS6043	Data Mining and Warehousing	2	0	1	0	3	B
4	B18CS6044	System Modeling and Simulation	3	0	0	0	3	D
5	B18CS6045	Research Methodology	4	0	0	4	4	F
		(SC-6)						
1	B18CS6051	Pattern Recognition	2	0	1	0	3	A
2	B18CS6052	Text & Web Mining	2	0	1	0	3	A
3	B18CS6053	Wireless and Mobile Networks	3	0	0	0	3	D
4	B18CS6054	Parallel Processing and Algorithms	2	0	1	0	3	D
		(SC-7)						
1	B18CS6061	Mobile Application Development	2	0	0	1	3	E
2	B18CS6062	Advanced Computer Networks	3	0	0	0	3	D
3	B18CS6063	Introduction to Genomic Sciences	3	0	0	0	3	F
4	B18CS6064	UI/UX Design	2	0	0	1	3	B
		Semester – VII (SC-8)						
1	B18CS7041	Augmented and virtual Reality	3	0	0	0	3	A
2	B18CS7042	Network Programming	2	0	0	1	3	D
3	B18CS7043	C# and. Net	2	0	1	0	3	E
4	B18CS7044	Natural Language Processing	3	0	0	0	3	A
		(SC-9)						
1	B18CS7051	Data Science using R	2	0	0	1	3	E
2	B18CS7052	Deep Learning	2	0	1	0	3	B
3	B18CS7053	Multimedia Computing and Networks	3	0	0	0	3	D
4	B18CS7054	Business Intelligence and Process Management	3	0	0	0	3	B
		(SC-10)						
1	B18CS7061	Human Computer Interaction	3	0	0	0	3	B
2	B18CS7062	Computer Graphics and Animation	2	0	1	0	3	E

3	B18CS7063	Software Defined Networks and Network Function Virtualization	3	0	0	0	3	D
4	B18CS7064	Advanced Web Technology	2	0	0	1	3	F
		(SC-11)						
1	B18CS7071	Big Data Analytics	2	0	1	0	3	A
2	B18CS7072	Block Chain Technology	3	0	0	0	3	A
3	B18CS7073	Cloud Security	3	0	0	0	3	A
4	B18CS7074	Bio-informatics	2	0	0	1	3	B
		Semester VIII (SC-12)						
1	B18CS8031	Real Time Systems	3	0	0	0	3	A
2	B18CS8032	Innovation and Entrepreneurship Present	2	0	1	0	3	B
3	B18CS8033	Ethical Hacking and IT Security Evaluation	3	0	0	0	3	F
4	B18CS8034	Cognitive Science and Computing	3	0	1	0	3	F
5	B18CS8035	Data Compression						E

Mapping of Course Outcomes with programme Outcomes

(Notations: L=Low or 1, M=Medium or 2, H=High or 3)

Course Code	POS/ Cos	PO1	Po2	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B18CS1010	**CO1**	H	H	M	M	H	L	-	-	-	-	-	-	-	H	-
	CO2	H	H	H	H	H	L	-	-	-	-	-	-	-	-	H
	CO3	H	H	M	M	H	L	-	-	-	-	-	-	H	-	-
	CO4	M	H	M	H	H	L	-	-	-	-	-	-	H	-	-
B18CS1020	**CO1**	M	L	-	-	-	-	-	-	-	-	-	-	H	-	-
	CO2	M	L	H	M	M	H	H	-	-	-	-	-	H	-	-
	CO3	M	M	H	M	L	H	L	-	-	-	-	-	-	-	H
	CO4	M	M	M	M	M	L	M	-	-	-	-	-	-	-	H
	CO1	H	M	M	H	M	-	-	L	-	-	-	-	H	H	-

B18CS1030	**CO2**	H	M	M	H	M	-	-	L	-	-	-	-	H	H	-
	CO3	M	L	M	H	L	-	-	L	-	-	-	-	-	H	H
	CO4	M	L	H	H	L	-	-	-	-	-	L	-	-	H	H
B18CS1040	**CO1**	M	L	H	L	M	L	-	-	-	-	-	-	H	-	-
	CO2	L	H	M	M	L	-	-	-	-	-	-	-	H	-	-
	CO3	M	M	M	M	L	-	-	-	-	-	-	-	-	H	H
	CO4	H	H	H	L	L	-	-	-	-	-	-	-	-	H	H
B18CS1050	**CO1**	L	M	L	-	-	H	H	L	L	-	L	-	-	H	-
	CO2	-	H	L	L	L	H	H	L	M	L	L	L	H	-	-
	CO3	M	H	M	L	H	H	H	L	-	L	M	M	-	H	H
	CO4	L	M	L	-	L	H	H	L	M	L	L	M	-	-	H
B18CS1060	**CO1**	-	-	-	-	-	H	M	-	H	H	-	H	H	-	-
	CO2	-	-	-	-	-	H	H	-	H	H	-	H	H	-	-
	CO3	-	-	-	-	-	H	M	-	H	M	-	H	H	-	-
	CO4	-	-	-	-	-	H	H	-	H	H	-	H	H	-	-
B18CS1070	**CO1**	H	M	-	-	-	-	M	-	M	-	-	-	H	-	-
	CO2	M	M	-	-	-	-	M	-	M	-	-	-	-	-	-
	CO3	M	M	-	-	-	-	L	-	L	-	-	-	H	-	-
	CO4	H	H	-	-	-	-	M	-	M	-	-	-	-	H	H
B18CS1080	**CO1**	L	L	L	L	-	M	-	-	-	-	-	-	-	-	H
	CO2	L		L	-	-	M	M	-	-	-	-	-	-	H	-
	CO3	L	L	-	-	-	M	M	-	-	-	-	-	-	H	-
	CO4	L	M	L	-	-	L	L	-	-	-	-	-	-	H	H
B18CS2010	**CO1**	H	H	M	M	H	L	-	-	-	-	-	-	H	H	-
	CO2	H	H	M	M	H	L	-	-	-	-	-	-	H	H	H
	CO3	H	H	M	M	M	L	-	-	-	-	-	-	-	-	H
	CO4	H	H	M	M	H	L	-	-	-	-	-	-	-	H	-
B18CS2020	**CO1**	L	-	-	M	-	-	-	-	-	-	-	-	-	H	-
	CO2	L	-	L		-	-	-	-	-	M	-	-	-	H	-
	CO3	L	-	-	M	-	-	-	-	-	-	-	-	H	-	-
	CO4	L	-	-	L	-	-	-	-	-	-	-	-	-	H	H
B18CS2030	**CO1**	H	M	H	H	L	-	-	-	-	-	-	-	H	H	-
	CO2	M	M	M	M	L	-	-	-	-	-	-	-	H	-	-
	CO3	H	M	H	H	M	-	-	-	-	-	-	L	H	H	-
	CO4	H	M	H	H	M	-	-	-	-	-	-	M	H	H	-
B18CS2040	**CO1**	-	-	-	-	-	H	H	-	H	H	-	H	-	-	-
	CO2	-	-	-	-	-	H	H	-	H	H	-	H	-	-	-

	CO3	-	-	-	-	-	-	-	-	-	-	-	H	-	-	-
	CO4	-	-	-	-	-	H	H	-	H	H	-	H	-	-	-
B18CS2050	**CO1**	L	-	-	-	-	H	M	M	L	-	-	H	-	-	-
	CO2	L	-	-	-	-	M		M	L	-	-	M	-	-	-
	CO3	L	-	-	-	-	-	M	H	-	H	-	H	-	-	-
	CO4	L	-	-	-	-	-	M	H	-	M	-	H	-	-	-
B18CS2060	**CO1**	H	M	M	L	H	-	-	-	-	-	-	-	H	H	-
	CO2	H	L	L	L	H	-	-	-	-	-	-	-	H	-	-
	CO3	H	H	H	M	H	-	-	-	-	-	-	-	H	H	-
	CO4	H	H	H	H	H	-	-	-	-	-	-	-	H	H	H
B18CS2070	**CO1**	H	M	M	L	M	M	-	-	-	-	-	L	H	H	H
	CO2	M	M	H	-	-	L	-	-	-	L	H	L	H	H	-
	CO3	-	-	M	-	M	L	-	-	-	-	M	-	H	-	-
	CO4	M	M	M	-	M	M	-	-	-	L	M	L	H	H	H
B18CS2080	**CO1**	H	H	H	H	H	-	-	-	-	-	-	M	H	H	H
	CO2	H	H	H	M	L	-	-	-	-	-	-	M	H	H	-
	CO3	M	H	L	M	L	-	-	-	-	-	-	M	H	-	-
	CO4	H	H	H	M	L	-	-	-	-	-	-	M	H	H	H
B18CS3010	**CO1**	H	H	H	M	M	-	-	-	-	-	-	-	H	H	-
	CO2	H	M	H	M	H	-	-	-	-	-	-	-	H	H	-
	CO3	H	M	H	M	M	-	-	-	-	-	-	-	H	-	-
	CO4	H	H	H	M	L	-	-	-	-	-	-	-	H	H	H
B18CS3020	**CO1**	H	M	H	H	M	-	-	-	-	-	-	-	H	-	-
	CO2	M	M	M	M	M	-	-	-	-	-	-	-	H	-	-
	CO3	H	H	H	H	M	-	-	-	-	-	-	-	-	H	-
	CO4	M	M	M	M	M	-	-	-	-	-	-	-	-	H	-
B18CS3030	**CO1**	H	H	M	M	L	-	-	-	-	-	-	-	H	-	-
	CO2	H	H	M	M	L	-	-	-	-	-	-	-	H	-	-
	CO3	H	H	L	H	L	-	-	-	-	-	-	-	-	H	H
	CO4	H	H	H	H	M	-	-	-	-	-	-	L	H	H	-
	CO1	H	M	M	H	M	-	-	-	-	-	-	-	H	-	-

B18CS3040	**CO2**	H	M	H	H	M	-	-	-	-	-	-	-	H	H	-
	CO3	H	L	M	H	L	-	-	-	-	-	-	-	H	H	-
	CO4	H	L	H	H	M	-	-	-	-	-	-	-	H	H	-
B18CS3050	**CO1**	H	H	M	M	H	L	-	-	-	-	-	-	H	-	-
	CO2	H	H	M	M	H	L	-	-	-	-	-	-	H	-	-
	CO3	H	H	M	M	M	L	-	-	-	-	-	-	H	H	-
	CO4	H	H	M	M	H	L	-	-	-	-	-	-	H	H	-
B18CS3060	**CO1**	M	H	H	L	H	M	-	-	-	-	-	-	H	H	-
	CO2	L	H	M	L	H	L	-	-	-	-	-	-	H	H	-
	CO3	L	M	H	L	H	L	-	-	-	-	-	-	H	-	-
	CO4	M	H	H	L	M	M	-	-	-	-	-	-	**H**	H	H
B18CS3070	**CO1**	H	H	-	L	L	-	-	-	-	-	-	L	H	H	-
	CO2	H	H	L	M	H	-	-	-	-	-	L	L	H	H	-
	CO3	H	M	L	L	H	-	-	-	-	-	L	-	H	H	-
	CO4	H	M	M	M	H	-	-	-	-	-	-	-	**H**	H	-
B18CS3080	**CO1**	H	M	M	-	-	-	-	-	-	-	-	-	H	-	-
	CO2	H	M	-	-	M	-	-	-	-	L	-	-	-	H	-
	CO3	H	H	-	-	H	-	-	-	-	-	-	-	-	H	-
	CO4	H	H	-	-	-	-	-	-	-	L	-	-	-	-	H
B18CS4010	**CO1**	M	M	L	H	L	-	-	-	-	-	-	L	H	H	-
	CO2	M	M	L	M	M	-	-	-	-	-	-	M	H	H	-
	CO3	M	M	L	H	L	-	-	-	-	-	-	M	H	H	H
	CO4	M	L	L	H	M	-	-	-	-	-	-	L	**H**	H	H
	CO1	H	L	H	H	M	L	L	-	-	-	-	-	**H**	-	-

B18CS4020	**CO2**	H	H	M	M	M	L	M	-	-	-	-	-	H	**H**	-
	CO3	H	H	H	M	M	M	L	-	-	-	-	-	H	**H**	-
	CO4	M	M	M	M	H	M	L	-	-	-	-	-	H	H	**H**
B18CS4030	**CO1**	H	H	M	M	M	-	-	-	-	L	-	L	**H**	**H**	-
	CO2	H	H	M	H	L	-	-	-	-	-	-	L	**H**	**H**	-
	CO3	H	H	M	H	H	-	-	-	-	-	-	L	**H**	**H**	**H**
	CO4	H	H	M	H	L	-	-	-	-	L	L	L	**H**	**H**	-
B18CS4040	**CO1**	M	H	-	-	-	-	H	-	-	-	-	L	**H**	-	-
	CO2	H	H	-	M	-	-	-	-	-	M	-	-	**H**	-	-
	CO3	H	-	-	-	-	-	-	-	-	-	M	-	**H**	-	-
	CO4	H	H	-	M	-	-	-	-	-	M	M	-	**H**	**H**	-
B18CS4051	**CO1**	H	H	H	H	H	-	-	-	-	-	-	-	**H**	-	-
	CO2	H	H	H	H	H	L	-	-	-	-	-	-	**H**	H	-
	CO3	H	H	H	M	M	L	L	-	-	-	-	-	**H**	H	-
	CO4	H	H	H	H	M	-	-	-	L	-	-	-	**H**	H	-
B18CS4052	**CO1**	H	L	L	M	M	L	-	-	-	-	-	L	H	-	-
	CO2	M	M	M	M	L	-	-	-	-	-	-	L	H	-	-
	CO3	M	M	L	L	L	-	-	-	-	-	-	-	H	H	-
	CO4	M	L	L	L	L	-	-	-	-	-	-	-	H	H	-
B18CS4053	**CO1**	M	L	H	M	M	-	-	-	-	-	-	-	**H**	-	-
	CO2	M	M	M	H	L	-	-	-	-	-	-	-	**H**	-	-
	CO3	M	H	H	M	L	-	-	-	-	-	-	-	**H**	-	-
	CO4	H	H	L	M	L	-	-	-	-	-	-	-	**H**	-	-
	CO1	H	H	M	M	M	-	-	-	-	-	-	-	H	**H**	-
	CO2	H	H	H	M	H	-	-	-	-	-	-	-	H	**H**	-

B18CS4054	**CO3**	H	H	H	M	H	-	-	-	-	-	-	-	H	**H**	-
	CO4	H	H	H	H	H	-	-	-	-	-	-	-	H	**H**	-
B18CS4055	**CO1**	H	M	H	M		M	-	-	-	-	-	-	**H**	-	-
	CO2	M	M	M	H	M	M	-	-	-	-	-	-	**H**	-	-
	CO3	M	M	M	M	M	L	-	-	-	-	-	-	**H**	**H**	-
	CO4	M	M	H	H	M	H	-	-	-	-	-	-	**H**	**H**	-
B18CS4060	**CO1**	H	M	M	H	H	-	-	-	-	-	-	-	-	**H**	**H**
	CO2	H	M	M	H	H	-	-	-	-	-	-	-	-	**H**	**H**
	CO3	H	M	M	H	H	-	-	-	-	-	-	-	**H**	-	-
	CO4	H	M	M	H	H	-	-	-	-	-	-	-	-	**H**	**H**
B18CS4070	**CO1**	M	H	-	-	-	-	-	-	-	-	-	-	-	**H**	-
	CO2	-	H	-	-	M	-	-	-	-	-	-	-	**H**	-	-
	CO3	-	-	-	-	-	-	-	-	-	M	H	-	-	**H**	**H**
	CO4	-	-	-	M	-	-	-	H	-	-	-	-	-	**H**	-
B18CS5010	**CO1**	M	M	L	L	L	-	-	-	-	-	L	L	**H**	-	-
	CO2	M	M	L	L	L	-	-	-	-	-	L	L	**H**	-	-
	CO3	M	M	L	L	L	-	-	-	-	-	L	L	**H**	-	-
	CO4	M	M	L	L	L	-	-	-	-	-	L	L	-	**H**	-
B18CS5020	**CO1**	H	M	M	H	H	-	-	-	-	-	-	-	H	**H**	-
	CO2	H	M	H	M	H	-	-	-	-	-	-	-	-	**H**	-
	CO3	H	M	H	H	H	-	-	-	-	-	-	-	-	**H**	-
	CO4	H	M	M	H	H	-	-	-	-	-	-	-	H	-	-
B18CS5030	**CO1**	H	H	H	H	M	L	-	-	-	-	-	L	**H**	-	-
	CO2	H	H	H	H	M	M	-	-	-	-	-	L	**H**	-	-
	CO3	H	H	H	H	M	L	-	-	-	-	-	M	**H**	-	-

	CO4	H	H	H	M	M	L	-	-	-	-	-	L	**H**	**H**	**H**
B18CS5040	**CO1**	L	L	M	-	L	-	-	-	-	-	-	-	**H**	-	-
	CO2	L	M	H	M	L	-	-	-	-	-	-	-	**H**	-	-
	CO3	L	M	H	H	L	-	-	-	L	-	-	L	-	**H**	-
	CO4	M	M	M	L	M	-	-	-	-	-	-	-	**H**	-	-
B18CS5051	**CO1**	M	M	H	L	M	-	-	-	-	-	-	-	**H**	-	-
	CO2	M	M	H	H	M	-	-	-	-	-	-	-	-	**H**	-
	CO3	M	H	H	M	H	-	-	-	-	-	-	-	-	**H**	-
	CO4	M	H	H	H	H	-	-	-	-	-	-	-	**H**	**H**	H
B18CS5052	**CO1**	H	H	H	M	H	M	-	-		-	-	-	-	-	H
	CO2	M	H	H	M	M	H	-	-	-	-	-	-	**H**	-	-
	CO3	H	H	M	M	H	H	-	-	-	-	-	-	**H**	-	-
	CO4	M	H	H	H	H	M	-	-	-	-	-	-	**H**	-	-
B18CS5053	**CO1**	H	M	M	M	L	-	-	-	L	L	-	-	**H**	-	-
	CO2	H	H	M	M	L	-	-	-	-	-	-	-	**H**	-	-
	CO3	H	M	M	L	L	-	-	-	-	L	-	-	-	**H**	H
	CO4	H	H	H	H	M	L	-	-	-	-	-	L	**H**	-	-
B18CS5054	**CO1**	H	M	L	L	-	-	-	-	-	-	-	-	**H**	-	-
	CO2	H	M	M	M	-	-	-	-	-	-	-	-	H	-	-
	CO3	H	H	H	M	-	H	-	-	-	-	-	-	H	-	-
	CO4	H	H	L	M	-	-	-	-	-	-	-	-	H	**H**	-
B18CS5055	**CO1**	H	M	M	H	M	-	-	-	-	-	-	-	**H**	-	-
	CO2	H	M	H	H	M	-	-	-	-	-	-	-	**H**	H	-
	CO3	H	L	M	H	L	-	-	-	-	-	-	-	-	H	-
	CO4	H	L	H	H	M	-	-	-	-	-	-	-	**H**	-	-
B18CS5061	**CO1**	M	L	H	H	M	-	-	-	-	-	-	-	H	-	-
	CO2	H	H	H	H	L	-	-	-	-	-	-	-	H	-	-
	CO3	H	M	H	H	L	-	-	-	-	-	-	-	H	-	-
	CO4	H	H	H	H	M	-	-	-	-	-	-	M	H	**H**	-
B18CS5062	**CO1**	H	M	H	M	L	M	-	-	-	-	-	-	**H**	-	-
	CO2	H	H	M	H	M	M	-	-	-	-	-	-	**H**	-	-
	CO3	L	M	H	L	M	L	-	-	-	-	-	-	**H**	-	-

	CO4	H	H	H	M	M	H	-	-	-	-	-	-	**H**	H	H
B18CS5063	**CO1**	H	H	M	M	M	-	-	-	-	-	-	-	H	-	-
	CO2	H	H	H	H	H	-	-	-	-	-	-	-	-	H	-
	CO3	H	H	H	H	H	-	-	-	-	-	-	-	-	H	**H**
	CO4	H	H	H	M	M	-	-	-	-	-	-	-	H	-	-
B18CS5064	**CO1**	H	M	M	L	M	-	-	-	H	-	-	L	**H**	**H**	-
	CO2	H	M	L	L	-	-	-	-	H	-	-	L	**H**	**H**	-
	CO3	H	M	M	M	M	-	-	-	H	-	-	L	-	**H**	-
	CO4	H	M	H	M	H	-	-	-	M	-	-	M	-	**H**	-
B18CS5065	**CO1**	H	M	H	H	M	L	-	-	-	-	-	L	-	**H**	-
	CO2	H	M	H	M	M	M	-	-	-	-	-	L	**H**	-	-
	CO3	M	H	M	M	M	L	-	-	-	-	-	M	**H**	-	-
	CO4	H	M	H	M	M	L	-	-	-	-	-	L	-	**H**	-
B18CS5070	**CO1**	M	M	M	M	M	-	-	-	-	-	-	-	**H**	-	-
	CO2	M	M	M	M	M	L	-	-	-	-	-	L	**H**	**H**	**H**
	CO3	M	M	M	M	M	L	-	-	-	-	-	L	**H**	-	-
	CO4	M	M	M	M	M	L	-	-	-	-	-	L	**H**	-	**H**
B18CS5080	**CO1**	H	L	-	-	M	-	-	-	-	-	M	-	**H**	-	**H**
	CO2	H	-	-	-	-	-	M	-	-	-	-	L	**H**	-	-
	CO3	H	M	-	-	M	-	M	-	-	-	-	-	**H**	-	-
	CO4	H	M	-	-	M	-	M	-	-	-	-	-	**H**	-	-
B18CS6010	**CO1**	M	H	H	H	M	M	-	-	-	-	-	-	**H**	-	-
	CO2	M	H	H	H	M	L	-	-	-	-	-	-	**H**	-	-
	CO3	H	H	M	H	M	L	-	-	-	-	-	-	-	**H**	-
	CO4	H	H	H	H	H	L	-	-	-	-	-	-	-	**H**	**H**

B18CS6020	**CO1**	H	H	H	H	M	-	-	-	-	-	-	-	H	-	-
	CO2	H	H	H	H	M	-	-	-	-	-	-	-	H	-	-
	CO3	H	H	H	H	M	-	-	-	-	-	-	-	H	-	H
	CO4	H	H	H	H	M	-	-	-	-	-	-	-	H	-	-
B18CS6031	**CO1**	H	M	-	-	H	-	L	-	L	-	-	-	**H**	-	-
	CO2	M	H	-	L	-	-	M	-	-	-	-	-	**H**	**H**	-
	CO3	M	-	L	-	-	M	-	L	-	-	-	-	-	**H**	H
	CO4	H	M	-	-	H	L	-	M	L	-	-	-	**H**	-	-
B18CS6032	**CO1**	M	H	M	M	M	-	-	L	-	-	L	L	H	-	-
	CO2	L	M	L	L	M	-	-	L	-	-	-	-	H	-	-
	CO3	L	M	M	M	L	-	-	L	-	-	L	-	H	-	-
	CO4	L	M	M	M	H	-	-	L	-	-	-	-	-	**H**	H
B18CS6033	**CO1**	M	M	M	L	L	-	-	-	-	-	L	L	**H**	-	-
	CO2	M	M	M	L	L	-	-	-	-	-	L	L	-	**H**	-
	CO3	M	M	M	L	L	-	-	-	-	-	L	L	**H**	-	-
	CO4	M	M	M	L	L	-	-	-	-	-	L	L	-	**H**	H
B18CS6034	**CO1**	H	M	H	L	H	-	-	-	-	-	-	-	-	**H**	-
	CO2	H	H	H	M	H	-	-	-	-	-	-	-	H	-	-
	CO3	H	M	H	H	H	-	-	-	-	-	-	-	H	-	-
	CO4	H	M	M	M	M	-	-	-	-	-	-	-	-	**H**	H
B18CS6035	**CO1**	H	H	H	M	M	-	-	-	-	-	-	-	H	-	-
	CO2	H	H	M	H	M	-	-	-	-	-	-	-	-	**H**	-
	CO3	H	H	M	H	M	-	-	-	-	-	-	-	H	-	-
	CO4	H	H	H	H	H	-	-	-	-	-	-	-	-	**H**	H
B18CS6041	**CO1**	H	M	M	H	H	H	L	L	-	-	-	-	H	-	-

	CO2	H	H	M	H	H	L	-	-	-	-	-	-	H	-	-
	CO3	H	H	M	H	H	L	-	-	-	-	-	-	-	H	-
	CO4	H	H	M	H	H	H	H	M	-	-	-	L	-	H	H
B18CS6042	**CO1**	H		H	H	H	-	-	-	-	-	-	-	-	H	H
	CO2	H	L	M	M	H	-	-	-	-	-	-	-	H	-	-
	CO3	H	L	H	H	H	-	-	-	-	-	-	-	-	H	H
	CO4	H	L	H	H	H	-	-	-	-	-	-	-	-	H	H
B18CS6043	**CO1**	M	M	M	M	M	-	-	-	-	-	-	-	H	-	-
	CO2	M	M	M	M	M	L	-	-	-	-	-	L	H	-	-
	CO3	M	M	M	M	M	L	-	-	-	-	-	L	-	H	-
	CO4	M	M	M	M	M	L	-	-	-	-	-	L	-	-	H
B18CS6044	**CO1**	H	M	M	L	M	-	-	-	-	-	-	-	H	-	-
	CO2	H	M	M	L	M	-	-	-	-	-	-	-	H	-	-
	CO3	H	L	H	M	M	-	-	-	-	-	-	-	-	H	H
	CO4	H	L	M	M	H	-	-	-	-	-	-	-	H	-	-
B18CS6045	**CO1**	H	M	-	-	-	-	-	-	H	-	-	H	H	-	-
	CO2	M	M	-	L	H	-	-	-	M	-	-	M	H	-	-
	CO3	H	H	-	-	-	-	-	-		-	-	-	H	-	-
	CO4	H	H	-	M	-	-	-	-	H	-	-	-	H	-	H
B18CS6051	**CO1**	H	H	M	M	L	-	-	-	-	-	-	-	H	-	-
	CO2	H	H	M	H	L	-	-	-	-	-	-	-	H	-	-
	CO3	H	H	H	M	L	-	-	-	-	-	-	-	H	-	-
	CO4	H	M	M	L	M	-	-	-	-	-	-	-	-	H	H
B18CS6052	**CO1**	H	L	M	M	M	-	-	-	-	-	-	-	H	-	-
	CO2	M	H	L	M	L	-	-	-	-	-	-	-	H	-	-

	CO3	M	L	L	M	L	-	-	-	-	-	-	-	H	-	-
	CO4	M	M	L	H	M	-	-	-	-	-	-	-	-	**H**	**H**
B18CS6053	**CO1**	H	M	M	M	M	-	H	H	-	-	-	-	**H**	-	-
	CO2	H	H	M	M	H	-	H	-	-	-	-	M	**H**	-	-
	CO3	H	H	H	M	H	H	H	-	H	-	-	-	**H**	-	-
	CO4	H	H	H	M	H	-	H	-	-	-	-	-	-	**H**	**H**
B18CS6054	**CO1**	H	H	H	H	M	-	-	-	-	-	-	-	**H**	-	-
	CO2	H	M	L	M	L	-	-	-	-	-	-	-	-	-	**H**
	CO3	H	M	M	M	M	-	-	-	-	-	-	-	H	-	-
	CO4	H	H	L	L	M	-	-	-	-	-	-	-	-	**H**	**H**
B18CS6061	**CO1**	H	M	H	M	L	L	-	-	M	M	-	-	**H**	-	-
	CO2	M	H	M	H	M	M	-	-	H	M	-	M	-	-	**H**
	CO3	-	M	H	L	M	-	-	-	H	L	M	-	H	H	-
	CO4	H	H	H	M	M	L	-	-	M	M	L	-	-	**H**	**H**
B18CS6062	**CO1**	H	M	H	H	M	L	-	-	L	-	-	L	**H**	-	-
	CO2	H	H	H	H	M	M	-	-	L	-	-	L	**H**	-	-
	CO3	M	H	H	M	M	L	-	-	L	-	-	M	-	**H**	H
	CO4	H	M	H	M	M	L	-	-	L	-	-	L	**H**	-	-
B18CS6063	**CO1**	M	M	L	-	L	-	-	-	-	-	-	-	**H**	-	-
	CO2	H	M	M	M	L	-	-	-	-	-	-	-	-	-	**H**
	CO3	M	M	M	L	-	-	-	-	-	-	-	-	H	-	-
	CO4	M	M	L	M	L	-	-	-	-	-	-	-	**H**	-	-
B18CS6064	**CO1**	H	M	M	M	M	L	L	-	L	-	-	M	**H**	-	-
	CO2	H	M	M	M	L	-	-	-	L	-	-	L	**H**	-	-
	CO3	H	M	M	M	L	-	-	-	L	-	-	M	-	H	H

	CO4	H	H	M	M	L	-	-	-	L	-	-	M	-	H	H
B18CS6070	**CO1**	-	-	-	-	H	-	-	-	-	-	-	-	H	-	-
	CO2	M	H	-	-	-	-	-	-	-		-	-	H	-	H
	CO3	-	-	-	-	H	-	-	M	M	-	-	-	H	-	-
	CO4	-		-	-	-	-	-	M		-	-	-	H	-	H
B18CS7010	**CO1**	H	L	H	H	M	-	-	-	-	-	-		H	-	-
	CO2	H	M	M	H	M	-	-	-	-	-	-		H	-	-
	CO3	H		H	H	M	-	-	-	-	-	-		-	H	H
	CO4	H	M	H	H	M	-	-	-	-	-	-		-	H	H
B18CS7020	**CO1**	M	M	M	M	L	-	-	-	-	-	-	-	H	-	-
	CO2	H	M	H	L	M	-	-	-	-	-	-	-	-	H	-
	CO3	H	L	M	M	H	-	-	-	-	-	-	-	-	H	H
	CO4	M	M	M	L	L	-	-	-	-	-	-	-	-	H	H
B18CS7031	**CO1**	H	H	M	H	H	-	-	-	-	-	-	-	H	-	-
	CO2	H	H	H	H	M	L	L	-	-	-	-	-	H	-	-
	CO3	H	H	M	M	M	L	L	-	-	-	-	L	H	-	-
	CO4	H	H	H	M	L	L	L	-	-	-	-	-	-	H	H
B18CS7032 DATA STRUCTURE	**CO1**	H	M	M	L	L	-	-	-	H	-	-	L	H	H	-
	CO2	H	L	M	M	L	-	-	-	M	-	-	L	H	H	-
	CO3	H	L	H	H	M	-	-	-	H	-	-	H	H	H	-
	CO4	H	M	M	M	L	-	-	-	H	-		H	-	H	-
B18CS7041	**CO1**	H	-	-	-	-	-	-	-		H	-	-	H	-	-
	CO2	H	H	H	-	H	-	-	-	-	H	-	-	-	-	H
	CO3	H	H	H	-	H	-	-	-	-	H	M	-	-	H	H
	CO4	H	-	-	-	-	-	-	-	-	H	M	-	H	-	-

B18CS7042	**CO1**	M	L	L	M	L	-	-	-	-	-	-	-	**H**	H	-
	CO2	M	L	L	H	M	-	-	-	-	-	-	-	-	H	-
	CO3	L	L	L	H	H	-	-	-	-	-	-	-	-	H	H
	CO4	L	H	M	M	H	-	-	-	-	-	-	-	-	H	-
B18CS7043	**CO1**	H	M	M	H	H	-	-	-	-	-	-	-	H	-	-
	CO2	H	H	H	M	M	-	-	-	-	-	-	-	-	**H**	H
	CO3	H	H	H	L	M	-	-	-	-	-	-	-	**H**	-	H
	CO4	M	M	M	M	L	-	-	-	-	-	-	-	-	H	H
B18CS7044	**CO1**	M	H	H	H	M	-	-	-	-	-	-	-	**H**	-	**H**
	CO2	M	H	M	H	H	-	-	-	-	-	-	-	-	**H**	-
	CO3	M	H	M	H	M	-	-	-	-	-	-	-	-	**H**	**H**
	CO4	H	H	L	H	M	-	-	-	-	-	-	-	**H**	-	-
B18CS7051	**CO1**	H	M	H	L	H	-	-	-	-	-	-	-	**H**	-	-
	CO2	H	M	L	H	M	-	-	-	-	-	-	-	-	**H**	**H**
	CO3	M	L	L	L	M	-	-	-	-	-	-	-	-	**H**	-
	CO4	H	M	H	L	M	-	-	-	-	-	-	-	-	**H**	**H**
B18CS7052	**CO1**	M	M	L	M	-	-	-	-	-	-	-	-	**H**	**H**	-
	CO2	M	-	L	M	L	-	-	L	-	-	-	-	**H**	**H**	-
	CO3	L	-	L	M	M	-	-	L	-	-	-	-	**H**	-	**H**
	CO4	L	L	-	M	L	-	-	-	-	-	-	-	**H**	-	-
B18CS7053	**CO1**	H	M	H	M	H	L	L	-	-	-	-	-	**H**	-	-
	CO2	M	M	H	M	H	L	-	-	-	-	-	-	**H**	**H**	-
	CO3	H	M	H	L	H	L	L	-	L	-	L	-	-	-	**H**

	CO4	H	M	H	L	M	L	L	-	L	-	-	-	**H**	-	-
B18CS7054	**CO1**	M	M	L	-	M	-	-	-	L	L	L	L	**H**	-	-
	CO2	H	M	H	M	-	-	-	-	-	-	H	-	**H**	-	-
	CO3	H	H	M	M	-	H	H	H	-	L	M	L	**H**	-	-
	CO4	M	H	M	M	-	-	-	-	-	-	M	L	**H**	-	-
B18CS7061	**CO1**	H	H	H	L	M	-	-	-	-	-	-	-	**H**	-	-
	CO2	H	M	L	L	M	-	-	-	-	-	-	-	-	**H**	-
	CO3	H	M	M	H	H	-	-	-	-	-	-	-	**H**	-	**H**
	CO4	M	H	H	M	M	-	-	-	-	-	-	-	**H**	-	-
B18CS7062	**CO1**	H	M	H	L	H	-	-	L	-	-	-	-	-	**H**	**H**
	CO2	H	M	H	M	H	-	-	-	-	-	-	-	**H**	-	-
	CO3	H	H	M	M	H	-	-	-	-	-	-	-	**H**	-	-
	CO4	M	L	M	M	H	L	-	L	-	-	-	-	-	**H**	**H**
B18CS7063	**CO1**	H	H	H	M	M	-	-	-	-	-	-	-	**H**	-	-
	CO2	H	H	H	H	M	-	-	-	-	-	-	-	**H**	-	-
	CO3	H	H	H	M	H	L	L	-	-	-	-	-	**H**	-	-
	CO4	H	H	H	H	M	L	L	-	-	-	-	-	-	-	**H**
B18CS7064	**CO1**	M	H	M	H	M	-	-	-	-	-	-	-	**H**	-	**H**
	CO2	M	M	H	H	M	-	-	-	-	-	-	-	-	**H**	**H**
	CO3	H	H	M	M	M	-	-	-	-	-	-	-	-	**H**	-
	CO4	M	M	H	H	H	-	-	-	-	-	-	-	-	**H**	**H**
B18CS7071	**CO1**	M	H	H	M	M	-	-	-	L	-	-	H	**H**	-	-
	CO2	H	H	H	H	H	-	-	-	L	-	-	H	**H**	-	-
	CO3	H	H	H	H	H	-	-	-	L	-	-	H	-	**H**	**H**
	CO4	H	H	H	H	H	-	-	-	M	-	-	H	**H**	-	**H**
B18CS7072	**CO1**	M	M	M	M	M	_	_	_	_	_	_	L	**H**	-	-

	CO2	H	H	M	H	M	-	-	-	-	-	-	L	**H**	-	-
	CO3	M	H	H	M	M	-	-	-	-	-	-	L	-	**H**	-
	CO4	M	H	H	M	M	-	-	-	-	-	-	L	-	**H**	**H**
B18CS7073	**CO1**	H	M	M	M	L	-	-	-	-	-	-	-	**H**	-	-
	CO2	H	H	M	H	L	-	-	-	-	-	-	-	-	**H**	-
	CO3	H	M	H	M	M	-	-	-	-	-	-	-	**H**	-	-
	CO4	H	H	H	M	M	-	-	-	-	-	-	-	-	**H**	-
B18CS7074	**CO1**	H	H	-	M	H	-	-	-	-	-	-	-	**H**	-	-
	CO2	H	H	L	L	-	-	-	-	-	-	-	-	-	-	**H**
	CO3	H	H	H	M	L	-	-	-	-	-	-	-	**H**	-	-
	CO4	M	H	H	L	L	-	-	-	-	-	-	-	-	**H**	-
B18CS8031	**CO1**	H	M	M	L	L	-	-	-	-	-	-	L	**H**	-	-
	CO2	H	H	M	H	M	-	-	-	-	-	-	H	**H**	**H**	-
	CO3	H	H	M	M	L	-	-	-	-	-	-	M	**H**	-	-
	CO4	H	M	M	H	M	-	-	-	-	-	-	H	-	**H**	**H**
B18CS8032	**CO1**	L	M	L	-	-	L	L	-	M	M	M	M	-	-	-
	CO2	L	M	L	-	L	L	L	-	M	M	M	M	-	-	-
	CO3	L	L	L	-	L	L	L	-	M	M	M	M	-	-	-
	CO4	L	L	L	-		L	L	-	M	M	H	M	-	-	-
B18CS8033	**CO1**	-	-	H	-	M	-	H	L	-	-	-	-	**H**	-	-
	CO2	-	-	H	-	M	-	H	L	-	-	M	-	-	-	**H**
	CO3	-	-	H	-	M	-	H	L	M	-	-	-	-	**H**	**H**
	CO4	-	-	H	-	M	-	H	L	M	-	-	-	-	**H**	-
B18CS8034	**CO1**	H	H	H	M	M	L	-	-	-	-	-	L	**H**	-	-
	CO2	H	H	M	M	M	-	-	-	-	-	-	-	-	**H**	-

	CO3	M	M	H	M	M	-	-	-	-	-	-	L	**-**	**-**	**H**
	CO4	H	H	H	M	M	L	-	-	-	-	-	L	**-**	**H**	**-**
B18CS8035	**CO1**	M	H	-	H	H	M	-	L	-	-	-	-	**H**	**-**	**-**
	CO2	H	H	M	H	H	M	-	-	-	-	-	-	**H**	**-**	**H**
	CO3	H	H	M	H	H	M	-	-	-	-	-	-	**H**	**-**	**-**
	CO4	H	H	M	H	H	M	-	-	-	-	-	-	**H**	**-**	**-**

Mapping of PEO’S with Respect to POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
PEO1	√	√	√	√	√	√	√		√		√		√		√
PEO2	√	√	√		√	√					√			√	
PEO3	√	√	√		√					√			√	√	√

List of some Global Certifications:

1. CISCO: CCNA (Network Associate), CCNP (Network Professional – Routing and Switching), CCNA (NA with Security Credential)
2. MICROSOFT: MCSD (Solutions developer for web applications), MCSA (Solutions associate windows server), MCSE (Systems engineer), Data Science
3. IEEE: SDA (Software development associate)
4. CompTIA: Security+, A+, Linux+
5. Citrix certified professional Virtualization CCP-V, by CITRIX
6. Risk and information systems control (CRISC), by ISACA
7. Scrum master by Scrum Alliance
8. Information Security Manager by ISACA
9. Project management professional by PMI
10. Citrix certified associate Networking (CCA-N)
11. Certified ethical hacker by EC council

12. Certified information systems security professional CISSP by ISC
13. Certified information systems auditor CISA, by ISACA
14. AWS certified solutions architect associate
15. Google certified professional
16. Google adwords professional
17. Google cloud professional
18. IBM Certification (developer, administrator, database)
19. Oracle certification
20. Dell EMC certification (storage, networking, server)
21. HP certification
22. Intel certification
23. Mcafee certification
24. VMWARE certification

List of some MOOC Centres:

1. Swayam
2. NPTEL
3. Coursera
4. Edx
5. Khan academy
6. Udacity
7. Udemy
8. Stanford online
9. WizIq

Guidelines for Internship/Project Work/Global Certification Programs

1. 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.

2. Students can take-up the internship only if it is approved by RU authorities.

3. Project work phase 1 comprises of literature survey, review paper writing, and problem formulation, identification of tools and techniques, and methodology for the project. Project work phase – 2, in 4th semester should have an outcome: publication in a reputed National/International Journal or a patent filing to earn 2 credits

4. Global Certification programs: Students have to register for global certification programs of their choice such as networking, JAVA, ORACLE, etc. The students can also choose skill development programs conducted by the UIIC or School, which may not be globally certified. However, weightage is more for global certification courses (10% weightage is accounted less for non-global programs). The registration must happen before beginning of the third semester.

Guidelines for Evaluation of Project Work/Internship/ Skill Development Global Certification Program

1. Evaluation of Major/Minor Project

Sl.No	Examination	Max. Marks	Requirements/Documents To Be Submitted	Tentative Schedule
1	IA1	25	1.Synopsis Report 2.Weekly progress Reports 3.Presentation	6 weeks from semester start date
2	IA2	25	1. MID-TERM report 2. Weekly progress Reports 3.Presenation	6 weeks from IA1
3	IA3	20 marks for Viva 30 marks for Thesis Evaluation Total 50	1. Thesis Report 2. Weekly progress Reports. 3.Final Presentation	Two weeks from IA2

2. Evaluation of Internship

Sl.No.	EXAM	MAX.MARKS	Documents To Be Submitted	Tentative Scheduling
1	IA1	25	1.Synopsis Report/PHASE-1 2.Presenation	6 weeks from semester start date

2	IA2	25	1.MID-TERM report/ PHASE-2 2.Presenation	6 weeks from IA1
3	IA3	20 marks for Viva 30 marks for Thesis Total 50	1.Internship Final Report 3.Final Presentation	Two weeks from IA2

3. Evaluation of Global Certification Program

Sl.No	**EXAM**	**MAX.MARKS**	**Documents To Be Submitted**	**Tentative Scheduling**
1	IA1	25	1. PHASE-1 Report on their topic of Certification. 2. Presentation.	6 weeks from semester start date
2	IA2	25	1. MID-TERM report/ PHASE-2 on Their Topic of Certification. 2.Presenation	6 weeks from IA1
3	IA3/SEE	20 marks for Viva 30 marks for Thesis Total 50	1. Final Report 2. Final Presentation 3. Global Certificate.	Two weeks from IA2

B Tech (Computer Science and Engineering)

Detailed Syllabus

I Semester

B18CS1010	Multivariable Calculus and Linear Algebra	L	T	P	C
Duration:14 Wks		4	0	0	4

Prerequisites:

Knowledge of limits, continuity, differentiation, integration, matrices, determinants, and geometry.

Course Description:

This course covers basic concepts of calculus and linear algebra particularly in power series expansion of functions, techniques to solve undefined forms, angle between the polar curves, solving system of equations and to find the inverse of matrix.

Course Objectives:

Objectives of this course are to:

1. Explain the scalar product and vector product of two or more vectors
2. Illustrate how to find angle between polar curves with a suitable example.
3. Demonstrate the use of Radius of curvature of the curves that 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):

On successful completion of this course, the student will be able to:

CO1: Apply Taylor's and Maclaurin's series for finding series expansions of functions and approximating values.

CO2: Identify and evaluate the radius of curvature of the given curve. Also evaluate the given indeterminate form using L' Hospital rule.

CO3: Make use of Gauss elimination and Gauss Jordon method for solving the system of equations, if the given system of equations is consistent.

CO4: Determine the Eigen values, the corresponding Eigen vectors and diagonalize the given square matrix.

Course Contents:

UNIT- 1

Introduction to Vector Calculus: Definition and types of vectors, algebra of vectors, scalar (or dot) product of two vectors, scalar product of three vectors and vector product of three vectors.

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

Self-Learning Components:

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

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, 43^{nd} edition, 2015.*
3. *Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 9^{th} edition,2013.*
4. *Ron Larson, "Multivariable Calculus, Cengage Learning", 10th Edition, 2013.*

References:

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.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	H	M	M	H	L	-	-	-	-	-	-
CO 2	H	H	H	H	H	L	-	-	-	-	-	-
CO 3	H	H	M	M	H	L	-	-	-	-	-	-
CO 4	M	H	M	H	H	L	-	-	-	-	-	

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS1020	Chemistry	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Chemistry in Intermediate.

Course Description

This course provides the fundamental knowledge of basic principles of Engineering chemistry which is required for basic foundation in Engineering Education irrespective of branch. The course also provides the introduction to the electrochemistry concepts like Cell reactions, Fuel cells and its applications, Battery technology, Polymer materials and Nano-materials.

Course Objectives:

The objectives of this course are to:

1. Explain the basic concepts of Atomic and Molecular Structure, energy level diagram and quantum chemistry
2. Design construction and applications of Batteries, fuel cells and solar cells
3. Classify the types of Corrosion, corrosion control and metal finishing techniques
5. Discuss the use of engineering materials like Nano, Polymers Semiconductors, superconductors, magnetic materials, liquid crystals in various applications

Course Outcomes:

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

CO1: Analyze the basic concepts of Atomic and Molecular structure, energy level diagrams and quantum mechanics

CO2: Outline the construction and working of batteries fuel cells and solar cells

CO3: Apply the knowledge of corrosion science and metal finishing essential for corrosion control of commercially available materials like PCB and circuits

CO4: Identify the applications of engineering materials in various fields.

Course Content:

UNIT-1:

Electrons in Atomic, Molecular Structure and Periodicity :

Electrons in Atomic, molecular structure: Classical to quantum mechanical transition, Origin of quantum mechanics, dual nature of light and matter, concept of quantization – Max Planck, Einstein, de Broglie, Schrödinger wave equation, particle in a box (1D)-Energy solutions, wave nature and quantum states of electron, orbital wave functions in bond formation (H2)

Periodic Properties: Effective nuclear charge, penetration of orbital, atomic and ionic sizes, ionization energies, electron affinity and electro negativity.

UNIT-2:

Energy Storage and Conversion Devices:

Battery: Introduction to electrochemistry, Basic concepts of Cells and Battery, Battery characteristics –primary (Leclanche Cell), secondary (Lead-Acid), Lithium batteries, Advantage of use of Li as electrode material (Lithium & Lithium ion), Electrochemical Capacitor.

Fuel cells: Difference between battery and fuel cell, types of fuel cells- construction working, applications, advantages& limitations of Solid oxide fuel cells and phosphoric acid fuel cell. Photovoltaic cell: Band structure of solids and the role of doping on band structures. Properties of Silicon, advantages, P-N Junction diode, antireflective coatings. Construction, working of photovoltaic cells, applications, advantages and disadvantages

UNIT-3:

Science of Corrosion and its Control:

Corrosion: Electrochemical theory of corrosion, Types of Corrosion- Differential metal corrosion, Differential aeration corrosion (Pitting & water line),

Boiler corrosion, and Grain boundary corrosion, Factors affecting rate of corrosion-Primary, secondary. Corrosion control: Galvanizing & tinning, cathodic protection & Anodic Protection. Metal Finishing: Theory of electroplating. Effect of plating variables on the nature of electro deposit- electroplating process, Electroplating of gold. Electro less plating of Copper and PCB.

UNIT 4:

Chemistry of Engineering Materials:

Semiconducting and Super Conducting materials: Principle and some example. Magnetic material: Principle and types of magnetic materials-applications of magnetic materials in storage devices. Polymers-Introduction, Polymer composites (carbon fibre and Kevlar, synthesis, advantages, applications).Conducting polymers: Mechanism, synthesis and applications of polyacetyline, polyaniline. Liquid Crystals: Introduction, classification and applications.

Nanomaterials-Introduction – Definition, classification based on dimensionality (1D, 2D and 3D), quantum confinement (electron confinement). Size dependent properties- surface area, magnetic properties (GMR phenomenon) and thermal properties (melting point). Properties of Carbon Nanomaterials (mention of -Fullerenes, Graphene, Carbon nanotubes).

Self-learning component: Molecular orbitals of diatomic molecules. Alkaline Fuel Cell, Introduction to Electromagnetic spectrum, Czocharlski method, Pourbaix diagram (Al, Fe). Inorganic Coatings and aromaticity, Crystal field theory and transition metal ions and their magnetic properties, HSAB Concepts, molecular geometries Inhibitors, Types of polymerization, Applications of nano materials- in various fields, Glass transition temperature (tg) - definition, significance. Structure and Property relationship – tensile strength and plastic and elastic deformation.

Textbooks:

1. SS Dhara, "A Text book of Engineering Chemistry" , S. Chand Publications, New Delhi,

12th Edition, 2014.

2. Shashichawla, "Text Book of Engineering Chemistry", Dhanapath Rai & Co Publications, Reprint Edition 2013.

3. P.W. Atkins, "Physical Chemistry", Oxford university press, 11thEdition, 2017.

4. Shikha Agarwal, "EngineeringChemistry: Fundamentals and Applications", Cambridge

University Press, 2016

6. M.G.Fontana., "Corrosion Engineering", Tata McGraw Hill, 3rd Edition, 2017.

References:

1. *V.R. Gowrikar, N.N. Vishwanathan and J. Sreedhar, "Polymerchemistry", Wiley eastern ltd, 1993.*
2. *Charles P. Poole Jr., Frank J. Owens, "Introduction to Nanotechnology, Wiley India Publishers, 2004.*
3. *Krishan K Chawla," Composite materials: Science and Engineering", Springer International edition, 2nd edition, 1985.*

Mapping COs with POs (Program outcomes)

Course Outcome	**PO1**	**P2**	**PO3**	**PO4**	**PO5**	**PO6**	**P7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO 1	M	L	-	-	-	-	-	-	-	-	-	-
CO 2	M	L	H	M	M	H	H	-	-	-	-	-
CO 3	M	M	H	M	L	H	L	-	-	-	-	-
CO 4	M	M	M	M	M	L	M	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS1030	Programming for Problem Solving	L	T	P	C
Duration:14 Wks		3	0	0	3

Course Description:

The objectives of this course is to make students learn basic principles of problem solving, present the syntax and semantics of the "C" language, implement through C language using constructs offered by the language.

Prerequisites:

The fundamental concepts in computer algorithms and programming

Course Objectives:

Objectives of this course are to:

1. Explain the different programming constructs of C to be used for a given application.
2. Illustrate the Usage of iterative statements, conditional Statements for solving the real world problems.
3. Demonstrate the use parameter passing mechanism for solving the real world problems.
4. Illustrate the use of structures and unions for solving the real world problems.

Course Outcomes (CO's):

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

CO1 Identify the basic programming constructs of C to be used to compute the roots of quadratic equation.

CO2 Develop a C program to find transpose of a matrix using Iterative statements (loops) and Arrays.

CO3 Build a C program to concatenate two strings by using parameter passing mechanism.

CO4 Apply the basic concepts Union & Structures to read and print employee's detail.

Course Contents:

Unit -1:

Introduction: Introduction to Linux and Windows OS. Installation of Linux, Awareness of various programming and scripting languages and listing of top 10 languages. Opensource Tools and Technologies. Github and its usage for software development.

Fundamentals of problem solving and introduction to C-language: Algorithm and flowchart & advantages of algorithm (pseudo code),basic flow chart symbols**,** structure of C program with example**, C** language & its features, C tokens , data types in C **,**variables, constants, input / output functions

Operators: (unary operator, assignment operator, arithmetic operator, relational operators, logical operators &bitwise operator, conditional operator, increment and decrement operator, special operator).

Expressions &statements: Postfix, primary, prefix, unary, binary, ternary & assignment

Unit2:

Branching constructs

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

Unconditional statements: break and continue statement, Goto statement, return statement

Iterative statements (loops): while loop, do while, difference between while and do while for loop.

Arrays: one dimensional array, two dimensional array, searching techniques, sorting.

Unit -3:

Functions: function definition, types of functions, location of function in a program, structure of a function, parameter passing mechanisms, call by value & call by address.

Strings: string operations with and without using inbuilt string functions (string length, string compare, string copy, string concatenation, string reverse).

Unit -4:

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

Pointers: Introduction to pointers.

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

Command Line Arguments: argc, argv with simple examples, Introduction to UNIX commands.

Self Learning component:

Fundamentals ofcomputergraphics:output primitives – Line, Circle and Ellipse drawing algorithms - Attributes of output primitives, Two dimensional Geometric Transformation.

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

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 McGRAW Hill, 2000.
3. B.S. Anami, S.A. Angadi and S. S. Manvi, "Computer Concepts and C Programming: A Holistic Approach", second edition ,PHI, 2008.
4. NanjeshBennur, Dr. C.K.Subbaraya, "Programming in C", 2nd Edition, Excellent Publishing House, 2015.

References:

1. E. Balaguruswamy,"Programming in ANSI C", 4th edition, TATA MCGRAW Hill, 2008.
2. Donald Hearn, Pauline Baker, "Computer Graphics C Version", second edition, PearsonE ducation,2004.

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	H	M	M	H	M	-	-	L	-	-	-	-
CO2	H	M	M	H	M	-	-	L	-	-	-	-
CO3	M	L	M	H	L	-	-	L	-	-	-	-
CO4	M	L	H	H	L	-	-	-	-	-	L	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS1040	Basic Electrical and Electronics Engineering	L	T	P	C
Duration:14 Wks		4	0	0	4

Prerequisites:

Fundamentals in Engineering, Mathematics and Physics.

Course Description:

This course in Electrical Engineering covers basic concepts of electrical engineering and electromagnetism. The course also introduces the student to the working AC and DC Circuits. The course also helps the student understand 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 Objectives:

The objectives of this course are to:

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.

Course Outcomes:

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

CO1. Outline the basics of electrical engineering terminology and the usage.
CO2. Identify the Differences between single and three phase systems and learn the working of the same.
CO3. Design different building blocks in digital electronics using logic gates.
CO4. Analyze the applications of diode in rectifiers, filter circuits and wave shaping.

Course Content:

UNIT-1:

Introduction to Basic Concepts & Single-Phase AC Circuits: A. Basic Concepts: Ohm's Law and Kirchhoff's Laws; Analysis of series, parallel and series-parallel circuits excited independent voltage sources; Power and energy. Electromagnetism: Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy stored in magnetic fields. Introduction to DC Circuits.

Single Phase AC Circuits: Generation of sinusoidal voltage- definition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series- parallel circuits.

UNIT-2:

Three Phase AC Circuits and Transformers: A. AC Circuits:,Three Phase A.C. Circuits covering, Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power (Expression for Power in Star and Delta, No numerical)

B. Transformers: Principle of operation and construction of single-phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation;

UNIT-3:

Digital Electronics: Introduction, Switching and Logic Levels, Digital Waveform (Sections 9.1 to 9.3). Number Systems: Decimal Number System, Binary Number System, Converting Decimal to Binary, Hexadecimal Number System: Converting Binary to Hexadecimal, Hexadecimal to Binary, Converting Hexadecimal to Decimal, Converting Decimal to Hexadecimal, Octal Numbers: Binary to Octal Conversion. Complement of Binary Numbers. Boolean Algebra Theorems, De Morgan's theorem.

Digital Circuits: Logic gates, NOT Gate, AND Gate, OR Gate, XOR Gate, NAND Gate, NOR Gate, X-NOR Gate. Algebraic Simplification, NAND and NOR Implementation, NAND Implementation, NOR Implementation. Half adder, Full adder.

UNIT 4:

Semiconductor Diodes and Applications: p-n junction diode, Characteristics and Parameters, Diode approximations, DC load line analysis, Half-wave rectifier, Two-diode Full-wave rectifier, Bridge rectifier, Capacitor filter circuit (only qualitative approach), Zener diode voltage regulators: Regulator circuit with no load, Loaded Regulator. Numerical examples as applicable.

Self-learning components:

Bipolar Junction Transistors: BJT operation, BJT Voltages and Currents, BJT amplification, Common Base, Common Emitter and Common Collector Characteristics, Electromagnetism: Electromagnetic Induction, Electromagnetic Pulse and Electromagnetic Radiation.

Text books:

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

References:

1. Theodore Wildi, "Electrical Machines, Drives, and Power, 5thSystems", Pearson Edition, 2007.
2. Hughes, "Electrical Technology", International Students 9th Edition, Pearson, 2005.
3. International Journal of Electrical Power and Energy Systems (https://www.journals.elsevier.com/international-journal-of-electrical-power-and-energy-systems)
4. Journal of Electrical Engineering (https://link.springer.com/journal/202)

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	M	L	H	L	M	L	-	-	-	-	-	-
CO 2	L	H	M	M	L	-	-	-	-	-	-	-
CO 3	M	M	M	M	L	-	-	-	-	M-	-	-
CO 4	H	H	H	L	L	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS1050	Environmental Science	**L**	**T**	**P**	**C**
Duration:14 Wks		2	0	0	2

Prerequisites:

Basic knowledge of Environmental Science studied at higher secondary & school level.

Course Description:

Environmental Science is a multidisciplinary subject which includes various aspects from physics, chemistry, Ecology, Biology, Earth science & Engineering etc. Environmental Studies includes the introduction to environment, Objectives & guiding principles of Environmental education, environmental ethics, Components of Environment, Impacts of Engineering/human activities on environment, Sustainable development, Role of individual and government in environmental Protection, and various various topics related to environmental science imparted through this course.

Course Objectives:

The objectives of this course are to:

1. Discuss Foster clear awareness and concern about economic, social, political and ecological interdependence in urban and rural area
2. Influence the new patterns of behaviors of individuals, groups and society as a whole towards the environment
3. List the knowledge values, attitudes, commitment and skills needed to protect and improve the environment
4. Elaborate the evaluation of the environmental measures and education programs.

Course Outcomes:

On successful completion of this course, the student will be able to:

CO1. Adapt the environmental conditions and protect it

CO2. Estimate the role of individual, government and NGO in environmental protection.

CO3. Interpret the new renewable energy resources with high efficiency through active research.

CO4. Analyze the ecological imbalances and protect it.

Course Content:

UNIT-1:

Multidisciplinary nature of environmental studies: Introduction 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, 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. Solid Waste management – Municipal solid waste, Biomedical waste, Industrial solid waste and Electronic waste (E-Waste).

UNIT-3:

Energy & Natural resources: Energy – Definition, classification of energy resources, 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 analternative 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, Deforestaion-Causes, effects and controlling measures)

UNIT 4:

Ecology and ecosystem: 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.

Self-learning component:

Waste water treatment processes, hydrology and modern methods adopted for mining activities, remote sensing and its applications, disaster management, case studies of Bhopal gas tragedy, Chernobyl nuclear disaster, London smog.

Text books:

1.*R.J. Ranjit Daniels and JagadishKrishnaswamy, Co-authored & Customised by Dr.MS Reddy &Chandrashekar, "Environmental Studies", Wiley India Private Ltd., New Delhi (Authors from REVA University), 2017.*

2. Benny Joseph, "Environmental Studies" -Revised Edition, Tata McGraw – Hill PublishingCompany Limited, 2017.

3. Ashish Shukla, Renu Singh, Anil Kumar, Environmental Science, Revised Edition,IKInternational Publishing House Pvt.Ltd, 2018.

4. Dr.S.M.Prakash, Environmental Studies by Elite Publishers Mangalore, 2017.

5. R.J. Ranjit Daniels and JagadishKrishnaswamy, "Environmental Studies", Wiley India PrivateLtd., New Delhi, 2009.

6. G.Tyler Miller, Scott E.Spoolman, Environmental Sciences, Cengage Learning, 14th Edition, 2015.

References:

1. BharuchaErach, "The Biodiversity of India", Mapin Publishing Pvt. Ltd., Ahmedabad, India, 2017.

2. RajagopalanR.,"Environmental Studies – from Crisis to cure", Oxford University Press, 2017.

3. Environmental Science by Arvind walia, Kalyani Publications, 2018.

4. Jadhav, H &Bhosale, V.M. Environmental Protection and Laws. Revised Edition, HimalayaPub.House, Delhi, 2018.

5. Sharma B.K., Environmental Chemistry. Goel Publ. House, Meerut, 2018.

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	L	M	L	-	-	H	H	L	L	-	L	-
CO 2	-	H	L	L	L	H	H	L	M	L	L	L
CO 3	M	H	M	L	H	H	H	L	-	L	M	M
CO 4	L	M	L	-	L	H	H	L	M	L	L	M

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS1060	Technical English – I	L	T	P	C
Duration:14 Wks		2	0	0	2

Prerequisites:

Fundamentals of Spoken English.

Course Description:

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 Objectives:

The objectives of this course are to:

1. Develop basic communication skills in English.
2. Emphasize on the development of speaking skills amongst learners of Engineering and Technology
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.

Course Outcomes:

On successful completion of this course, the student 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 oneor 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).

Course Content:

UNIT-1:

Functional English: Grammar: Prepositions; Modal Auxiliaries, Listening: Listening to audio (verbal sounds), Speaking: Debating Skills, Reading: Skimming a reading passage; Scanning for specific information, Writing: Email communication

UNIT-2:

Interpersonal Skills: Grammar: Tenses; Wh-questions, Listening& Speaking: Listening and responding to video lectures / talks, Reading: Reading Comprehension; Critical Reading; Finding key information in a given text, **Writing:** Process descriptions (general/specific); Recommendations

UNIT-3:

Multitasking Skills Grammar: Conditional Sentences, Listening & Speaking: Listening to specifictask; focused audio tracks and responding, Reading: Reading and interpreting visual material, Writing: Channel conversion (flowchart into process); Types of paragraph (cause and effect / compare and contrast / narrative / analytical); Note Taking/ Note Making

UNIT 4:

Communication Skills Grammar: Direct and indirect speech, Listening & Speaking: Watching videos / documentaries and responding to questions based on them; Role plays, Reading: Making inference from the reading passage; predicting the content of a reading passage, **Writing:** Interpreting visual materials (line graphs, pie charts etc.); Different types of Essay Writing.

Text 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.*

References:

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

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	H	M	-	H	H	-	H
CO2	-	-	-	-	-	H	H	-	H	H	-	H
CO3	-	-	-	-	-	H	M	-	H	M	-	H
CO4	-	-	-	-	-	H	H	-	H	H	-	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS1070	Basic Electrical and Electronics Engineering Lab	L	T	P	C
Duration:14 Wks		0	0	2	2

Prerequisites:

Nil.

Course Description

The Course covers conduction of experiments to Analyze, Design and simulate mechanism of FUSE, MCB, for two-way switch or staircase wiring, to determine the additive and subtractive polarity of a single- phase transformer, Determination of VI characteristics Zener Diode, Silicon Diode, Half Wave rectifier using Diode.

Course Objectives:

The objectives of this course are to:

1. Build a broad concept of various types of electrical apparatus, tools and instrumentation.
2. Provide hands on experience with electrical apparatus and electrical safety norms.
3. Analyze the schematics for making electrical connection of different appliances.
4. Develop collecting and interpreting experimental data, writing skills in students.

Course Outcomes:

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

CO1: Make use of the basic knowledge of electrical terminology in conducting the experiments.

CO2: Differentiate between single and three phase systems and learn the working of the same.

CO3: Develop different building blocks in digital electronics using logic gates and implement simple logic functions using basic universal gates.

CO4: Design diodes in rectifiers, filter circuits and wave shaping.

Course Content:
List of Experiments

Introduction to Simulation tools: PSPICE 9.1 Student Version- Design and simulate analog and digital circuits, Digital Simulator -Digital Simulator has a toolbar of digital circuit elements, including logic gates, flip-flops, switches, and indicators.

SL. NO.	EXPERIMENT
1.	Electrical Safety Training. To Study the importance of Earthing during accidental shorting of line wire and the body of equipment. To study the Importance and mechanism of FUSE.
2.	Home Electrical Wiring Demonstration 1. To study the Importance and mechanism of MCB.
3.	Home Electrical Wiring Demonstration 2. To study & verify the connection procedure for fluorescent lamp wiring. To study the connection of Fan with switch and regulator.
4.	Two-way switch/ staircase wiring. To study & verify the connection procedure for two-way switch or staircase wiring.
5.	Behavior of current and voltage in series and parallel circuits. To study and verify the behavior of current and voltage in series circuit. To study and verify the behavior of current and voltage in parallel circuit
6.	Polarity test on single phase transformer. To determine the additive polarity of a single- phase transformer. To determine the subtractive polarity of a single- phase transformer.
7.	Polarity test on single phase transformer. To determine the subtractive polarity of a three- phase transformer.
8.	Determination of VI characteristics of Zener Diode

9.	Determination of VI characteristics of Silicon Diode
10.	Design and Analysis of a Half Wave rectifier using Diode
11.	Characteristics Configuration of BJT in Common Emitter
12.	Characteristics Configuration of FET in Common Source
13.	Half Wave and Full Wave Rectifier Without Filter
14.	Half Wave and Full Wave Rectifier with Filter

Text books:

1.Nagrath I.J. and D. P. Kothari), Basic Electrical Engineering, Third Edition Tata McGrawHill, 2009.
2.Hayt and Kimberly, Engineering Circuit Analysis, 8th Edition, Tata McGraw Hill, 2013.
3.Kulshreshtha D.C., Basic Electrical Engineering, Tata McGraw Hill, 2009.
4.Rajendra Prasad, Fundamentals of Electrical Engineering, Prentice Hall, India, 2009.
5.Hughes, E., Electrical Technology, Pearson, 2005.
6.David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5th Edition, 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, 5thSystems", Pearson Edition, 2007.
2. Hughes, "Electrical Technology", International Students 9th Edition, Pearson, 2005.
3. International Journal of Electrical Power and Energy Systems (https://www.journals.elsevier.com/international-journal-of-electrical-power-and-energy- systems)
4. Journal of Electrical Engineering (https://link.springer.com/journal/202)

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	M	-	-	-	-	M	-	M	-	-	-
CO2	M	M	-	-	-	-	M	-	M	-	-	-
CO3	M	M	-	-	-	-	L	-	L	-	-	-
CO4	H	H	-	-	-	-	M	-	M	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS1080	Chemistry Lab	**L**	**T**	**P**	**C**
Duration:14 Wks		0	0	2	2

Prerequisites:

Students taking this course shall have the knowledge of the following:

1. Handling glassware, apparatus, Acids, Bases toxic chemicals and safety precautions in the laboratory.

2. Chemical awareness and basic chemical reactions.

Course Description:

The Course covers conduction of experiments to analyze the material present in a sample using different methods, qualitative and quantitative analysis of materials, testing hardness of water and other experiments using various methods.

Course Objectives:

1: Distinguish qualitative and quantitative analysis of materials by classical and instrumental methods for developing experimental skills in building technical competence

2: Analyse different instrumental and titrimetric methods for estimation of the samples

3: Discuss the hardness and impurities in water

4: Explain ions present in unknown substance/ores using titrimetric and instrumental metals

Course Outcomes:

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

CO1: Analyze the amount of material present in the sample by different instrumental methods.

CO2: Evaluate the amount of oxygen demand, alkalinity, and hardness of the different water samples.

CO3: Estimate impurities in water.

CO4: Test the ions present in unknown substance/ores using titrimetric and instrumental metals

Lab Experiments:

Sl No	List of Experiments
1.	Potentiometric Estimation of Mohrs salt.
2.	Colorimetric estimation of copper.
3.	Conductometric estimation of acid mixture using standard NaOH.
4.	Determination of pKa of given weak acid using pH meter.
5.	Determination of viscosity co-efficient of a given organic Liquid.
6.	Determination of total hardness of the given water sample.
7.	Determination of calcium oxide in the given cement sample.
8.	Determination of COD of the given waste water sample.
9.	Determination of percentage of copper in the given brass sample.
10	Determination of iron in the given sample of Haematite ore using Potassium dicromate.
11	Estimation of Alkalinity of the given water sample using standard HCl solution
12	Flame photometric estimation of sodium in the given water sample.
13	Electroplating of Copper and Nickel.
14	Determination of Calcium in a milk sample.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	L	L	-	M	-	-	-	-	-	-
CO2	L		L	-	-	M	M	-	-	-	-	-
CO3	L	L	-	-	-	M	M	-	-	-	-	-
CO4	L	M	L	-	-	L	L	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

II Semester Syllabus

B18CS2010	Probability and Statistics	L	T	P	C
Duration:14 Wks		4	0	0	4

Prerequisites:

Knowledge of statistics – mean, mode, median, and knowledge of set theory, permutation and combination, basics of probability theory.

Course Description:

This course covers concepts of curve fitting, data interpretation, probability distributions and sampling analysis. This course provides an elementary introduction to probability and statistics and applications with basic combinatorics, random variables, probability distributions, Bayesian inference, hypothesis testing, confidence intervals and linear regression.

Course Objectives:

The objectives of this course are to:

1. Describe Curve fitting and regression in various problems in Computer Science & engineering fields
2. Illustrate the applications of Probability and statistics in various computer science 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 methods for systematic model buildings.

Course Outcomes (Cos):

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

CO1. Solve the problems of Curve fitting and regression in various problems in Computer Science & Engineering fields.

CO2. Apply the concepts of Probability and statistics in various computer science engineering fields like data mining, classification problems etc.

CO3. Develop a stochastic problem as Markov model as a problem solving methods for systematic model buildings.

CO4. Make use of sampling theory concepts to solve various engineering problems like structured and unstructured data models.

Course Contents:

UNIT- 1

Curve Fitting: Curve fitting by the method of least squares and fitting of the curves of the form, $y = ax + b$, $y = ax^2 + bx + c$, $y = ae^{bx}$ *and* $y = ax^b$

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.

Self-learning components:

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

Text books:

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

McGraw Hill Professional, 1998, pp. 256.

References:

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. 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.,"Probabilityand Statistics" S. Chand Publishing, 2015.

5. J. K. Sharma "Operations Research theory and applications", Macmillan

publishers, fifthedition, 2013.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	H	M	M	H	L	-	-	-	-	-	-
CO 2	H	H	M	M	H	L	-	-	-	-	-	-
CO 3	H	H	M	M	M	L	-	-	-	-	-	-
CO 4	H	H	M	M	H	L	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS2020	Physics	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

The fundamental concepts in physics related to atomic physics, electricity and magnetism, mechanics, waves and optics.

Course Description:

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

Course Objectives:

The objectives of this course are to:

1. Impart the knowledge about wave mechanics and its applications
2. Demonstrate the different applications of lasers, and optical fibers
3. Discuss different types of display technologies, superconductors and its applications
4. Explain the importance of quantum computation, nanomaterials , synthesis and application

Course Outcomes(Cos):

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

CO1: Apply the role of wave mechanics and uncertainty in quantum physics to solve time-dependent and independent Schrodinger equations for particle in a well. (Apply)

CO2: Demonstrate the working of LASER and its application in holography and optical fiber communications (Understanding, Analysis)

CO3: Summarize superconductivity with applications and demonstrate touch screen and display Technologies. (Comprehension, Application)

CO4: Make use of synthesis of nano-materials like CNTs and basics of quantum computation (Analysis)

Course Contents:

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**:** Heisenberg's uncertainty principle, its significance and its applications (nonexistence of electron inside the nucleus). 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, Construction and working of Carbon Dioxide (CO2) laser &semiconductor laser and their applications. Applications: Holography (recording and reconstruction of images) and its applications.

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- 3

Superconductors: Zero resistance, Critical temperature (Tc), Critical field (Hc), Critical current density (Jc), Perfect diamagnetism, Meissner effect, Type I and Type II superconductors, Isotope effect, BCS theory of superconductivity, Applications-Superconducting magnets and Maglev vehicle. Display technology: Touch screen technologies: Resistive and capacitive touch screen and Displays: CRT, Field emission display, Plasma display, LED display, OLED display, LCD display.

UNIT- 4

Nanomaterials: Introduction to nanoscience, nanomaterials and their applications, Synthesis of nano materials using bottom-up method (arc-discharge method), top-down methods (ball milling method), Carbon Nanotubes: properties and applications. 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.

Self-learning component:

Introduction to haptics. Magnetic storage devices, solid state storage devices, optical storage devices, and characteristics of materials used in manufacture of laptops/desktops (body, internal circuit connection), heat sink cooling, liquid cooling, fan based cooling, laser printer working, accelerometers. Gold nano particles as storage devices

Text books:

1. William T. Silfvast, Laser Fundamentals, Cambridge University press, New York, 2004
2. D. Halliday, R. Resnick and J. Walker, Fundamentals of Physics, John Wiley and Sons, New York, 10thedition 2013.
3. R. K. Gaur and S.L. Gupta, Engineering Physics, DhanpatRai Publications (P) Ltd, New Delhi. 53rd edition, 2014.
4. M.N. Avadhanulu and P.G. Kshirsagar, A text book of Engineering Physics, S. Chand and Company, New Delhi, 2014.

References:

1. CharlsKittel, Introduction to Solid State Physics, Wiley, Delhi,8th Edition, 2004
2. Arthur Beiser, Concepts of modern Physics, Tata McGraw Hill publications, New Delhi, 8th Edition, 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, Springer Publication, Second edition 2012.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	L	-	-	M	-	-	-	-	-	-	-	-
CO2	L	-	L		-	-	-	-	-	M	-	-
CO3	L	-	-	M	-	-	-	-	-	-	-	-
CO4	L	-	-	L	-	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS2030	Object Oriented Programming	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Programming for problem solving[B18CS1030]

Course Description:

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), overloading operations, inheritance mechanisms, virtual functions and friend functions are discussed. File I/O operations, Templates and exception handling mechanisms are also introduced.

Course Objectives:

The objectives of this course are to:

1. Explain the basic concepts of objects and classes for a real world application.
2. Illustrate the use of operator overloading/function overloading for given applications.
3. Demonstrate the use of inheritance in real worldapplications.
4. Describe I/O streams and Templates and ExceptionHandling.

Course Outcomes:

On successful completion of this course, the student will be able to:

CO1: Apply the basic concepts of objects and classes for a real world application.
CO2: Utilize foperator overloading / function overloading in given real world applications.
CO3: Develop programs using Inheritance feature of object oriented programming.
CO4: Design and develop programs using I/O streams ,Templates and Exception Handling.

Course Content:

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 classexceptions.

Self-Learning Components: I/O System Basics, File I/O: C++ stream classes, Formatted I/O, <fstream> and File classes.

Text books:

1. *HerbertSchildt:TheCompleteReferenceC++,4thEdition,TataMcGrawHill,2003.*
2. *SanleyB.Lippmann,JoseeLajore:C++Primer,4thEdition,PearsonEducation,2005.*

References:

1. *PaulJDeitel, HarveyMDeitel:C++ for Programmers, Pearson Education,2009.*

2. *KRVenugopal, Rajkumar Buyya,TRaviShankar:MasteringC++,TataMcGrawHill, 1999.*

3. *ACM,ACMTransactionsonProgrammingLanguagesandSystems(TOPLAS).*

4. *ACM Journal on Object-OrientedProgramming*

Mapping COs with POs (Program outcomes)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	H	L	-	-	-	-	-	-	-
CO2	M	M	M	M	L	-	-	-	-	-	-	-
CO3	H	M	H	H	M	-	-	-	-	-	-	L
CO4	H	M	H	H	M	-	-	-	-	-	-	M

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO

B18CS2040	Technical English – II	**L**	**T**	**P**	**C**
Duration:14 Wks		2	0	0	2

Prerequisites:

Fundamentals of Spoken English.

Course Description:

This course aims at utilizing the ability of using language skills effectively in real-life scenarios, to develop the learners' competence in employability skills, to improve the habit of writing, leading to effective and efficient communication, to prioritize specially on the development of technical reading and speaking skills among the learners.

Course Objectives:

The objectives of this course are to:

1. Enable learners of Engineering and Technology develop their basic communication skills in English
2. Emphasize specially the development of speaking skills amongst learners of Engineering and Technology
3. Ensure that learners use the 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

Course Outcomes:

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

CO1: Organize their opinions clearly and meaningfully.
CO2: Demonstrate the ability to speak appropriately in social and professional contexts.
CO3: Build inferences from the text.
CO4: Take part in interviews confidently and Develop accurate writing skills using different.

Course Content:

UNIT-1:

Language Acquisition: Grammar: Active and passive voice, Listening & Speaking: Listening to informal conversations and interacting, Reading: Developing analytical skills; Deductive and inductive reasoning, Writing: Giving Instructions; Dialogue Writing

UNIT-2:

Persuasive Skills Grammar: Compound words; Phrasal verbs, Listening: Listening to situation baseddialogues. Speaking: Group Discussions, Reading: Reading a short story or an article from newspaper; Critical reading, Writing: Formal letters (Accepting/ inviting/ declining); Personal letters (Inviting your friend to a function, congratulating someone for his / her success, thanking one's friends / relatives**)**

UNIT-3:

Cognitive Skills Grammar: Homonyms; homophones, Listening: Listening to conversations;

Understanding the structure of conversations, Speaking: Presentation Skills, Reading: Extensive reading, Writing: Report Writing (Feasibility/ Project report - report format – recommendations/ suggestions - interpretation of data using charts, PPT); Precis Writing.

UNIT 4:

Employability Skills Grammar: Idioms; Single Word Substitutes, Listening: Listening to atelephone conversation; viewing model interviews (face-to-face, telephonic and video conferencing), Speaking: Interview Skills, Mock Interviews, Reading: Reading job advertisements and the profile of the company concerned, Writing: Applying for a job; Writing a cover letter with résumé / CV.

Self-learning comments:

Active listening, basic phone skills, mohile personality and E-mail communication.

Text books:

1.Thorpe, Edgar and Showick Thorpe. Objective English. Pearson Education, 2013.
2.Dixson, Robert J. Everyday Dialogues in English. Prentice Hall India Pvt Ltd., 1988.
3.Turton, Nigel D. ABC of Common Errors. Mac Millan Publishers, 1995.

References:

1. Bansal, R.K. and J.B. Harrison. Spoken English. Orient Blackswan, 2013.
2. Raman, Meenakshi and Sangeeta Sharma. Technical Communication. Oxford University Press, 2015.
3. Samson, T. (ed.) Innovate with English. Cambridge University Press, 2010.
4. Kumar, E Suresh, J. Savitri and P Sreehari (ed). Effective English. Pearson Education, 2009.
5. Goodale, Malcolm. Professional Presentation. Cambridge University Press, 2013.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	H	H	-	H	H	-	H
CO2	-	-	-	-	-	H	H	-	H	H	-	H
CO3	-	-	-	-	-	-	-	-	-	-	-	H
CO4	-	-	-	-	-	H	H	-	H	H	-	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS2050	Indian constitution and professional ethics	L	T	P	C
Duration:14 Wks		2	0	0	2

Prerequisites:

Intermediate level Constitution of India and Professional Ethics.

Course Description:

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 Objectives:

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.

Course Outcomes:

On successful completion of this 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 and make them face the world as a bonafide citizen.

CO3:Illustrate the professional ethics and human values.

CO4: Summarize ethical standards followed by different companies.

Course Content:

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

Self-learning component:

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

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.

References:

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.

3.Dr. Durga Das Basu, Introduction to constitution of India.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	-	-	-	-	H	M	M	L	-	-	H
CO2	L	-	-	-	-	M		M	L	-	-	M
CO3	L	-	-	-	-	-	M	H	-	H	-	H
CO4	L	-	-	-	-	-	M	H	-	M	-	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS2060	Computer Aided Engineering Drawing Lab	L	T	P	C
Duration:14 Wks		0	0	2	2

Prerequisites:

Nil

Course Description:

The Course provides an introduction to engineering drawing which is one of the most important tool for an engineer. The Course covers fundamentals of drawing points, lines, planes and solid objects with different types of projections.

Course Objectives:

1. Discuss the fundamental concepts of engineering drawing.
2. Explain the component descriptions as per the commonly practiced standards.
3. Explore 2D drawings of points, lines, planes and solids in sketch book.
4. Describe Orthographic projections and development of solids using solid edge software in computer.

Course Outcomes:

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

CO1: Apply various concepts to solve practical problems related to engineering drawing.

CO2: Identify component descriptions as per the commonly practiced standards.

CO3: Construct 2D drawings of points, lines, planes and solids in sketch book.

CO4: Create Orthographic projections and development of solids using solid edge software in computer.

List of Experiments

Sl.No.	NAME OF THE EXPERIMENT
1.	A point 30 mm above XY line is the front view of two points A and B. The top view of A is 40 mm behind VP and the top view of B is 45 mm infront of VP. Draw the projections of the points and state the quadrants in which the points are situated.
2.	Draw the projections of the following points on the same XY line, keeping convenient distance between each projectors. Name the Quadrants in whey they lie. E - 30 mm below HP and 25 mm behind VP.

	F - 35 mm below HP and 30 mm infront of VP. G - on HP and 30 mm infront of VP. H - on HP and 35 mm behind VP.
3.	A line has its end A 10 mm above HP and 15 mm infront of VP. The end B is 55 mm above HP and line is inclined at 30º to HP and 35º to VP. The distance between the end projectors is 50 mm. Draw the projections of the line. Determine the true length of the line and its inclination with VP.
4.	The front view of a 90 mm long line which is inclined at 45º to the XY line, measures 65 mm. End A is 15 mm above the XY line and is in VP. Draw the projections of the line and find its inclinations with HP and VP.
5.	A triangular plane lamina of sides 25 mm is resting on HP with one of its corners touching it, such that the side opposite to the corner on which it rests is 15 mm above HP and makes an angle of 30º with VP. Draw t6he top and front views in this position. Also determine the inclination of the lamina to the reference plane.
6.	A pentagonal lamina of edges 25 mm is resting on HP with one of its sides such that the surface makes an angle of 60 º with HP. The edge on which it rests is inclined at 45 º to VP. Draw its projections.
7.	A square prism 35 mm sides of base and 60 mm axis length rests on HP on one of its corners of the base such that the two base edges containing the corner on which it rests make equal inclinations with HP. Draw the projections of the prism when the axis of the prism is inclined to HP at 40º and to VP at 30º.
8.	A hexagonal prism 25 mm sides of base and 50 mm axis length rests on HP on one of its edges. Draw the projections of the prism when the axis is inclined to HP at 45º and appears to be inclined to VP at 40º.
9.	A pentagonal pyramid 25 mm sides of base sand 50 mm axis length rests on HP on one of its edges of the base. Draw the projections of the pyramid when the axis is inclined to HP at 45º and VP at 30º.
10.	A hexagonal pyramid 25mm sides of base and 50mm axis length rests on HP on one of its edges of the base. Draw the projections of the pyramid when the axis is inclined to HP at 45 º and VP at 30 º.
11.	A regular pentagonal pyramid of side of base 35mm and altitude 65mm has its base on HP with a side of base perpendicular to VP. The pyramid is cut by a section plane which is perpendicular to the VP and inclined at 300 to HP. The cutting plane meets the axis of the pyramid at a point 30mm below the vertex. Obtain the development of the remaining part of the pyramid.
12.	A right cone of 55mm diameter of base and 75mm height stands on its base on HP. It is cut to the shape of truncated cone with its truncated surface inclined at 450 to the

	axis lying at a distance of 40mm from the apex of the cone. Obtain the development of the lateral surface of the truncated cone.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO11 0	PO1 1	PO1 2
CO1	H	M	M	L	H	-	-	-	-	-	-	-
CO2	H	L	L	L	H	-	-	-	-	-	-	-
CO3	H	H	H	M	H	-	-	-	-	-	-	-
CO4	H	H	H	H	H	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS2070	Object Oriented Programming Lab	L	T	P	C
Duration:14 Wks		0	0	2	2

Prerequisites:

Knowledge of any programming Languages like Programming for problem solving(B18CS1030)

Course Description:

This course helps students to understand the fundamentals of object oriented concepts to develop solutions for various application problems.

Course Objectives:

1. Explain the fundamentals of OOPS concepts that is required to develop simple programs.
2. Discuss object-oriented programming to visualize problems in terms of objects
3. Describe models like encapsulation, inheritance and polymorphism in programs .2030
2. Describe I/O streams and Templates and ExceptionHandling.

Course Outcomes:

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

CO1: Apply good programming style and understand the impact of style on developing and maintaining programs.

CO2: Design object oriented solutions for small systems involving multiple objects.

CO3: Illustrate the use of object oriented programming model: abstract data types, encapsulation, inheritance and polymorphism.

CO4: Design and develop an object-oriented software for larger systems of Industry relevance.

List ofExperiments:

Experiment Nos.	Programs
1	Write a C++ program to create a class EMPLOYEE, with data members Name-First name, last name, Address, Employee_Number,salary. Define functions to read values from the user and display the same.
2	An election is contested among 5 candidates. Each candidate is identified by their code(1,2,3,4,5) and voting is done by entering the code of the candidate in the ballot paper. Write a C++ code to count the number of votes for each candidate and declare the candidate person with highest number of votes as winner. Note: any value in the ballot paper other than the candidate code is considered as “None Of The Above” (NOTA). If NOTA gets the highest
3	The HR of the company decides to store the concatenated names(first name and last name) of the employees in database. Write a C++ program to use copy constructor for concatenation of names. String S1=”Ram”, S2 = “Sharma”. S3=S1+S2
4	Perform addition of two complex numbers by overloading binary plus operator(+) operator using friend function.
5	Write a C++ program to print the Fibonacci series 0 1 1 2 3 5 8 13 …. By getting a number as input and print those many values in the series as output. Example: if 5 is given as input, it should print first 5 numbers of the series 0 1
6	Database of student contains Name, age, year, semester and marks score. The grade is calculated according to their percentage of marks scored. a. 90 % and above - S grade b. 80% to 89% -- A grade c. 70% to 79% -- B grade d. 60% to 69% -- C grade Write a C++ program to create object for the student and print their grade.
7	Write a Program to design a student class representing student roll no. and a test class (derived class of student) representing the scores of the student in various subjects and sports class representing the score in sports. The sports and test class should be inherited by a result class having the functionality to add the scores and display the final result for a student.

8	Write a program to find maximum of two numbers using friend function.(note: one number is member of class ONE and other number is a member of class TWO.)
9	Area can be computed for any polygon. Calculate and return the area of rectangle and triangle by defining a single virtual function Area(). Write a C++ program to use virtual function (polymorphism)
10	A simple calculator performs different arithmetic operations such as addition, subtraction, division, modulus and multiplication. Write a C++ program for a simple calculator using inline function and handle the exception for divide by zero. Additional programs
11	Define a class in C++ with following description: Private Members: A data member Flight number of type integer A data member Destination of type string A data member Distance of type float A data member Fuel of type float A member function CALFUEL() to calculate the value of Fuel as per the following criteria Distance Fuel <=1000 500 more than 1000 and <=2000 1100 more than 2000 2200 Public Members : INFO () to allow user to enter values for Flight Number, Destination, Distance & call function CALFUEL() to calculate the quantity of Fuel SHOWINFO() to allow user to view the content of all the data members
12	Write a C++program to design a class called complex to represent a complex number. The complex class must use a external function (use it as friend function) to add two complex numbers. The function should return an object of type complex representing the sum of two numbers.
13	Write a C++ program to demonstrate the inheritance in the animal kingdom.
14	Write a C++ program to read infix arithmetic expressions as input from a file, evaluates all of the expressions, and writes the resulting answers to the standard output
15	Write a C++ program to write number 1 to 100 in a data file NOTES.TXT.
16	Write a C++ program to create a file of student info and store the information about 10 students. The attributes of each student are as below: Name, SRN, Sem, Discipline.
17	Write a C++ program to print half pyramid using alphabets.

18	Write a C++ program to print characters through ASCII value using cout
19	Write a C++ program to access public data members inside main function using pointers.
20	Write a C++ program to print the size of different types of pointers along with value addresses

Mapping COs with POs (Program outcomes)

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Course Outcomes	**Program outcomes**											
	PO 1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**
CO1	H	M	M	L	M	M						
CO2	M	M	H	M		L						
CO3	H	L	M	M	M	L						
CO4	M	M	M	M	M	M						

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS2080	Physics Lab	L	T	P	C
Duration:14 Wks		0	0	2	2

Prerequisites

Intermediate Physics

Course Description

The course covers fundamentals of engineering physics that involves conducting experiments to study the characteristics of components like laser, semiconductor materials, optical fibres, capacitors, solar cell etc.

Course Objectives:

1. Explain fundamental characteristics of components like semi conductors, laser etc.
2. Discuss new technology in physics and compare its results with theoretical calculations.
3. Describe observed optical phenomena in nature.
4. Enumerate physical properties of material

Course Outcomes:

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

CO1: Develop experiments to identify the characteristics of components like semi conductors, laser etc.

CO2: Apply the knowledge of new technology in physics and comparison of results with theoretical Calculations.

CO3: Analyze observed optical phenomena in nature.

C04: Design experiments to calculate physical properties of material.

Course Contents:

List of Experiment

Sl. No.	EXPERIMENT
1	To find the velocity of ultrasonic waves in non-conducting medium by piezo- electricmethod

2	To find the band gap of intrinsic semi-conductor using four probe method
3	To find the value of Planck's constant by using Light emitting diode
4	To study the V-I characteristics of a zener diode
5	To find the laser parameters–wavelength and divergence of laser light byDiffraction method
6	To study the photo diode characteristics and hence to verify the inverse square law
7	To determine capacitance anddielectric constant of a capacitor by charging and discharging a capacitor
8	Study of attenuation and propagation characteristics of optical fibre cable
9	Determination of Particle size using laser
10	Construction and study of IC regulation properties of a given power supply
11	Study of electrical characteristics of a solar cell
12	Determination of numerical aperture of a given optical fibre
13	Determination of electrical resistivity of Germanium crystal and study thevariation of resistivity with temperature by four probe method
14	To Study the characteristics of a given npn transistor and to determine currentgain and amplification factor in CE mode
15	To determine the resonance frequency and bandwidth of a given LCR circuit(Series and Parallel)

Additional Experiments 1.

Study forward and reverse characterisitics for a zener diode using the pspice software and find knee voltage and breakdown voltage

2. Study the frequnce response of series and parallel LCR circuits using pspice software

3. Determine current gain, input resistance and output resistance for a transistor by studying its input, output and transfer characteristics using pspice software.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO11 0	PO1 1	PO1 2
CO1	H	H	H	H	H	-	-	-	-	-	-	M
CO2	H	H	H	M	L	-	-	-	-	-	-	M
CO3	M	H	L	M	L	-	-	-	-	-	-	M
CO4	H	H	H	M	L	-	-	-	-	-	-	M

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

II Year Detailed Syllabus

III Semester

Syllabus

B18CS3010	Digital Logic Design	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Knowledge of Basic Electrical and Electronics Engineering [B18CS1040].

Course Description:

This course covers basic concepts and techniques of combinational and sequential digital logic circuits, notably basic building blocks such as different types of latches, flip flops, registers, synchronous and asynchronous counters.

Course Objectives:

The objectives of this course are to:

1. Explain the construction of K-maps to simplify Boolean expressions.

2. Demonstrate the working of combinational and sequential circuits based on the input conditions.

3.Describe characteristic equations of various types of Flip-Flops and types of shift registers.

4. Illustrate circuit implementation using flip flop based approach and ROM based approach.

Course Outcomes:

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

CO1 Make use the K-map and QM-method to simplify Boolean expression and implement the reduced expression.

CO2 Analyze the behavior of data processing circuits like adders, multiplexers, demultiplexers encoders and decoders and use them for simple applications.

CO3 Illustrate the behavior of different Flip-flops and express their behavior in all possible forms and realizing shift registers.

CO4 Design counters and synchronous sequential circuits using Moore and Mealy model

Course Content:

UNIT-1:

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, Quine-McCluskey method. Introduction to EDA tools for Digital Design.

Application study1: Logical Function Unit

UNIT-2:

Analysis and Design of Combinational Circuits: Half adder; full Adder; Half Subtractor; full Subtractor; Serial Adder/Subtractor; Carry Look Ahead adder; BCD adder; encoder and decoder; multiplexers and Demultiplexers; cascading of Mux; Boolean function implementation using Mux and Decoders. Application study2: Calculator

UNIT-3:

Introduction to Sequential circuits: The S R Latch; edge and level triggering, flip-flops: SR, JK, D, T, and Master-Slave; Characteristic tables and equations; registers, shift register, universal shift register

Application sudy3: Digital combinational lock

UNIT 4:

Sequential Design: Counters: Analysis of Binary ripple Up/Down counter, Analysis and design of synchronous mod-*n* counter using flip-flop, state machine notation, Introduction to Mealy and Moore model circuits, Sequence detector.

Application study4: Vending machine

Self-learning component:

Memory devices (ROM, RAM), Elevator, Digital clock.

Text books:

1. D P Leach, A P Malvino, and GouthamSaha, “Digital Principles and Applications”, Tata McGraw-Hill, 7th edition, 2006.
2. Moshe Morris Mano, “Digital Design”, Prentice Hall, 3rd edition, 2004.

References:

1. Samuel C Lee, “Digital Circuits and Logic Design”, PHI Course Pvt. Ltd., 2008.
2. Charles H Roth Jr., “Fundamentals of Logic Design”, Cengage Course, 5th edition, 2014.
3. John M Yarbrough, “Digital Logic Applications and Design”, Thomson Course, 2001.
4. Donald D Givone, “Digital Principles and Design”, Tata McGraw-Hill 2002.

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M	-	-	-	-	-	-	-
CO2	H	M	H	M	H	-	-	-	-	-	-	-
CO3	H	M	H	M	M	-	-	-	-	-	-	-
CO4	H	H	H	M	L	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS3020	Analog Electronic Circuits	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Basic Electrical and Electronics Engineering [B18CS1040]

Course Description:

This course covers the design, construction of analog electronic circuits. The main contents are: the basic principles of operation, terminal characteristics, and equivalent circuit models for, transistors, and op-amps..

Course Objectives:

The objectives of this course are to:

1. Demonstrate the working of Bipolar junction transistors with a special focus on common Emitter Fixed bias configuration
2. Illustrate the Field effect transistors and their working principle.
3. Describe the various oscillator circuits and limiters using diodes.
4. Discuss the various analog circuits constructed using Operational amplifier

Course Outcomes (Cos):

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

CO1: Analyse Bipolar junction transistors with a special focus on designing amplifiers with discrete components

CO2: Classify the Field effect transistors and summarise their working principle.

CO3: Build the various oscillator circuits and limiters using diodes.

CO4: Construct various Analog circuits using Operational amplifier.

Course Content:

UNIT- 1

Transistors, UJT and Thyristors:

Operating Point, Common-EmitterConfiguration-Fixedbias, Thermal Runaway,Transistor Switch, Unijunction Transistors, SCR, EDAtool.

UNIT -2

Field Effect Transistors:

Bipolar Junction Transistors versus Field Effect Transistors, Junction Field Effect Transistors, Metal Oxide Field Effect Transistors, Differences between JFETs and MOSFETs, Handling

MOSFETs, Biasing MOSFETs- Voltage divider Bias, FET Applications-Amplifiers, Switches, CMOS Devices.

UNIT- 3

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 ofOscillators.

UNIT- 4

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.

Type of amplifier configurations, Relaxation Oscillator, Current-To-Voltage Converter, Voltage-To-Current Converter, Sine Wave Oscillators.

Text books:

1. Anil K Maini, Varsha Agarwal: Electronic Devices and Circuits, Wiley, 2009.

References:

1. *.JacobMillman, ChristosHalkias, ChetanDParikh: Millman's Integrated Electronics-Analog andDigital Circuits and Systems, 2ndEdition, Tata McGraw Hill, 2010.*
2. *R. D. Sudhaker Samuel: Electronic Circuits, Sanguine-Pearson,2010.*

Mapping COs with POs (Program outcomes)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	H	M	-	-	-	-	-	-	-
CO2	M	M	M	M	M	-	-	-	-	-	-	-
CO3	H	H	H	H	M	-	-	-	-	-	-	-
CO4	M	M	M	M	M	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS3030	Programming with Java	L	T	P	C
Duration:14 Wks		3	0	1	4

Prerequisites:

Programming for Problem Solving [B18CS1030], Object Oriented Programming [B18CS2030], Data Structures [B18CS3040]

Course Description:

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-orientedfeaturesandadvanceJavaprogrammingskills.Students learn to create robust object-oriented applications with Java.

Course Objectives

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 inJava.
3. Demonstrate the extending a class (inheritance) and use proper program anomaly handlingstructures.
4. Discuss the use of Java generics andcollections.

Course Outcomes (Cos):

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

CO1: Make use of array concepts in java to store and sort the given raw data.

CO2: Apply the features of OOPS in java to solve the real-world problems.

CO3: Develop program for stack implementation using Exception Handling in java.

CO4: Identify suitable build-in functions to solve real world applications

Course Contents:

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. Introduction to industry 4.0 introduction to framework for working with java.

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 ininterface; Lambda Expressions; Methodand Constructor References; Local and AnonymousClasses

UNIT- 3

INHERITANCE AND EXCEPTIONS

Extending a Class; Object: The Cosmic Superclass; Enumerations; Runtime TypeInformation 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

Self-learning component:

The EclipseIDE; Streams; Processing Input and Output; Concurrent Programming; Swingand JavaFX; Networking; JDBC DatabaseAccess

Text books:

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

References:

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

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	L	-	-	-	-	-	-	-
CO2	H	H	M	M	L	-	-	-	-	-	-	-
CO3	H	H	L	H	L	-	-	-	-	-	-	-
CO4	H	H	H	H	M	-	-	-	-	-	-	L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Sample Assignments for Internal Assessment:
Use Java Programming Language to complete the assignment.

Assignment	Description	Concepts
SCIENTIFIC COMPUTING		
Global Sequence Alignment	ComputethesimilaritybetweentwoDNA sequences.	dynamic programming, string
Particle Collision Simulation	SimulatethemotionofNcollidingparticles accordingtothelawsofelasticcollisio.	priority queue, event- driven simulation
Root Finding	ComputesquarerootsusingNewton' method.	loops, numerical computation
Cracking the Genetic Code	Findthegeneticencodingofaminoacis, given a protein and a genetic sequence known to contain thatprotein.	strings, file input
COMBINATORIAL OPTIMIZATION		
Traveling Salesperson Problem	Findtheshortestrouteconnecting13509 Indiancities.	linked list, heuristic
TEXT PROCESSING		
Word Searching	Searchforwordshorizontally,verticaly anddiagonallyina2Dcharacterarray	tries
Redundancy Detector	Findthelongestrepeatedsequencein giventext.	suffix sorting, string
Text Indexin	Build an inverted index of a text corpus and find the position of query strings in the text	suffix sorting or binary search tree

COMMUNICATION		
Prefix Free Codes	Decode a message compressed usin Huffman codes.	binary trees, data compression
Burrows-Wheeler	Implement a novel text compressio scheme that out-compresses PKZIP	suffix sorting, array data compression
RSA Cryptosysten	Implement the RSA cryptosystem.	big integers, repeated squaring, analysis of algorithms
DISCRETE MATH		
Linked List Sort	Shell sort a linked list.	linked list, shellsort
Factoring	Factor large integers using Pollard'srho method.	big integers, Euclid' algorithm
Deques and Randomized Queues	Create deque and randomized queue ADTs.	abstract data types, generics
Stock Marke	Predict the performance of a stock using Dilbert'srule.	loops

Lab Experiments

SNo.	Experiment Problem Statement
1	The sieve of Eratosthenes is one of the most efficient ways to find all primes smaller n than n when is smaller than 10 million .Given a number n, use JAVA to print all primes smaller than or equal to n.

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 linearequations
	is resolved by the means of matrices. Develop a JAVA program to solve a given set of linear equations.
3	Tocomputeasquarerootofanypositivenumber a,start withan initial guess $x = x_1$for $\sqrt{a}$; we then calculate successive approximations $x_2, x_3 \dots, \sqrt{a}$using theformula: $\boldsymbol{x_i = \frac{x_{i-1} + (a/x_{i-1})}{2}, i = 2, 3, \dots}$ Develop a JAVA application that implementstheabove $SQRT$function to compute the square root of any positive number
4	Model a lamp as a Java object. Make a Lamp class. This will contain at least one instance variable which will be of type Boolean and will hold the state of the lamp :i.e.,whether itisonor 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 followingtasks: create a lampobject; turn it on andoff; printthethelamp'son/offstatustotheconsole.

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 divisionoperations.

	The String class in JAVA has a static method compareToIgnoreCase, 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

6	compare To Ignore Case function as a parameter to the sort function using method reference.Print the sorted array.
7	XYZ technologies is firm that has 5 employees with 1 manager, and 4 technicians. XYZ wants to digitize it spay roll system, the following requirements: Dearness Allowanceis 70% of basic for allemployees. House Rent Allowance is 30% of basic for all employees . income Tax is 40% of gross salary for all employees. Theannualincrementstotheemployeesaretobegivenofthe followingcriteria:- Manager10%ofthebasicsalary,and Technicians15%ofbasic.DevelopthepayrollforXYZ.Implement aclasshierarchyusinginheritance,whereEneloyeeisan abstractclassandManagerandTechnicianarederivedfrom Eneloyee.Demonstrateapolymorphicbehaviorforgivingthe annualincrements.
8	DefineanewExceptionclassnamedOddException.Createanew class named EvenOdd. Write method called halfOf(), which takesanintasparameterandthrowsanOddExceptioniftheintis oddorzero,otherwisereturns(int/2).Writeamainmethodthat calls halfOf() three times (onc each with an even int, an odd int, and zero), with three try/catch blocks, and prints either the output of halfOf() or the caughtOddException.
9	Implement a class named Fraction that represents fractionswith 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 handlingmechanism.
10	Create a class Student that has instance variables as Name, Age, Addressandaccessorandmutatormethodstoaccesstheinstance variables along with display method to print the details of student. Next write a main() function that will create acollection of 10 students and reverse the list. Print the details before and after reversing thecollection.
11	Use generics to build a class Sort. Implement the bubble sort algorithm to sort an array of any type.
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).

B18CS3040	Data Structures	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Programming for Problem Solving (B18CS1030)

Course Description:

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 Objectives:

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):

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

CO1: Utilize Java Arrays in program to generate random numbers

CO2: Design and Develop a java program for implementing the process scheduling algorithms using queue.

CO3: Build a program in Java to convert infix expression to postfix using stack.

CO4: Apply Trees Data Structure for storing files on disk.

Course Content:

UNIT 1

Introduction to java: base types, “hello universe” java program, classes and objects, Strings, Wrappers, Arrays and Enum types, type conversion
Fundamental Data Structure:Arrays – definition, sorting an array- insertion sort, java methods for array operations, random number generation

UNIT 2

Linked list: Singly linked list definition, illustration- insert and deleting at beginning and end of list, implementation in java. Circular linked list – implementation in java; Doubly linked list- illustration of insertions and deletions.
Application : Round robin scheduling using linked list.

UNIT 3
Stacks: definition, stack ADT, Array implementation of stack, linked list implementation, implementation of stack class in java.
Application: java implementation for reversing an array using stack; illustration of infix to post fix conversion, evaluation of postfix expression.
Queue: definition, Queue ADT, array implementation, linked list implementation
Application: printer job assigning using circular queue

UNIT 4
Trees : general trees- definitions and properties; Binary Tree ADT, Binary Tree properties, Binary Tree interface in java, Abstract BinaryTree base class in java, linked list representation of Binary Tree, Java implementation of linked binary tree structure.

Application: Tree traversal – illustration of preorder, postorder traversal.

Self Learning: Storing game entities in a array, Pseudo-random number generators, reversing an array using a stack, Matching parentheses and HTML tags, Double ended queue, application of tree traversals

Text Books:

l. 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

References:

l. Richard Gilberg, BehrouzForouzan, "Data Structures: A Pseudo code Approach with C", Cengage Learning, 2004.

2.DebasisSamanta, "Classic Data Structures", second edition, PHI Learning Private Limited, 20ll.

Mapping of CO-PO

Course Outcomes	Program Outcomes											
	P01	**P02**	**P03**	**P04**	**P05**	**P06**	**P07**	**P08**	**P09**	**P010**	**P011**	**P012**
CO 1	H	M	M	H	M	-	-	-	-	-	-	-
CO 2	H	M	H	H	M	-	-	-	-	-	-	-
CO 3	H	L	M	H	L	-	-	-	-	-	-	-
CO 4	H	L	H	H	M	-	-	-	-	-	-	-

Where, L (Low 1 point), M (Medium 2 point) and H (High 3 point) represents strength of correlation between CO and PO.

B18CS3050	Discrete Mathematics	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Multi-variable calculus and linear algebra [B18CS1010], Probability and Statistics [B18CS2010]

Course Description:

A course designed to prepare math, computer science and engineering majors for a background in abstraction, notation and critical thinking for the mathematics most directly related to computer science. Topics include: logic, relations, functions, basic set theory, countability and counting arguments, proof techniques, mathematical induction, graph theory, combinatorics, discrete probability, recursion, recurrence relations, elementary number theory.

Course Objectives:

1. Explain the strategies for potential proofs in logical sequential order without mathematical symbols (plain English).

2. Demonstrate how to carry out the operations on discrete structures such as sets, relations and functions.

3. Illustrate the use of Algebraic structures and how to carry out operations on them.

4. Discuss the concepts of Lattices and boolean algebra

Course Outcomes (Cos):

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

CO1: Identify the mathematical problems in the field of engineering science(AI) and obtain the solution for the same and draw conclusions from facts, using logical gates designing the chips usedfor CPU's and other critical components of digital drives

CO2: Formulate problems and solve recurrence relations also apply knowledge of pigeon hole principle to solve real time problems.

CO3: Apply group theory to reduce multiplicative complexity to creation of digital holograms(Engineering Science), also apply knowledge of group theory in the field general science as a kind of abstract mathematical tool.

CO4: Make use of the Ideas of lattice theory in implementation of knowledge representation language and use of Boolean algebra in modelling and simplifying switching circuits

Course Contents:

UNIT-1: Set Theory & Logic

Set theory fundamental operations ; propositions; negation; disjunction and conjuction; implication and equivalence; truth tables;laws of Logic; predicates; quantifiers; rules of Inference; methods of proofs;

UNIT-2: Relations

Relations; representation of relations by graphs; properties of relations; equivalence relations and partitions;

UNIT-3: Functions

Functions; mappings; injection and surjections; composition of functions; inverse functions; pigeon hole principle;StirlingNumbers

UNIT-4: Lattices and boolean algebra: Partial ordering – Posets – Lattices as posets – Properties of lattices - Lattices as algebraic systems – Sub lattices – Direct product and homomorphism – Some special lattices –Booleanalgebra.

Self-learning component:

Function Composition and Inverse Functions, Equivalence Relations and Partitions, Method of generating functions. Application of concepts to Data mining techniques like Classification, Association, Clustering, Regression Analysis.

Text books:

1. Kenneth H Rosen , Discrete mathematics and its application, McGraw Hill, Sept. 2002
2. Englewood cliffs, Graph theory and its applications tp Engineering and computer science, Prentice Hall, 1974.

References:

1. V.Krishnamurthy, Combinatorics: Theory and Applications, East-West Press Pt. Ltd., Delhi,1986.
2. Oscar Levin, Discrete mathematics: An Open Introduction, CreateSpace Independent Publishing Platform, 2nd edition, 2016

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	H	M	M	H	L	-	-	-	-	-	-
CO 2	H	H	M	M	H	L	-	-	-	-	-	-
CO 3	H	H	M	M	M	L	-	-	-	-	-	-
CO 4	H	H	M	M	H	L	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS3060	Software Engineering	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Any Programming language

CourseDescription:

The course provides students with a 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

CourseObjectives:

1. Discuss the importance of the software development process.
2. Demonstrate the workflow of Automatingprocess.
3. Explain the development of a software using Agilemethod
4. Illustrate with case study, the importance of DevOps.

Course Outcomes:

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

CO1: Apply software development process to solve complex problems of engineering.

CO2: Make use of Agile principle for rapid software development.

CO3: Distinguish between the traditional SDLC and agile ALM model for efficient and effective product delivery.

CO4: Develop the real world applications using DevOps tools .

Course Content:

Unit-1

Introduction Defining the Software Development Process: Goals of Defining the Software Development Process , Why Is Defining the Software Development Process Important? , Where Do I Start?, Explaining the Software Development Lifecycle , Systems versus Software Development Lifecycle Defining Requirements, Managing Complexity and Change,Validity of Requirements, Testing Requirements ,Functional Requirements, Nonfunctional Requirements, Epics and Stories, Planning for Changing Requirements, Workflow for Defining Requirements, Test- Driven Development , Designing Systems ,Software Development ,Testing , Testing the Application ,Testing the Process Itself , Continuous Integration , Continuous Delivery and Deployment , Defining Phases of the Lifecycle ,Documentation Required , DevOps , Communicating with All Stakeholders, Production Support ,Maintenance and Bugfixes, Lifecycle in the Beginning ,Maintenance of the Lifecycle ,Creating the Knowledge Base.

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?, Focus on 12 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 OpenSource, 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 RightTools,Defining the UseCase,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, NeedforRapidChange, Knowledge Management, theCross-FunctionalTeam, 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 ProcessImprovement.

Self-learning component:

Case study on Critical system; Case study on ATM using agile method

Textbooks:

1. BobAielloandLeslieSachs,“AgileApplicationLifecycleManagementUsingDevOpsto DriveProcessImprovement”,AddisonWesly,Firstprinting,June2016.

Reference books:

1. RogerS,“SoftwareEngineering-APractitioner’sApproach”,seventhedition,

1. Pressman, 2010.

2. RogerPressman, I an sommerville,“SoftwareEngineering”,9thedition,2010.

3. HansVanVliet, “SoftwareEngineering: PrinciplesandPractices”,2008.

4. Richard Fairley, “Software Engineering Concepts”,2008.

5. ACM Transactions on Software Engineering and Methodology (TOSEM).

6. IEEE Transactions on SoftwareEngineering.

Mapping Cos with POs(Program outcomes)

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
CO1	M	H	H	L	H	M	-	-	-	-	-	-
CO2	L	H	M	L	H	L	-	-	-	-	-	-
CO3	L	M	H	L	H	L	-	-	-	-	-	-
CO4	M	H	H	L	M	M	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS3070	Data Structures Lab	L	T	P	C
Duration:14 Wks		0	0	2	2

Prerequisites:

Knowledge of any programming Languages like JAVA

Course Description:

This course helps students to understand the fundamentals of Data structures concepts like stacks, queues, trees, lists etc. This is a core of data storage which is very vital in processing data in the primary memory. The course involves understanding and implementation of various data structure concepts.

Course Objectives:

1. Explain the fundamentals of arrays to develop simple programs.
2. Discuss data structures to solve problems like infix to postfix and similar kind.
3. Demonstrate structures to handle various sorting algorithms.
4. Illustrate lists and tree structures to develop applications

Course Outcomes:

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

CO1: Apply complex array operations on given 2D matrix to convert it to a sparse matrix .
CO2: Choose appropriate data-structures for converting infix expression to postfix expression.
CO3: Develop applications based on different data structures for sorting, searching and computing.
CO4: Utilize the linked list to implement tree structures.

Sl. No	**List of Experiment**
1	Write a Java program using the data structure arrays to multiply two given matrices of same order
2	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.
3	Write Java programs to implement the STACK ADT using an array.

4	Write Java programs to implement the QUEUE ADT using an array.
5	The compilers always convert infix expression into postfix to perform further operations like parsing, lexical analysis etc. Select an appropriate data structure and develop a program to convert an infix expression into postfix using stack.
6	Write Java programs to implement the STACK ADT using a singly linked list.
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.
8	Write Java programs to implement the QUEUE ADT using a singly linked list.
9	Write a java program that determines whether parenthetic symbols ( ), { } and [ ] are nested correctly in a string of characters (use stack ADT).
10	Write a java program that uses both stack and queue to test whether the given string is a palindrome (Use Java Utility).
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).
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).

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	-	L	L	-	-	-	-	-	-	L
CO2	H	H	L	M	H	-	-	-	-	-	L	L
CO3	H	M	L	L	H	-	-	-	-	-	L	-
CO4	H	M	M	M	H	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS3080	Logic Design and Analog Circuits Lab	L	T	P	C
Duration:14 Wks		0	0	2	2

Prerequisites:

Basic Electrical & Electronics Engineering B18CS1040

Course Description:

The course provides foundation on designing and implementation of logic circuits. Analog circuits will be simulated using ORCAD tool and digital circuits using XILINX tool which helps in gaining experience in creating and testing of circuits.

Course Objectives:

1. Explain behavior of sequential Digital logic circuits using hardware components.
2. Discuss different families of digital integrated circuits, build, and troubleshoot combinational circuits using digital integrated circuits.
3. Illustrate circuits for basic knowledge in solid state electronics including diodes, BJT, and operational amplifier.
4. Describe analog electronic circuits using discrete components and analyze its output

Course Outcomes:

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

CO1: Examine behavior of sequential Digital logic circuits using hardware components.

CO2: Design different families of digital integrated circuits, build, and troubleshoot combinational circuits using digital integrated circuits.

CO3: Construct circuits for basic knowledge in solid state electronics including diodes, BJT, and operational amplifier.

CO4: Develop the ability to analyze and design analog electronic circuits using discrete components

LAB Experiments:

Sl. No.		Experiment
1	a	Realization of Half/Full adder and Half/Full Subtractors using logic gates
	b	Design and develop VHDL code to realize Full adder and Full Subtractors
2	a	Given a 4-variable logic expression, simplify it using Entered Variable Map and realize the simplified logic expression using 8:1 multiplexer IC
	b	Design and develop the VHDL code for an 8:1 multiplexer. Simulate and verify it's working
3	a	Realize a J-K Master / Slave Flip-Flop using NAND gates and verify its truth table
	b	Design and develop the Verilog / VHDL code for D Flip-Flop with positive- edge triggering. Simulate and verify its working
4	a	a)Design and implement a mod-n (n<8) synchronous up counter using J-K Flip-Flop ICs and demonstrate its working
	b	Design and develop the Verilog / VHDL code for mod-8 up counter. Simulate and verify its working.
5	a	Design and implement a ring counter using 4-bit shift register and demonstrate its working
	b	Design and develop the Verilog / VHDL code for switched tail counter. Simulate and verify its working.
6		To build and simulate CE amplifier (RC coupled amplifier) for its frequency response and measure the bandwidth.
7		To simulate a rectangular wave form generator (Op-amp relaxation oscillator) and compare the frequency and duty cycle with the design specifications

8		To simulate a positive clipper, double ended clipper & positive clamper circuits using diodes
9		To simulate a Wien bridge Oscillator
10		To determine the working of a power supply and observe the waveforms
11		To determine the working of a Waveform Generators/Converters and observe the waveforms
12		To simulate a Schmitt trigger using Op-amp and compare the UTP and LTP values with the given specification

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	-	-	-	-	-	-	-	-	-
CO2	H	M	-	-	M	-	-	-	-	L	-	-
CO3	H	H	-	-	H	-	-	-	-	-	-	-
CO4	H	H	-	-	-	-	-	-	-	L	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO

IV Semester Syllabus

B18CS4010	Design and Analysis of Algorithm	L	T	P	C
Duration:14 Wks		3	0	1	4

Prerequisites:

Programming for Problem Solving (B18CS1030), Data Structures using Java (B18CS3040)

Course Description:

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 Objectives

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):

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

CO1: Apply the knowledge of mathematical foundation for the analysis of algorithms.

CO2: Design and Develop the algorithms for the problems using brute force and divide and conquer design paradigm.

CO3: Build algorithms based on greedy and dynamic programming techniques.

CO4: Utilize backtracking and branch and bound techniques to solve the problems (TSP, Knapsack).

Course Contents:

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, Depth-First Search and Breadth-First Search, Divide-and-Conquer: Merge sort, Quick sort, Multiplication of Large Integers, Decrease-and-Conquer- Insertion Sort, 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

Self-learning component:

Decrease-and-Conquer: Algorithms for Generating Combinatorial Objects, Divide-and-Conquer: Strassen's Matrix Multiplication, Space and Time Trade-Offs: Hashing, Greedy Technique: Knapsack Problem, Huffman Trees and Codes, Coping with the Limitations of Algorithm Power: Hamiltonian Circuit Problem, Knapsack Problem

Text books:

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.

Reference books:

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

2. The design and analysis of computer algorithms, 4th Edition Addison-Wesley

3. ACM Transactions on Algorithms.

4. ACM Journal of Algorithms and Computational Technology.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	L	H	L	-	-	-	-	-	-	L
CO2	M	M	L	M	M	-	-	-	-	-	-	M
CO3	M	M	L	H	L	-	-	-	-	-	-	M
CO4	M	L	L	H	M	-	-	-	-	-	-	L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Lab Experiments:

1. Search for a given pattern in a text string using Brute Force String Matching.
2. Sort a set of elements in ascending order using Quick Sort algorithm.
3. Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's and Prim’s algorithms. Differentiate the methods.

4. From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijikstra's algorithm
5. Design and Implement 0/1 Knapsack problem using Dynamic Programming.
6. Implement All-Pairs Shortest Paths Problem using Floyd's algorithm
7. Obtain the DFS ordering of vertices in a given digraph.
8. Implement Horspool's algorithmforStringMatchingandfindthenumberofkey comparisons in successful search and unsuccessful search
9. Sort a given set of elements in ascending order which has duplicate entries. Use the sorting by counting algorithm
10. Implement N Queen's problem using Back Tracking.
11. Write a program to find network of people of same location in Linkedin social network.
12. Write a program to sort all transactions of Big Mall by quantity of sales.

B18CS4020	Graph Theory	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Discrete Mathematics (B18CS3050)

Course Description:

Graph theory is the core content of Discrete Mathematics, and Discrete Mathematics is the theoretical basis of computer science and network information science. This course will cover the fundamental concepts of Graph Theory: simple graphs, digraphs, Eulerian and Hamiltonian graphs, trees, matchings, networks, paths and cycles, graph coloring, and planar graphs. There is an emphasis on applications to real world problems and on graph algorithms such as those for spanning trees, shortest paths, and network flows.

Course Objectives

The objectives of this course are to:

1. Explain induced subgraphs, cliques, matchings and covers in graphs

2. Illustrate the different types of graphs viz. Hamiltonian and/or Eulerian

3. Discuss problems involving Trees and its applications

4. Demonstrate algorithmic steps using graph theory in solving real world problems.

Course Outcomes (Cos):

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

CO1: Formulate graph models and process the same for Engineering, Science, and Social Science towards society.

CO2: Identify the problem in the field of GSM network, map colouring and obtain the solution using graph colouring concept.

CO3: Design a LAN network and transmit secure code using spanning tree concept, also apply tree concept in 3D video game.

CO4: Apply graph algorithm and tree as tools to visualize and simplify problem.

Course Contents:

UNIT-1:

Introduction: Konigsberg's Bridge problem, Utilities problem, Seating Problems, graphs,Representation of graphs, Directed graphs, incidence, adjacency, degree,Indegree , out degree, regular graphs, complete graphs, Null graphs, Bipartite graphs, Isomorphism, Directed graphs, Sub graphs, Walk, Trail, Path, Cycle, Connected and Disconnected graphs, Weakly Connected and Strongly Connected, Components, Complement of Graph, Partition , Decomposition. Computer science applications.

UNIT-2:

Eulerian and Hamiltonian Graph and Graph coloring: Operation on graphs, Definition of EulerTrail, Euler graph, Standard theorems on Euler graphs Hamiltonian Path, Hamiltonian Cycle and Hamiltonian Graph, Standard theorems on Hamiltonian Graph, Planar graph, Detection of Planarity, Geometric dual, Euler formula, 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 set, Max flow Min cut theorem. Computer science applications.

UNIT-3:

Trees and algorithms: Trees, Spanning Tree, Distance, Center, Radius, Rank nullity, Spanning trees,Rooted and binary tree, Binary tree in search procedure, Sorting, Depth-First Search(DFS), Breadth-First Search(BFS), Prefix codes , Weighted trees, Matrix representation, Incidence matrix, Circuit matrix, Fundamental circuit matrix, Cut set matrix, Adjacency matrix, Path matrix. Computer science applications.

UNIT-4:

Algorithms: Introduction, Algorithm efficiency, Inorder and Post Order Algorithms, Minimalspanning tree algorithm- Kruskal algorithm, Prims algorithm, Shortest path algorithm-Dijikstra's algorithm, Warshall – Floyd's algorithm, Algorithm for connectedness and components, Travelling Salesman problem (TSP), Algorithm for TSP (to find Hamilton Circuit). Computer science applications.

Self-learning component:

Explore Algorithms on Graphs and Network Flows. Derivation of Time Complexities for advanced algorithms.

Text books:

1. NarsinghDeo, "Graph Theory with Applications to Engineering and Computer Science", Prentice-Hall, 2014.

2. Ralph P Grimaldi, Discreteand Combinatorial mathematics, Pearson Education, 5th edition, 2014.

3. Douglas B, “Introduction to Graph Theory”, Prentice Hall of India, 2nd edition, 2015.

Reference books:

1. Frank Harary, "Graph Theory", Narosa, 2013.
2. J.A Bondy and U.S.R Murthy, Graph Theory with applications, Macmillan, 2013
3. GeirAgnarsson and Raymond Geenlaw; Graph Theory modeling, Applications and algorithms, Pearson Education, 2007.
4. IEEE Journals and Magazines on Graph Theoy.

Mapping Cos with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	L	H	H	M	L	L	-	-	-	-	-
CO 2	H	H	M	M	M	L	M	-	-	-	-	-
CO 3	H	H	H	M	M	M	L	-	-	-	-	-
CO 4	M	M	M	M	H	M	L	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS4030	Database Management System	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Discrete Mathematics(B18CS3050)

Course Description:

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 Objectives:

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.

Course Outcomes (Cos):

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

CO1	Design conceptual entity relationship diagrams for the real world applications.
CO2	Make use of the concepts of relational algebra to solve queries over database.
CO3	Construct the real world database and solve queries over it using SQL commands.
CO4	Develop an optimized database using design guidelines and normalization technique.

Course Contents:

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.

Self –Learning Components:

Sequences, synonyms, Triggers and Procedures and Introduction to Transaction Management Systems.

Text books:

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

References:

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

Mapping Cos with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012
CO1	H	H	M	M	M	-	-	-	-	L	-	L
CO2	H	H	M	H	L	-	-	-	-	-	-	L
CO3	H	H	M	H	H	-	-	-	-	-	-	L
CO4	H	H	M	H	L	-	-	-	-	L	L	L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS4040	Computer Organization and Architecture	L	T	P	C
Duration:16 Wks		3	0	0	3

Prerequisites:

Basic electrical and Electronics [B18CS1040]

Course Description:

The course provides students with an understanding of the design of fundamental blocks used for building a computer system and interfacing techniques of these blocks to achieve different configurations of an "entire computer system". The course also gives introduction to multi core architecture and parallel programming.

Course Objectives:

The objectives of this course are to:

3. Explain the basics of arithmetic and logical operations
4. Demonstrate programs using instruction set of ARM processor
5. Illustrate performance tradeoff between different memory units and instruction sets
6. Discuss basics of parallelism and significance of multi core architecture.

Course Outcomes (Cos):

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

1. Understand the arithmetic and logical operations
2. Solve simple programming assignments using instruction set of ARM processor
3. Distinguish performance tradeoff between different memory units and instruction sets
4. Summarize the basics of computer hardware and how software interacts with computer hardware and also interpret parallelism, its applications, multi core architecture.

Course Contents:

Unit 1

Introduction: Microprocessor, Microcontroller, Microcomputer, IOT, ARM Processor Introduction to architecture and features of Microprocessor, Microcontroller, Microcomputer, and IOT (block diagram based). History of microprocessors and microcontrollers. IOT based boards. Introduction to ARM, ARM architecture, Instruction set of ARM Processor, Addressing modes, programs for data movement, logic operations, and loopoperations

UNIT -2

Basics: Computer Arithmetic Computer arithmetic - integer addition and subtraction, ripple carry adder, carry look-ahead adder, multiplication - shift-and-add, Booth multiplier, carry save multiplier, etc. Division - restoring and non-restoring techniques, floating point arithmetic. Addressing Modes, Instruction Set Instruction set architecture of a CPU - registers,

UNIT- 3

InstructionExecution Flow, Instructionexecutioncycle, RTLinterpretation ofinstructions, addressing modes; Hardwareand Micro-programbasedcontrol Unit DesignCPUcontrol unit design: hardwired and micro-programmed design approaches: ARM pipelines

UNIT- 4

Memory Architecture, Peripherals and Input-Output Memory system design: semi-conductor memory technologies, memory organization: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions.

Peripheral devices and their characteristics: Input-output subsystems, I/O transfers - program controlled, interrupt driven and DMA ARM cortex memory

Advanced Computer architecture concepts

Parallelism, SIMD architectures, MIMD architectures, Processor interconnection, Multicore systems - structure, performance, complexity, power consumption, memory utilisation, software development issues for multicore systems

Self-learning component:

More Recent Applications: Data-levelparallelism - motivation, challenges, applications. Super Computing. Cluster based computing. Grid and cloud computing. RISC and CISC architecture.

Text books:

1. Carl Hamacher ,ZvonkoVranesic, SafwatZaky, NaraigManjikian, "Computer Organization and Embedded Systems", Sixth Edition, McgraHIll.

Reference books:

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.

Mapping COs with POs (Program outcomes):

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	-	-	-	-	H	-	-	-	-	L
CO2	H	H	-	M	-	-	-	-	-	M	-	-
CO3	H	-	-	-	-	-	-	-	-	-	M	-
CO4	H	H	-	M	-	-	-	-	-	M	M	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS4051	Signals and Systems	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Analog Electronic circuits[B18CS3020]

Course Description:

This course provides insight into fundamentals of Continuous and Discrete-time signals and systems, their properties and representations. It introduces time domain representation of Linear Time invariant Systems such as Convolution Sum, Convolution Integral, differential equation and difference equations representation. It makes the students to understand the signal representation in Fourier domain such as Fourier transform, discrete time Fourier transform and Z-domain. It gives a brief insight into application of z-transform to solve impulse function of LTI systems etc.,

Course Objectives :

The objectives of this course are to:

1. Illustrate the operations on Signals, and the properties ofSystems.
2. Explain Convolution operation on an LTISystem.
3. DesignconversionofsignalsbetweenTimeandFrequencydomainusingFourier Transform.
4. Demonstrate the behavior of Causal LTI system using properties of Z-Transform.

Course Outcomes (Cos):

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

CO1: Make use of operations on Signals for processing the given signals.

CO2: Apply Convolution operation on an LTI System.

CO3: Develop Fourier Transform methods to interconvert signal between Time and Frequency domain.

CO4: Analyse the behaviour of Causal LTI system using properties of Z-Transform.

Course Content:

UNIT- 1:

Classification of Signals and Systems: Definition of a signals and system, Elementary signals, Basic operations on signals, Classification ofsignals.

UNIT- 2:

Analysis of Linear Time Invariant Systems:

Properties of systems, Time domain representation of LTI system: Impulse response representation, convolutionsum, convolutionintegral .Block diagram representation.

UNIT-3:

Fourier Representation for signals: Continuous time Fourier series, discrete timeFourier series, Discrete time Fourier Transform (Definitions Only) - Continuous time Fourier Transform and their properties, Inverse Fourier transform. Applications of Fourier representations:

Sampling theorem and Nyquist rate.

UNIT-4:

Z-Transform: Introduction, Z - transform, properties of ROC, properties of Z - transforms, Inversion of Z - Transform, Unilateral Z-Transform and its application to solve difference equations.

Self Learning components:

Transform Analysis of LTI systems, Computational structures for implementing Discrete- Time systems, Laplace transform.

Textbooks:

1. SimonHaykins,“Signalsandsystems”,JohnWiley,IndiaPvtLtd,SecondEdition,2008.2.

2. MichaelRoberts,“Fundamentalsofsignalsandsystems”,TATAMcGrawHill,2nd

Edition, 2010

3. PierreMuret, Fundamentals of Electronics 2: Continuous-timesignalsandsystems, Wiley, 1st Edition,20184. Willsky,Oppenheim,SignalsandSystems,Pearson,2ndEdition,2015

Referencebooks:

1. AllanV.Oppenheim,S.WilskyandS.H.Nawab,“SignalsandSystems”, PearsonEducation, Second Edition, 1997.

2. EdwardWKamen&Bonnie'sHeck,"FundamentalsofSignalsand Systems", Pearson Education, Third Edition,2007.

3. RodgerE.Ziemer,WilliamH.Tranter,D.RonaldFannin."Signals&systems",Pearson Education, Fourth Edition, 2003.

4. Ganesh Rao and SatishTunga, "Signals and Systems",Pearson/Sanguine

TechnicalPublishers, 2004

5. UdayKumar.S, "Signals and Systems", Prism books Pvt.Ltd, 6th Edition2015

6.IEEE Transactions on SignalProcessing.

Mapping Cos with Pos (Programoutcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	H	-	-	-	-	-	-	-
CO2	H	H	H	H	H	L	-	-	-	-	-	-
CO3	H	H	H	M	M	L	L	-	-	-	-	-
CO4	H	H	H	H	M	-	-	-	L	-	-	-

Where,L(Low), M(Medium) and H(High) represents strength of correlation between CO and PO.

B18CS4052	System Software	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Data Structures [B18CS3040].

Course Description:

The course provides the architecture of SIC and SIC/XE machine to build the concepts of System Software, function of various system software: assemblers; loaders and linkers, and macro processors.

Course Objectives:

The objectives of the course are to;

1. Explain basics of system software and differentiate between system software and application software.
2. Describe assemblers design (pass1 and pass2) for the SIC and SIC/XE machine architecture.
3. Illustrate the working of the pass1 and pass2 algorithms of linkers and loaders.
4. Discuss functions and algorithms of macro-processor.

Course Outcomes (Cos):

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

CO1:Make use of different instruction formats and addressing modes of SIC and SIC/XE architectures for implementing arithmetic operations.

CO2:Identify the suitable data structures required to develop various system software's.

CO3:Develop the programs for the pass1 and pass2 algorithms of linkers and loaders.

CO4:Apply functions and algorithms of macro-processor to process a given macro definition.

Course Content:

UNIT- 1:

Architecture of SIC; SIC\XE: Introduction: system software and machine architecture; Simplified Instructional Computer (SIC) – SIC; SIC/XE machine architecture; SIC and SIC/XE programming examples

UNIT- 2:

Assemblers: Basic assembler function; a simple SIC assembler; assembler algorithm and data structures; machine dependent assembler features - instruction formats; machine independent assembler features – literals symbol definition statements; expression; program blocks; control sections and programming linking

UNIT- 3:

Loaders and Linkers: Basic loader functions; design of an absolute loader; a simple bootstrap loader; machine-dependent loader features –relocation; program linking; algorithm and data structures for a linking loader; machine-independent loader features - automatic library search; loader options

UNIT- 4:

Macro Processor: Basic macro processor functions; macro definitions and expansion; macro processor algorithm and data structures; machine- independent macro processor features - concatenation of macro parameters; generation of unique labels; conditional macro expansion; keyword macro parameters

Self Learning Components:

Design of a micro preprocessor, Peep hole optimizer and Compile and GO loader.

Text books:

1. Leland L Beck, System Software, 3rd Edition, Pearson Education, 2002.
2. Alfred V. Aho, Compilers: Principles, Techniques and Tools, Pearson, 2nd Edition, 2013.

References:

1. H. Dave, Compilers: Principles and Practice, Pearson, 1st Edition, 2012
2. Elsevier Journal of Systems and Software.
3. IEEE Transactions on Software Engineering

Mapping Co's with Po's (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	L	M	M	L	-	-	-	-	-	L
CO2	M	M	M	M	L	-	-	-	-	-	-	L
CO3	M	M	L	L	L	-	-	-	-	-	-	-
CO4	M	L	L	L	L	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS4053	Embedded Systems Design	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Digital Logic Design [B18CS3010]

Course Description:

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.

CourseObjectives:

The objectives of this course areto:

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/Softwareco-design techniques for micro controller-based embedded systems.

Course Outcomes (Cos):

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

CO1: Identify the optimal composition and characteristics of an embedded system

CO2: Analyze and discover the motives and caused of using sensors and actuators

CO3: Examine the protocols and software tools employed in embedded system design.

CO4: Compare the knowledge of Hardware/Software co-design techniques for microcontroller- based embedded systems.

Course Content:

UNIT- 1

Introduction to Embedded Systems: Application Domain of Embedded Systems; Desirable Features and General Characteristics of Embedded Systems; Model of an Embedded System; Microprocessor vs Microcontroller; Example of a Simple Embedded System; Figures ofMerit for an Embedded System; Classification of MCUs: 4/8/16/32Bits.

Embedded Systems - The Hardware Point of View:

Microcontroller Unit (MCU); A Popular 8-bit MCU; Memory for Embedded Systems; Low Power Design; Pullup and Pulldown Resistors.

UNIT -2

Sensors, ADCs and Actuators: **Sensors;** Analog to Digital Converters; Actuators. Examples of Embedded Systems: Mobile Phone; Automotive Electronics; Radio Frequency Identification (RIFD); Wireless Sensor Networks (WISENET); Robotics; Biomedical Applications; Brain Machine Interface.

UNIT- 3

Buses and Protocols: Defining Buses and Protocols; On-boardBusesforEmbeddedSystems; External Buses; Automotive Buses; Wireless CommunicationProtocols.

Software Development Tools: Embedded Program Development; Downloading the HexFile to the Non-volatile Memory; HardwareSimulator.

UNIT- 4

Real-time Operating Systems: Real-time Tasks; Real-time Systems; Types of Real-time Systems; Real-time Operating Systems (RTOS); Real-time Scheduling Algorithms; Rate Monotonic Algorithm; The Earliest Deadline First Algorithm; Qualities of a Good RTOS.

HardwareSoftwareCo-designandEmbeddedProductDevelopmentLifecycleManagement:

Hardware Software Co-design; Modelling of Systems; Embedded Product Development Lifecycle Management; LifecycleModels.

Self-learning component:

Programming in Embedded C; ARM (Part 1: Architecture and Assembly Language Programming; Part 2: Peripheral Programming of ARM MCU Using C); PSoC-SoC for Embedded Applications; DSP

Processors.

Textbooks:

1.LylaB.Das,EmbeddedSystem:AnIntegratedApproach,Pearson,2013

2.KVKKPrasad,Embedded/RealTimeSystems,DreamtechPress,2005.

3. PeterM,EmbeddedSystemDesign:EmbeddedSystemsFoundationsofCyber-Physical Systems, and Internet of Things, Springer, 3rd Edition,2018

4. RobToulson, Fast and Effective Systems Design, Newnes Publisher,2ndEdition,2016

Reference books:

1. FrankVahid,TonyD.Givargis,EmbeddedSystemDesign-AUnifiedHardware/Software Introduction, John Wiley,2002.

2. JonathanW.Valvano,EmbeddedMicrocomputerSystems,3rd.edition,CengageLearning, 2011.

3.David E. Simon, An Embedded Software Primer, Pearson Ed.,2005.

4.Raj Kamal, Introduction to Embedded Systems, TMH,2002.

5.SriRamVIyer,PankajGupta,EmbeddedRealTimeSystemsProgramming,TMH,2004.

6.MichaelBarr,ProgrammingEmbeddedSystemsinCandC++,O'Reilly,1999.

7.International Journal of Embedded Systems-InderSciencePublishers.

Mapping Cos with POs(Program outcomes)

	PROGRAM OUTCOMES											
COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	H	M	M	-	-	-	-	-	-	-
CO2	M	M	M	H	L	-	-	-	-	-	-	-
CO3	M	H	H	M	L	-	-	-	-	-	-	-
CO4	H	H	L	M	L	-	-	-	-	-	-	-

Where, L(Low), M(Medium) and H(High) represents strength of correlation between CO and PO.

B18CS4054	Operation Research	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Basic Mathematics, Linear Algebra(B18CS1010)

Course Description:

This course teaches a student the science of modelling and optimization. It provides tools and theories to solve these real-world problems by finding the optimal solutions to the models subject to constraints of time, labour, resource, material, and business rules. With Operations Research, people make intelligent decisions to develop and manage their processes and businesses.

Course Objectives:

The objectives of this course are to:

1. Explain basic concepts of Operation Research.

2. Illustrate a real world problem as a linear programing problem

3. Discuss applications of dynamic programming and integer programming to solve an optimization problem.

4. Describe mathematical models based on game theory.

Course Outcomes (Cos):

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

CO1: Develop a mathematical model for a real-world decision making problem using linear programming

CO2: Apply various mathematical equations with simplex method and Transportation-Assignment problem for linear programming.

CO3: Solve multi-stage decision problems into dynamic programming and Integer programming problems

CO4: Design a theoretical framework to produce optimal decision making among competing players.

Course Contents:

UNIT-1

Introduction to Operations Research: Overview of Operations Research Modelling Approach,origin of operations research, nature of operations research, impact of operations research, defining a problem and gathering data, formulating a mathematical model, deriving solution from model, testing models, preparing to apply model, implementation, Introduction to optimisation , Engineering Applications of Optimization, Statement of Optimization Problem.

UNIT-2

Linear and Non Linear Programming: Linear Programming - Applications of linear programming, standard form of linear programming problem, solution of a system of linear simultaneous equations simplex algorithm, two phases of simplex method. Transportation problem, assignment problem

Non-Linear Programming - Unimodal function, unrestricted search – search with fixed step size, search with accelerated step size, Exhaustive search, random walk methods, Gradient of a function- evaluation of gradient, rate of change of a function along a direction, Transportation problem, assignment problem.

UNIT-3

Dynamic and Integer Programming: Dynamic Programming-Multistage decision process-definitionand examples, Concept of sub-optimisation and principle of optimality, computation procedure in dynamic programming, example illustrating calculus methods of solution, example illustrating tabular method of solution.

Integer Programming – Graphical representation, Gomory's cutting plane method-concept of a cutting plane, Gomory's method for integer programming problems, branch and bound methods.

Unit-4

Game Theory and Metaheuristics: Basic terminology – Player, Strategy, Optimal strategy, Payoff,Saddle point, Value of the game The formulation of two person, zero sum games, solving simple games- a prototype example, Pure Strategies (Minimax and Maximin Criterion)games with mixed strategies, graphical solution procedure, solving by linear programming.

Self-learning component:

Stochastic modelling and simulation, Metaheuristics.

Text books:

1. Frederick S Hillier, Gerals J Lieberman, Bodhibrata Nag, PreetamBasu, Introduction to Operations Research, , 9th Edition, McGraw Hill Education, Special Indian Edition, 2012.

2. Singiresu S Rao, Engineering Optimization Theory and Practice, 3rd Edition, New Age International, 3rd reprint, 2018.

3. K.V.Mittal, C.Mohan, Optimization Methods in Operations research and System Analysis, , 3rd Edition New Age International Publishers, 1996.

Reference books:

1. Frank Tillman, A Professional's guide to problem solving with decision science, Pioneering Partnership, 2nd Edition, 2018.

2. A Taha, Operations Research: An Introduction, Pearson, 10th Edition, 2016.

3. Hamdy A. Taha, Operations Research An Introduction, , 8th Edition, Pearson Education, 2007.

4. IEEE Transactions on Evolutionary Computation.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	H	M	M	M	-	-	-	-	-	-	-
CO 2	H	H	H	M	H	-	-	-	-	-	-	-
CO 3	H	H	H	M	H	-	-	-	-	-	-	-
CO 4	H	H	H	H	H	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO

B18CS4055	Numerical Techniques	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Multivariable Calculus and Linear Algebra [B18CS1010] Discrete Mathematics [B18CS3050]

Course Description:

This course emphasizes on the development of numerical algorithms to provide solutionsto 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 (1) the guaranteed accuracy that various methods provide, (2) the efficiency and scalability for large scale systems. and (3) issues of stability.

1. Course Objectives
2. 1. The objectives of this course areto: Explainnumericalmethodstoobtainapproximatesolutionstomathematicalproblems.
3. Illustrate numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and non linear equations, and the solution of differential equations.
4. Evaluate the accuracy of common numerical methods.
5. Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractablemathematicalproblems.

Course Outcomes (Cos):

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

CO1:Apply numerical methods to obtain approximate solutions for mathematical problems.

CO2: Make use of numerical methods for various mathematical operations.

CO3: Analyse the performance of common numerical methods.

C04: Solve the real world problems using differential equations, Euler's and Runge-Kutta methods

Course Content:

Unit 1:

Floating Point Numbers and Errors: Floating point representation of a number and their arithmetic operations, Errors and their analysis: Approximate Numbers, Significant Digits, RoundOff error, Truncation error, Absolute error, Relative error.

NumericalSolutionstoAlgebraicandTranscendentalEquations:Bolzano's Bisectionmethod, SimpleIterationmethod,MethodofFalsePosition:RegulaFalsiMethod,Newton'smethodfor simpleandmultipleroots,Allmethod'sconvergenceanalysisandorderofconvergence.

UNIT 2:

Solution of Simultaneous Linear Algebraic Systems: Direct Methods: Gauss elimination method (with row pivoting) and Gauss Jordan method, Iterative methods: Jacobi and Gauss- Seidel iterative methods

UNIT 3:

Interpolation: Finite Differences: Forward Differences, Backward Differences, Central Differences, Gregory Newton's forward and backward interpolation, Gauss' forward and backward interpolation Lagrange interpolation formula.

UNIT 4:

Numerical integration: Newton-Cotesquadratureformulae:TrapezoidalandSimpson's

rules Differential Equations: Euler's and Runge-Kutta methods (up to fourth-order).

Self learning component:

Shooting techniques,Relaxation techniques, Richards on extrapolation, Least-squares approximation

Text books:

1.T.Veerarajan,T.Ramachandran,"NumericalMethodswithProgramsinC",Tata

McGraw-Hill Education, 2nd edition, 2006.

2.CurtisF.GeraldandPatrickO.Wheatley,"AppliedNumericalAnalysis",Pearson,7th

Edition, 2003.

3.M.K.Jain,S.R.K.IyengarandR.K.Jain,"NumericalMethodsforScientificand

4.Engineering Computation”, New Age International Publishers, 6th edition, 2012.

5.Daniel Di Pietro, Numerical Methods for PDEs, Springer, 1st Edition,2018.

6.Mateos,Alonso,ComputationalMathematicalNumericalAnalysisandApplications, Springer, 1st Edition,2017

Reference books:

1ManishGoyal,“ComputerBasedNumericalAndStatisticalTechniques”,Infinity

Science Press LLC, Laxmi Publication, 2007

2. StevenC.Chappra,“NumericalMethodsforEngineers”,McGraw-HillHigher Education; 7th edition,2014

3. AttilaMate,IntroductionToNumericalAnalysisWithCPrograms“,2014

4.SIAM Journal on numericalAnalysis.

5. Elsevier Journal of Applied numericalMathematics.

Mapping COswithPOs(Programoutcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M		M	-	-	-	-	-	-
CO2	M	M	M	H	M	M	-	-	-	-	-	-
CO3	M	M	M	M	M	L	-	-	-	-	-	-
CO4	M	M	H	H	M	H	-	-	-	-	-	-

Where, L(Low), M(Medium) and H(High) represents strength of correlation between CO and PO.

B18CS4060	Database Management System Lab	L	T	P	C
Duration:14 Wks		0	0	2	2

Prerequisites:

Data structures lab [B18CS3070]

Course Description:

The course provides an introduction to Database Management systems. The requirement of modern days is to have an automated system that manages, modifies and updates data accurately. This is achieved by a DBMS in robust, correct and non-redundant way. This lab aims at practicing and solving DDL, DML and DCL queries using MySQL for achieving the same.

Course Objectives:

1. Explain the basics constraints of relational model.
2. Demonstrate the relational model using MySQL by incorporating the basic constraints
3. Illustrate the use of DDL, DML and DCL commands in SQL.
4. Make use of the SQL commands to construct database for any real world application.

Course Outcomes:

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

CO1: Design database schema and entity relationship diagrams for any real world application.
CO2: Develop database for the application.
CO3: Formulate the database with data in it for the application.
CO4: Construct queries for database using SQL commands for the application.

List ofExperiments:

Experiment Nos.	Programs
1	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) 1. Write SQL queries to 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. Queries
2	Considerthe following schema for Order Database: SALESMAN (Salesman_id, Name, City,Commision) CUSTOMER (Customer_id, Cust_Name, City, Grade, Salesman_id) ORDERS (Ord_No, Purchase_Amt, Ord_Date, Customer_id, Salesman_id) 1. Write SQL queries to Count the customers with grades above Banglore'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(using union operation) 4. Create a view that finds the salesman who has the customer with the highest order of a day. Demonstrate the DELETE operation by removing salesman with id 1000. All his orders must also be deleted.
3	Consider the schema for Movie Database: ACTOR (Act_id, Act_Name, Act_Gender) DIRECTOR (Dir_id, Dir_Name, Dir_Phone) MOVIES (Mov_id, Mov_Title, Mov_Year, Mov_Lang, Dir_id) MOVIE_CAST (Act_id, Mov_id, Role) RATING (Mov_id, Rev_Stars) Write SQL queries to 1. List the titles of all movies directed by 'Hitchcock'. 2. Find the movie names where one or more actors acted in two or more movies. 3. List all actors who acted in a movie before 2000 and also in a movie after 2015 (use JOIN operation) 4. Find the title of movies and number of stars for each movie that has at least one rating and find the highest number of stars that movie received. Sort the result by movie title. Update rating of all movies directed by 'Steven Spielberg' to5.
4	**Consider the schema for College Database:** **STUDENT (USN, SName, Address, Phone, Gender)** **SEMSEC (SSID, Sem, Sec)**

	CLASS (USN, SSID) SUBJECT (Subcode, Title, Sem, Credits) IAMARKS (USN, Subcode, SSID, Test1, Test2, Test3, FinalIA) Write SQL queries to 1. List all the student details studying in fourth semester 'C' section. 2. Compute the total number of male and female students in each semester and in each section. 3. Create a view of Test1 marks of student USN '1BI15CS101' in all subjects. 4. Calculate the FinalIA (average of best two test marks) and update the corresponding table for all students. 5. Categorize students based on the following criterion: • If FinalIA = 17 to 20 then CAT = 'Outstanding' • If FinalIA = 12 to 16 then CAT ='Average' If FinalIA< 12 then CAT ='Weak'.Give these details only for 8th semester A, B, and C section students
5	Consider the schema for Company Database: EMPLOYEE (SSN, Name, Address, Sex, Salary, SuperSSN, DNo) DEPARTMENT (DNo, DName, MgrSSN, MgrStartDate) DLOCATION (DNo,DLoc) PROJECT (PNo, PName, PLocation, DNo) WORKS_ON (SSN, PNo, Hours) Write SQL queries to 1. Make a list of all project numbers for projects that involve an employee whose last name is 'Scott', either as a worker or as a manager of the department that controls the project. 2. Show the resulting salaries if every employee working on the 'IoT' project is given a 10 percent raise. Find the sum of the salaries of all employees of the 'Accounts' department, as well as the maximum salary, the minimum salary, and the average salary in this department. 3. Retrieve the name of each employee who works on all the projects controlled by department number. 4. (use NOT EXISTS operator). For each department that has more than five employees, retrieve the department number and the number of its employees who are making more than Rs. 6,00,000.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	H	H	-	-	-	-	-	-	-
CO2	H	M	M	H	H	-	-	-	-	-	-	-
CO3	H	M	M	H	H	-	-	-	-	-	-	-
CO4	H	M	M	H	H	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Recommended Learning Resources:

1. https://www.arduino.cc
2. Peter J Knaggs, "ARM Assembly Language Programming",2016. (http://www.rigwit.co.uk/ARMBook/ARMBook.pdf)

B18CS4070	ARM Microcontroller and IOT	L	T	P	C
Duration:14 Wks		**0**	**0**	**2**	**2**

Prerequisites:

Computer Organization and Architecture[B18CS4040]

Course Description:

The course provides an introduction to ARM assembly programming and Arduino programming. It covers the fundamentals of assembly programming and students will be able execute simple to moderate programs. Arduino covers basic programming required for interfacing sensors, actuators and cloud.

Course Objectives:

1. To Explain how to write assembly language programs for the ARM microcontroller
2. To demonstrate how to Interface various environmental and human interfaces with ARM microcontrollers
3. To illustrate the use of modern system development tools in the design of a microcontroller-based system
4. To discuss the development of microcontroller-based embedded systems for real-world control applications

Course Outcomes:

On successful completion of this course, student will be able to:

1. Construct assembly language programs for the ARM microcontroller
2. Interface various environmental and human interfaces with ARM microcontrollers
3. Use modern system development tools in the design of a microcontroller-based system
4. Develop microcontroller-based embedded systems for real-world control applications

List of Experiments:

PART-A (ARM Experiments)	
1.	a) Write an assembly language program to realize the given expressions i)A=B+C-D ii)A=4A+B iii)X=3X+4Y+9Z Write an assembly language program to add two 64-bit numbers.
2.	Write an assembly language program to find average of N 32-bit numbers.
3.	Write an assembly language program to find number of occurrences of a number in a given list using linear search method.
4.	Write an assembly language program to count number of ones in a given 32-bit binary number.
5.	Write an assembly language program to find factorial of a given 32-bit number using procedure.
PART-B (IoT Experiments)	
1.	Design and construct a module to drive stepper motor clockwise and anti-clockwise using Arduino board to indicate that plant need to be watered by sensing its moisture level.
2.	Design and construct a module to interface LCD to display the temperature and moisture values using Arduino board.
3.	Design and construct a module to interface ultrasonic sensor to alert the obstacle (turn ON the buzzer) using Arduino board.
4.	Design and construct a module to drive stepper motor clockwise and anti-clockwise using Arduino board to indicate that there is a gas leakage by sensing it.
5.	Design and construct a module to interface light sensor to detect the darkness and switch ON the LED.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	-	-	-	-	-	-	-	-	-	-
CO2	-	H	-	-	M	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	M	H	-
CO4	-	-	-	M	-	-	-	H	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Recommended Learning Resources:

3. https://www.arduino.cc
4. Peter J Knaggs, "ARM Assembly Language Programming",2016. (http://www.rigwit.co.uk/ARMBook/ARMBook.pdf)

III Year Detailed Syllabus

V Semester
Syllabus

B18CS5010	Finite Automata and Formal Languages	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Discrete Mathematics (B18CS3050)

Course Description:

The course introduces some fundamental concepts in automata theory and formal languages including finite automaton, regular expression, formal language, grammar, pushdown automaton, and Turing machine. These form basic models of computation; they are also the foundation of many branches of computer science, e.g. compilers, software engineering, concurrent systems, etc.

Course Objectives:

1 Explain the concepts of Deterministic and Non-Deterministic Automata.

2. Demonstrate the use of regular expressions for constructing DFA and NFA.

3. Illustrate the construction of context free grammar for a given data.

4. Describe computing Machine including PDA and Turing Machine

Course Outcomes (COs):

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

CO1: Construct the Finite State Machine by applying the concepts of DFA and NFA.
CO2: Make use of regular expressions for constructing DFA and NFA.
CO3: Identify ambiguity in grammar and Construct CFG for the given language in normal forms.
CO4: Apply the concepts of Push down Automata and Turing machine for a given language.

Course Contents:

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.

Self-Learning:

Applications of Finite Automata and Applications of Regular Expressions.

Recommended Learning Resources (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.

Recommended Learning Resources (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.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	O8	PO9	PO10	PO11	PO12
CO1	M	M	L	L	L	-	-	-	-	-	L	L
CO2	M	M	L	L	L	-	-	-	-	-	L	L
CO3	M	M	L	L	L	-	-	-	-	-	L	L
CO4	M	M	L	L	L	-	-	-	-	-	L	L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO

B18CS5020	Python for Data Analysis	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Probability and Statistics [B18CS2010]

Course Description:

Python Is a language with a simple syntax, and a powerful set of libraries. It is an interpreted language, with a rich programming environment, including a robust debugger and profiler. While it is easy for beginners to learn, it is widely used in many scientific areas for data. Python is a very powerful programming language used for many different applications. Over time, the huge community around this open source language has created quite a few tools to efficiently work with Python. In recent years, a number of tools have been built specifically for data science. As a result, analyzing data with Python has never been easier exploration. This course is an introduction to the Python programming for analyzing data for students without prior programming experience.

Course Objectives:

The objectives of the course are to:

1. Discuss the basics of Python
2. Demonstrate the use of multi-dimensional arrays inNumPy
3. Describe how python pandas is used for data analysis, simple statistical analyses and data visualizations.
4. Illustrate the importing, exporting and pre-processing of the data in Python.

Course Outcomes(Cos):

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

CO1: Demonstrate the fundamental commands to interact with underlying operating system using command line arguments.

CO2: Develop programs using NumPy arrays and its properties.

CO3: Design and develop programs for analysing and visualising statistical data.

CO4: Make use of importing, exporting and pre-processing features of the data in Python.

Course CONTENT

UNIT -1

Introduction: Why Python for Data Analysis?, Python as Glue , Solving the "Two-Language" Problem , Why Not Python?, Essential Python Libraries, Introductory Examples:usa.gov data from bit.ly, Counting Time Zones in Pure Python, Counting Time Zones with pandas, Movie Lens Data Set, Measuring rating disagreement, US Baby Names, Analysing Naming Trends. Data Types, Variables and Simple I/O, Branching, While Looping, For Looping, Strings, Tuples, Functions, File Handling. The %run Command, Executing Code from the Clipboard, Keyboard Shortcuts Exceptions and Trace backs, Magic Commands, Qt-based Rich GUI Console, Matplotlib Integration and Pylab Mode, Using the Command History, Searching and Reusing the Command History, Input and Output Variables, Logging the Input and Output, Interacting with the Operating System, Shell Commands and Aliases.

UNIT -2

IPython & NumPy Basics: Interactive Debugger, Timing Code: %time and %Timeit, Basic Profiling:

%prun and %run -p, profiling a Function Line-by-Line. Arrays and Vectorized Computation: The NumPy ndarray: A Multidimensional Array Object ,Creating ndarrays Data Types for ndarrays, The NumPy ndarray: A Multidimensional Array Object ,Creating ndarrays, Data Types for ndarrays, Operations between Arrays and Scalars, Basic Indexing and Slicing ,

Boolean Indexing ,Fancy Indexing Transposing Arrays and Swapping Axes, Universal Functions: Fast Element-wise Array Functions, Data Processing Using Arrays ,Expressing Conditional Logic as Array Operations ,Mathematical and Statistical Methods, Methods for Boolean Arrays, Sorting, Unique and Other Set Logic File Input and Output with Arrays.

UNIT -3

Getting Started with pandas: Introduction to pandas Data Structures, Series, Data Frame, Index Objects, Essential Functionality, Reindexing, Dropping entries from an axis ,Indexing, selection, and filtering ,Arithmetic and data alignment, Function application and mapping, Sorting and ranking ,Axis indexes with duplicate values

,Summarizing and Computing Descriptive Statistics, Correlation and Covariance, Unique Values, Value Counts, and Membership ,Handling Missing Data ,Filtering Out Missing Data, Filling in Missing Data, Hierarchical Indexing ,Reordering and Sorting Levels, Summary Statistics by Level ,Using a Data Frame's Columns.

UNIT -4

Data Loading, Storage, and File Formats: Reading and Writing Data in Text Format, Reading Text Files in Pieces, Writing Data Out to Text Format Manually Working with Delimited Formats, JSON Data , XML and HTML: Web Scraping, Binary Data Formats, Using HDF5 Format, Reading Microsoft Excel Files, Data

Transformation, Removing Duplicates, Transforming Data Using a Function or Mapping Replacing Values ,Renaming Axis Indexes ,Discretization and Binning, Detecting and Filtering Outliers, Permutation and Random Sampling, Computing Indicator/Dummy Variables.

Self Learning Component:

Data Visualization: Plotting line graph, bar graph, Scatter Plot & box plot.

Text Books:

1. Wes McKinney, Python for Data Analysis, Oreilly Publications, 1st edition,2015.
2. Kenneth A. Lambert, Fundamentals of Python: First Programs (introduction to Programming), 2nd Edition, 2018.

References:

1. Mark Lutz, Learning Python, Oreilly, 5th edition,2013.
2. Elsevier Journal on Data mining.
3. Springer Journal of Data Science and Analytics.
4. IEEE Journal on Data Mining.
5. IEEE Journal on Data Mining and Analytics.

Mapping COs with POs (Program outcomes):

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	M	M	H	H	-	-	-	-	-	-	-

CO 2	H	M	H	M	H	-	-	-	-	-	-	-
CO 3	H	M	H	H	H	-	-	-	-	-	-	-
CO 4	H	M	M	H	H	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS5030	Computer Networks	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Programming for Problem Solving (B18CS1030), Computer Organization and Architecture (B18CS4040)

Course Description:

The main emphasis of this course is on the organization and management of local area networks (LANs). The course description include learning about computer network organization and implementation, obtaining a theoretical understanding of data communication and computer networks, and about Open Systems Interconnection (OSI) communication model with TCP/IP protocol; This course provides knowledge of error detection and recovery; local area networks; bridges, routers and gateways; network naming and addressing; and local and remote procedures. This course also emphasis on User Datagram Protocol, TCP Congestion Control; DNS Message Formatting and Remote Login. Protocols

Course Objectives:

The main objectives of this course are:

1. Explain the protocol stacks (OSI and TCP/IP) for data communication
2. Discuss the error detection & correction strategies for data transmission.
3. Design the connection establishment of network computing devices.
4. Illustrate the TCP, UDP protocols and explain Domain Name System.

Course Outcomes:

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

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

CO1: Outline the protocol stacks (OSI and TCP/IP) used for data communication.

CO2: Apply error detection & correction strategies for data transmission.

CO3: Analyzethe connectionestablishment of networkcomputing devices.

CO4: Compare TCP, UDP protocols and explain Domain Name System.

Course Contents:

UNIT – 1:

Introduction to Data Communication and Networking: Internet history and Internet today, Data Communications, Networks, Network Topologies, Classification of Networks, Protocols & Standards, Introduction to Network Tools-(WireShark, Packet Tracer, NS3, etc), Layered Tasks, The OSI model, Layers in OSI model, TCP/IP Protocol suite, Addressing. Introduction to switching: Circuit Switched Networks, Datagram Networks, Virtual Circuit Networks, Physical Layer – Periodic Analog signals, Digital signals, Request bit rate, shanon capacity, performance, PCM, DM, Parallel transmission, serial transmission, ASK, FSK, PSK, QAM, AM, FM, PM.

UNIT – 2:

Coding: Line Coding and block coding. Multiplexing: FDM, WDM, TDM, FHSS, DSSS, and Transmission Media.

Error Detection and Correction: Introduction, cyclic Codes: Cyclic redundancy code generation for checksum. Frames, Packets, Data Link Protocols: HDLC, Point-to-Point Protocol.

MAC Protocols: classification of MAC protocols, Random access (ALOHA, CSMA/CD, CSMA/CA), Controlled Access (Reservation, Polling, Token passing), Channelization Protocols (FDMA, TDMA, CDMA)

Introduction to Networking Devices: Digital Subscriber Line Modems, Cable Modems, Repeaters, Hubs, Bridges, Routers, and High layered switches, Gateways, Virtual LAN.

UNIT-3:

Standards: IEEE Standards, Standard Ethernet, Fast Ethernet, Gigabit Ethernet. IEEE 802.11: Architecture, MAC Sublayer, Addressing Mechanism. Bluetooth Architecture.

Introduction to Wireless networks-Wifi, WiMAX, 4G, 5G, Satellite Networks, MPLS, VPN, ATM.

Network Layer: IPv4 addresses, IP Datagram format, ICMP Messages, Mobile IP, IPv6 addresses, IPv6 Packet Format, Transition from IPv4 to IPv6, Routing algorithms (Distance Vector, Link State and Path vector), Unicast Routing protocols(RIP, OSPF), Introduction to BGP, Introduction to Multicasting protocols, brief introduction to multicast protocols such DVMRP, MOSPF, PIM, IGMP.

UNIT-4:

Transport Layer: Introduction to GoBack-N, Selective repeat N, Piggybacking. Services and port numbers, User Datagram Protocol (UDP): UDP Segment, Transmission Control. Protocol (TCP):

TCP Segment, TCP Connection Set up, Application of TCP and UDP. TCP flow control, TCP error control, TCP Congestion Control and options. Introduction to SCTP services and features.

Application Layer: Client server programming using UDP and TCP, Name/Address Mapping, DNS Message Format.

Self-Learning Component:

Remote Login. Protocols: TELNET Protocol and SSH Protocol. Electronic Mail (E-Mail), World Wide Web (WWW).

Text books:

1. Behrouz A Forouzan: Data Communications and Networking, 5th Edition, McGraw – Hill, 2016.
2. Nader F. Mir: Computer and Communication Networks, Pearson Education, 2009

Reference Books:

1. Alberto Leon-Garcia and Indra idjaja: Communication Networks – Fundamental Concepts and Key Architectures, 2nd Edition Tata McGraw – Hill, 2004.
2. Andrew S. Tanenbaum: Computer Networks, 4th Edition, Pearson Education, 2005.
3. Larry L. Peterson and Bruce S. Davie: Computer Networks- A system Approach, 5th Edition, Elsevier, 2012.
4. William Stallings: Data and Computer Communications, 10th Edition, Pearson Education, 2008.
5. Douglas E. Comer: Internetworking with TCP/IP Vol.1, 6th Edition, Pearson, 1995.
6. IEEE Transactions on Networking.
7. Elsevier Journal of Computer Networks
8. Springer Journal of communications and Information networks.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	H	H	H	M	L	-	-	-	-	-	L
CO 2	H	H	H	H	M	M	-	-	-	-	-	L
CO 3	H	H	H	H	M	L	-	-	-	-	-	M
CO 4	H	H	H	M	M	L	-	-	-	-	-	L

B18CS5040	Operating Systems	L	T	P	C
Duration:14 Wks		3	0	1	4

Prerequisites:

Programming for Problem Solving (B18CS1030), Computer Organization and Architecture (B18CS4040)

Course Description:

This course starts with a brief historical perspective of the evolution of operating system and then covers the major components of most of the operating systems. The operating system provides a well-known, convenient, and efficient interface between user programs and the bare hardware of the computer on which they run. The operating system is responsible for allowing resources (e.g., disks, networks, and processors) to be shared, providing common services needed by many different programs (e.g., file service, the ability to start or stop processes, and access to the printer) and protecting individual programs from one another. Emphasis is given to three major OS subsystems: process management (processes, threads, CPU scheduling, synchronization, and deadlock), memory management (segmentation, paging, swapping) and file systems.

Course Objectives:

The objectives of this course are to:

1. Discuss the history, basics and structure of Operating System.
2. Demonstrate the process and threading concepts.
3. Illustrate the different scheduling and deadlock techniques
4. Explain the physical, virtual memory management techniques and file structure of UNIX operating system.

Course Outcomes (Cos):

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

CO1: Identify the major components and different services of Operating system
CO2: Evaluate the performance of different CPU Scheduling algorithms for the given real world applications.
CO3: Build applications to overcome synchronisation problems and to avoid deadlocks
CO4: Compare and contrast physical and virtual memory management techniques and interpret the file systems concepts

Course Contents :

UNIT – 1:

Operating System Principles: Evolution of Operating Systems, Structural overview, Types of Operating System and operations, Computing environments, Operating System Services, User - Operating System interface, System calls and system programs, Operating System structure.

UNIT – 2:

Process Management: Process concept, process scheduling, Operations on processes, Inter process communication. Multi-Threaded Programming, Overview, Multithreading models, Thread Libraries, threading issues. Process scheduling: Basic concepts, scheduling criteria, Scheduling algorithms, Multiple Processor scheduling, thread scheduling.

UNIT-3:

Synchronization and Deadlock

Synchronization: The Critical section problem; Peterson's solution; Synchronization hardware; Semaphores; Classical problems of synchronization: The Bounded-Buffer Problem, The Readers–Writers Problem, The Dining-Philosophers Problem; Monitors.

Deadlock: Definition, Deadlock characteristics, Deadlock Prevention, Deadlock Avoidance: banker's algorithm, Deadlock detection and Recovery.

UNIT – 4:

Memory Management: Memory Management Strategies, Swapping, contiguous memory allocation, Paging, structure of page table, Segmentation. Virtual Memory Management: Background, Demand paging, copy-on-write, Page replacement, Allocation methods, Thrashing.

File System: File concept; Access methods; Directory structure; File system mounting; File sharing; Protection.

Self-learning components:

Virtual machines and Introduction to Linux Operating System, Introduction to Distributed computing, Parallel computing, grid computing, cloud computing.

Text books:

1. Abraham Silberschatz, Peter Bear Galvin, Greg Gagne, Operating System Principles, Wiley Asia Student Edition, 2009.

2. William Stallings, Operating Systems: Internals and Design Principles, Prentice Hall

of India, seventh edition, 2011.

3. D. M. Dhamdhere; Operating Systems: A Concept-Based Approach; Tata McGraw-Hill, Third edition 2012.

Reference books:

1. Frederic Magoules, Jie Pan, Kiat-An Tan, Abhinit Kumar, Introduction to Grid Computing, CRC Press, Second Edition, 2014

2. Andrew Tanenbaum & Albert Woodhull, Operating Systems: Design and Implementation. Prentice-Hall, Third edition, 2014.

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	M	-	L	-	-	-	-	-	-	-
CO2	L	M	H	M	L	-	-	-	-	-	-	-
CO3	L	M	H	H	L	-	-	-	L	-	-	L
CO4	M	M	M	L	M	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

List of Experiments

Sl.NO.	NAME OF THE EXPERIMENT
1	A child process in computing is a process created by another process (the parent process). This technique pertains to multitasking operating system and sometimes called a sub-process or subtask. Now, use C language to create a child process to read commands from the standard input and execute them.
2	Fibonacci series is one of the optimal searching techniques. Multi-threaded program is used to execute multiple process or threads concurrently by the central processing unit. Now, run a Multi-threaded program in C to generate and print the Fibonacci series in such a way that one thread has

	to generate the numbers up to the limit specified by the user and another thread to print them.
3	In multiprogramming environment, several processes execute at the same time sharing the processor time. It is required to understand the performance of the policies FCFS and SJF in proper utilization of CPU time. Therefore write program to compare their performance metrics in terms of average waiting time and average turnaround time.
4	To design and develop operating system, it is necessary to develop various modules like, Process Manager, Memory Manager, Input-Output Manager and Network Manager and many more. The process manager is one of the important modules of OS. It deals with creation and execution of multiple processes sharing the processor time. The process manager uses various scheduling policies. Hence, there is a need to understand the various scheduling policies. Hence, given the list of processes and their CPU burst times, display/print the Gantt chart for Priority. For each of the scheduling policies, compute and print the average waiting time and average turnaround time.
5	Given the list of processes and their CPU burst times, display/print the Gantt chart for Round Robin Algorithm. For each of the scheduling policies, compute and print the average waiting time and average turnaround time.
6	Producer-Consumer Problem also known as bounded-buffer problem is an example of multi-process synchronization problem. This problem arises when the producer and consumer share a common, fixed size buffer. The solution can be obtained by means of inter–process communication typically using Semaphores. Now, implement a process with a produces thread and a consumer thread which makes use of bounded buffer. Use any suitable synchronization construct. (Implement producer-consumer problem using semaphores).
7	Banker's Algorithm is used for Deadlock Avoiding purpose. It is suitable to resource allocation system with multiple instances of each resource type. Implement Banker's Algorithm which finds whether the state is safe or not.
8	The operating system manages the computer's memory. The OS allocates required memory for the task and deallocates memory after execution of task. There are many allocation strategies. Write a C program to simulate

	the Multi Programming with Variable number of Task (MVT) memory strategy.
9	The operating system replaces the page of a old process whenever a new process page has to be loaded in memory. To select the page for replacement there are many methods. Write a C program to implement LRU page replacement algorithm.
10	The operating system manages storage of information by creating and storing information in the file. There are many methods of creating file. Write a C program to implement any one of the file allocation techniques (Linked, Indexed or Contiguous).
	Optional Lab Programs
1	Implement shared memory and semaphore concepts for inter process communication.
2	Implement file organization strategies a) single level b) Two level c) Hierarchical
3	Write a C program to simulate the concept of Dining-Philosophers problem.
4	Write programs using the following system calls of UNIX operating system: exec, getpid, exit, wait, close, stat, opendir, readdir.
5	Write a C program to simulate the following contiguous memory allocation techniques a) Worst-fit b) Best-fit.
6	Implement Memory management Scheme-II a) Segmentation Concept.
7	Write a C program to simulate the First fit contiguous memory allocation technique.
8	Write a C program to simulate disk scheduling algorithms a) FCFS b) SCAN c) C-SCAN.
9	Design and develop a data recording system that receives data from LAN and records it in a file .Use threading and buffering & Synchronization Mechanisms.

10	Write a program that demonstrates the usage of the shared resources using semaphores

B18CS5051	Object oriented Analysis and Design	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Programming for Problem Solving [B18CS1030]

Course Description:

This course introduces object models and designs from system requirements; use the modelling concepts provided by UML; identify use cases and expand them into full behavioral designs; expand the analysis into a design ready for implementation and construct designs that are reliable. The course begins with an overview of the object-oriented analysis and design.

Course Objectives:

The objective of this course is to:

1. Explain the object-oriented models for developing large applications
2. Describe the classes and objects.
3. Demonstrate the use of various UML diagrams in real world applications.
4. Discuss different case studies that make use of OOAD concepts.

Course Outcomes (Cos):

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

CO1: Identify sutible object models for solving the given real world problems.

CO2: Create objects and classes for a given real world problem.

CO3: Design use-case and sequence diagrams for the given real world application.

CO4: Develop real world application using Object oriented approach.

Course Content:

UNIT- 1

Complexity: The Structure of Complex Systems, Inherent Complexity of Software, five Attributes of a Complex System, Organized and Disorganized Complexity, Bringing Order to Chaos On Designing Complex Systems.

The Object Model: The Evolution of the Object Model, Foundations of the Object Model, Elements of the Object Model, Applying the Object Model.

UNIT -2

Classes and Objects: The Nature of an Object, Relationships among Objects, The Nature of a Class, Relationships among Classes, The Interplay of Classes and Objects, On Building Quality Classes and Objects.

Classification: The Importance of Proper Classification, Identifying Classes and Objects, Key Abstractions and Mechanisms.

UNIT- 3

Notation: The Unified Modelling Language, Package Diagrams, Component Diagrams, Deployment Diagrams, Use Case Diagrams, Activity Diagrams, Class Diagrams, Sequence

Diagrams, Interaction Overview Diagrams, Composite Structure Diagrams, State Machine Diagrams, Timing Diagrams, Object Diagrams, Communication Diagrams. Process: First Principles, The Macro Process: The Software Development Lifecycle, The Micro Process: The Analysis and Design Process.

Unit- 4

Case Study: Web Application: Vacation Tracking System: Inception, Elaboration, Construction, Transition and Post-Transition.

Self-learning components:

System Usability and Measuring User Satisfaction: Usability Testing, User Satisfaction Test, Analyzing User Satisfaction by Satisfaction Test Template, Developing Usability Test Plans and Test Cases.

Text books:

1.Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Bobbi J. Young, Jim Conallen and Kelli A. Houston, Object-Oriented Analysis and Design with Applications, Third Edition, Addison Wesley, 2009.

Referencebooks:

1. Brett McLaughlin, Gary Pollice, David West, Head First Object-Oriented Analysis and Design: A Brain Friendly Guide to OOA&D, Oreilly Media Inc, 2007.

2.Brahma Dathan, Sarnath Ramnath, Object-Oriented Analysis, Design and Implementation: An Integrated Approach, Springer Universities Press, 2015.

3.James J. Odell, Advanced Object-Oriented Analysis and Design Using UML, SIGS Books and Mutimedia, 1998.

4.Elsevier Journal of systems and software.

5.Springer Journal of Object-Oriented Programming.

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	M	M	H	L	M	-	-	-	-	-	-	-
CO2	M	M	H	H	M	-	-	-	-	-	-	-
CO3	M	H	H	M	H	-	-	-	-	-	-	-
CO4	M	H	H	H	H	-	-	-	-	-	-	-

Where, L(Low), M(Medium) and H(High) represents strength of correlation between CO and PO.

B18CS5052	IoT Programming and Applications	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Programming for Problem Solving. [B18CS1030]

Course Description:

The course covers the importance of IoT in society, the current components of typical IoT devices and trends for the future. IoT design considerations, constraints and interfacing between the physical world and your device will also be covered. This course will get to know how to make design trade-offs between hardware and software. It also covers key components of networking to ensure that students understand how to connect their device to theInternet.

Course Objectives

The objectives of this course are to:

1. Explain basics of Arduinoprograms.
2. Illustrate sample programs to interface sensors to aurdino board storead, process and analyze data.
3. Demonstrate WebApp storead and stored at a from sensors, and to monitor and control IoTdevices.
4. Discuss IoT programming to develop larger smart products useful for thesociety.

Course Outcomes(Cos):

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

CO1:Develop programs to interface sensors to Aurdino board stored, process and analyze data.

CO2: Analyse the performance of Communication Protocols used in real time IoT Projects.

CO3: Make use of different IoT Patterns to develop the real world applications.

CO4: Identify the IoTsecurity requirments to solve the given real world problem.

Course Content:

UNIT- 1

BuildingBlocks: Arduino Basics, Hardware Requirements, Software Requirements: Toolbar, Status Window, Serial Monitor Window; Arduino Programming Language Reference Internet Connectivity:ArduinoUno Wired Connectivity(Ethernet),HardwareRequired,Software Required Circuit, Code(Arduino), FinalProduct; Arduino Uno Wireless Connectivity(WiFi), Hardware Required, Software Required, Circuit, Code (Arduino), FinalProduct

Communication Protocols: HTTP: Code (Arduino), Final Product; MQTT: Intrusion Detection System, Remote Lighting Control, Code (Arduino), Final Product

UNIT -2

ComplexFlows: Node-RED: Hardware Required, Software Required, Circuit, Node-REDFlow, Code (Arduino), External Libraries, Internet Connectivity (Wireless),Read Sensor Data, Data Publish, Standard Functions and the FinalProduct.

IoT Patterns: Real-time Clients: Hardware Required, Software Required, Circuit, Code (Arduino): External Libraries, Internet Connectivity (Wireless), Read Sensor Data, Data Publish, Standard Functions, Code (Android): Project Setup, Screen Layout, Screen Logic, MQTT Client and the Final Product.

IoT Patterns: Remote Control: Hardware Required, Software Required, Circuit, Code (Android): Project Setup, Screen Layout, Screen Logic; MQTTClient,Code(Arduino):External Libraries, Internet Connectivity(Wireless) ,Data Subscribe, Control Lights, Standard Functions and the Final Product.

UNIT- 3

IoTPatterns: On-Demand Clients: Hardware Required, Software Required, Circuit, Database

Table (MySQL), Code(PHP):DatabaseConnection,ReceiveandStoreSensorData,GettheParking Spot

Count;Code(Arduino):ExternalLibraries,InternetConnectivity(Wireless),ReadSensor Data;Code

(iOS): Project Setup, Screen Layout, Screen Logic and the Final Product.

IoT Patterns: Web Apps: Hardware Required, Software Required, Circuit, Database Table (MySQL),Code(PHP):DatabaseConnection,ReceiveandStoreSensorData,Dashboard;Code (Arduino): External Libraries, Internet Connectivity (Wireless), Read Sensor Data, Data Publish, Standard Functions and the FinalProduct.

IoT Patterns: Location Aware: Hardware Required, Software Required, Circuit, Database Table (MySQL),Code(PHP):Database Connection, Receive and Store Sensor Data, Map; Code (Arduino):External Libraries, Get GPSCoordinates, Data Publish, Standard Functions and the Final

Product.

UNIT-4

IoT Patterns: Machine to Human: Hardware Required, Software Required, Circuit, Code (Arduino): External Libraries, Internet Connectivity (Wireless), Read Sensor Data, Data Publish, Standard Functions, Effektif Workflow: Process Creation, Process Configurations; Node-RED Flow and the Final Product.

IoT Patterns: Machine to Machine: Light Sensor Device, Code (Arduino): Lighting Control Device, Code (Arduino) and the Final Product

IoT Platforms: Hardware Required, Software Required, Circuit, Xively Setup, Zapier Setup, Xively Trigger, Code (Arduino): External Libraries, Internet Connectivity (Wireless), Read Sensor Data, Data Publish, Standard Functions and the Final Product.

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

Self-learning component:

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, Mediatek Linkit One, Particle Photon, Tessel, Adafruit Flora, LightBlue Bean, Udoo Neo, Intel Edison)

Text books

1. AdeelJaved,BuildingArduinoProjectsfortheInternetofThings:ExperimentswithReal-World Applications, 2015,Apress.
2. BrianRussell,DrewVanDuren,PracticalInternetofThingsSecurity(KindleEdition),2016

Reference books:

1. AgusKurniawan,SmartInternetofThingsProjects,PacktPublishing,2016.

2. IEEE Internet of ThingsJournal.

3. Elsevier Journal of Internet of Things.

MappingCOswithPOs(Programoutcomes)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	H	M	-	-		-	-	-
CO2	M	H	H	M	M	H	-	-	-	-	-	-
CO3	H	H	M	M	H	H	-	-	-	-	-	-
CO4	M	H	H	H	H	M	-	-	-	-	-	-

Where, L(Low), M(Medium) and H(High) represents strength of correlation between CO and PO.

B18CS5053	Software Testing	L	T	P	C
Duration:14Wks		3	0	0	3

Prerequisites:

Software Engineering (B18CS3060)

Course Description:

This course examines fundamental software testing and related program analysis techniques. In particular, the important phases of testing will be reviewed, emphasizing the significance of each phase when testing different types of software. The course will also include concepts such as test case generation, test coverage, regression testing, program analysis (e.g., program-flow and data-flow analysis), and test prioritization

Course Objectives (Cos):

1. Discuss fundamental concepts in software testing.
2. Illustrate the use of different software testing methods.
3. Demonstrate the use of Selenium IDE to develop applications.
4. Discuss the use of locators in developing real worldapplications.

Course Outcomes (Cos):

On successfulcompletionofthiscourse; the student will be able to:

CO1: Identify the fundamental concepts in software testing.

CO2: Analyse the performance of testing methods on the given real world applications.

CO3: Develop an application using Software Testing IDE.

CO4: Make use of locators in developing real world applications.

CourseContent:

Unit1

Introduction: Software Testing Principles Need for testing, Basic definitions, Test cases, Insights from a Venn diagram, Identifying test cases, Error and fault taxonomies, Levels of testing, Examples: Generalized pseudocode, The triangle problem, The NextDate function, The commission problem. Introduction to Automated testing tools (open source and commercial)

Unit 2

FunctionalTesting: Boundary value analysis, Robustness testing,Equivalence Class Testing, Decision table method, Examples: The triangleproblem,

Structural Testing: Path Testing: DD-Paths, Test Coverage Metrics, Basis path Testing; Dataflow Testing: define/Use Testing, Slice Based Testing

Unit 3

Getting Started with Selenium IDE: Important preliminary points, What is Selenium IDE, installing Selenium IDE, Selenium IDE, Rules for automation, Recording your first test with Selenium IDE Updating a test to assert items are on the page,updating a test to verify items on the page adding Selenium IDE comments, Multiplying windows, Working with multiple windows.

Unit 4

L**ocators**: LocatingelementsbyID, FindingIDs of elements onthepagewithFirebug,finding elements by ID, Moving elements on the page, finding elements by name, Adding filters to the name, finding elements by link text. Overview of Selenium Web Driver, History of Selenium Architecture, Web Driver API, Web DriverSPI.

Self-learning component:

Automated Testing tools: QTP tools, Lab View etc, ATLM.

Text Books:

1.P.C. Jorgensen, Software Testing A Craftman's Approach, CRC Press , by Auerbach Publications

ISBN 9781466560680 , October 18, 2013.

2.David Burns, Selenium 2 Testing Tools Beginner's Guide.

Reference books:

1. Glenford J. Myers, The Art of Software Testing, John Wiley & Sons 1979 2. Boris Beizer,Black-Box

Testing: Techniques for Functional Testing of Software and Systems, John Wiley & Sons 1995.

2. William E. Perry, Effective Methods for Software Testing (2nd Edition) , JohnWiley & Sons 2000

3Journal of Software Engineering and Research Engineering.

4.International Journal of Software Engineering, Technology and Applications

MappingCOswithPOs(Programoutcomes)

Course Outcomes	**Program Outcomes**											
	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011	PO12
CO1	H	M	M	M	L	-	-	-	L	L	-	-
CO2	H	H	M	M	L	-	-	-	-	-	-	-
CO3	H	M	M	L	L	-	-	-	-	L	-	-
CO4	H	H	H	H	M	L	-	-	-	-	-	L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS5054	Digital Communication	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Probability and Statistics [B18CS2010], Signals and Systems [B18CS4051]

Course Description:

The course focuses on digital transmission and reception, signal space representations, spectral analysis of digitally modulated waveforms, design considerations for band limited channels, introductory concepts of information theory, and error correction coding. The course is intended for graduate/senior undergraduate level students. While the course is intended to serve as a introduction to digital communications, the pre-requisites/co-requisites listed are absolutely necessary.

Course Objectives (Cos)

The objectives of this course is to:

1: Demonstrate the limitations of analog communications resources bandwidth and power to appreciate the effective use of such Resources

2: Discuss the flow and processing of information from the source to various units atthe transmitter side.

3: Illustrate the inverse operations at the receiver to facilitate the retrieval of transmitted information.

4: Describe various processing units of a digital communication system.

Course Outcomes (Cos):

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

CO1: Identify the limitations of analog communications resources bandwidth and power to appreciate the effective use of such Resources

CO2: Analyze the flow and processing of information from the source to various units at the transmitter side.

CO3: Make use of the inverse operations at the receiver to facilitate the retrieval of transmitted information.

CO4: Apply the different Channel coding methods for the given real world data.

Course Content:

Unit- 1

Information Theory: Information and entropy, conditional entropy and redundancy, Shannon Fano coding, Mutual Information, Information loss due to noise, source codings - Huffman Code, variable length coding, Source coding to Increase average Information per bit, Lossy source coding.

Unit -2

Digital Modulation Techniques: Introduction, ASK,ASK Modulator, Coherent ASK Detector, Non-Coherent ASK Detector, FSK, Bandwidth and Frequency Spectrum of FSK. Non coherent FSK Detector, Coherent FSK Detector, FSK Detection Using PLL, BPSK, Coherent PSK Detection, QPSK, Differential PSK.

Unit- 3

Spread Spectrum Modulation Techniques: Use of Spread Spectrum, Direct Sequence Spread Spectrum (DSSS), Code Division Multiple Access, and Ranging using DSSS. Frequency Hopping Spread Spectrum, PN - sequences: Generation and Characteristics. Synchronization in Spread Spectrum Systems

Unit- 4

Channel coding: Waveform Coding, Types of Error control, Structured Sequences, Matrix description of Linear Block Codes, Error detection and error Correction capabilities of linear block codes, Cyclic Codes, Algebraic structure, encoding.

Self-Learning Component:

Power spectra of digitally modulated signals, Performance comparison of digital modulation schemes, Signal space theory and various modulation schemes.

Text books:

1. Bernard Sklar, "Digital Communications - Fundamentals and Applications", Pearson Education (Asia) Pvt. Ltd, 2nd Edition, 2014.

2. Herbert Taub. Donald L Schiling, Goutam Sana, Principles of communication systems, 3rd Edition, McGraw-Hill, 2008.

3. Sam Shanmugam, Digital and Analog Communicator Systems, John Wiley, 2005.

Reference books:

1. John G. Proakis . Masoud Salehi, Digital Communications, 5th Edition, McGraw-Hill, 2008.

2. Simon Haykin, Digital Communication, John Wiley, 2005.

3. Ian A. Glover, Peter M. Grant, Digital Communications, Edition, Pearson Edu., 2008.

4. B.P. Lathi, Communication Systems, BS Publication, 2006.

5. Elsevier Journal Digital Communications and Networks.

6. IEEE Transactions on Communications.

7. Journal of Analog and Digital Communications.

Mapping COswith POs(Programoutcomes)

Course Outcomes	**Program Outcomes**											
	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011	PO12
CO1	H	M	L	L	-	-	-	-	-	-	-	-
CO2	H	M	M	M	-	-	-	-	-	-	-	-
CO3	H	H	H	M	-	H	-	-	-	-	-	-
CO4	H	H	L	M	-	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS5055	Microprocessors and Interfacing	L	T	P	C
Duration:14Wks		3	0	0	3

Prerequisites:

Digital Logic Design [B18CS3010]

Course Description:

The course describes the architecture, programming and interfacing of 8086 Microprocessor. It helps the student in building simple assembly language programs for 8086 Microprocessor. It also gives instruction to advanced microprocessors, GPUs and DSPs.

Course Objectives (Cos):

The objectives of this course is to:

1. Explain the architecture, pin configuration of various microprocessors and Interfacing ICs,

Identify various addressing modes.

2.Illustrate 8086 assembly language Interrupt based real time applications.

3. Discuss 8086 programming for interfacing peripheral devices for control applications.

4.Describe the architecture of various advanced microprocessors.

Course Outcomes (Cos):

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

CO1: Identify the suitable addressing modes and instructions formats of 8086 architecture to develop program for the given real world problem.

CO2: Make use of addressing modes and instructions formats of 8086 architecture to develop assembly language programs for the given real world problem.

CO3: Develop 8086 program to interface peripheral devices for control applications.

CO4: Compare the architecture of various advanced microprocessors.

Course Content:

Unit -1:

Intel 8086 Microprocessor: Architecture of 8086, Register organization, Signal description, Physical memory organization, General bus operation, Input/output addressing capability, Special processor activities, Minimum and Maximum mode of 8086 system and timings.8086 Machine language Instructions: instruction formats, Addressing modes - Register, Immediate, Direct, Register indirect, Base plus index, Register relative and Base relative plus index addressing modes. Assembler directives -Symbols, variables, constants, different types of directives, Introduction to IDE and MASMa Assembler Programming examples on debugging.

Unit -2:

Instruction Set Of 8086 Microprocessor: Data transfer instructions, Arithmetic and logical instructions, conditional and unconditional branch instructions, String instructions, Looping instructions, Machine control instructions, Shift and rotate instructions, Assembly language programming.

Introduction to stack, Stack structure of 8086, Interrupts and interrupt service routines, Interrupt cycle of 8086, Non-maskable interrupt, Maskable interrupt (INTR).Interrupt programming, Timing and delays, Macros.

Unit -3:

Peripherals And Their Interfacing With 8086: Static and dynamic RAM interfacing, Input and output ports Interfacing, Stepper motor Interfacing, Interfacing of Analog to digital converter and Digital to analog converter.

Programmable Input-Output Port 8255 (PPI): Modes of operation of 8255, Key board and display interfacing, Control of high power devices using 8255, programming examples.

Unit-4:

Introduction to Advanced Microprocessors: Introduction to Intel Microprocessors - 80186, 80286, 80386, 80486, Pentium, Pentium-II, Pentium-IV, Xeon. Overview of Architecture, Programming and Interfacing of these processors. Introduction to Kiel Software, Multicore programming, GPUs, SGX and DSP processors.

Self-learning component: Coding and decoding of 8086 instructions set with some examples, Explore Complete Instructions set of 8086 Microprocessor in detail.

Text books:

1.A. K Ray and K.M. Bhurchandi, Advanced Microprocessor and Peripherals -Tata McGraw Hill, 2007.

2.K.R. Venugopal and Rajakumar, Microprocessor X86 Programming, BPB Publications, 2003.

Reference books:

1. Yu Cheng Liu & Glenn A Gibson, Microcomputer systems 8086/8088 family, Architecture, Programming and Design -2nd Edition, Prentice Hall of India, July 2003.

2. Douglas V Hall, Microprocessor and Interfacing, Programming & Hardware, 2nd Edition, Penram International, 2006.

3. Barry. B. Bray, The Intel Microprocessor - 4th Edition, PHI, 1997.

4. Springer Lecture notes in Electrical engineering -Embedded Microcontroller Interfacing.

5. Elsevier Journal of Microprocessors and Interfacing.

Mapping Cos with POs(Programoutcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	M	M	H	M	-	-	-	-	-	-	-
CO 2	H	M	H	H	M	-	-	-	-	-	-	-
CO 3	H	L	M	H	L	-	-	-	-	-	-	-
CO 4	H	L	H	H	M	-	-	-	-	-	-	-

Where, L(Low), M(Medium) and H(High) represents strength of correlation between CO and PO.

B18CS5061	Unix System Programming	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites

Programming Problem solving [B18CS1030]

Course Objectives

Objectives of this course are to:

1. Discuss the UNIX, ANSI Standards and POSIX API'S forfiles.
2. Describe the API's for implementing process control and to Identify System call interface for process management, multitasking programs.
3. Demonstrate the use of Signals and Daemon processes in UNIX.
4. Explain different API's and IPC methods.

Course Outcomes

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

CO1	Make use of POSIX API'S to work with files.
CO2	Apply the API's for implementing UNIX commands, process control and process management.
CO3	Utilize Signals and Daemon processes in UNIX.
CO4	Develop programs for message queues, FIFO programs and data transfer socket using appropriate API's, IPC methods and Sockets.

Course Content

UNIT -1

UNIX System Overview, files & API's: UNIX system overview: UNIX architecture, logging in, files and directories, user identification, System calls and library functions.

UNIX File Types & API's: File types, File attributes, Application Program Interface to Files, Unix Kernel support for files, Directory files, Hard & symbolic links, API's: open, create, read, write, close, link, unlink.

UNIT - 2

UNIX Process and Relationships: Introduction, main function, process termination, command-line arguments, environment list, memory layout of C programs, UNIX kernel support for processes.

Process control: fork, vfork, exit, wait, waitpid, race conditions, exec functions, changing user IDs and group IDs, system function, process accounting, user identification, process times;

Process Relationships: Introduction, Terminal Logins, Network Logins, Process Groups, Sessions, Controlling Terminal, Job Control, Execution of shell programs.

UNIT – 3

Signals & Daemon Processes: Signals: The UNIX Kernel Support for Signals, Signal Mask, sigaction (), The SIGCHLD Signal and the waitpid, Kill, Alarm, Interval Timers; Daemon Processes: Introduction, Daemon Characteristics, Coding Rules, Error Logging, Client-Server Model.

UNIT - 4

Inter Process Communication: Overview of IPC Methods: Shared Memory; Pipes, popen(), pclose(), Co processes, FIFOs, System V IPC, Stream Pipes, Passing File Descriptors , Message Passing.

File Types, The UNIX and POSIX File System, The UNIX and POSIX File Attributes, In odes in UNIX System, Application Program Interface to Files, UNIX Kernel Support for Files, Relationship of C Stream Pointers and File Descriptors, Directory Files, Hard and Symbolic Links.

Self Learning component

OPENMP, OPENMPI, Sockets

Text books:

1. Unix System Programming Using C++, by Terrence Chan - Prentice Hall India, 2011.
2. Advanced Programming in the UNIX Environment, by Stephen A. Rago, W. Richard Stevens, third edition, Pearson Education / PHI, 2013.

Reference books:

1. UNIX Systems Programming: Communication, Concurrency, and Threads by Kay A. Robbins and Steven Robbins, Prentice Hall; 2 edition, December 2015.
2. UNIX Network Programming, Interprocess Communications (Paperback) (2nd Edition) by W. Richard Stevens, Addison-Wesley.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	H	H	M	-	-	-	-	-	-	-
CO2	H	H	H	H	L	-	-	-	-	-	-	-
CO3	H	M	H	H	L	-	-	-	-	-	-	-
CO4	H	H	H	H	M	-	-	-	-	-	-	M

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS5062	Advanced DBMS	**L**	**T**	**P**	**C**
Duration:14 Wks		**3**	**0**	**0**	**3**

Prerequisites:

Database Management System [B18CS4030]

Course Description:

Advanced database system deals with current and emerging technologies which enables to handle complex applications, provides a comprehensive understanding of data modelling techniques, OLAP, OLTP,Data warehouse and its practical implementation.

Course Objectives:

1. Discuss object oriented concepts and object relational data bases.
2. Describe Parallel and distributed database.
3. Illustrate queries for distributed data storage and processing.
4. Explain enhanced data models for applications.

Course Outcomes (Cos):

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

CO1	Identify the features of Object Definition Language and Object Query Language for given real world applications.
CO2	Develop Complex queries in SQL and ODMG for parallel and distributed databases.
CO3	Make use of different types of databases and other technologies to mine the data.
CO4	Design multidimention model for a given application in Data mining.

Course Content:

Introduction to various tools and frameworks: Introduction to OLAP, OLTP and Data warehouse system, data modelling, star schema, snow flake schema. Build Data warehouse/data mart using opensource tools like pentaho data integration tool, pentaho business analytics. OLAP versus OLTP, Introduction to various tools

Overview of Object-Oriented Concepts, Object and Object-Relational Databases: Objects, Encapsulation, Polymorphism, Type and class hierarchies etc. Object model of ODMG, Object definition Language ODL; Object Query Language OQL; Overview of C++ language binding; Conceptual design of Object database; Overview of object relational features of SQL; Object-relational features of Oracle.

Unit -2

Parallel and Distributed Databases: Architectures for parallel databases; Parallel query evaluation; Parallelizing individual operations; Parallel query optimizations; Introduction to distributed databases; Distributed DBMS architectures; Storing data in a Distributed DBMS; Distributed catalog management; Distributed Query processing; Updating distributed data; Distributed transactions; Distributed Concurrency control and Recovery.

Unit - 3

Enhanced Data Models for Some Advanced Applications: Active database concepts and triggers; Temporal, Spatial, and Deductive Databases - Basic concepts

Unit - 4

Data Warehousing and Data Mining: Introduction to decision support, OLAP, multidimensional model, Window queries in SQL, Finding answers quickly, Implementation techniques for OLAP, Data Warehousing, Introduction to Data Mining, Counting co-occurrences, Mining for rules, Tree-structured rules, Clustering, Similarity search over sequences, Incremental mining and data streams;

Self-learning component:

More Recent Applications: Mobile databases; Multimedia databases; Geographical Information Systems; Genome data management, P-P database, Transaction management.

Text Books:

1. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, 3rd Edition, McGraw- Hill, 2003.

2. Elmasri and Navathe, Fundamentals of Database Systems, 5th Edition, Pearson Education, 2007.

3. Jiawei Han, MichelineKamber, Jian Pei, Data Mining: Concepts and Techniques, Elsevier, 2011.

Reference books:

1. Connolly and Begg, Database Systems, 4th Edition, Pearson Education, 2002.
2. Journal of Data and Information Quality (JDIQ)
3. ACM Transactions on Knowledge Discovery from Data (TKDD)
4. ACM Transactions on Database Systems (TODS)
5. IEEE Transactions on Knowledge and Data Engineering

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	P O8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	L	M						
CO2	H	H	M	H	M	M						
CO3	L	M	H	L	M	L						
CO4	H	H	H	M	M	H						

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS5063	Introduction to Robotics	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites

Multivariable Calculus and Linear Algebra [B18CS1010], Physics [B18CS2020]

Course Description

This course introduces techniques, algorithms and principles of interactive computer graphics and animation, this course also prepares for study in real-time rendering, realistic image Synthesis, and computer animation.

Course Objectives

1. Discuss the fundamental concepts of Robotics.

2. Explain intelligent module for robotic motion control.

3. Demonstrate robotic vision system using transformation techniques.

4. Illustrate the working of innovative robotic devices.

Course Outcomes (Cos)

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

CO1: Outline the fundamentals and architecture of robotics.

CO2: Design an Intelligent module for robotic motion control.

CO3: Develop robotic vision system using transformation techniques and sensors.

CO4: Make use of innovative robotic devices for industrial and socially relevant applications.

Course Contents:

Unit - 1

Introduction: Robot anatomy-Definition, law of robotics, History and Terminology of Robotics- Accuracy and repeatability of Robotics-Simple problems-Specifications of Robot-Speed of Robot- Robot joints and links-Robot classifications-Architecture of robotic systems-Robot Drive systems- Hydraulic, Pneumatic and Electric system.

Unit -2

End effectors and robot controls: Mechanical grippers-Slider crank mechanism, Screw type, Rotaryactuators, cam type-Magnetic grippers-Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems-Robot controls-Point to point control, Continuous path control, Intelligent robot-Control system for robot joint-Control actions-Feedback devices-Encoder, Illustration using ARDUINO Boards

Unit - 3

Robot transformations and sensors: Robot kinematics-Types- 2D, 3D Transformation-Scaling,Rotation, and Translation- Homogeneous coordinates, multiple transformation-Simple problems. Sensors in robot – Touch sensors-Tactile sensor – proximity and range sensors – Robotic vision sensor-Force sensor-Light sensors, Pressure sensors, Illustration using ARDUINO Boards

Unit - 4

Robot cell design and applications :Robot work cell design and control-Sequence control, Operatorinterface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using MATLAB, NXT Software Introductions-Robot applications- Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting and undersea robot. Introduction to robotic operating system (ROS) .

Self-learning component

MICRO/NANO ROBOTICS SYSTEM, MATLAB, NXT Software, Bio inspired Robots, Home automation Robots.

Text books:

1. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education, 2009

2. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss,Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, McGraw Hill, 2012

.**Reference books:**

1. Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin,Robotics Engineering an Integrated Approach, Phi Learning.,2009.

2. Francis N. Nagy, Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc., 1987.

3. P.A. Janaki Raman, Robotics and Image Processing an Introduction, Tata McGraw Hill Publishing Company Ltd., 1995

4. Carl D. Crane and Joseph Duffy, Kinematic Analysis of Robot manipulators, Cambridge University press, 2008.

5. Craig. J. J. Introduction to Robotics mechanics and control, Addison- Wesley, 1999.

6. Elsevier Journal of Robotics and autonomous systems
7. IEEE Journal on robotics and automation

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	P O8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	M	-	-	-	-	-	-	-
CO2	H	H	H	H	H	-	-	-	-	-	-	-
CO3	H	H	H	H	H	-	-	-	-	-	-	-
CO4	H	H	H	M	M	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS5064	High Performance Computing	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Computer organization and architecture [B18CS4040], and Programming for Problem Solving [B18CS1030].

Course Description:

The goal of this course is to give students solid foundations for developing, analyzing, and implementing parallel and locality-efficient algorithms. This course focuses on theoretical underpinnings. To give a practical feeling for how algorithms map to and behave on real systems and will supplement algorithmic theory with hands-on exercises on modern HPC systems, such as Cilk Plus or OpenMP on shared memory nodes, CUDA for graphics co- processors (GPUs) and OpenMPI for message passing.

Course Objectives:

The objectives of this course are to:

1. Explain the features of Modern processors and parallel computers
2. Describe different levels of parallelism along with the synchronization and scheduling
3. Demonstrate the use of features of OpenMP programming.
4. llustrate the use of features of Open MPI programming.

Course Outcomes(Cos):

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

CO1: Identify different levels of parallelism that can be applied to solve the given real world problems.

CO2: Develop the programs using different levels of parallelism to solve the real world problems.

CO3: Make use of features of **OpenMP** to develop parallel programs for solving real world problems.

CO4: Apply the features of Distributed-memory parallel programming with openMPI for solving real world problems.

Course Content:

Unit- 1

Modern Processors: Stored-program computer architect; General-purpose cache-based microprocessor architecture; Memory hierarchies; Multicore processors; Multithreaded processors; Vector processors.

Parallel computers: Taxonomy of parallel computing paradigms; Shared-memory computers; Distributed-memory computers; Hierarchical (hybrid) systems; Networks.

Unit -2

Basics of parallelization: Why parallelize; Parallelism; Parallel scalability.

Unit- 3

Shared-memory parallel programming with OpenMP: Introduction to OpenMP; Case study: OpenMP-parallel Jacobi algorithm; Advanced OpenMP: Wavefront parallelization.

Efficient OpenMP programming: Profiling OpenMP programs; Performance pitfalls; Case study: Parallel sparse matrix-vector multiply.

Unit- 4

Distributed-memory parallel programming with MPI: Message passing; A short introduction to MPI; Example: MPI parallelization of a Jacobi solver.

Efficient MPI programming: MPI performance tools; Communication parameters; Synchronization, serialization, contention; Reducing communication overhead; Understanding intranode point-to-point communication.

Self-learning component:

1. More Recent Applications: Mobile databases; Multimedia databases; Geographical Information Systems; Genome data management.

Text books:

1. Introduction to High Performance Computing for Scientists and Engineers, Georg Hager, Gerhard Wellein, CRC Press, CRC Press,2011.

Reference books:

1. Parallel Programming in OpenMP ,Rohit Chandra , Leo Dagum , DrorMaydan , David Kohr, Jeff McDonald , Ramesh Menon.

2. Multi-core programming,Increase performance through software multiyhreading by Shameem Akhter and Jason Roberts 6. IEEE Transactions on Knowledge and Data Engineering.

3. Kai Hwang ,Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw Hill 1993

4. George S. Almasi and Alan Gottlieb ,Highly Parallel Computing.

5. Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar ,Introduction to Parallel Computing,, 2nd edition, Addison-Welsey, © 2003..

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	L	M	-	-	-	H	-	-	L
CO2	H	M	L	L	-	-	-	-	H	-	-	L
CO3	H	M	M	M	M	-	-	-	H	-	-	L
CO4	H	M	H	M	H	-	-		M	-		M

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS5065	Differential and Difference equations	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Multivariable Calculus and Linear Algebra [B18CS1010]

Course Description:

To study and understand the application approach of the conceptof differential equations arise from many studies.Difference equations arise in the study of electrical networks, in the theory of problems in all modern scientific and engineering probability, in statistical problems and many otherfields of engineering.

Course Objectives (Cos)

The objectives of this course is to:

1. Explain first order and higher order Differential equations.
2. Illustrate homogenous and non-homogenous Partial Differential Equations.
3. Demonstrate the solving of Difference equations.
4. Discuss the applications of Z-Transforms in solving Difference equations.

Course Outcomes (Cos):

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

CO1: Solve first order and higher order Differential equations.

CO2 Distinguish between homogenous and non-homogenous Partial Differential Equations.

CO3: Make use of Difference equations in a given real time problems.

CO4: Choose the appropriate theorem to solve the given real time applications .

Contents:

UNIT-1

Differential equations: Differential Equations of first order and first degree: Bernoulli's Equation,Exact equations and reducible to exact form (1. Close to expression M or N and find IF 2. y f(x) dx+x g(y) dy).

Linear Differential Equations: Definitions, Complete solution, Operator D, Rules for finding the complementary function, Inverse operator, Rules for finding the particular integral.

Applications:Newton's Law of cooling, Rate of Decay of radioactive problems.

UNIT-2

Partial Differential Equations: Formation of Partial differential equations, Solution of lagranges linear PDE, Solutions of non homogenous PDE by direct integration, Solution of homogenous PDE involving derivatives with respect to one independent variable, Solution of PDE by Product method

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UNIT-3

Difference Equations: Formation of Difference Equations -Linear Difference Equations- Rules for finding the complementary function and Particular Integral -Simultaneous Difference Equations with constant coefficients. Application to Deflection of a loaded string

UNIT-4

Z-Transforms: Definition- Properties-Shifting Properties-Multiplication by n-Initial value theorem, Final value theorem and problems-Convolution theorem-Inverse Z-Transforms. Application to Difference Equations by using Z-Transforms.

Self Learning Components:

Higher Order Linear equations, Boundary Value Problems

Text books:

1.B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 42ndedition, 2013.

2.Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 9th edition, 2012.

Reference book:

1.B.V. Ramana, “Higher Engineering Mathematics”, Tata McGraw Hill Publications, 1stedition, 2010.

2.R.K.Jain and S.R.K.Iyengar, “Advanced Engineering Mathematics”, Narosa PublishingHouse, 4th edition, 2002.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	M	H	H	M	L						L
CO 2	H	M	H	M	M	M						L
CO 3	M	H	M	M	M	L						M
CO 4	H	M	H	M	M	L						L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and

B18CS5070	Statistical Data analysis Lab	L	T	P	C
Duration:14 Wks		0	0	2	2

Prerequisites:

Probability and Statistics [B18CS2010]

Course Description:

This laboratory course enables students to practice different statistical techniques used in data analysis pipeline using Python. The data analysis ecosystem of Python is explored. Publicly available dataset will be downloaded for carrying out different data cleaning techniques like normalization and standardization, calculation of summary statistics, numerical and string operations on statistics. The aim of this course is to enable a student to manipulate data by application of statistical methods and derive interesting relationships and regularities among elements of data. This course will also introduce visualization tools like matplotlib and seaborn in Python. Visualization of data often helps to get a better understanding of the data. The students are expected to know how to program in any programming language. Knowledge of linear algebra, probability and statistics is a prerequisite for this lab.

Course Objectives:

1. 1. To write code for reading from various data sources and writing results back
2. To derive statistical measures from data
3. To apply regression and correlation operations on data
4. To generate plots from data

Course Outcomes:

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

CO1: Interpret statistical reasoning, modelling and limitations

CO2: Perform statistical analysis using tools and software

CO3: Demonstrate classification of datasets with supervised learning.

CO4: Build applications using PYTHON

List of Experiments:

S No	**Experiment Problem Statement** **Implementthefollowing using Python.**
1	Linear Regression: Single variable Here, the data set is in the form of a single input variable with corresponding output variable. We can use a dataset like GDP of a country v/s number of medals won in Olympics. A single linear model y = ax + b is used to fit a line to the data and thus find the parameters a & b.
2	Linear Regression: Multiple variables Here, the data set has more than one input variables and one real valued input variable. A linear function of the form y = a1x1 + a2x2 + a3x3 … + b is fitted to the data using gradient descent to arrive at optimal values of the parameters a1 , a2 … an ; b. Here, we use input variables as GDP of the country and population as the input parameters and the number of medals won in Olympics as output variable
3	Polynomial regression: Here, we use an nth degree polynomial to fit the input data to the output. A single variable input is converted to multiple variables by using the variable with different powers. Egg: Input x is converted to x, x2, x3 … an. Rest of the regression is same as multi variables linear regression. Issues of overfitting and bias are explored.
4	Ridge regression: Polynomial regression suffersfrom either underfitting (bias) oroverfitting (variance). The bias issue can be overcome by using a higher order polynomial. However, variance problem does not have a straight forward solution. We use L2 regularization for overcoming this problem, which is also called ridge regression. Essentially the cost function is modified to avoid large values of parameters.
6	Logistic regression: Single variable In case the output label is a class variable instead of a real valued variable, then, linear regression cannot be used. A logistic function in the form of a sigmoid or tank function is used. Optimization is carried out in a similar way as linear regression. Iris data set which is a standard classification dataset with only one variable as input is used for implementing logistic regression.

6	Logistic regression: Multiple variable The problem statement is similar to single variable logistic regression except that, more than one input variables are used. Here, we use IRIS database with multiple input variables for implementing logistic regression
7	Polynomial Logistic Regression: Here, a single variable input is converted to a multi variable input by raising it to different powers. Once this setup is created, rest of the problem solving is same as multi-variable logistic regression. Here, again we use the same dataset (IRIS), which is used for single variable logistic regression.
8	Logistic regression with regularization: Polynomial logistic regression suffers from overfitting if a very complex model is used. To overcome this problem, we redefine this loss function such that the parameters do not acquire large values. Implementation is similar to Ridge regression.
9	Single layer Neural Network: Neural network can be used to implement complex functions due to the non-linearity of neurons. In this experiment we use a single hidden layer of 10 neurons with softmax activation function to achieve handwritten digit classification. MNIST dataset is used as input to this Neural network.
10	Multi layer Neural Network: Multi-layer Neural networks are immensely powerful in implementing very complex functions thus enabling us to accomplish difficult classification tasks. Here we use IRIS dataset with multiple input variables to achieve the classification. The performance of this multi-layer neural network with that of logistic regression can be compared to see how Neural network achieves better accuracy compared to the logistic regression.

11	Support Vector Machine: Support Vector Machines achieve classification task by finding a decision boundary which has maximum separation from the members of each class. As SVMs use only few data points which are in the vicinity of the decision boundary they are less susceptible to over fitting. Here again we use the IRIS data set with multiple variables as input to the classification task.
12	Auto encoder: Auto encoders are unsupervised learning algorithms which take high dimensional inputs and compress them to their low dimensional representation. Here we use the MNIST handwritten digits database for training the auto encoder and find the compression we can achieve in and the accuracy of such a compression

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M	M	M	-	-	-	-	-	-	-
CO2	M	M	M	M	M	L	-	-	-	-	-	L
CO3	M	M	M	M	M	L	-	-	-	-	-	L
CO4	M	M	M	M	M	L	-	-	-	-	-	L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS5080	Computer Networks Lab	L	T	P	C
Duration :14Wks		0	0	2	2

Prerequisites:

Programming for Problem Solving [B18CS1030], Computer Organization and Architecture [B18CS4040]

Course Description:

The course description includes learning about computer network organization and implementation. This course provides knowledge of error detection and recovery,network naming and addressing; and local and remote procedures. This course also emphasis on User Datagram Protocol, TCP Congestion Control; DNS Message Formatting and Remote Login. Protocols:

Course Objectives:

The main objectives of this course are:

1. Describe the knowledge of the basic protocols involved in wired/wireless communication process.
2. Explain the key issues for the realization of errors detection and correction in Packets.
3. Discuss different network performance concepts and traffic issues for Quality of Service (QoS) in communication.
4:Illustrate concepts of classical computer and network security paradigms.

Course Outcomes:

On successful completion of this course; the student will be able to:
CO1: Make use of the knowledge of the basic protocols involved in wired/wireless communication process.
CO2: Identify the key issues for the realization of errors detection and correction in Packets.
CO3: Compare different network performance concepts and traffic issues for Quality of Service (QoS) in communication.
CO4: Assess concepts of classical computer and network security paradigms.

Lab Experiments:

SNo.	Experiment Problem Statement
1	Introduction to: (a) discrete event simulation, (b) NS 3, (c) NS 3 Installation, (d) NetAnim.
2	Write a NS3 program to connect two nodes with a point to pint link, which have unique interface. Analyze the network performance using UDP client server.
3	Write a NS 3 program to demonstrate star topology and bus topology. Analyze the performance using UDP based applications.
4	Write a NS3 program to demonstrate hybrid topology of routers and nodes. Analyze the performance using UDP based applications.
5	Write a NS3 program to implement FTP using TCP bulk transfer, Analyze the performance.
6	Write a NS 3 program to create a simple dumbbell topology, two clients and two servers, two nodes forming bridges of the dumbbell. Use point to point links. Install UDP socket instance on one of the nodes of both sides of dumbbell. Analyze the network performance by clogging the bridge capacity from half to full.
7	Write NS 3 Program to configure two nodes on an 802.11b physical layer, with802.11b NICs in adhoc mode, and by default, sends one packet of 1000 (application) bytes to the other node. The physical layer is configured to receive at a fixed RSS (regardless of the distance and transmit power); therefore, changing position of the nodes has no effect. Analyze the performance.
	Install wireshark, and analyze the packets using it on a selected interface. Apply filters and check the packets.
	Install packet tracer, and consider a topology and configure VLAN.
	Install NMAP, and execute atleast 10 commands to demonstrate the scanning of networks hosts and ports.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	L	-	-	M	-	-	-	-	-	M	-
CO 2	H	-	-	-	-	-	M	-	-	-	-	L
CO 3	H	M	-	-	M	-	M	-	-	-	-	-
CO 4	H	M	-	-	M	-	M	-	-	-	-	-

Where L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

VI Semester Syllabus

B18CS6010	Machine Learning for Data Analytics	L	T	P	C
Duration:14 Wks		3	0	1	4

Prerequisites:

Probability and Statistics [B18CS2010], Python for Data Analysis [B18CS5020]

Course Description:

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 Statristics & Data Visualization for Machine Learning.

Course Objectives:

The objectives of this course is to:

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.

Course Outcomes (Cos):

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

CO1: Make use of predictive data analytics tools to analyse the characteristics of datasets.

CO2:Choose machine learning technique and computing environment suitable for the given application.

CO3: Apply a linear regression model for the given rela world application.

CO4: Develop an application to make use of decision trees to solve the real world problem.

Course Contents:

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 Neighbour Algorithm, Handling Noisy Data, Efficient Memory Search

Data Normalization, Predicting Continuous Targets, Other Measures of Similarity Feature Selection.

Self-learning component:

Data Visualization, Bar Plots, Histograms and Box Plots.

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.

Reference books:

1. Tom M. Mitchell, Machine Learning, McGraw-Hill Education (INDIAN EDITION), 2013.
2. Ethem Alpaydin, 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; 1st edition, 2001.
4. Springer Journal of Machine Learning.
5. International Journal of Machine Learning and Computing.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	M	H	H	H	M	M	-	-	-	-	-	-
CO 2	M	H	H	H	M	L	-	-	-	-	-	-

CO 3	H	H	M	H	M	L	-	-	-	-	-	-
CO 4	H	H	H	H	H	L	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Lab Experiments (Project Based)

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

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

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/

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

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.

a. Refer the following link to download the real estate sales price of a house Data set: https://data.world/datasets/real-estate

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
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
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/
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/

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/

B18CS6020	Cloud Computing and Big Data	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites

Computer Networks [B18CS5030]

Course Description:

This course provides a hands-on comprehensive study of Cloud concepts and capabilities across the various Cloud service models including Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). It gives insight into various cloud infrastructure and management mechanisms. The introduction to Azure App Service and Web Apps is given.

Course Objectives:

The objectives of this course are to:

1. Discuss the various Cloud computing service models like Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).
2. Explain the working of cloud computing technologies like data center technology, web technology, multitenant technology and service technology.
3. Illustrate the use of various cloud computing mechanisms like load balancer, automated scaled listener, failover system and more in real world applications.
4. Describe virtualization of application and resources in Cloud scenario.

Course Outcomes (COs):

On successful completion of this course, the student is expected to be able to:

CO1. Identify basic requirements related to cloud computing technologies.

CO2. Compare and contrast different layers of cloud computing viz. Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).

CO3. Make use of Cloud management mechanisms in solving real world problems.

CO4: **Apply the** Bigdata concepts in real world applications

Course Content:

UNIT 1:

Introduction to Cloud Computing: Origins and Influences, Basic Concepts and Terminology, Goals and Benefits, Risks and Challenges.

Fundamental Concepts and Models: Roles and Boundaries, Cloud Characteristics, Cloud Delivery Models and Cloud Deployment Models.

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:

Specialized Cloud Mechanisms: Automated Scaling Listener; Load Balancer; SLA Monitor; Pay-per-use Monitor; Audit Monitor; Failover System; Hypervisor; Resource cluster; Multi-device Broker; State Management Database Cloud Management Mechanisms: Remote Administration System; Resource Management System; SLA Management System; Billing Management System.

Unit 4:

Big Data: The Data Explosion, Why is big data special?, Storing Big Data, Big Data Analytics, Big data and medicine, big data & big business, big data security and big data & society.

Self-Learning Components:

Implementation of different Cloud Service Delivery and Deployment Models.

Text Books:

1. Thomas Erl , Ricardo Puttini , Zaigham Mahmood Cloud Computing: Concepts, Technology & Architecture PHI, 2013.

2.Dawn. E. Holmes, ”Big Data- A short Introduction”, Oxford University Press, 2017.

Reference Books:

l. Dan C. Marinescu, Cloud Computing: Theory and Practice, MK, 2017.

Rajkuma rBuyya, JamesBroberg, Andrzej Goscinski, Cloud Computing- Principles and Pradigms, Wiley, 2011 by john wiley & Sons.

Gautam Shroff, Enterprise Cloud Computing- Technology, Architecture, Applications, CAMBRIDGE, 2010.

Kai Hwang, Geoffrey C. Fox, Jack J Dongarra, Distributed and Cloud Computing,MK,20l2

Michael Collier, Robin Shahan, Fundamentals of Azure-Microsoft Azure Essentials, Microsoft Press, 2nd Edition,20l6.

Neil Peterson, Get started guide for Azure IT operators, Microsoft,20l6.

Roberto Brunetti, Windows Azure-Step by Step, Oreilly Media,20ll.

Journal of Cloud Computing -Advances, Systems and Applications, Springer Open.

International Journal of Cloud Computing, INDERSCIENCE Publishers. l0. IEEE Transactions on Cloud Computing

ll. International Journal of Cloud Applications and Computing (IJCAC), IGI Global.

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	PO11	PO12
CO1	H	H	H	H	M	-	-	-	-	-	-	-
CO2	H	H	H	H	M	-	-	-	-	-	-	-
CO3	H	H	H	H	M	-	-	-	-	-	-	-
CO4	H	H	H	H	M	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6031	**Signal Processing with SCILAB**	**L**	**T**	**P**	**C**
Duration:14 Wks		**3**	**0**	**0**	**3**

Prerequisites:

Multivariable calculus and Linear algebra(B18CS1010)

CourseDescription:

This course provides insight into fundamentals of Continuous and Discrete-time signals and systems, their properties and representations, understanding of signal representation in Frequency domain, discrete Fourier transform and its properties. It introduces fast Fourier transform and finite impulse response filter designing. It analyses infinite impulse response filter designing.

Course Objectives:

1. Explain the Discrete Fourier Transform (DFT)properties.
2. Describe algorithms to compute DFT & IDFT, FFT MATLAB commands.
3. Enumerate various characteristics of commonly used analog filters
4. Discuss various Designs of FIR Filters and Digital Filter Structures.

Course Outcomes

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

CO1: Make use of discrete Fourier transform to represent signal in frequency domain.

CO2: Identify and solve signal representation problems using DFT properties with fast Fourier transforms using radix-2 form.

CO3: Design IIR filters in analog domain and linear phase FIR filters using windows.

CO4: Apply the frequency transformation techniques in real world applications.

Content:

Unit-1:

Discrete Fourier Transforms & its properties: The Discrete Fourier Transform (DFT)- Definition & Concept, and Properties of DFT: Periodicity, Linearity, and Symmetry Properties, Circular Convolution, Additional DFT Properties. Problems. DFT SCILAB commands

Unit -2:

FastFourierTransformAlgorithms: A linear filtering approach based on DFT, Filtering of long data sequences using overlap - add method, direct computation of the DFT, efficient computation of the DFT, FFT algorithms: Radix-2DIT-FFT,DIF-FFT algorithms to compute DFT & IDFT, FFT SCILAB commands.

Unit -3:

Design of IIR Filters: Characteristics of commonly used analog filters, design of Butterworth and Chebyshevanalog filters. Frequency transformations in the analog domain, design of digital IIR Butterworth. IIR MATLABcommands.

Unit -4:

Design of FIR Filters and Digital Filter Structures: Introduction to Linear-phase FIR filters, Symmetric and Anti-symmetric FIR Filters, Design of Linear phase FIR filters using windowing technique: Rectangular, Hamming & Kaiser windows. Design of Linear phase FIR filters by frequency sampling method. Implementation of FIR digital filters: Frequency sampling structures, direct form-I Linear phase structures, Implementation of IIR digital filters: Direct form-I & Direct form-II structures, filter SCILAB commands.

Self-learning component:

Implement the above using Scilab and Octave instead of Matlab.

Textbooks:

1. Proakis&Monalakis,"Digitalsignalprocessing-PrinciplesAlgorithms&Applications",PHI, 4thEdition, New Delhi, 2007.
2. SanjitKMitra,"DigitalsignalLaboratoryusingMATLAB",MGHEd.2000.
3. Ashok Ambardar, "Digital signal processing: A modern Introduction", CengageLearning, 2009.

Reference books:

1.Oppenheim & Schaffer, "Discrete Time Signal Processing", PHI,2003.

2.S.K.Mitra, "Digital Signal Processing", Tata Mc-Graw Hill, 2nd Edition,2004.

Mapping Cos with POs(Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	-	-	H	-	L	-	L	-	-	-
CO2	M	H	-	L	-	-	M	-	-	-	-	-
CO3	M	-	L	-	-	M	-	L	-	-	-	-
CO4	H	M	-	-	H	L	-	M	L	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6032	Principles of Programming languages	L	T	P	C
Duration:14 Wks		3	0	0	3

Pre-requisites

JavaScript, Ruby, Python (B18CS5020), Java(B18CS3030), C++ (B18CS2030), Data Structures(B18CS3040), Design and Analysis of Algorithms(B18CS4010), and Finate automata and Formal Languages(B18CS5010).

Course description:

The course is aimed at introducing the student with the general concepts common to all programming languages so as to make them learn new languages. The course describes overview of Compilation Programming Language Syntax , Specifying Syntax, Scanning, Parsing, Theoretical Foundations, Semantic Analysis,Core Issues in Language Design, Type Systems.

Course Objectives

The objectives of this course are to:

1. Explain the fundamentals of programming languages design and implementation.
2. Describe Names, Scopes, and Bindings of objects, variables.
3. Discuss various machine architectures and issues in language design.
4. Illustrate the use of Composite Types, Records (Structures), Arrays, Strings, Sets, Pointers and Recursive Types, Lists, Files and Input/Output structures, data abstraction.

Course Outcomes

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

CO1: Utilize the fundamentals of programming languages to implement real world applications.

CO2: Compare Scopes, and Bindings of various objects and variables used in given real world application.

CO3: Identify the issues in language design based on target machine architecture**.**

CO4: Develop real world applications using type systems.

Course Content:

Unit 1:

Introduction: The Art of Language Design, The Programming Language Spectrum, Why Study Programming Languages? Compilation and Interpretation, Programming Environments, An Overview of Compilation

Programming Language Syntax : Specifying Syntax, Scanning, Parsing, Theoretical Foundations

Unit 2:

Names, Scopes, and Bindings:

The Notion of Binding Time, Object Lifetime and Storage Management, Scope Rules, Implementing Scope,The Meaning of Names Within a Scope, The Binding of Referencing Environments, Macro Expansion, Separate Compilation

Semantic Analysis: The Role of the Semantic Analyzer, Attribute Grammars,Evaluating Attributes, Action Routines, Space Management for Attributes, Bottom-Up Evaluation, Top-Down Evaluation, Tree Grammars and Syntax Tree Decoration

Unit 3:

Target Machine Architecture: The Memory Hierarchy, Data Representation, Instruction Set Architecture (ISA), Architecture and Implementation, Compiling for Modern Processors

Core Issues in Language Design: Control Flow, Expression Evaluation, Structured and Unstructured Flow, Sequencing, Selection, Iteration, Recursion, Nondeterminancy

Unit 4:

Type Systems: Overview, Type Checking, Parametric Polymorphism, Equality Testing and Assignment, Composite Types, Records (Structures), Arrays, Strings, Sets, Pointers and Recursive Types, Lists, Files and Input/Output Subroutines and Control Abstraction, Review of Stack Layout, Calling Sequences, Parameter Passing, Exception Handling, Coroutines, Events Data Abstraction and Object Orientation: Object-Oriented Programming, Encapsulation and Inheritance, Initialization and Finalization, Dynamic Method Binding, Mix- in Inheritance, True Multiple Inheritance,Object-Oriented Programming Revisited

Self-Learning: Alternative Programming Models, Functional Languages, Logic Languages, Concurrency, Scripting Languages.

Text books:

1. Michael L. Scott , “Programming Language Pragmatics” 4th Edition, Morgan Kaufmann Publishers ,

2. Robert W. Sebesta , “Concepts of Programming Languages”, 11th Edition , University of Colorado, Colorado Springs ©2016 |Pearson

3. R. Toal, R. Rivera, A. Schneider, and E. Choe, “Programming Language Explorations”, CRC Press, 2017.

Reference Books:

1.M Hennessey, The Semantics of Programming Languages, John Wiley, 1990.

2. IEEE, IEEE Transactions on Computers.

3. Elsevier, Computer Languages, Systems and Structures.

4.Springer, Journal of Logic, Language and Information.

5.ACM, ACM Transactions on Programming Languages and Systems (TOPLAS).

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	M	M	M	-	-	L	-	-	L	L
CO2	L	M	L	L	M	-	-	L	-	-	-	-
CO3	L	M	M	M	L	-	-	L	-	-	L	-
CO4	L	M	M	M	H	-	-	L	-	-	-	

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6033	Compiler Design	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Finite Automata and formal languages (B18CS5010)

Course Description:

The Course intends to make students learn the techniques needed for compiler construction and also develops analytical skills. The course is conceptual.

Course Objectives:

1. Explain the concepts of Object-Oriented programming, Object-Relational Databases and Compilers.
2. Describe how syntax tree can be constructed to check the syntax of the given input.
3. Discuss different types of parsers and syntax directed definition and translation.
4. Demonstrate how code optimization and code generation is done for a given source code.

Course Outcomes (Cos):

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

CO1: Identify the lexical, syntactic and semantic analysis into meaningful phases for a compiler to translate statements of source language.

CO2: Experiment the knowledge of different parsers by constructing the top down and SLR parsers.

CO3: Make use of different types of parsers and syntax directed definition and translation to check the syntax of the given input.

CO4: Develop the code optimization and code generation for a given source code.

Course Content:

Unit- 1

Introduction to Compilers: Language processors; the structure of a Compiler;

Lexical analysis: Tokens, Regular expressions, Finite state automata, translating regular expressions into finite state automata;

Unit -2

Syntax analysis 1: Context-free grammars, Derivations and syntax trees, Handling ambiguous grammars, Top-down parsing, Bottom-up parsing - SLR( );

Unit- 3

Syntax Analysis 2: More powerful LR Parsers;

Syntax-directed translation: Syntax-directed definitions; Evaluation orders for SDDs; Applications of syntax-directed translation; Parser stack implementation of Postfix SDT;

Unit- 4

Code optimization and generation: Basic blocks and Flow graphs; Optimization of basic blocks;

Intermediate code generation: Variants of syntax trees; Three-address code; Control flow; back patching;

Self-learning component:

More Recent Applications: translating regular expressions into finite state automata; survey of latest compilers for dealing with parallel programming.

Text books:

1. A. V. Aho, R. Sethi and J. D. Ullman, Compilers - Principles, Techniques, and Tools, Addison-wesley, Pearson Education, 2001.

2. Charles N. Fischer, Richard J. leBlanc, Jr., Crafting a Compiler with C, Pearson Education, 1991.

3. Kenneth C Louden, Compiler Construction Principles & Practice, Cengage Learning, 1997.

Reference books:

1. A.W. Appel, Modern Compiler Implementation in Java, Cambridge University Press, 2002.
2. IEEE, IEEE Transactions on Computers.
3. Elsevier, Computer Languages, Systems and Structures.
4. Springer, Journal of Logic, Language and Information.
5. ACM, ACM Transactions on Programming Languages and Systems (TOPLAS).

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M	L	L	-	-	-	-	-	L	L
CO2	M	M	M	L	L	-	-	-	-	-	L	L
CO3	M	M	M	L	L	-	-	-	-	-	L	L
CO4	M	M	M	L	L	-	-	-	-	-	L	L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6034	Artificial Intelligence	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Programming for Problem solving [B18CS1030]

Course Description:

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 Objectives

The objectives of this course are to:

1. Discuss the basics of Artificial Intelligence (AI).
2. Illustrate knowledge representation issues and methods
3. Explain planning methods/algorithms in problem solving
4. Demonstrate various learning methods for constructing knowledge.

Course Outcomes (Cos):

At the end of the course, the students shall be able to:

CO1: Explain basics of Artificial Intelligence and AI search strategies.

C02: Represent knowledge using logic and apply reasoning methods

CO3: Construct plans using agent technology for solving problems.

C04: Employ learning and reasoning methods in programs for constructing the Knowledge.

Course Contents:

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:

Learning: Learning from observations; Inductive learning; A general model of learning agents; Learning decision trees; Using information Theory, Learning general logical descriptions; Computational learning theory, Reinforcement learning; Passive learning in a known environment, passive learning in Unknown environment; Examples: Connection to server, creating database, selecting a database; Active learning in an unknown environment; Neural Networks; Applications of Neural Networks

Self-Learning Components:

PEAS (Performance, Environment, Actuators and Sensors) for Agents ,Genetic Algorithm,Distributed Agents,Wumpus World game (Understanding the game and applying planning and learning rules),Bioinformatics.

Recommended Learning Resources (Text books):

1. Russell & Norvig: Artificial Intelligence: A Modern Approach, Third Edition, Prentice-Hall, 2010.
2. Elaine Rich, Kevin Knight: Artificial Intelligence, 3rdedition, TataMcgraw Hill, 2009.
3. Timothy J. Ross: Fuzzy Logic with Engineering applications: Third Edition, 2010

Recommended Learning Resources (Reference books):

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.*

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	L	H	-	-	-	-	-	-	-
CO2	H	H	H	M	H	-	-	-	-	-	-	-
CO3	H	M	H	H	H	-	-	-	-	-	-	-
CO4	H	M	M	M	M	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6035		L	T	P	C
Duration:14 Wks	Computer Design with Verilog	3	0	0	3

Prerequisites:

Digital Logic Design [B18CS3010]

Course Description:

This course aims to provide students with the understanding of the different technologies related to HDLs, construct, compile and execute Verilog HDL programs using provided software tools. Design digital components and circuits that are testable, reusable, and synthesizable.

Course Objectives (Cos):

The objectives of this course is to:

1: Illustrate Verilog hardware description languages (HDL).

2: Discuss digital circuits required for various applications.

3: Explain the verification of Behavioral and RTL models.

4: Describe Synthesizing RTL models to standard cell libraries and FPGAs

Course Outcomes (Cos):

On successful completion of this course, the student will be able to:

CO1: Make use of Verilog hardware description languages (HDL) for Gate Level Modeling

CO2: Design digital circuits using Verilog for real world applications.

CO3: Make use of Shift registers and counters to constructs Verilog.

CO4: Develop Verilog code using Moore and mealy models for realizing Serial Adder.

Course Content:

UNIT -1

ASIC Design Flow, Introduction to Verilog, Language Constructs and Conventions in Verilog, Gate Level Modeling, Architecture of FPGA.

UNIT -2

Modeling at Data Flow Level, Continuous Assignment Structures, Delays and Continuous Assignments, Assignment to Vectors, Operators, Verilog for combinational Circuits, Design of Adder, Subtractor, Decoders, Encoders, Multiplexer, code Converter.

UNIT -3

Behavioral Modeling: Operator and Assignments, Functional Bifurcation, Initial & Always Construct, Assignments with Delays, wait construct, Multiple always blocks, If and if-else, assign-deassign, repeat Construct, Loop Construct: for, while& forever, Parallel blocks, force- release construct, event Design of Flip flop, Shift register and Counters using Verilog.

UNIT -4

Functions, Tasks, user defined primitives, State Machine: Moore and mealy state model, Verilog code for Moore-type FSM, Specification of Mealy FSM using Verilog, Mealy-type and Moore-type FSM for Serial Adder.

Self-Learning Component:

Mealy-type and Moore type FSM for Serial Adder.

Text books:

1. S. Brown & Z. Vransesic, Fundamental of digital Logic with Verilog design, TMH, 2002
2. T.R. Padmanabhan& B. Bala Tripura Sundari, Design through Verilog HDL, Wiley Publcations, 2009

Reference Books:

1. Frank Vahid, Digital Design, Wiley, 2006.
2. M. Ercegovac, T. Lang and L.J. Moreno, Introduction to Digital Systems, Wiley, 2000.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	H	H	M	M	-	-	-	-	-	-	-
CO 2	H	H	M	H	M	-	-	-	-	-	-	-
CO 3	H	H	M	H	M	-	-	-	-	-	-	-
CO 4	H	H	H	H	H	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6041	Digital Image Processing	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Signals and Systems [B18CS4051]

Course Description:

The course covers fundamentals of digital image processing, and various image Transforms, Image Enhancement Techniques, Image restoration Techniques and methods, image compression and Segmentation used in digital image processing.

Course Objectives:

The objectives of the course are.

1. Discuss the fundamental steps of Image Processing
2. Explain different filtering operations in spatial domain for smoothening and sharpening the images
3. Describe the concept of Image restoration.
4. Inculcate knowledge about image compression and color employ image processing techniques for various applications.

Course Outcomes:

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

CO1: Make use of the fundamental steps in digital Image Processing for Zooming and Shrinking Digital Images.

CO2: Utilze different filtering operations in spatial and frequency domain for smoothening and sharpening the images.

CO3: Develop real world applications using Filtering techniques for image enhancement and restoration.

CO4: Apply colour image processing, image compression and image segmentation in real world applications.

Course Content:

UNIT -1

Introduction: What is Digital Image Processing, Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, and Components of an Image Processing System. Digital Image Fundamentals: Elements of Visual Perception, A Simple Image Formation Model, Basic Concepts in Sampling and Quantization, Representing Digital Images, Spatial and Gray-level Resolution, Zooming and Shrinking Digital Images, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations.

UNIT -2

Image Enhancement in the Spatial Domain: Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods. Image Enhancement in the Frequency Domain: Introduction to the Fourier Transform and the Frequency Domain, Smoothing Frequency- Domain Filters, Sharpening Frequency- Domain Filters, Holomorphic Filtering.

UNIT -3

Image Restoration: A Model of the Image degradation/Restoration process, Noise Models, Restoration in the Presence of Noise Only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Square Filtering, Geometric Mean Filter.

UNIT -4

Color Fundamentals: Color Models, Pseudo color Image Processing, Basics of Full- Color Image Processing, Color Transformations, Smoothing and Sharpening, Color Segmentation, Noise in Color Images, Color Image Compression. Morphological Image Processing: Preliminaries, Dilation and Erosion, Opening and Closing, the Hit-or-Miss Transformation, Some Basic Morphological Algorithms. Image Segmentation: Detection of Discontinuities, Edge Linking and Boundary Detection,

Self-Learning Component:

Thresholding, Region-Based Segmentation.

Text books:

1. Gonzalez and Woods, Digital Image Processing ,2nd Edition, Prentice Hall,2008

2.Anil.K.Jain ,Fundamentals of Digital image processing,Prentice Hall,2004.

References:

1.Alasdair Mc Andrew; Introduction to Digital Image Processing; Cengage learning; 2009.

2.J. G. Proakis; Introduction to Digital Signal Processing; PHI.

3IEEE transactions on image processing

4.ACM Transactions on image processing

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	H	H	H	L	L				
CO2	H	H	M	H	H	L						
CO3	H	H	M	H	H	L						
CO4	H	H	M	H	H	H	H	M				L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6042	Advanced Java Programming	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Programming with Java [B18CS3030], Data Structures [B18CS3040].

Course Description:

This course intends to provide a clear understanding of each of the topics of Advanced Java Programming. The course covers advanced concepts of JAVA programming JSP, Servlets, Networking and database programming, Advanced GUI, Java Beans and Distributed Objects. The course also introduces students to advanced research topics. Students are expected to do independent reading of research papers and make class presentations.

Course Objectives:

The objectives of the course are to:

1. Explain the concepts required for developing the web applications using JSP and Servlets.
2. Demonstrate the use of networking and databases in real world applications.
3. Illustrate the development of GUI programs using Swings and AWT concepts.
4. Discuss the use of Java Beans and distributed objects in real world applications.

Course Outcomes (COs):

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

CO1 Develop Web page using JSP and Servlets for real world applications.

CO2 Make use of networking concepts to design a socket to connect to a HTTP server, and database concepts to demonstrate SQL queries.

CO3 Develop GUI Programs to create a login screen using Swings and AWT concepts.

CO4 Build a simple calculator application using Java Beans and web service using JAX-WS for accessing information from the web server.

Course Content:

Unit - 1

JSP and Servlets: JSP: Introduction, Jsp Life Cycle, Jsp Implicit Objects & Scopes, Jsp Directives, Jsp Scripting Elements, Jsp Actions, JSTL & Tag Library; Servlets: Introduction, Web application Architecture, Http Protocol & Http Methods, Web Server & Web Container, Servlet Interface, GenericServlet, HttpServlet, Servlet Life Cycle, ServletConfig, ServletContext, Servlet Communication-Servlet-Browser communication, Web-component Communication, Servlet-Applet Communication, Session Tracking Mechanisms, Filters & Wrappers, Listeners, Web-Security;

Unit -2

Networking and Database Programming: Networking: Connecting to a Server, Implementing servers, Interruptible Sockets, Sending Email, Making URL Connections; Database Programming: The Design of JDBC, SQL, JDBC Configuration, Executing SQL statements, Query Execution, Result sets, row sets, Metadata, Transactions, Connection Management in Web and Enterprise Applications, Introduction to LDAP.

Unit - 3

Advanced Swings and AWT: Advanced Swings: Lists, Tables, Trees, Text Components, Progress Indicators, Components Organizers; Advanced AWT: The Rendering Pipeline, Shapes, Areas, Strokes, Paint, Coordinate Transformations, Clipping, Transparency and Composition, Readers and Writers for Images, Image Manipulation, Printing, Clip Board, Drag and Drop, Platform Integration,

Unit - 4

Java Beans and Distributed Objects: Bean- Writing Process, Using Beans to Build and Application, Naming Patters for Bean Properties and Events, Bean Info Classes, Property editors, Customizers, JavaBean Persistence; Distributed Objects: Remote Method Calls, The RMI Programming Model, Parameters and Return Values in Remote Methods, Remote Object Activation, Web Services and JAX-WS.

Self-learning component:

File handling and Extended Mark-up Language (XML).

Text Books:

1.Steven Holzner, Java Black Book, Black Group Books, 2000

2.Uttam K Roy, Advanced Java Programming, Oxford Press, 2015.

3.Joe Wigglesworth and Paula McMillan, Java Programming: Advanced Topics,3rd edition, Thomson Press, 2003.

Reference books

1. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Data Structures and Algorithms in Java, 6th Edition, Wiley, 2014.

2. Robert Lafore, Data Structures and Algorithms in Java, 2nd Edition, Sams, 2002

3Danny Poo; Object-Oriented Programming and Java; Second Edition; Springer; 2008

4.H.M.Dietel and P.J.Dietel; Java How to Program; Sixth Edition; Pearson Education/PHI

5. Cay.S.Horstmann and Gary Cornell; Core Java 2, Vol 1, Fundamentals; Seventh Edition; Pearson Education/PHI

6. Cay.S.Horstmann and Gary Cornell; Core Java 2, Vol 2, Advanced Features; Seventh Edition; Pearson Education/PHI.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	-	H	H	H	-	-	-	-	-	-	-
CO2	H	L	M	M	H	-	-	-	-	-	-	-
CO3	H	L	H	H	H	-	-	-	-	-	-	-
CO4	H	L	H	H	H	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6043	Data Mining and Warehousing	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Database Management systems (B18CS4030)

Course Description:

Data warehousing and data mining are two major areas of exploration for knowledge discovery in databases. Data mining is for relatively unstructured data for which more sophisticated techniques are needed. The course aims to cover powerful data mining techniques including clustering, association rules. It then teaches high volume data processing mechanisms by building warehouse schemas such as snowflake, and star.

Course Objectives

The objectives of this course are to:

1. Describe the basic concepts of Data Warehouse and Data Mining techniques.
2. Illustrate the processing of raw data to make it suitable for various data mining algorithms.
3. Explain the measurement of interesting patterns in different databases
4. Discuss the techniques of clustering, classification, association finding, feature selection and visualization to real world data.

Course Outcomes (Cos):

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

CO1: Outline the basic concepts of Data Warehouse and Data Mining techniques.

CO2: Make use of preprocessing techniques to process raw data to make it suitable for various data mining algorithms.

CO3: Solve classification problems using by identifying suitable machine learning algorithm.

CO4:. Apply the techniques of clustering to cluster real world data.

Course Contents:

Unit - 1

Data Warehousing: Introduction, Operational Data Stores (ODS), Extraction TransformationLoading (ETL), Data Warehouses, Design Issues, Guidelines for Data Warehouse Implementation, Data Warehouse Metadata, Online Analytical Processing (OLAP): Introduction, Characteristics of OLAP systems, Multidimensional view and Data cube.

Unit -2

Data Mining: What is Data Mining? Motivating Challenges, The origins of data mining, Data MiningTasks, Types of Data, Data Quality, Data Pre-processing, Measures of Similarity and Dissimilarity, Data Mining Applications, Visualization

Unit – 3

Association Analysis: Basic Concepts and Algorithms, Frequent Itemset Generation, RuleGeneration, Compact Representation of Frequent Itemsets, Alternative methods for generating Frequent Itemsets, FP GROWTH Algorithm, Evaluation of Association Patterns .

Unit – 4

Clustering: Clustering Techniques: Overview, Features of cluster analysis, Types of Data andComputing Distance, Types of Cluster Analysis Methods, Partitional Methods, Hierarchical Methods, Density Based Methods, Quality and Validity of Cluster Analysis.

Self-learning component:

Decision Trees, Rule Based Classifiers, Nearest Neighbour Classifiers.

Text books:

1.A Pang-Ning Tan, Michael Steinbach and Vipin Kumar, “Introduction to Data Mining”, Pearson Education, 2007.

2.Jiawei Han and MichelineKamber, “Data Mining Concepts and Techniques” Second Edition, Elsevier, Reprinted 2008.

R**eference books:**

1.K.P. Soman, ShyamDiwakar and V. Ajay, “Insight into Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2006.

2. G. K. Gupta, “Introduction to Data Mining with Case Studies”, Easter Economy Edition, Prentice Hall of India, 2006.

3. Data Mining and Knowledge Science – Springer.

4Inderscience,The International Journal ofDataMining, Modelling and Management-

5.IEEE, IEEE Transactions on Knowledge and Data Engineering.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M	M	M	-	-	-	-	-	-	-
CO2	M	M	M	M	M	L	-	-	-	-	-	L
CO3	M	M	M	M	M	L	-	-	-	-	-	L
CO4	M	M	M	M	M	L	-	-	-	-	-	L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6044	System Modeling and Simulation	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:

Probability and Statistics (B18CS2010).

Course Description:

System modelling is a process of development of a model for a real world operation. Model is built to check the feasibility of implementation of the real world applications. Simulation is the imitation of the operation of a real world system that gives information about the system being investigated. . The system may be electrical, electronic, industrial, and chemical. The activities of the model consist of events, or inputs and outputs, which are activated at certain points in time and in this way affect the overall state of the system.

Course Objectives:

Objectives of this course are to:

1. Explain the concept of simulation along with single channel and multichannel queuing system.

2. Illustrate the working of discrete event system and manual simulation with respect to event scheduling algorithm.

3. Discuss random number generation and variates with different testing techniques.

4. Describe how to model, calibrate, verify and validate a software model along with simulation

Course Outcomes (Cos):

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

CO1 Make use of the simulation tools in real world applications.

CO2 Analyse the concept of scheduling w.r.t time and events simulation analysis.

CO3 Develop an application program for generation of random numbers and random variates using different techniques.

CO4 Compare Verification and Validation of simulation models for given real world data.

Course Content:

UNIT- 1

Introduction to Simulation: Simulation, Advantages, Disadvantages, Areas of application, System environment, components of a system, Model of a system, types of models, Discrete Event system simulation, steps in a simulation study. Simulation Examples: Simulation of Queuing systems, Simulation of Inventory System.

UNIT -2

General Principles: Concepts in discrete - event simulation, event scheduling/ Time advance algorithm, simulation using event scheduling, list processing.

Statistical models in simulation: Review of terminology and concepts; Useful statistical models, Discrete distribution: Bernoulli distribution, Binomial distribution, Geometric and Poisson distribution. Continuous distribution: Uniform distribution, Exponential distribution and normal distribution.

UNIT- 3

Random Numbers: Properties, Generations methods, Tests for Random number- Frequency test, Runs test, Autocorrelation test.

Random Variate Generation: Inverse Transform Technique- Exponential, Uniform distributions, direct transformation for Normal and log normal Distributions, convolution methods- Erlang distribution, Acceptance Rejection Technique.

UNIT- 4

Analysis of Simulation Data

Input Modelling: Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis.

Verification and Validation of Model: Model Building, Verification, Calibration and Validation of Models.

Self-learning component:

Types of simulations with respect to output analysis;Output analysis for terminating simulations; Output analysis for steady-state simulations.

Text books:

1. Jerry Banks, John S. Carson II, Barry L. Nelson,David M. Nicol, Discrete-Event System Simulation,Pearson Education, 4th Edition, 2007.

2. Lawrence M. Leemis, Stephen K. Park,Discrete – Event Simulation: A First Course Pearson Education/ Prentice-Hall India, 2006.

References:

1. Geoffrey Gordon, System Simulation, Prentice Hall publication, 2nd Edition, 1991
2. Averill M Law, W David Kelton, Simulation Modelling & Analysis, McGraw Hill International Editions
– Industrial Engineering series, 4th Edition.
3. Narsingh Deo, Systems Simulation with Digital Computer, PHI Publication (EEE), 3rd Edition, 2004

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
CO1	H	M	M	L	M							
CO2	H	M	M	L	M							
CO3	H	L	H	M	M							
CO4	H	L	M	M	H							

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6045	Research Methodology	L	T	P	C
Duration :14Wks		4	0	0	4

Pre-Requisites:

Fundamental knowledge in C/C++, Java & MS-World

Course Description:

This course offers "An overview of research methodology including basic concepts employed in quantitative and qualitative research methods. Includes computer applications for research. This course introduces research methods as they apply to the higher education (HIED) field of study. HIED 695 provides a macroperspective of the methods associated with conducting scholarly research in all follow-on core, elective, quantitative and qualitative courses; and the doctoral dissertation. Completion of HIED 695 is a prerequisite for follow-on tools courses.

Course Objectives:

The objectives of this course are to:

1. Discuss the dimensions and methods of research.
2. Design an informed choice from the large number of alternative methods and experimental designs available
3. Enable the student to present a good research proposal.
4. Explain the knowledge and skills required for undertaking a research project, for presenting a conference paper and for writing a scientific article.

Course Outcomes:

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

CO1: Make use of the dimensions and methods of research for solving real world problems

CO2: Identify the appropriate research problem and parameters to carry out the research work

CO3: Apply different research skills in preparing proposal for research project and technical paper.

CO4: Create IPR documents using Latex Tool.

Course Content:

Unit - 1:

Research Methodology: An Introduction - meaning of research - objectives of research - motivation in research - types of research - research approaches - significance of research - research methods versus methodology - research and scientific method - importance of knowing how research is done - research processes - criteria of good research (Kothari)

Defining research problem: selecting the problem - necessity of defining the problem - techniques involved in defining a problem. (Kothari)

Unit - 2:

Research design: Meaning of research design - need for research design - features of good design - different research designs - basic principles of experimental design. (Kothari)

Originality in Research- research skills - time management - role of supervisor and scholar - interaction with subject experts. (Oliver, Stephen Covey, Slides from Net)

Review of Literature Description: Review of Literature: Significance of review of literature - source for literature: books -journals - proceedings - thesis and dissertations - unpublished items. On-line Searching: Database - SciFinder - Scopus - Science Direct - Searching research articles - Citation Index - Impact Factor - H-index etc, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self- Plagiarism. (Slides from net)

Thesis Writing: The preliminary pages and the introduction - the literature review - methodology - the data analysis - the conclusions - the references (in IEEE and ACM format). (Oliver, Slides from Net)

Unit - 3:

Data Collection and Preparation: Sample surveys, sampling errors, types of sampling designs, experiment and surveys, collection of primary data and secondary data, methods, data preparation process, outliers, analysis, statistics. (Kothari)

Descriptive Statistics: measures of central tendency, dispersion, skewness, relationship, kurtosis, sampling distribution, central limit theorem, statistical inference (Kothari)

Introduction to Tools used in Computer Science: MATLAB, NS2/3, C, C++, Java, Web Service, SPSS, SAS, LOTUS, Excel, Latex and Ms Word. (From net)

Unit - 4:

Testing hypothesis: Concepts, testing, critical region, decision, and hypothesis testing for mean proportion and variance, limitations, chi-square test, one-way ANOVA. (Kothari)

Linear Regression Analysis: Simple model, multiple model and T-test. (Kothari)

LaTeX and Beamer Description: Writing scientific report - structure and components of research report - revision and refining' - writing project proposal - paper writing for international journals, submitting to editors - conference presentation - preparation of effective slides, pictures, graphs - citation styles. Software for detection ofPlagiarism. IPR and Patent filing.

Note: Every batch of students comprising maximum of 4 members should define a research problem. Develop solution for the problem. Write a technical paper and publish it in IEEE/reputed conference/ Journal.

Text Books:

1. C. R. Kothari, Research Methodology Methods and Techniques, 2nd. ed. New Delhi: New Age International Publishers, 2009.

2. R. Panneerselvam, Research Methodology, New Delhi: PHI, 2005.

3. P. Oliver, Writing Your Thesis, New Delhi:Vistaar Publications, 2004.

4. F. Mittelbach and M. Goossens,The LATEX Companion, 2nd. ed. Addison Wesley, 2004.

Reference Books:

1. J. W. Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 3nd. ed. Sage Publications, 2008.

2. Kumar, Research Methodology: A Step by Step Guide for Beginners, 2nd. ed. Indian: PE, 2005.

3. B. C. Nakra and K. K. Chaudhry, Instrumentation, Measurement and Analysis,2nd. ed. New Delhi: TMH publishing Co. Ltd., 2005.

4. I. Gregory, Ethics in Research, Continuum, 2005.

5. COLIN NEVILLI, " The complete guide to referencing and avoiding plagiarism" , Second Edition published by Open Up Study Skills.

6. RUDRA PRATAP , " Getting Started with MATLAB " , published by Oxford University Press-2010

7. TEERAWAT, ISSARIYAKUL, EKRAM, HOSSAIN – 2008 , "Introduction to Network Simulator NS2"

8. https://www.stir.ac.uk/media/services/registry/quality/BookofPlagiarism.pdfceur-ws.org/Vol-706/poster22.pdf

9. https://books.google.co.in/books?isbn=1446281094

10. www.nalsarpro.org/pl/projects/modelproject2.pdf

11. www.uninova.pt/cam/teaching/SRMT/SRMTunit11.pdf

12. http://matlab_tools.myetang.com/index_e.htm

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	M	-	-	-	-	-	-	H	-	-	H
CO 2	M	M	-	L	H	-	-	-	M	-	-	M
CO 3	H	H	-	-	-	-	-	-		-	-	-
CO 4	H	H	-	M	-	-	-	-	H	-	-	-

B18CS6051	Pattern Recognition	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Linear Algebra(B18CS1010)

Course Description:

The course provides an overview of the theory, principles and algorithms used to construct high performance information processing systems that learn from experience. The course discusses main and modern concepts for model selection and parameter estimation in recognition, decision making and statistical learning problems.

Course Objectives:

The objectives of the course are to;

1. Explain pattern recognition concepts and its applications.

2. Discuss various mathematical models required for pattern recognition tasks.

3. Describe the nearest neighbour classifier and bayes classifier

4. Demonstrate the supervised and unsupervised tasks

Course Outcomes(Cos):

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

CO1: Identify the areas where Machine Learning can offer a solution to Pattern Recognition.

CO2: Apply probability and data set to evaluate the pattern recognition features.

CO3: Make use of data structures representation and classifier algorithms to solve pattern recognition problems.

CO4: Develop algorithms for applications involving Pattern Recognition.

Course Contents:

Unit- 1

Introduction: Definition of PR, Applications, Datasets for PR, Different paradigms for PR, Introduction to probability, events, random variables, Joint distributions and densities, moments. Estimation minimum risk estimators, problems.

Unit -2

Representation: Data structures for PR, Representation of clusters, proximity measures, size of patterns, Abstraction of Data set, Feature extraction, Feature selection, Evaluation.

Unit- 3

Nearest Neighbor based classifiers & Bayes classifier: Nearest neighbor algorithm, variants of NN algorithms, use of NN for transaction databases, efficient algorithms, Data reduction, prototype selection, Bayes theorem, minimum error rate classifier, estimation of probabilities, estimation of probabilities, comparison with NNC, Naive Bayes classifier, Basyessian belief network.

Unit- 4

Decision Trees: Introduction, DT for PR, Construction of DT, Splitting at the nodes, Over-fitting & Pruning, Examples.

Self-learning component:

Clustering: Hierarchical (Agglomerative, single/complete/average linkage, wards, Partitional (Forgy's, k-means, Iso-data), clustering large data sets, examples.

Text books:

1. Pattern Recognition (An Introduction) , V Susheela Devi, M Narsimha Murthy, Universities Press, ISBN 978-81-7371-725-3,2011.

2. Pattern Recognition & Image Analysis, Earl Gose, Richard Johnsonbaugh, Steve Jost. PHI ISBN-81-203-1484-0, 1996

Reference books:

1. Duda R. O., P.E. Hart, D.G. Stork., Pattern Classification, John Wiley and sons, 2000.

2. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009

3. C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes												
	P01	P02	P03	P04	P05	P06	P07	P08	P08	P09	P10	P11	P12
CO1	H	H	M	M	L	-	-	-	-	-	-	-	-
CO2	H	H	M	H	L	-	-	-	-	-	-	-	-
CO3	H	H	H	M	L	-	-	-	-	-	-	-	-
CO4	H	M	M	L	M	-	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6052	Text and Web Mining	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Probability and statistics [B18CS2010] and Database Management System [B18CS4030].

Course Description:

This course in web and text data mining covers basic concepts and techniques of the data mining and application of these techniques in text data and web data for various types of analysis. The course also introduces some research topics which can be used for implementation in projects.

Course Objectives:

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.

Course Outcomes:

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

CO1: Choose the Data mining techniques to extract data from given dataset.

CO2: Apply appropriate classification algorithm to analyze the given data.

CO3: Identify suitable Web Mining technique to perform social network analysis.

CO4: Design web crawlers for information retrieval from web.

Course Content:

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, Stoplist 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, LogitBoost, 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.

S**elf-learning component:**

PageRank for Social network analysis and Focused Crawlers

Text books:

1. Michael W. Berry and Jacob Kogan, Text Mining: Applications and Theory, Wiley, 2010

2. Bing Liu, Web DataMining: Exploring Hyperlinks, Contents and Usage Data, springer, 2007.

References:

1. Jiawei Han, MichelineKamber, Jian Pei, Data Mining: Concepts and Techniques, Elsevier, 2011.

2. ACM Transactions on Knowledge Discovery from Data (TKDD)

3. IEEE Transactions on Knowledge and Data Engineering.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	M	M	M	-	-	-	-	-	-	-
CO2	M	H	L	M	L	-	-	-	-	-	-	-
CO3	M	L	L	M	L	-	-	-	-	-	-	-
CO4	M	M	L	H	M	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6053	Wireless and Mobile Networks	L	T	P	C
Duration :14Wks		3	0	0	3

Pre-requisites:

Computer Networks (B18CS5030)

Course Description:

This course will introduce to wireless communication and mobile computing. It covers the fundamentals of wireless transmission and telecommunication system such as GSM, GPRS, DECT, and UMTS. Mobile network layer and transport layers covers about mobile IP, Traditional TCP and the architecture of LTE and its protocol.

Course Objectives:

1. Explain the basic concepts of wireless communication.

2. Describe wireless network architecture and concepts of Ad-hoc network.

3. Demonstrate the working of wireless Local area networks and wireless ad-hoc networks.

4. Discuss various applications using the wireless technologies

Course Outcomes (Cos):

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

CO1 Outline the fundamental concepts of wireless communication.

CO2 Compare the working of wireless network and wireless Ad-hoc network.

CO3 Make use of the Wireless Application protocol in a real world application.

CO4 Develop applications using the wireless technologies.

Course Contents:

UNIT -1

Introduction: Fundamentals of wireless communication: Wireless communication system, Wireless media, Frequency spectrum, Wireless communication channel specifications, Types of wireless communication systems.

Basics of wireless networks: Wireless network architecture, Wireless network reference model, Wireless networking issues.

UNIT -2

Telecommunication System: Global system for mobile communications (GSM) Services, System Architecture, Radio interface, protocol, handover, General packet radio service (GPRS). DECT System Architecture, protocol, TETRA, UMTS System Architecture.

Wireless Body Area Networks, Properties, Network architecture, Components, Network Protocols, Bluetooth and Zigbee, Applications.

UNIT -3

Wireless Local Area Networks: Network Components, Network architecture, WLAN standards, WLAN protocols, IEEE 802.11p, WLAN applications.

Wireless Ad Hoc Networks: Wireless Ad Hoc Networks, Mobile Ad Hoc networks, Wireless sensor networks, Vehicular Ad Hoc networks (VANETs).

UNIT -4

Wireless Application protocol: Version 1.X Architecture, WAP 2.0.

4G LTE Networks: Introduction, LTE, LTE Architecture, Protocol layer Architecture, LTE Advanced, 5G Networks overview.

Self-learning components:

Network Function Virtualization (NFV),Capability-based Security,5G,Cyber Physical Systems (CPS), and Capability-based Security.

Text books:

1. Sunil Kumar S.Manvi,Mahabaleshwar S.Kakkasageri, Wireless and mobile networks concepts and protocols- ,second edition, Wiley,2016.

2. Jochen H. Schillier, Mobile Communications, 2nd edition, Pearson publishers.

References:

1. Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal, Mobile computing technology, Application and service creation, Second edition, Tata McGraw Hill Education Private limited, 2010.

2. IEEE Transactions on Vehicular Technology

3. IEEE Transactions on Wireless Communications

4. Springer Wireless Networks Journal

Mapping COs with POs (Program outcomes):

Course Outcomes	Program Outcomes											
	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012
CO1	H	M	M	M	M		H	H				
CO2	H	H	M	M	H		H					M
CO3	H	H	H	M	H	H	H		H			
CO4	H	H	H	M	H		H					

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6054	Parallel Processing and Algorithms	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:

Computer organization and Architecture (B18CS4040), Problem Solving with Programming (B18CS1030), Design and Analysis of Algorithm (B18CS4010).

Course Description:

In a parallel computation, multiple processors work together to solve a given problem. These are exciting times in parallel computing. The largest parallel machine has over a hundred thousand processors, and it is believed that machines with over ten thousand processors will be commonly available by the end of the decade. Furthermore, with most chip manufacturers moving toward multicore processors, most machines will soon be parallel ones. It is, therefore, essential to learn to use parallel machines effectively.

Course Objectives:

1. Explain the concepts of parallelism.
2. Demonstrate the use of OpenMP for implementing shared memory concepts.
3. Discuss the computational bottlenecks of basic computational problems.
4. Illustrate the use of graph algorithms for solving problems.

Course Outcomes (Cos):

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

CO1:Make use of the parallelism concepts in Parallel Programming Platforms.

CO2: Develop parallel programs using OpenMP and pthreads for real world applications.

CO3: Analyze computational bottlenecks of basic computational problems.

CO4: Develop programs using graph algorithms for solving Shortest Paths and Transitive Closure problems.

Course Contents:

Unit- 1

Introduction to Parallel Computing: Motivating Parallelism, Scope of Parallel Computing. Parallel Programming Platforms: Implicit Parallelism-Trends in Microprocessor Architectures, Limitations of Memory System Performance, Dichotomy of Parallel Computing Platforms. Principles of Parallel Algorithm Design: Decomposition Techniques, Characteristics of Tasks and Interactions, Parallel Algorithm Models.

Unit -2

Programming Shared Address Space Platforms: Thread Basics, Why Threads?, The POSIX Thread API, Thread Basics: Creation and Termination, Synchronization Primitives in Pthreads, Controlling Thread and Synchronization Attributes, Thread Cancellation, Composite Synchronization Constructs, Tips for Designing Asynchronous Programs, OpenMP: a Standard for Directive Based Parallel Programming.

Unit- 3

Dense Matrix Algorithms: Matrix-Matrix Multiplication. Sorting: Issues in Sorting on Parallel Computers, Bubble Sort and its Variants, Quicksort. Graph Algorithms: Definitions and Representation, Minimum Spanning Tree: Prim's Algorithm.

Unit- 4

Graph Algorithms continued: Single-Source Shortest Paths: Dijkstra's Algorithm, All-Pairs Shortest Paths and Transitive Closure. Search Algorithms for Discrete Optimization Problems: Definitions and Examples, Sequential Search Algorithms, Search Overhead Factor, Parallel Depth-First Search, Parallel Best-First Search, Speedup Anomalies in Parallel Search Algorithms.

Self-learning component:

Algorithms merging and sorting, Lower Bounds Lock Free synchronization, load stealing, lock free synchronization.

Text books:

1. Introduction to Parallel Computing (2nd Edition). Ananth Grama , George Karypis, Vipin Kumar, Anshul Gupta - Addison Wesley Publications, ISBN : 0-201-64865-2,2003.

Reference books:

1. Parallel Programming in C with MPI and OpenMP by M.J. Quinn, McGraw-Hill Science/Engineering/Math, 1st edition, ISBN: 0072822562,2003.

2. OpenMP: www.openmp.org/

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	H	H	H	M	-	-	-	-	-	-	-
CO2	H	M	L	M	L	-	-	-	-	-	-	-
CO3	H	M	M	M	M	-	-	-	-	-	-	-
CO4	H	H	L	L	M	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6061	Mobile Application Development	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:

Programming with Java [B18CS3030], Data Structures[B18CS3040]

Course Description:

This course introduces programming technologies, design and development tools related to mobile applications. Topics include accessing device capabilities, industry standards, operating systems, and programming for mobile applications using OS Software Development Kit (SDK).

Course Objectives:

1. Discuss mobile application models/architectures and patterns for development of a mobile software application

2 Demonstrate the installation of software and tools required for development of android applications.

3. Illustrate the use of fundamentals of android with graphics and animation APIs.

4. Describe an application with multimedia concepts of audio, video with entertainment services.

Course Outcomes:

CO1	Make use of Android features to develop real world application.
CO2	Design a suitable user interface and database for the given real world application.
CO3	Choose the intrinsic controls required for the development of real world applications.
CO4	Develop Android Services for multimedia, camera and location based activities.

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

Course Content:

Unit-1:

Introduction to mobile communication and computing: Introduction to mobile computing, Novel applications, limitations and GSM architecture, Mobile services, System architecture, Radio interface, protocols, Handover and security, Smart phone operating systems and smart phones applications.

Unit-2:

Fundamentals of Android Application Development: Introduction to Android., The Android

4.1 Jelly Bean SDK, Understanding the Android Software Stack, Installing the Android SDK, Creating Android Virtual Devices, Creating the First Android Project, Using the Text View Control, Using the Android Emulator.

Unit-3:

Layouts, Menus and Graphics in Android: Menus:Options menu and app bar,Context menu and contextual action mode,Popup menu, Defining a Menu in XML, Creating an Options Menu, Changing menu items at runtime, Creating Contextual Menus, Creating Menu Groups, Adding Menu Items Based on an Intent, Activity, Service, BroadcastReceiver and Content Provider.

Building Blocks for Android Application Design, Laying Out Controls in Containers. Graphics and Animation: Drawing graphics in Android, Creating Animation with Android's Graphics API.

Unit 4:

Creating the Activity, Working with views: Exploring common views, using a list view, creating custom views, understanding layout. Using Selection Widgets and Debugging Displaying and Fetching Information Using Dialogs and Fragments. Multimedia: Playing Audio, Playing Video and Capturing Media. Advanced Android Programming: Internet, Entertainment, and Services.

Self-learning component:

More Recent Applications: Multimedia;2D graphics ; networking support in Android, Introduction to IoS, App. Development.

Text books:

1. Bill Phillips, Chris Stewart, and Kristin Marsican, Android Programming: The Big Nerd Ranch Guide pearson technology group,3rd Edition,2015.

2. Barry Burd, Android Application Development All-in-One For Dummies ,wiley publisher,2nd Edition, 2012.

3. ZigurdMednieks, Laird Dornin, G. Blake Meike, Masumi Nakamura,Programming Android: Java Programming for the New Generation of Mobile Devices,oiley,2nd Edition,2012.

Reference books:

1. Greg Nudelman, Android Design Patterns: Interaction Design Solutions for Developer, wiley, 2013.

2. Jason Tyler, App Inventor for Android: Build Your Own Apps No Experience Required!, wiley,2011.

3. J.F.Dimarzio, Android programming with Android studio,wrox,4th edition ,2017

4. Maurice Sharp Erica Sadun Rod Strougo, Learning iOS Development-A Hands-on Guide to the Fundamentals of iOS Programming, Addison Wesley by Pearson Education, Inc.2014.

5. Wei-Meng Lee, Beginning Swift Programming, Wiley India Pvt. Ltd.,2018.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	L	L			M	M		
CO2	M	H	M	H	M	M			H	M		M
CO3		M	H	L	M				H	L	M	
CO4	H	H	H	M	M	L			M	M	L	

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6062	Advanced Computer Networks	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:

Computer Organization and Architecture [B18CS4040], Computer Networks [B18CS5030]

Course Description:

This course is designed to introduce advanced topics in computer networks. Algorithms and protocols at the application, transport, network and medium access layers. The course explores emerging research challenges in the field of information and content centric networks. This course assumes students with graduate level knowledge in Computer Networks, familiarity with Operating Systems, Statistics and proficiency in at least one programming language. The course is also organized in traditional lectures, and also students will have chance to study the state-of-art research in Computer Networks field that is particularly interesting to them, and work on it.

Course Objectives:

1. Explain the concepts of SONET and ATM.
2. Discuss the different application protocols.
3. Describe the Congestion Control and Resource Allocation techniques.
4. Demonstrate the management of computer network.

Course Outcomes:

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

CO1: Choose the most appropriate networking architecture and technologies for the given real world application.

CO2: Identify deficiencies in existing protocols and formulate new and better protocols.

CO3: Design the topological and routing strategies for an IP based networking infrastructure

CO4: Make use of internet socket programming for the given real world application.

Course Content:

UNIT-1

SONET: Architecture, SONET Layers, Frames, Multiplexing, Networks.

ATM: Design Goals, Problems, Architecture, ATM Layers, ATM switch structure, ATM LAN's. Applications of ATM networks.

UNIT-2

Application Protocols: BGP, Traditional Applications- SMTP, MIME, IMAP, HTTP, Web services, FTP, TELNET. Multimedia Applications, Infrastructure services-DNS, SNMP.

UNIT-3

Congestion Control and Resource Allocation: Issues in Resource Allocation, Network Model, Taxonomy, Evaluation Criteria. Queuing Disciplines: FIFO, Fair Queuing, Congestion-Avoidance Mechanisms: DECbit, Random Early Detection (RED), Source-Based Congestion Avoidance, Quality of Service: Application Requirements, Integrated Services (RSVP), Differentiated Services (EF, AF), and Equation-Based Congestion Control.

UNIT-4

NetworkManagement: Introduction, SNMP, ASN.1

Socket Programming in Java: Introduction, Programming with UDP, Programming with TCP.

Self-Learning Component:

Project development using (NS3 Tool or NetSim). MPLS, VPN, IGMP. SSH, AES, Blowfish.

Text books:

l. Larry L. Peterson & Bruce S. Davie: Computer Networks A Systems Approach, 4th Edition, Elsevier.

2. Behrouz A Forouzan: Data Communications and Networking, 5th Edition, McGraw – Hill, 2006

References:

l. Nader F. Mir: Computer and Communication Networks, Pearson Education, 2009

2. Alberto Leon-Garcia and Indra Widjaja: Communication Networks – Fundamental Concepts and Key Architectures, 2nd Edition Tata McGraw – Hill, 2004.

3. Andrew S. Tanenbaum: Computer Networks, 4th Edition, Pearson Education, 2005.

4. Larry L. Peterson and Bruce S. Davie: Computer Networks- A system Approach, 5th Edition, Elsevier, 20l2.

5. William Stallings: Data and Computer Communications, l0th Edition, Pearson Education, 2008.

6. Douglas E. Comer: Internetworking with TCP/IP Vol.l, 6th Edition, Pearson, l995.

7. IEEE Network Magazine

8. IET Communications

9. Elsevier Computer Networks

l0. Springer Journal of Networks and Systems Management.

Mapping COs with POs (Program outcomes):

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO 1	H	M	H	H	M	L	-	-	L	-	-	L
CO 2	H	H	H	H	M	M	-	-	L	-	-	L
CO 3	M	H	H	M	M	L	-	-	L	-	-	M
CO 4	H	M	H	M	M	L	-	-	L	-	-	L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO

B18CS6063	Introduction to Genomic Data Science	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Database Management(B18CS4030)

Course Description:

This is the first course in the Genomic Data Science Specialization. This course introduces to the basic biology of modern genomics and the experimental tools that is used to measure it. Central Dogma of Molecular Biology is introduced and how next-generation sequencing can be used to measure DNA, RNA, and epigenetic patterns is done is covered. An introduction to the key concepts in computing and data science, how data from next-generation sequencing experiments are generated and analyzed are covered.

Course Objectives:

1. Explain the basic concepts of bioinformatics
2. Discuss different information search and data retrieval tools.
3. Demonstrate the use of Genome Analysis and Gene Mapping with respect to a real world Application.
4. Illustrate the use of Gene Identification and Prediction in a real-world application.

Course Outcomes (Cos):

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

CO1: Make use of basic concepts of Bioinformatics

CO2: Apply Search and Data Retrieval for any real world application.

CO3: Analyze Genome process and Gene Mapping.

CO4: Evaluate Gene Identification and Prediction in Genomic DNA

Course Contents:

Unit- 1

Bioinformatics: An Introduction

Introduction, Historical Overview and Definition, Bioinformatics Applications, Major Databases in

Bioinformatics, Data Management and Analysis, Molecular Biology and Bioinformatics, Central Dogma of Molecular Biology, Biological Databases Considerations.

Unit-2

Information Search and Data Retrieval:

Introduction, Electronic Libraries, Tools for Web Search, Data Retrieval Tools, Data Mining of Biologica Databases.

Unit-3

Genome Analysis and Gene Mapping

Introduction, Genome Analysis, Genome Mapping, The Sequence Assembly problem, Genetic Mapping and Linkage Analysis, Physical Maps, Cloning the entire Genome, Genome Sequencing, Applications of Genetic Maps, Sequence Assembly Tools, Identification of Genes in Contigs, The Human Genome Project.

Unit-4

Gene Identification and Prediction

Introduction, Basis of Gene Prediction, Pattern Recognition, Gene Prediction Methods, Other Gene Prediction Tools.

Self-learning components:

Genome data management, sequencing the pairs of genomes, Hidden Markov Models, Phylogenetics.

Text books:

1. S.C. Rastogi, N. Mendiratta, P. Rastogi,Bioinformatics Methods and Applications, 4th Edition, EEE, PHI, 2013.

2. Andreas D. Baxevanis, B. F. Francis Ouellette, BIOINFORMATICS A Practical Guide to the Analysis of Genes and Proteins, 2nd Edition, Wiley Interscience, 2001.

3. Lloyd Low, MarttiTammi, Bioinformatics-Practical-Generation-Sequencing-Applications, 2017

4. T. R. Sharma, Genome-Analysis-Bioinformatics-Practical-Approach, I.K. International Publishing House Pvt. Ltd, 2009

Reference books:

1. Genomic Data Science | Coursera

2. Introduction to Genomic Data Science | edX

3. Computational Genomics and Data Science Program, National Human Genome Research Institute.

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	L	-	L	-	-	-	-	-	-	-
CO2	H	M	M	M	L	-	-	-	-	-	-	-
CO3	M	M	M	L	-	-	-	-	-	-	-	-
CO4	M	M	L	M	L	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO

B18CS6064	User Interface(UI)/User Experience(UX) Design	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:

Programming with Java [B18CS3030]

Course Description:

This course is designed to give a foundational understanding of how people interact with computers and computing technology, and will provide with a set of basic skills for evaluating and designing for this type of interaction. These are valuable skills to have, especially if a student is considering post-baccalaureate work in the fields of psychology, design, computer science, or plan to work in industry with such technology. Even if a student does not plan to pursue a career in such areas, this is useful information to know to improve his/her own interaction with technology.

Course Objectives:

The overall objectives of the Course are as follows:

1.Explain user interface design process for a given problem

2: Illustrate the selection of designs, utilize the design thinking processes with UX/UI tools.

3: Describe the assumptions and prototype potential design solutions.

4: Discuss the issues and challenges to achieving a human-centered design process, especially with regard to user experience design

Course Outcomes (Cos):

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

C01. Identify the new technologies to design user interfaces for the given real world application.

CO2. Make use of the UI/UX design process to develop the given real world application.

CO3. Develop applications using various Interaction styles including Direct Manipulation andVirtual Environment.

CO4. Design web and mobile UI/UX based application using structure plane.

Course Content:

UNIT- 1

A Design Process for Digital Products; A Design Process for Digital Products; Modeling Users: Personas and Goals.

UNIT -2

Setting the Vision: Scenarios and Design Requirements; Designing the Product: Framework and Refinement; A Basis for Good Product Behavior

UNIT- 3

User Experience and Why It Matters? Meet the Elements; Understanding the Strategy Plane; Understanding the Scope Plane.

UNIT- 4

Understanding the Structure Plane; Understanding the Skeleton Plane; Understanding the Surface Plane; UI/UX Designing for the Desktop, Mobile and other devices. UI/UX Designing for the web.

Self-Learning Components:

Implementation of Common sight patterns in the Interaction design, Prediction of User expectations, Choosing and using the best UI patterns.

Text books:

1.Alan Cooper, About Face-Essential of the User Interface Design, Wiley, 4th edition, 2014

2.Jenifer Tidwell, Designing Interfaces, O'Reilly Media, 2nd edition, 2010.

Reference books:

1. William Buxton, Sketching user experiences-getting the design right and the right design, Elsevier-Morgan Kaufmann, 2007.

2. Don Norman, The Design of Everyday Things - Revised and Expanded Edition, 2013.

3. Jesse James Garrett - The Elements of User Experience-User-Centred Design for the Web and Beyond, 2nd Edition, New Riders Press, 2010.

4. ACM, International Journal of Human-Computer Studies.

5.IEEE, Transactions on Human-Machine Systems.

6.Elsevier, International Journal of Human-Computer Studies.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	M	M	M	M	L	L	-	L	-	-	M
CO2	H	M	M	M	L	-	-	-	L	-	-	L
CO3	H	M	M	M	L	-	-	-	L	-	-	M
CO4	H	H	M	M	L	-	-	-	L	-	-	M

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS6070	Cloud Computing Lab	L	T	P	C
Duration :14Wks		0	0	2	2

Prerequisites:

Operating System[B18CS5040], Computer Networks[B18CS5030], Database Management System[B18CS4030].

Course Description:

The course provides introduction to Google Docs, Google Sheets, Google Slides and Google Forms, describes various virtualization techniques, how to create multiple VM's using VMware products, discuss on MapReduce programming model in Big Data – Hadoop framework using sample data and also provides basic knowledge on IoT applications using Cloud.

Course Objectives:

1. Describe the knowledge of Map Reduce framework in solving problems related to big data.
2. Discuss Google Docs, Google Sheets, Google Slides and Google Forms.
3. Explore hands on experience on cloud environments.
4. Explain IoT applications using Cloud.

Course Outcomes:

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

CO1: Illustrate MapReduce programs on Hadoop and analyze the results.

CO2: Develop documents, spreadsheets, slides and forms using Google Docs, Google Sheets, Google Slides and Google Forms.

CO3: Design simple experiments on VMware products.

CO4: Make use of features of Cloud to develop IoT applications.

List ofExperiments:

Experiment Nos.	Programs
1	Evaluate the performance of MapReduce program on word count for different file size.
2	Use MapReduce to implement K-Means Clustering for a real-world big data clustering.
3	Design a document, excel sheet and presentation using Google Docs, Google sheets and Google Slides.
4	Create multiple VM's on a single physical machine. Provide communication between them using and without using vClient.
5	Demonstrate the communication of VM's on different physical devices using ESXI.
6	Illustrate the cloning of VM's.
7	Illustrate the backup-restore scenario.
8	Add iSCSI adapter and modify the relative parameters. Create a new VMkernel using iSCSI port binding.
9	Performance Analysis of Virtual Machine vs Physical Machine.
10	Design a module to control an LED from Webserver using NodeMcu or Esp8266 programming with Arduino IDE.

Additional Experiments:

Experiment Nos.	Programs
1	Create a data center using vCenter for multiple VM's.
2	Install and configure the vSphere Web client.
3	Illustration of vMotion to move the VM's from one ESXi to another ESXi.
4	Design and Demonstrate a program using CloudSim, showing how t create a datacenter with one host and run one cloudlet on it.
5	Design and Demonstrate using CloudSim, showing how to create two datacenters with one host each and run cloudlets of two users on them.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	H	-	-	-	-	-	-	-
CO2	M	H	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	H	-	-	M	-	-	-	-
CO4	-	-	-	-	-	-	-	M	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

IVth Year
Detailed Syllabus

VII Semester Syllabus

B18CS7010	Web Application Development	L	T	P	C
Duration :14Wks		3	0	1	4

Prerequisites:

Peogramming with Java (B18CS3030) and Database Management System (B18CS4030).

Course Description:

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 Objectives:

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.
4. Describe the principles of object oriented development using Perl and PHP.

Course Outcomes (Cos):

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

CO1	Experiment with various HTML tags to create a web page.
CO2	Make use of Cascading Style Sheets to design a web page.
CO3	Develop client-side environment using Angular JS, Java Scripts and XML for Web based applications.
CO4	Build a server-side environment using PHP and Perl for Web base application.

Course Contents:

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

Managing State, The Problem of State in Web Applications, Passing Information via Query Strings, Passing Information via the URL Path, Cookies, Serialization, Session State, Caching, JavaScript and jQuery, Angular JS, JavaScript Pseudo-Classes, XML Processing and Web Services, XML Processing, Overview of Web Services.

Unit- 4

Introduction to Perl and PHP. Arrays and Superglobals, Arrays, GET and POST Superglobal Arrays, $_SERVER Array, $_Files Array, Reading/Writing Files, PHP Classes and Objects, Object-Oriented Overview, Classes and Objects in PHP, Object Oriented Design, Error Handling and Validation, What are Errors and Exceptions?, PHP Error Reporting, PHP Error and Exception Handling.

Self-learning component:

HTML5, JQuery, XML, Ruby, Introduction to REST and RESTful API

Text books:

1. Randy Connolly, Ricardo Hoar, "Fundamentals of Web Development”, Pearson Education India, 1st Edition, 2016

2. Jeffrey C. Jackson, "Web Technologies--A Computer Science Perspective", Pearson Education, 1st Edition, 2006.

3. Robert. W. Sebesta, "Programming the World Wide Web", Pearson Education, 4th Edition, 2007.

References:

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

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012
CO1	H	L	H	H	M	-	-	-	-	-	-	-
CO2	H	M	M	H	M	-	-	-	-	-	-	-
CO3	H	M	H	H	M	-	-	-	-	-	-	-
CO4	H	M	H	H	M	-	-	-	-	-	-	-

Where L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

Sample Assignments:

1. Create a static REVA University web page using HTMLtags
2. Create a web page that will have separate links to show map of India and World. When user will open a map of India, create links to display the information of each state i.e. highlighted in the map in a separate window/document. (The information should be brief i.e. not more than 3-4 sentences.)
   When user will open a worldmap, show the list of countries on clicking the image in a new wi ndow.
3. Write an HTML page to displayinformation of three products. The name of three productssh ould be displayed at the top. The hyperlink should be provided to move to the details of the product like its features, size, price etc .alongwith its image. The link shouldbe internal link.
4. Explain the following tags with the attributes that often required.Write suitable examplefor e ach. 1) SELECT 2) TEXTAREA
5. What is CSS and List out the properties of CSS.
6. Differentiate between java and JavaScript.
7. Explain with sample programperl.
8. Explain with sample programphp.
9. Create a website using HTML, perl to store the students information of the school.
10. Discuss the working of admission process using a web page in PHP.

B18CS7020	Cryptography and Network Security	L	T	P	C
Duration:14 Wks		3	0	0	3

Pre-requisites:

Computer Networks [B18CS5030]

Course Description:

Computers around the world are systematically being victimized by rampant hacking The goal of the ethical hacker is to help the organization take preemptive measures against malicious attacks by attacking the system himself; all the while staying within legal limits. As technology advances and organization depend on technology increasingly, information assets have evolved into critical components of survival. If hacking involves creativity and thinking 'out- of-the-box', then vulnerability testing and security audits will not ensure the security proofing of an organization. To ensure that organizations have adequately protected their information assets, they must adopt the approach of 'defense in depth'. In other words, they must penetrate their networks and assess the security posture for vulnerabilities and exposure. This course helps develops individuals in the specific network security discipline of Ethical Hacking from a vendor-neutral perspective.

Course Objectives:

The objectives of this course are to:

1. Explain the fundamental concepts of cryptography.
2. Describe public key cryptography and message authentication.

3: Demonstrate the key distribution using Symmetric or Asymmetric encryption

4. Discuss security applications in the field of Information technology

Course Outcomes (COs):

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

CO1: Identify the fundamental concepts of cryptography.

CO2: Develop a program for implementing public key cryptography and message authentication.

CO3: Build key distribution system using Symmetric or Asymmetric encryption

CO4: Design and develop security applications in the field of Information technology.

Course Contents:

Unit - 1

Introduction: The OSI Security Architecture, Security Attacks, Security Services, mechanisms, Amodel for network security, symmetric encryption principles, Symmetric Block Encryption Algorithms, Data Encryption Standards, Strength of DES, Triple DES, Advanced Encryption Standard.

Unit – 2

Public-Key Cryptography and Message Authentication: Public key Cryptographic Principles,

Public Key Cryptographic Algorithms (RSA, Diffie-Hellman), Approaches to Message Authentication, Secure Hash Functions (SHA-512), Message AuthenticationCodes, Digital Signatures.Introduction to Secure programming with the OpenSSL API: OpenSSL, Headers and initialization, Setting up an unsecured connection, Setting up a secure connection, Error detection.

Unit – 3

Network Security Applications: Symmetric key distribution using Symmetric encryption, Kerberos(Key Exchange), key distribution using Asymmetric encryption X.509 Certificate Format, Secure socket layer and transport layer security, PGP- Features of PGP, Key Rings in PGP, S/MIME, IP security Overview.

Unit – 4

System Security: Intrusion Detection, Password Management, Virus and threats, VirusCountermeasures, Firewalls, The Need for Firewalls, Firewall Characteristics, Types of Firewalls.Open Source Cryptography libraries -a C++98 crypto library, Mhash open source C library and Crypto ++.

Self-learning component:

IoT complexity leads to security issues and further DDoS attacks, Malware, Cloud security, Roles of AI and machine learning in cyber security.

Text Books:

1. William Stallings, Network Security Essentials Applications and Standards, Fourth edition, Prentice Hall, 2011.

2. Behrouz A. Forouzan, Cryptography and Network Security, McGraw Hill, 2007.

Reference Books:

1. William Stallings, Cryptography and Network Security Principles and Practice, Pearson, Sixth edition, 2013

2. Joseph MiggaKizza, Guide to Computer Security, Springer Science & Media Inc., Third edition, 2015

3. Andrew S.Tanenbaum, Computer Networks, Pearson, Fifth edition, 2015.

4. AtulKahate, Cryptography and Network Security, McGraw Hill, 2013.

5. Springer Journal of Cryptographic Engineering , ISSN 2190-8508

6. ACM,ACM- International Journal of Applied Cryptography,ISSN:1753-0563

7. IEEE, IEEE Transactions on Information Forensics and Security.

8. Elsevier, Journal of Information Security and Applications.

a. https://www.alienvault.com/blogs/security-essentials/open-source-network-security-tools-for-newbies.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M	M	L	-	-	-	-	-	-	-
CO2	H	M	H	L	M	-	-	-	-	-	-	-
CO3	H	L	M	M	H	-	-	-	-	-	-	-
CO4	M	M	M	L	L	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7031	Internet Computing and Applications	L	T	P	C
Duration:14Wks		3	0	0	3

Prerequisites:

NIL

Course Description:

The course aims to provide an understanding with the principles on which the Internet and other distributed systems are based. Emphasizes the power of Javascript, PHP to design web pages that dynamically interact with databases that reside on a server. Scripting tools to build web pages that connect to servers and Client-Side Programming, Server-Side Programming, Database Connectivity to web applications.

Course Objectives:

The objectives of this course are to:

1. Describe the different types of computer networks.
2. Illustrate the use of distributed system technologies in real world applications.
3. Demonstrate the use of Java script in real world applications.
4. Explain the features of PHP, HTML and MySQL.

Course Outcomes:

On successful completion of this course, the student will be able to:

CO1: Identify the fundamental concepts of networking to connect web-based applications using distributed computing technologies.

CO2: Outline the working of remote method invocation to access remote methods.

CO3: Make use of javascript in web programming to develop web-based applications.

CO4: Develop a real world application using PHP.

Course Content:

Unit -1:

Introduction to Networks: Data Communications, Networks: LAN, MAN, WAN, Layers, Protocols and Interfaces of OSI Reference Model and TCP/IP Model.

Internet: URLs, the World Wide Web, WWW Architecture, Web Browsers, Web Servers, Web Search Engines, MIME, HTTP, FTP, Web Service, Software as a service

Unit -2:

Distributed Computing: Client Server, Cloud, parallel computing and Grid computing, Remote Procedure Call (RPC) and Remote Method Invocation (RMI).

Unit 3:

JavaScript: Introduction: Overview of Java Script, Object orientation and Java Script, Data types and Variables - Operators, Expressions, and Statements - Functions - Objects - Array, Document Object Model - Event Handling - Controlling Windows & Frames and Documents - Form handling and validations, Errors in scripts, Example

UNIT 4:

PHP: Introduction and basic syntax of PHP, decision and looping with examples, PHP and HTML, Arrays, functions, Browser control and detection, string, Form processing, Files, Advance Features: Cookies and Sessions, Object Oriented Programming with PHP. PHP and MySQL: Basic commands with PHP examples, Connection to server, creating database, selecting a database, listing database, listing table names, creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, PHP myadmin and database bugs.

Self-learning component:

Dynamic Documents with Javascript: Positioning elements, Moving elements, Element Visibility, Changing colors and fonts, Dynamic content, Stacking elements, Locating the mouse cursor, Reacting to a mouse click, Dragging and dropping elements, E-Commerce, Real Estate Business, Education, Health, Research and Social Networks like Facebook, FlipKart etc.

Text books

1.M.L.Liu, Distributed computing, Principles and Applications, Pearson Education, 4th edition, 2008.

2.Grid Computing, Joshy Joseph & Craig fellenstein, Pearson Education, 3rd edition, 2004.

3.Robert W. Sebesta: Programming the World Wide Web, 4th Edition, Pearson Education, 2008.

Reference books

1. Deitel, Goldberg, 'Internet & World Wide Web How to Program', Third Edition, PearsonEducation, 2006.
2. Behrouz A , Forouzan , Data Communication and Networks, Tata McGrahill, 4th Edition, 2006
3. Achyut S. Godbole and AtulKahate, Web Technologies, Tata McGraw Hill, Third edition, 2003.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	H	H							
CO2	H	H	H	H	M	L	L					
CO3	H	H	M	M	M	L	L					L
CO4	H	H	H	M	L	L	L					

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7032	**Data Structures using C**	L	T	P	C
Duration: 14Wks.		3	0	0	3

Prerequisites:

C Programming Knowledge

Course Objectives

The objectives of this course are to:

1. Distnguish between primitive and non-primitive data structures.
2. Demonstrate the use of arrays in real world applications.
3. Explain operations and applications of lists and stacks.
4. Illustrate the use of queues in real world applications.

Course Outcomes

On successful completion of this course, the student is expected to be able to:

1. Identify an appropriate data structure required to represent the data to solve the given problem.
2. Apply the concept of Arrays for solving real world problem.
3. Develop a program using lists and stacks to solve real world problem.
4. Design and develop a real world application using queues.

Course Contents:

Unit 1:

Introduction to C and Data Structures: History of C, Data Types, Variables, Constants, Statements, Expressions, Control Statements, Flow Charts, Algorithms, Simple Programs,

Introduction to data structure; Definition, Primitive and non-primitive data types, Data Abstraction.

Unit 2:

Arrays: Single and two dimensional arrays, Application of arrays: Dynamic memory allocation, searching and sorting algorithms and simple programs

Unit 3:

Lists and Stacks:

Lists: Definition, Operations, Representation, Application of List Stacks: Definition, Operations, Representation, Application of Stack

Unit 4:

Queues and Application of the Course

Queues: Definition, Operations, Representation, Application of queue.

Applications of Course:

Application of Data Structures to different domains like Civil, Mechanical, Electrical, Electronics, MBA, etc.

Textbooks:

1. Horowitz, Sahni, Anderson-Freed, ***Fundamentals of Data Structures in C***, 2nd Edition, Universities Press, 2007.
2. Herbert Schildt, **C*: The Complete Reference***, 4th Edition, Tata McGraw Hill

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	L	L	-	-	-	H	-	-	L
CO2	H	L	M	M	L	-	-	-	M	-	-	L
CO3	H	L	H	H	M	-	-	-	H	-	-	H
CO4	H	M	M	M	L	-	-	-	H	-		H

B18CS7041	Augmented and Virtual Reality	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Problem Solving with Programming (C/C++)-[B18CS1030], Data Structures-[B18CS3040]

Course Description:

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 Objectives:

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.

Course Outcomes:

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

CO1: Identify the components of Augmented and Virtual Reality.

CO2: Apply multimodal user interaction and perception techniques involved in Virtual Reality.

CO3: Develop real world applications using Simulation and Interactive techniques.

CO4: Choose the innovative Virtual Reality solutions for industrial and social relevant applications.

Course Content:

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.

Self-learning component:

Unity 3D, Manus VR

Text books:

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.

Reference books:

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.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H									H		
CO 2	H	H	H		H					H		
CO 3	H	H	H		H					H	M	
CO 4	H									H	M	

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7042	Network Programming	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites

Programming for Problem solving [B18CS1030], Operating systems [B18CS5040], Computer Networks [B18CS5030].

Course Description

This course is focusing on the programming aspects of computer networks. The goal of this course is to understand the current trends of communication protocols, socket programming, interprocess communication, and to understand how network research is done. Further, this course introduces the basics of computer networks, network Security and Internet programming. Students acquire knowledge of client-server architecture and secure network communication.

Course Objectives:

The objectives of this course are to:

1. Illustrate the use of socket programming in a real world application.
2. Explain the features of client and server Architecture required for developing real world applications.
3. Demonstrate the various methods of securing a network application.
4. Discuss the Case Study of Networked Application and Secure Networked Application

Course Outcomes (Cos):

CO1 Make use of features of socket programming in a real world application.

CO2 Develop an application for client server Architecture using real world scenarios.

CO3 Design a secure network application using OPEN SSL and other tools.

CO4 Analyse Case Study for Networked Application and Secure Networked Application.

Course Content

UNIT - 1

Networks and Protocols: Circuits vs. Packets, Internetworking, Ethernets, Ethernet Frames, Addressing, Internet Protocol, User Datagram Protocol, Transmission Control Protocol, The Client- Server Model, The Domain Name System, State vs. Stateless, Methods for Maintaining State; Socket Programming: What Is a Socket, Using Sockets, User Datagram Protocol, File Transfer, and Error Handling.

UNIT - 2

Client-Server Architecture: Client Test Program, Multiplexing, Forking, Multithreading, Combining Preforming and Pre-threading, Method Choosing, Dealing with Large Amounts of Data, Debugging and Development Cycle;

Custom Protocol Implementation: Designing a Custom Protocol, Our Chat Protocol, Protocol Registration, TCP vs. UDP, Application Protocol Choices, Client-Server Architecture, Client-Side Considerations, Server- Side Considerations

UNIT - 3

Securing Network Communication: Tunnelling, Public Key Infrastructure, Secure Network Programming Using OpenSSL, The Old Scenario, The Present-Day Scenario, The PAM Library, Public Key Authentication, Single Sign-on, Common Attacks, Buffer Overflow, Secure Coding, Tools of the Trade

UNIT - 4

Case Study1: A Networked Application: Using the Server and Client

Case Study2: A Secure Networked Application: The Necessary Decisions, Code Design and Layout and the implementation of Code Analysis.

Self-Learning Component:

Creating TCP clients, Creating TCP servers, Servers handling multiple clients, Malticast applications.

TextBooks:

1. Keir Davis, John Turner and Nathan Yocom, “The Definitive Guide to Linux Network Programming’’, Apress, First edition, 2004.

2. Warren Gay, “Linux Socket Programming by Example”, Que, 1st edition, 2000.

References:

1. Graham Glass and King abls, “UNIX for Programmers and Users”, Pearson Education, 3rd edition, 1998.

2. M. J. Rochkind, “Advanced UNIX Programming”, Pearson Education, 2nd edition, 2004.

3. IEEE Transactions on Networking (IEEE TON)

4. ACM Transactions on Networking (ACM TON)

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012
CO1	M	L	L	M	L	-	-	-	-	-	-	-
CO2	M	L	L	H	M	-	-	-	-	-	-	-
CO3	L	L	L	H	H	-	-	-	-	-	-	-
CO4	L	H	M	M	H	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7043	C# and .Net	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Programming for problem solving [B18CS1030] and Object Oriented Programming [B18CS2030].

Course Description:

The course is geared towards providing students with the knowledge and skills they need to develop C# applications. C# is the core language of the Microsoft .NET framework, designed specifically to take advantage of CLI (Common Language Interface) features. The course focuses on C# program structure, language syntax, and implementation details. It is a simple, object-oriented, and type-safe programming language that is based on the C and C++ family of languages.

Course Objectives:

The objectives of the course are to:

1. Discuss Building Blocks of the .NET Platform.
2. Explain the fundamentals of C# language.
3. Demonstrate the use of the Object Oriented Programming features and Interfaces
4. Illustrate the use of exceptions in real world application.

Course Outcomes:

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

CO1: Identify the basic components of the .NET Framework.

CO2: Develop a progam using C# data types for real world applications.

CO3: Make use of various interface techniques to invoke interface Members at the object Level

CO4: Apply exception handling mechanisms of C# for real world applications.

Course Content:

UNIT - 1

Introducing C# and .NET Platform: The Building Block of the .NET Platform (CLR, CTS, and CLS), The Role of the .NET Base Class Libraries, What C# Brings to the Table, An Overview of .NET Binaries (aka Assemblies), the Role of the Common Intermediate Language, The Role of

.NET Type Metadata, The Role of the assembly Manifest, Understanding the Common Type System, Intrinsic CTS Data Types, Understanding the Common Languages Specification, Understanding the Common Language Runtime.

UNIT - 2

C# Language Fundamentals : The Anatomy of Basic C# Class, Creating objects: Constructor Basics, The Composition of a C# application, Default assignment and Variable Scope, The C# Member Initialization Syntax, Basic Input and Output with the Console Class, Understanding Value Types and Reference Types, The Master Node: System.Object, The System Data Types (and C# Aliases), Converting Between Value Types and Reference Types: Boxing and Unboxing, C# Iteration Constructs, C# Controls Flow Constructs, The Complete Set of C# Operators, Defining Custom Class Methods, Understating Static Methods, Methods Parameter Modifies, Array Manipulation in C#, String Manipulation in C#, C# Enumerations.

UNIT - 3

Object Oriented Programming and Interfaces: Formal definition of a C# class, Definition the "Default Public Interface" of a Type, Recapping the Pillars of OOP, The First Pillars: C#'s Encapsulation Services, Pseudo- Encapsulation: Creating Read-Only Fields. The Second Pillar: C#'s Inheritance Supports, keeping Family Secrets: The "Protected" Keyword, Nested Type Definitions, And the Third Pillar: C #'s Polymorphic Support, Casting Between. Defining Interfaces Using C# Invoking Interface Members at the object Level, Exercising the Shapes Hierarchy, Understanding Explicit Interface Implementation. Understanding Callback Interfaces.

UNIT - 4

Exceptions and Interfaces: Ode to Errors, Bugs, and Exceptions, The Role of .NET Exception Handing, The System. Exception Base Class, Throwing a Generic Exception, Catching Exception, CLR System - Level Exception (System. System Exception). Custom Application- Level Exception (System. System Exception), Handling Multiple Exception, The Family Block, Understanding object Lifetime.

Self-learning component:

Basics of Garbage Collection, Finalization a Type, the Finalization Process, Building an Ad Hoc Destruction Method, Garbage Collection Optimizations, the System. GC Type.

Text books:

1.Andrew Troselen; Pro C# with .NET 3.0, Seventh edition, 2007.

2.E Balaguruswamy: Programming in C#, 5th reprint, Tata McGraw Hill 2004

Reference books:

1. Vijay Nicoel, Visual C#.NET, 5th reprint, Tata McGraw Hill 2004
2. IEEE Transactions on Computers
3. ACM Transactions on Algorithms

Mapping COs with POs (Program outcomes)

Course						**Program Outcomes**						
Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	H	H	-	-	-	-	-	-	-
CO2	H	H	H	M	M	-	-	-	-	-	-	-
CO3	H	H	H	L	M	-	-	-	-	-	-	-
CO4	M	M	M	M	L	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7044	Natural Language Processing	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Finite Automata and Formal Language [B18CS5010] and Artificial Intelligence

CourseDescription

The course provides the basics of Natural-language processing (NLP), which is an area of computer science and artificial intelligence concerned with the interactions between computers and human (natural) languages, in particular how to program computers to fruitfully process large amounts of natural language data. Natural language processing (NLP) is the ability of a computer program to understand human language as it is spoken. NLP is a component of artificial intelligence (AI). Challenges in natural-language processing frequently involve speech recognition, natural-language understanding, andnatural-language generation.

CourseObjectives:

The objectives of this courses are to:

1. Explain the different linguistic components in a givensentence.
2. Describe the features of automatic Speech Recognition.
3. Demonstrate the design of a parse tree using context free grammar

for a given sentence.

4. 4.Illustrate the semantic and pragmatic interpretation.

Course Outcomes

Upon completion of this course, the student should be able to:

CO1: Identify the different linguistic components in a given sentence.

CO2: Developaprogram forimplementing automatic Speech Recognition.

CO3: Create a parse tree using context free grammar for a given sentence.

CO4: Apply the semantic and pragmaticinterpretation.

CourseContent:

UNIT - 1:

Morphology and part-of speech processing: Introduction -Regular Expressions and Automata- Non-Deterministic FSAs. Tranducers -English Morphology - Finite-State Morphological Parsing - Porter Stemmer - Tokenization- Detection and Correction of Spelling Errors. N-grams - Perplexity - Smoothing

- Interpolation - Backoff. Part-of- Speech Tagging - English Word Classes - Tagsets - Rule-Based - HMM
- Transformation-Based Tagging - Evaluation and Error Analysis.

UNIT - 2:

Speechprocessing: Phonetics-Articulatory Phonetics-PhonologicalCategories-Acoustic Phonetics and Signals - Speech Synthesis - Text Normalization - Phonetic and Acoustic Analysis

- Diphone Waveform synthesis - Evaluation- Automatic Speech Recognition -Architecture - MFCC vectors - Acoustic Likelihood Computation - Evaluation. Triphones - Discriminative Training - Modeling Variation. Computational Phonology-Finite-State Phonology.

UNIT - 3:

Syntax analysis :Formal Grammars of English - Constituency - Context-Free Grammars - Grammar Rules - Treebanks - Finite-State and Context-Free Grammars - Dependency Grammars. Syntactic Parsing - Parsing as Search - Ambiguity - Dynamic Programming Parsing Methods -CKY- Earley and Chart Parsing- Partial Parsing-Evaluation. Statistical Parsing - Probabilistic Context-Free Grammars - Probabilistic CKY Parsing of PCFGs -Probabilistic Lexicalized CFGs -Collins Parser. Language and Complexity

UNIT - 4:

Semantic and pragmatic interpretation : Representation of Meaning - Desirable Properties - Computational Semantics -Word Senses - Relations Between Senses - WorldNet - Event Participants- Proposition Bank -Frame Net -- Metaphor. Computational Lexical Semantics - Word Sense Disambiguation.

Applications: Information Extraction - Named Entity Recognition - Relation Detection and Classification -Temporal and Event Processing - Template-Filling, Properties of Human Conversations - Basic Dialogue Systems - VoiceXML - Information- State and Dialogue Acts, Machine Translation -Issues in Machine Translation - Classical MT and the Vauquois Triangle - Statistical MT - Phrase-Based Translation Model.

Self-learning Components:

Syllabification - Learning Phonology and Morphology, Summarization - Single and Multi-Document Summarization - Focused Summarization - Evaluation. Dialog and Conversational Agents, Alignment in MT -IBM Models -Evaluation

Text books:

1. Jurafsky and Martin, “Speech and Language Processing”, Pearson Prentice Hall, Second Edition, 2008.

2. Christopher D. Manning and Hinrich Schütze, “Foundations of Statistical Natural Language Processing”, MIT Press, First edition, 1999.

Referencebooks:

1. Stevan Bird, “Natural Language Processing with Python”, Shroff, 2009.

4. James Allen, “Natural Language Understanding”, Addison Wesley, Second Edition, 2007.

2. Nitin Indurkhya, Fred J. Damerau, “Handbook of Natural Language Processing”, (Chapman & Hall/CRC Machine Learning & Pattern Recognition), Second Edition, 2010.

3. Alexander Clark, Chris Fox, Shalom Lappin, “The Handbook of Computational Linguistics and Natural Language Processing”, Wiley-Blackwell, Second edition, 2012.

4. IEEE/ACM Transactions on Audio, Speech, and Language Processing.

5. Elsevier Journal of Computer Speech and Language.

6. Springer Journal of Natural Language Processing.

Mapping COs with POs (Program outcomes):

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	H	H	M	-	-	-	-	-	-	-
CO2	M	H	M	H	H	-	-	-	-	-	-	-
CO3	M	H	M	H	M	-	-	-	-	-	-	-
CO4	H	H	L	H	M	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7051	Data Science using R	L	T	P	C
Duration:14 Wks		3	0	0	3

Pre-requisites:

Probability and statistics(B18CS2010),Programming for problem solving(B18CS1030)

Course Description

R is rapidly becoming the leading language in data science and statistics. Today, 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 Objectives:

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.

Course Outcomes (Cos):

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

CO1: Make use of Control structures and functions for real world applications.

CO2: Apply the R garphics features for the given real world applications.

CO3: Solve real world problem using Regression Models .

CO4: Develop Predictive analysis model for the given real world problem.

Course Contents

Unit - 1

History and overview of R: R nuts and bolts, Getting Data In and Out of R, Interfaces to the Outside World, Subsetting R Objects,

Unit - 2

Managing Data Frames with the dplyr package, Control Structures, Functions, Loop functions

Unit - 3

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 Overplotting.

Unit - 4

Predictive analysis: Data preprocessing, Regression Models: Measuring performance in regression models, Linear Regression and its cousins: Linear regression, Nonlinear Regression Models: Neural networks.

Self-learning Component:

Creating own datasets, functions and packages in R and using packages in R; Executing linear model for example data set; Creating Neural Networks for example data set;

Text books:

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.

Reference books:

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.

Mapping COs with POs

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	M	H	L	H	-	-	-	-	-	-	-
CO 2	H	M	L	H	M	-	-	-	-	-	-	-
CO 3	M	L	L	L	M	-	-	-	-	-	-	-
CO 4	H	M	H	L	M	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7052	Deep Learning	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Machine Learning for Data Analytics [B18CS6010]

Course Description:

This course is an introduction to deep learning, a branch of machine learning concerned with the development and application of modern neural networks. Deep learning algorithms extract layered high-level representations of data in a way that maximizes performance on a given task. Deep learning is behind many recent advances in AI, including Siri's speech recognition, Facebook's tag suggestions and self-driving cars.

Course Objectives:

The objectives of this course are to:

1. Explain the basic concepts of Deep Learning.
2. Describe supervised and unsupervised learning.
3. Demonstrate the use of a deep learning neural network in a real world application.
4. Illustrate the use of deep learning techniques in neural networks and natural language processing

Course Outcomes:

On successful completion of this course; student shall be able to:
CO1: Apply the basic concepts of mathematics to solve problems based on deep learning concepts.

CO2: Make use of suitable machine learning algorithms on real world problems (classification, clustering).

CO3: Utilize deep learning neural network model on real time applications like (face recognition, speech recognition).

C04: Develop Recommender systems applications using CNN concepts of NLP.

Course Contents:

UNIT - 1

Machine Learning Basics: Linear Algebra-Scalors, Vectors, Matrices and Tensors, Eigen Decomposition, SVD, PCA Probability and Information Theory-Probability Distribution, Conditional Probability, Chain Rule of Conditional Probability, Bayes' Rule.

UNIT - 2

Numerical Computation: Overflow, Underflow, Gradient Based Optimization, Constrained Optimization, Linear Least Squares, Machine Learning Basics- Learning Algorithms, Overfitting and Underfitting, Maximum Likelihood Estimation, Supervised and Unsupervised Learning Algorithms, Building Machine Learning Algorithm, Challenges Motivating Deep Learning.

UNIT – 3

Deep Networks: Modern Practices-Example: Learning XOR, Gradient-Based Learning, Hidden Units, Architectural Design, Back-Propagation Algorithm.

UNIT - 4

Convolutional Networks: Recurrent Neural Networks, Applications- Natural Language Processing, Recommender Systems.

Self-Learning Component:

Linear factor Models, Structured probabilistics Models, Monte-Carlo Methods, Deep generative Modles.

Recommended Learning Resources (Text book):

1. Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning." First edition, An MIT Press book in preparation, 2015.

Recommended Learning Resources (Reference books):

1. Duda, R.O., Hart, P.E., and Stork, D.G. Pattern Classification. Wiley-Interscience. 2nd Edition. 2001.
2. Theodoridis, S. and Koutroumbas, K. Pattern Recognition. Edition 4. Academic Press, 2008.
3. Russell, S. and Norvig, N. Artificial Intelligence: A Modern Approach. Prentice Hall Series in Artificial Intelligence. 2003.
4. Springer Journal of Machine Learning.

Mapping COs with POs (Program outcomes):

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	L	M	-	-	-	-	-	-	-	-
CO2	M	-	L	M	L	-	-	L	-	-	-	-
CO3	L	-	L	M	M	-	-	L	-	-	-	-
CO4	L	L	-	M	L	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7053	Multimedia Computing & Networks	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Computer networks [B18CS5030] and Operating Systems [B18CS5040]

Course Description

This Course provides the knowledge of multimedia operating Systems and Quality of Service, compression standards, Network Protocols for multimedia communication and multimedia over wireless networks.

Course Objectives:

The objectives of this course are to:

1. Gain fundamental knowledge in understanding the basics of different multimedia networks and constrainsts for a good Quality of service in multimedia environment.
2. Demonstrate the process management and multimedia buffer management technique.
3. Explain the Network Services and Protocols for Multimedia Communications
4. Gain fundamental knowledge about multimedia communication across different networks.

Course Outcomes:

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

CO1: Identify the requirements and constraints for a good Quality of service in multimedia environment.

CO2: Make use of multimedia operating systems concepts to solve given real world application.

CO3: Develop Internet Telephony using Network Services and Protocols for effective Multimedia Communications.

CO4: Analyze the performance of the multimedia data transfer protocols used for Real world application.

Course Content:

UNIT - 1:

Introduction - Interdisciplinary Aspects of Multimedia, Quality of Service, Multimedia Operating Systems, Multimedia Networking and Communication, Synchronization.

Quality of Service - Requirements and Constraint, Quality of Service Concepts, Resources, Establishment Phase, Run-time Phase of Multimedia Call, QoS Management Architectures.

UNIT - 2:

Multimedia Operating Systems - Process Management, Real-Time Processing Requirements,Traditional Real-Time Scheduling, Real-time Scheduling: System Model, Soft-Real-Time Scheduling Concepts, Scheduling Policies, Prototype Operating Systems, Interposes Communication and Synchronization, Memory Management, Reservation Concept for Memory Management, Buffer Management Techniques, Buffer Management for Client/Server Systems, Device Management, System Architecture.

UNIT - 3:

Network Services and Protocols for Multimedia Communications - Protocol Layers of Computer Communication Networks, Local Area Network and Access Networks, Internet Technologies and Protocols, Multicast Extension, Quality-of-Service for Multimedia Communications, Protocols for Multimedia Transmission and Interaction, Case Study: Internet Telephony

UNIT - 4:

Internet Multimedia Content Distribution - Broadcast/Multicast for Heterogeneous Users,Application-Layer Multicast, Peer-to-Peer Video Streaming with Mesh Overlays, HTTP-Based Media Streaming. Multimedia Over Wireless and Mobile Networks - Characteristics of Wireless Channels, Wireless Networking Technologies, Multimedia Over Wireless Channels, Mobility Management.

Self-Learning component:

Social Media Sharing- Representative Social Media Services, User-Generated Media Content Sharing, Media Propagation in Online Social Networks

Text books:

1. Li, Ze-Nian, Drew, Mark S., Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, First edition, 2014.

2. Steinmetz, Ralf, Nahrstedt, Klara, “Multimedia Systems” Springer, Second edition, 2004

References:

1. Fred Halshall “Multimedia communication - Applications, Networks, Protocols and Standards”, Pearson education, Second edition, 2007.

2. R. Steimnetz, K. Nahrstedt, “Multimedia Computing, Communications and Applications”, Pearson Education, Sixth edition, 2008.

3. IEEE, IEEE Transactions on Multimedia.

4. ACM, ACM Transactions on Multimedia Computing, Communications, and Applications

5. Elsevier, Elsevier Journal on Multimedia Computing. Springer, Springer Journals on Communication Networks

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	H	L	L	-	-	-	-	-
CO2	M	M	H	M	H	L	-	-	-	-	--	-
CO3	H	M	H	L	H	L	L	-	L	-	L	-
CO4	H	M	H	L	M	L	L	-	L	-		-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7054	Business Intelligence and Process Management	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Database Management Systems [B18CS4030]

Course Description

Business Intelligence and Process Management (BPM) offers many challenges for software developers and scientists. This course introduces the business intelligence process management concepts, where a student gains overview of all aspects of business intelligence and process modelling, business process architectures and business process methodologies.

Course Objectives

1. Identify the tools and techniques of business intelligence required addressing a real world problem.
2. Illustrate the use of data integration and extraction processes to derive meaningful information from the data collected from varioius sources.
3. Apply business intelligence to database and other enterprise systems.
4. Explain Business Process Management architectures and components of business process methodology

Course Outcomes (Cos):

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

CO1: Choose the concepts of Business Intelligence (BI) to be used for data intergration and extraction process.

CO2: Apply Data warehousing concepts for Business Intelligence (BI) applications.

CO3: Identify legal and privacy issues to develop Business Intelligence applications.

CO4: Analyse different Business Process Management architectures and components of business process methodology for real time appliations.

Course Content:

UNIT - 1:

Introduction to Business Intelligence: Overview; Changing Business Environments and computerized decision support, A framework for Business Intelligence (BI), Why a BI Program?, Transaction processing vs. Analytic processing, Successful BI Implementation, Major Tools and Techniques of BI.

UNIT - 2:

Data Warehousing: Definitions and concepts, Process Overview, Architectures, Data Integration & the Extraction, Transformation, & Load (ETL) Process, Development, Implementation Issues, Real-Time data warehousing, Security Issues, Case Studies and Examples.

UNIT- 3:

Business Intelligence Implementation: Integration & Emerging Trends: Overview, BI and Integration Implementation, Connecting BI Systems to database & other enterprise systems, On-demand BI, Issues of Legality, Privacy and Ethics, Emerging topics in BI: An Overview.

UNIT- 4:

Business Process Management Architectures and Methodology: Business Process Management

Architectures: Workflow Management Architectures; Flexible Workflow Management; Web Services and their Composition; Advanced Service Composition. Business Process Methodology: Methodology Overview; Strategy and Organization; Survey; Design Phase; Platform Selection; Implementation and Testing; Operation and Controlling Phase.

Introduction to Robotics Process automation (RPA), RPA abilities, RPA Tools.

Self-learning component:

Tableau Tool and SPSS tool, Business Process Choreography Design and Implementation; Service Interaction Patterns

Text Books:

1. E. Turban, R. Sharda, D. Delen, David King, Business Intelligence, 2nd ed. Pearson India, 2010.

2. David Loshin, Business Intelligence: The Savvy Manager's Guide, Getting Onboard with Emerging IT, Morgan Kaufmann, First edition, 2003.

3. Mathias Weske, Business Process Management, Springer, ebook, 2007

Reference books:

1. Marlon Dumas et. al., Fundamentals of Business Process Management, Springer, ebook, 2012.

2. Van der Aalst, Process Mining: Discovery, Conformance and Enhancement of Business Processes, Third edition, 2011.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	M	M	L	-	M	-	-	-	L	L	L	L
CO 2	H	M	H	M	-	-	-	-	-	-	H	
CO 3	H	H	M	M	-	H	H	H	-	L	M	L
CO 4	M	H	M	M	-	-	-	-	-	-	M	L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7061	Human Computer Interaction	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:

Programming with Java [B18CS3030], Computer Graphics and Animation (B18CS7062)

Course Description:

This course presents the foundations of Human Computer Interaction (HCI). The contents are structured into phases comprising: Basic definitions and motivations of HCI, interaction paradigms, design principles and models, User-centred design methods comprising user studies, design approaches for interfaces and interaction, evaluation methods and techniques for data analysis, Research frontiers of HCI, including accessibility, universal design, and pervasive computing (ubiquitous, mobile and wearable computing).

Course Objectives:

The overall objective of the Course is as follows:

1. Explain the capabilities of both humans and computers from the viewpoint of human information processing.
2. Describe typical human-computer interaction (HCI) models and styles, as well as various HCI paradigms.
3. Demonstrate the use of an interactive design process and universal design principles in designing HCI systems.
4. Illustrate the use of different evaluation methods.

Course Outcomes (Cos):

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

CO1 Identify the suitable positioning and pointing device to be used to work with the given application.

CO2 Develop the user interface by Selecting an effective style for the given real world applications.

CO3 Make use of different UI design rules to develop a user interface for a real-world application.

CO4 Compare the different evaluation techniques used to measure the quality of User Interface.

Course Content:

UNIT- 1

Introduction to Human and the Computer: Human: Input-output channels, Human memory, Thinking: reasoning and problem solving, Emotion, Individual differences, Psychology and the design of interactive systems. The computer: Positioning, pointing and drawing, Display devices, Devices for virtual reality and 3D interaction, Physical controls, sensors and special devices, Paper: printing and scanning, Memory, Processing and networks.

UNIT -2

The interaction and Paradigms: Models of interaction, Frameworks and HCI, Ergonomics, Interaction styles, Elements of the WIMP interface, Interactivity, The context of the interaction. Paradigms: Paradigms for interaction. Interaction design basics: The process of design, User focus, Scenarios, Navigation design, Screen design and layout, Iteration and prototyping.

UNIT- 3

HCI in the software process and Design rules: The software life cycle, Usability engineering, Iterative design and prototyping. Principles to support usability, Standards, Guidelines, Golden rules and heuristics, HCI patterns. Universal designs.

UNIT- 4

Evaluation techniques: Goals of evaluation, Evaluation through expert analysis, Evaluation through user participation, choosing an evaluation method.

Self-learning component:

Designing user support systems, Ubiquitous computing applications research, Hypertext, multimedia and the World Wide Web.

Text books:

1. Alan Dix, Janet Finlay, Gregory Abowd & Russell Beale, Human-Computer Interaction. 3rd Edition. Prentice Hall, 2004.

2. Julie A. Jacko, Human-Computer Interaction Handbook, 3rd Edition, CRC Press, 2012.

3. Ben Shneiderman, Catherine Plaisant, Designing the User Interface, 6th Edition, Addison Wesley, 2017.

Reference books:

1. Jonathan Lazar, Jinjuan Heidi Feng, & Harry Hochheiser Research Methods in Human- Computer Interaction, Wiley, Second edition, 2010.
2. ACM, International Journal of Human-Computer Studies.
3. IEEE, Transactions on Human-Machine Systems.
4. Elsevier, International Journal of Human-Computer Studies.

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	L	M	-	-	-	-	-	-	-
CO2	H	M	L	L	M	-	-	-	-	-	-	-
CO3	H	M	M	H	H	-	-	-	-	-	-	-
CO4	M	H	H	M	M	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7062	Computer Graphics and Animation	L	T	P	C
Duration :14Wks		2	0	1	3

Prerequisites:

Programming for Problem Solving [B18CS1030]

Course Description:

This course introduces techniques, algorithms and principles of interactive computer graphics and animation, this course also prepares for study in real-time rendering, realistic image synthesis, and computer animation.

Course Objectives:

Objectives of this course are to:

1. Explain the basic principles of 3-dimensional computer graphics using Software and Hardware.
2. Describe the basics of Geometric transformation systems.
3. Demonstrate the use of two and three dimensional viewing pipeline.
4. Illustrate the use of Animation and Flash overview.

Course Outcomes (Cos):

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

CO1 Develop interactive computer graphics programs using OpenGL

CO2 Apply three dimensional transformations for a real world application

CO3 Identify requirements and constraints of two and three dimensional viewing pipeline.

CO4 Design Animations using ADOBE Flash for the given real world application.

Course Content:

UNIT- 1

Introduction to various graphical tools and platforms, OPENGL: Open GL Primitives & Attributes Pixel addressing and object geometry, Fill Area Primitives, Polygon Fill Areas, OpenGL Polygon Fill, Area functions, OpenGL Vertex arrays, Pixel Array Primitives, OpenGL Pixel array functions, Character Primitives, OpenGL Character Functions, OpenGL Display Lists, Open GL

Display Window Reshape Functions; OpenGL state variables, Colour and gray scale, openGL colour functions, Point Attributes, Line Attributes, General Scan Line Polygon Fill Algorithm

UNIT -2

Geometric Transformations Basic Two-dimensional Geometric Transformations, Matrix representation and Homogeneous Coordinates, Inverse Transformations, Two Dimensional Composite Transformations, Geometric transformations in Three dimensional Space, Three dimensional Translation, Three dimensional Rotation, Three dimensional Scaling, Composite Three dimensional Translation, Other Three dimensional Translation, Transformations

UNIT- 3

Viewing The Two and Three Dimensional Viewing Pipeline, The clipping window, Normalization and view port transformation., OpenGL Two Dimensional Viewing functions, Clipping algorithms,; Over view of Three dimensional Viewing concepts, The Three dimensional Viewing pipeline, Three dimensional Viewing coordinate parameters, transformation from word to viewing coordinates, Projections transformation, Orthogonal projections, Oblique parallel projections, Perspective Projections, Open GL Three dimensional viewing functions

UNIT- 4

Animation and Flash overview: Development of animation, Non Computer and computer based animation, Flash basics, Flash Work Environment, drawing overview, creating text boxes, creating animation.

Self-learning components:

Lighting and shading models, Tools for graphics and animation, VFX

Text books:

1. Edward Angel, Interactive Computer Graphics A Top Down Approach with OpenGL, Addison- Wesley, 5th Edition,2008

2. Malay K. Pakhira, Computer Graphics and Animation, PHI Learning Pvt. Ltd., First edition, 2010

Reference books:

1. Foley, Van Damn, Feiner and Hughes, Computer Graphics: Principles and Practice. Addison Wesley.

2. Modeling in Computer Graphics: Proceedings of the IFIP WG 5.10 Working Conference Tokyo, Japan, April 8-12, 1991 (IFIP Series on Computer Graphics) by Tosiyasu L Kunii

Mapping Cos with POs (Program Outcomes):

Course Outcomes	Program Outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	H	M	H	L	H			L				
CO2	H	M	H	M	H							
CO3	H	H	M	M	H							
CO4	M	L	M	M	H	L		L				

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7063	Software Defined Networks and Network Function Virtualization	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:

Computer Networks (B18CS5030)

Course Description:

The course introduces the concepts of Software Defined Networks, how SDN works and SDN in other environments. It also describes OpenFlow which is used for open network switching experiments. The last section covers Network Function Virtualization, its architecture and some of the research challenges in the design of NFV.

Course Objectives:

The objectives of this course are to:

1. Discuss the significance of SDN.
2. Demonstrate the use of different types of software defined networks.
3. Illustrate the use of Openflow additions in a real world application
4. Describe the virtual environment required to provide various services to users

Course Outcomes (COs):

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

CO1 Identify the role of SDN in a given real world applications.

CO2 Analyze the functions of different types of software defined networks

CO3 Make use of Openflow additions in a real world application

CO4 Develop a virtual environment to provide various services to users

Course Contents:

UNIT - 1:

Software Defined Networks – Introduction: Basic Packet-Switching Terminology, Historical Background. The Modern Data Centre, Traditional Switch Architecture, Autonomous and Dynamic Forwarding Tables, Can We Increase the Packet-Forwarding IQ?

Why SDN? : Evolution of Switches and Control Planes, Cost, SDN Implications for Research and Innovation, Data Centre Innovation, Data Centre Needs.

The Genesis of SDN: The Evolution of Networking Technology, Forerunners of SDN, Software Defined Networking is Born, Sustaining SDN Interoperability, Open Source Contributions, Legacy Mechanisms Evolve toward SDN, Network Virtualization.

UNIT - 2:

How SDN Works: Fundamental Characteristics of SDN, SDN Operation, SDN Devices, SDN Controller, SDN Applications, Alternate SDN Methods and Conclusion.

SDN in Other Environments: Wide Area Networks, Service Provider and Carrier Networks, Campus Networks, Hospitality Networks, Mobile Networks, In-Line Network Functions, Optical Networks, SDN vs. P2P/Overlay Networks and Conclusion.

UNIT - 3:

The OpenFlow Specification: Chapter-Specific Terminology, OpenFlow Overview, OpenFlow 1.0 and OpenFlow Basics, OpenFlow 1.1 Additions, OpenFlow 1.2 Additions, OpenFlow 1.3 Additions, OpenFlow Limitations and Conclusion.

UNIT - 4:

Network Function Virtualization: Introduction, History of Network Function Virtualization, NFV Examples and Related Work and Open Questions.

NFV Architecture: NFV Infrastructure (NFVI), Virtual Network Functions and Services, NFV Management and Orchestration (NFV MANO).

Business Model And Design Considerations: Business Model, NFV Design Considerations, NFV, SDN and Cloud Computing, NFV Standardization Activities, Collaborative NFV Projects, NFV Implementations.

Research Challenges: Management and Orchestration, Energy Efficiency, NFV Performance, Resource Allocation, Security, Privacy and Trust Modelling of Resources, Functions and Services and Research Directions in Selected NFV Use Cases.

Self-learning component:

Explore SDN in the data centre and also SDN applications.

Text books:

1. Paul Göransson, Chuck Black, "Software Defined Networks - A Comprehensive Approach", Morgan Kaufmann, 2014.

2. Rashid Mijumbi, Joan Serrat, Juan-Luis Gorricho, Niels Bouten, Filip De Turck, Raouf Boutaba, "Network Function Virtualization: State-of-the-art and Research Challenges", IEEE COMMUNICATIONS SURVEYS & TUTORIALS, 2015.

References:

1. Siamak Azodolmolky, "Software Defined Networking with OpenFlow", Packt Publishing Ltd, 2013.

2. Sreenivas Voruganti, Sriram Subramanian,"Software Defined Networking with OpenStack", Packt Publishing Ltd, 2016.

3. Jim Doherty, "SDN and NFV Simplified", Pearson Education, 2016.
Doug Marschke, Jeff Doyle, Pete Moyer, "Software Defined Networking: Anatomy of OpenFlow", Lulu Publishing services, 2015

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M	-	-	-	-	-	-	-
CO2	H	H	H	H	M	-	-	-	-	-	-	-
CO3	H	H	H	M	H	L	L	-	-	-	-	-
CO4	H	H	H	H	M	L	L	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7064	Advanced Web Technology	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:

Web Application Development [B18CS7010], Programming with Java [B18CS3030].

Course Description:

This course covers features of HTML 5 and CSS 3, controls and web services of ASP.Net and database access with MYSQL, basics of AngularJS, basics of AJAX and JQuery AJAX library, basics of Ruby, controls and RESTFul web services. These concepts are used in the development of Client-Server technology.

Course Objectives:

The objectives of this course are to:

1. Explain the features of HTML 5 and CSS-3.
2. Illustrate the use of ASP.Net and Angular JS as front end and MYSQL as backend in real world applications.
3. Demonstrate the use of AJAX and Ruby in real world applications.
4. Discuss the different RESTFul Web Services available for users.

Course Outcomes::

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

CO1 Utilize the tags of HTML5 and CSS3 to create web pages for a real world application.

CO2 Develop an agriculture website using ASP.Net and Angular JS for creating a front end and MYSQL as backend.

CO3 Build a regular expression in ruby to Validate the phone no for its correctness..

CO4 Design an application for making use of the different RESTFul Web Services available.

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Course Content:

UNIT-1

HTML 5 and CSS-3: Basic HTML Structure, Text, Images, CSS Building Blocks, Working with Style Sheets-Creating an External Style Sheet, Linking to External Style Sheets, Creating an Embedded Style Sheet, Formatting Text with Styles, Layout with Styles.

UNIT-2

ASP.Net and AngularJS : ASP.Net-Overview of .NET Framework, Introduction to C#, ASP.NET, ASP.NET Controls, Web Services, Architectures for Database Access, MYSQL Database System, Database Access with JDBC and MYSQL, AngularJS- The Basics of AngularJS, Databinding and first AngularJS Web Application.

UNIT-3

Ruby and AJAX: Origins and uses of Ruby, Scalar types and their operations, Simple input and output, Control statements, Arrays, Hashes, Methods, Classes, Code blocks and iterators, Pattern matching. Basic communication techniques – XHR, AJAX with images, Dynamic script loading, Cache control, AJAX patterns-Communication control patterns – predictive fetch, page preloading, submission throttling, periodic refresh, and multi-stage download, Fallback patterns, AJAX libraries – JQuery, JSON.

UNIT-4

Restful Web Services: What Makes RESTful Services Different?- Introducing the Simple Storage Service, Object-Oriented Design of S3, Resources, HTTP Response Codes, An S3 Client, Request Signing and Access Control, Using the S3 Client Library, Clients Made Transparent with ActiveResource, Parting Words, The Resource-Oriented Architecture, REST and ROA Best Practices, Ajax Applications as REST Client.

Self-learning Component:

Rails, Angular JS complete study.

Text books:

l. Elizabeth Castro, Bruce Hyslop, HTML5 and CSS3, 7th Edition, Peachpit Press, 20l2

2. Robert W. Sebesta, Programming the World Wide Web, 4th Edition, Pearson Education, 2008.

3. Nicholas C Zakas et al, Professional AJAX, 2nd Edition, Wrox publications,2007.

4. Ari Lerner, The Complete Book on AngularJS, Fullstack.io, 20l3.

5. Leonard Richardson and Sam Ruby, RESTFul Web Services, lst Edition, O'Reilly publications, 2007.

References:

l. Deitel P, Deitel HM, Internet and World Wide Web How To Program, Pearson Education, 20l2

2. AchyutS. Godbole and AtulKahate, Web Technologies, Tata McGraw Hill, 2003.

3. Jason Hunter, William Crawford, Java Servlet Programming, O'Reilly Publications, l998.

4. Paul S Wang, SandaKatila An introduction to Web design and programming Cengage Course, 2003.

5. ACM Transactions on Internet Technology

6. IEEE International Conference on Enterprise Computing and E-Commerce.

7. ACM Transactions on Information Systems.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**P03**	**PO4**	**PO5**	**P06**	**PO7**	**PO8**	**P09**	**PO10**	**PO11**	**P012**
CO1	M	H	M	H	M	-	-	-	-	-	-	-
CO2	M	M	H	H	M	-	-	-	-	-	-	-
CO3	H	H	M	M	M	-	-	-	-	-	-	-
CO4	M	M	H	H	H	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO

B18CS7071	Big Data Analytics	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:

Programming with Java (B18CS3030), Database Management System (B18CS4030)

Course Description:

This course provides practical foundation level training that enables immediate and effective participation in big data projects. The course provides grounding in basic and advanced methods to big data technology and tools, including MapReduce and Hadoop and its ecosystem.

Course Objectives:

1. Explain the concepts of Big Data and its Business Implications
2. Describe the features of Big-Data Analytics.
3. Demonstrate the use of features of Apache Hadoop Framework.
4. Discuss features of Pig and Hive.

Course Outcomes (Cos):

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

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

CO1: Outline the concepts of Big Data and its Business Implications.

CO2: Apply the theories of Big Data Analytics in the domain of Data warehousing and Mining.

CO3: Develop a real world application using features of Hadoop.

CO4: Make use of features of Pig and Hive for data analytics

Course Contents:

Unit-1:

Introduction to Big Data: - Classification of digital data, characteristics of data, evolution of big data, definition of big data, challenges with big data, what is big data, why big data, traditional business intelligence (BI) versus big data, A typical data warehouse environment, A typical hadoop environment, Terminologies used in Big Data Environments.

Unit-2:

Big Data Analytics-Where do we begin, what is Big Data Analytics, What Is Big Data Analytics ISN'T? Why this sudden hype around Big Data Analytics, Classification of Analytics, top challenges facing big data, why is big data analytics, Why is big Data Analytics Important, what kind of technologies are we looking toward to help meet the challenges posed by big data? Data Science, Few top analytical tools.

Unit-3:

Introduction to Hadoop:-Introducing Hadoop, why Hadoop, why not RDBMS, RDBMS versus Hadoop, History of Hadoop, Hadoop overview, usecase of Hadoop, Hadoop distributors, HDFS, Processing data with Hadoop, Hadoop-Features of Hadoop. MapReduce Daemons, How MapReduce works, MapReduce Example, Interacting with Hadoop Ecosystem, Mapper, Reducer, Combiner, Partitioner.

Unit-4:**Hadoop Related tools**:-Introduction to PIG, What is PIG, The anatomy of PIG,PIG on Hadoop, PIG Latin, Data types in PIG, running PIG, Execution modes,HDFS Commands, Relational operators, PIG versus Hive, Introduction to HIVE, What is hive ,hive architecture, hive data types, hive file formats,HQL,UDF.

Self-learning component:

NoSQL, MongoDB, Cassandra, Yarn, Flume, Sqoop

Text books:

1. *Seema Acharya, Subhashini Chellappan, Big data and data Analytics, Wiley, 2015.*
2. *O'Reilly, Hadoop The Definitive Guide, Tom White,2012*

Reference books:

1. Michael Minelli, Michele chambers, Ambiga Dhiraj: Big data, big analytics, Wiley,2013
2. P. Tan, M. Steinbach, V. Kumar, Introduction to Data Mining, Addison-Wesley, 2005.
3. J. Han, M. Kamber, Data Mining: Concepts and Techniques, 2nd ed. Morgan Kaufmann 2005.
4. IEEE,Introduction to the IEEE Transactions on Big Data
5. Elsevier,Big data research journal Elsevier
6. Springer, Journal on Big Data Springer.
7. ACM DL,The Journal of Machine Learning Research-ACM

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	M	H	H	M	M	-	-	-	L	-	-	H
CO 2	H	H	H	H	H	-	-	-	L	-	-	H
CO 3	H	H	H	H	H	-	-	-	L	-	-	H
CO 4	H	H	H	H	H	-	-	-	M	-	-	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7072	Block chain Technology	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Computer Networks (B18CS5030) and Database management System (B18CS4030).

Course Description:

Blockchain 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 blockchain. Blockchains 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 Objectives:

1. 1. Explain the basic concepts of Block chain technology.
2. Describe the features of Ethereum block chain technology.
3. Demonstrate the Smart Contract Basics interaction with users
4. Discuss different BlockChain Platforms that can be used in real world applications.

Course Outcomes:

CO1: Apply the features of Block chain technology in real world application.

CO2: Develop an application using Ethereum and solidity.

CO3: Design an application for making use of smart contract.

CO4: Make use of different blockchain platforms in real world application.

Course Content:

Unit-1:

Unit-1: The Blockchain: Introduction, Types of Blockchain, Structure of a Block,Block Header,Block Identifiers: Block Header Hash and Block Height,The Genesis Block,Linking

Blocks in the Blockchain,Merkle Trees and Simplified Payment Verification (SPV), Using Test Blockchains for Development.

Mining and Consensus :Introduction, Constructing the Block Header, Mining the Block, Proof-of-Work Algorithm, Target Representation, Successfully Mining the Block, Validating a New Block, Assembling and Selecting Chains of Blocks, Blockchain Forks,

Unit-2: Technology on Ethereum: Ethereum Accounts, Ethereum Work, Decentralized Applications, Decentralized Autonomous Organizations. Ethereum Blockchain Development, Best Practices, Solidity: Structure, Basic Data Types & Statements, Specific Data Types, Data Structures, Access Modifiers & Applications

Unit-3: Smart Contract Basics: Smart Contract Design, Smart Contract Life Cycle: Smart Contract interaction with Users and Enterprise Applications, Debugging Your Smart Contract, Smart Contract Validation, Run Ethereum Dapps in your browser, Develop a simple smart contract.

Unit 4: BlockChain Platforms: Alpha point distributed ledger programs, Corda, Chain Core, DomusTower, Hydra Chain, MultiChain, Hyperledger, Quorum, Stellar Blockchain Applications
: Global Public Health, Genomics, Block Chain Health, bitcoin and cryptocurrency.

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. Melanie Swan "Blockchain: Blueprint for a New Economy", O'Reilly Media, Third edition, Aug 2015.

3. Andreas M. Antonopoulos, Gavin Wood "Mastering Ethereum", O'Reilly Media, Inc., November 2018

Reference books:

1. Imran Bashir, Mastering Blockchain: Distributed ledger technology, decentralization, and smartcontracts" Packt , 2nd edition 2018.

2. Jimmy Cooper,“Blockchain Blueprint: Guide to Everything You Need to Know About Blockchain Technology and How It Is Creating a Revolution “,CreateSpace Independent Publishing Platform, 2017.

3. Deepak Puthal; Nisha Malik; Saraju P. Mohanty; Elias Kougianos; Chi Yang “The Blockchain as a Decentralized Security Framework [Future Directions]” Volume: 7, Issue: 2 , Pages: 18 – 21,Year: 2018.

4. Valentina Gatteschi; Fabrizio Lamberti; Claudio Demartini; Chiara Pranteda; Víctor Santamaría” To Blockchain or Not to Blockchain: That Is the Question “Volume: 20, Issue: 2 Pages: 62 - 74 ,2018.

5. Tien Tuan Anh Dinh; Rui Liu; Meihui Zhang; Gang Chen; Beng Chin Ooi; Ji Wang “Untangling Blockchain: A Data Processing View of Blockchain Systems” , Volume: 30, Issue: 7 ,Pages: 1366 – 1385 , Year: 2018.

6. 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.

7. 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.

8. Ashiq Anjum; Manu Sporny; Alan Sill “ Blockchain Standards for Compliance and Trust” , Volume: 4, Issue: 4 ,Pages: 84 – 90,Year: 2017.

9. Morgen E. Peck; Samuel K. Moore “The blossoming of the blockchain” , Volume: 54, Issue: 10 Pages: 24 – 25, Year: 2017.

10. Inderscience Journal of blockchain and cryptocurrency.

11. Ledger Journal of Cryptocurrency and Blockchain Technology.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	O8	PO9	PO10	PO11	PO12
CO1	M	M	M	M	M	_	_	_	_	_	_	L
CO2	H	H	M	H	M	_	_	_	_	_	_	L
CO3	M	H	H	M	M	_	_	_	_	_	_	L
CO4	M	H	H	M	M	_	_	_	_	_	_	L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7073	Cloud Security	L	T	P	C
Duration:14Wks		3	0	0	3

Prerequisites:

Cloud Computing and Bigdata(B18CS6020).

Course Description:

Cloud security is an evolving sub-domain of computer security, network security, and, more broadly, information security. It refers to a broad set of technologies deployed to protect data, applications, and the associated infrastructure of cloud computing. This course provides a practical survey of both the principles and practice of cloud security. The emphasis of this course is on the underlying principles and techniques of cloud security with examples of how they are applied in practice.

Course Objectives:

The objectives of this course are to:

1. Describe the cloud security principles and mechanisms.

2. Demonstrate the building of cloud security infrastructure using computer programming and configuration skills.

3. Illustrate how to discover threats and vulnerabilities to cloud computing.

4. Explain how to fix cloud security weaknesses.

Course Outcomes (COs):

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

CO 1: Choose the suitable cloud deployment model for storage of data pertaining to given applications.

CO 2: Build a cloud security infrastructure using computer programming and configuration skills.

CO 3: Identify the security management issues in the cloud with respect to SaaS ,IaaS and PaaS.

CO 4: Make use of various security policies for implementation of given real world problem.

Course Content:

Unit- 1

Introduction to Cloud Computing: Cloud Computing Defined, The SPI Framework for Cloud Computing, The Traditional Software Model, The Cloud Services Delivery Model, Cloud Deployment Models, Key Drivers to Adopting the Cloud, The Impact of Cloud Computing on Users, Governance in the Cloud, Barriers to Cloud Computing Adoption in the Enterprise

Infrastructure Security: The Network Level, Infrastructure Security: The Host Level, Infrastructure Security: The Application Level

Unit -2

Data Security and Storage: Aspects of Data Security, Data Security Mitigation, Provider Data and Its Security

Identity and Access Management: Trust Boundaries and IAM, Why IAM?, IAM Challenges, IAM Definitions, IAM Architecture and Practice, Getting Ready for the Cloud, Relevant IAM Standards and Protocols for Cloud Services, IAM Practices in the Cloud, Cloud Authorization Management, Cloud Service Provider IAM Practice

Unit- 3

Security management in the cloud: Security Management Standards, Security Management in the Cloud, Availability Management, SaaS Availability Management, PaaS Availability Management, IaaS Availability Management, Access Control, Security Vulnerability, Patch and Configuration Management

Privacy: What Is Privacy? What Is the Data Life Cycle? What Are the Key Privacy Concerns in the Cloud?

Who Is Responsible for Protecting Privacy? Changes to Privacy Risk Management and Compliance in Relation to Cloud Computing, Legal and Regulatory Implications, U.S. Laws and Regulations, International Laws and Regulations

Unit- 4

Audit and Compliance: Internal Policy Compliance, Governance, Risk, and Compliance (GRC), Illustrative Control Objectives for Cloud Computing, Incremental CSP-Specific Control Objectives, Additional Key Management Control Objectives, Control Considerations for CSP Users, Regulatory/External Compliance, Other Requirements, Cloud Security Alliance

Security-As-A-[Cloud] Service: Origins, Today's Offerings

Self-learning component:

Explore any one of the cloud (Amazon/Microsoft/Google/IBM/Cisco/Intel/Salesforce) for security.

Text books:

1. Tim Mather, Subra Kumaraswamy, Shahed Latif, Cloud Security and Privacy-An Enterprise Perspective on Risks and Compliance,2009, O'Reilly.

2. Vic (J.R.) Winkler, Securing The Cloud: Cloud Computing Security Techniques and Tactics Syngress/Elsevier - 978-1-59749-592-9

Reference books:

1. Tim Mather, Subra Kumaraswamy, Shahed Latif, Cloud Security and Privacy

An Enterprise Perspective on Risks and Compliance, O'Reilly Media, September 2009

2. Yeluri, Raghuram, Castro-Leon, Enrique, Building the Infrastructure for Cloud Security A Solutions View, Apress, 2014.

3. John Rhoton, Cloud Computing Protected: Security Assessment Handbook, 2013.

4. Ronal L Krutz, Russel Dean Vines, Cloud Security- A comprehensive Guide to Secure cloud Computing,Wiley.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	O8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	L	_	_	_	_	_	_	_
CO2	H	H	M	H	L	_	_	_	_	_	_	_
CO3	H	M	H	M	M	_	_	_	_	_	_	_
CO4	H	H	H	M	M	_	_	_	_	_	_	_

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS7074	Bio-Informatics	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Knowledge of Data Science, Molecular Biology

CourseDescription:

This course introduces to the basic biology of modern genomics and the experimental tools that is used to measure it. Central Dogma of Molecular Biology is introduced and how next-generation sequencing can be used to measure DNA, RNA, and epigenetic patterns is done is covered. An introduction to the key concepts in computing and data science, how data from next-generation sequencing experiments are generated and analyzed are covered.

Course Objectives

1. Explain the concepts of biological databases.
2. Demonstrate the use of different search and Data Retrieval techniques.
3. Discuss the genome analysis, mapping and genomesequencing.
4. Illustrate the use of different gene prediction methods

Course Outcomes(Cos):

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

CO 1: Outline the concepts of biological databases for data reterival.

CO 2: Make use of search and data retrieval techniques for the given real world genome data .

CO 3: Apply the genome analysis, mapping and genome sequencing to predict the gene.

CO 4: Develop Gene Identification and Prediction models for given genome data.

CourseContent:

Unit-1

Bioinformatics: An Introduction

Introduction, Historical Overview and Definition, Bioinformatics Applications, Major Databases in Bioinformatics, Data Management and Analysis, Molecular Biology and Bioinformatics, Central Dogma of Molecular Biology, Biological Databases Considerations.

Unit-2

Information Search and Data Retrieval:

Introduction, Electronic Libraries, Tools for Web Search, Data Retrieval Tools, Data Mining of Biological Databases.

Unit-3

Genome Analysis and Gene Mapping

Introduction, Genome Analysis, Genome Mapping, The Sequence Assembly problem, Genetic Mapping and Linkage Analysis, Physical Maps, Cloning the entire Genome, Genome Sequencing, Applications of Genetic Maps, Sequence Assembly Tools, Identification of Genes in Contigs, The Human Genome Project.

Unit-4

Gene Identification and Prediction

Introduction, Basis of Gene Prediction, Pattern Recognition, Gene Prediction Methods, Other Gene Prediction Tools.

Self-learning components:

Genome data management, sequencing the pairs of genomes, Hidden Markov Models, Phylogenetics.

Text books:

1. S.C. Rastogi, N. Mendiratta, P. Rastogi,Bioinformatics Methods and Applications, 4th Edition, EEE, PHI, 2013. 2. Andreas D. Baxevanis, B. F. Francis Ouellette, BIOINFORMATICS A Practical Guide to the Analysis of Genes and Proteins, 2nd Edition, Wiley Interscience, 2001

Referencebooks:

1. Lloyd Low, Martti Tammi, Bioinformatics-Practical-Generation-SequencingApplications,2017

2. T. R. Sharma, Genome-Analysis-Bioinformatics-Practical-Approach, I.K. International Publishing House Pvt. Ltd,2009

3. Genomic Data Science /Coursera

4. Introduction to Genomic Data Science /edX

5. Computational Genomics and Data Science Program, National Human Genome ResearchInstitute.

6. The Analysis of Gene Expression Data: An Overview of Methods andSoftware, Giovanni Parmigiani, Elizabeth S. Garrett, Rafael A. Irizarry, Scott L.Zeger

Mapping COs with POs (Programoutcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	H	-	M	H	-	-	-	-	-	-	-
CO 2	H	H	L	L	-	-	-	-	-	-	-	-
CO 3	H	H	H	M	L	-	-	-	-	-	-	-
CO 4	M	H	H	L	L	-	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

VIII Semester Syllabus

B18CS8031	Real Time Systems	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Operating systems [B18CS5040]

Course Description

This course familiarizes the fundamental problems concepts and approaches in the design and analysis of real-time systems. It also introduces various approaches, abstract models and terminologies for real-time scheduling. It also outlines various Priority-Ceiling Protocols used in resource sharing. Also gives the Impart knowledge of Real Time Operating Systems and Databases.

Course Objectives

The objectives of the course are to:

1. Explain the concepts of real-timesystems.
2. Demonstrate the use of algorithms in designing a real-timesystem.
3. Describe access Control in Multiple-Unit Resources to analyze, design and schedule the real- timesystems.
4. Discuss the characteristics of Real Time Operating Systems and Databases in newprojects.

Course Outcomes

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

CO1: Identify the fundamentals of Signal Processing and real-time systems.

CO2: Choose the appropriate algorithm to analyze and design a real-time system.

CO3: Make use of access Control in Multiple-Unit Resources to analyse, design and schedule the real-time systems.

CO4: Develop the applications using the characteristics of Real Time Operating Systems and Databases.

CourseContent:

Unit1:

Introduction: Definition, Typical Real Time Applications: Digital Control, High Level Controls, Signal Processing, Release Times, Deadlines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and DataDependency.

Unit 2:

Real Time Scheduling: Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective-Deadline-First (EDF) and Least-Slack-Time-First (LST) Algorithms, Rate Monotonic Algorithm, Offline Versus Online Scheduling, Scheduling Aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems.

Unit 3:

Resources Sharing: Effect of Resource Contention and Resource Access Control (RAC), Non-preemptive Critical Sections, Basic Priority-Inheritance and Priority-Ceiling Protocols, Stack Based Priority-Ceiling Protocol, Use of Priority-Ceiling Protocol in Dynamic Priority Systems, Preemption Ceiling Protocol, Access Control in Multiple-Unit Resources, Controlling Concurrent Accesses to Data Objects.

Unit 4:

Real Time Operating Systems and Databases: Features of RTOS, Time Services, UNIX as RTOS, POSIX Issues, Characteristic of Temporal data, Temporal Consistency, Concurrency Control, Overview of Commercial Real Time databases.

Self-Learning Component:

Case study on features of VxWorks and QNX.

Textbooks:

1. Jane W. S. Liu, Real Time Systems, Pearson Education Publication2000.

2. Mall Rajib, “Real Time Systems”, Pearson Education,2007

References:

1. Albert M. K. Cheng, “Real-Time Systems: Scheduling, Analysis, and Verification”, Wiley,2003

2. Springer, International Journal of Time-Critical ComputingSystems

3. Inderscience, International Journal of Embedded and Real-Time CommunicationSystems

4. Research Science Press, International Journal of Embedded Systems andComputer Engineering.

Mapping COs with POs (Programoutcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	L	L	-	-	-	-	-	-	L
CO2	H	H	M	H	M	-	-	-	-	-	-	H
CO3	H	H	M	M	L	-	-	-	-	-	-	M
CO4	H	M	M	H	M	-	-	-	-	-	-	H

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS8032	Innovation and Entrepreneurship	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

NIL

Course Description:

Students will develop skills for evaluating, articulating, refining, and pitching a new product or service offering, either as a start-up business or a new initiative within an existing firm. This course is appropriate for all students interested in innovation and design as necessary components of new businesses today. The aims to acquaint the students with challenges of starting new ventures and enable then to investigate, understand and internalize the process of setting up a business.

Course Objectives (Cos):

The objectives of this course are to:

1. Explain the basics of Entrepreneurship.

2. Demonstrate the use of different Business Models and Planning for Business.

3. Describe different Operations and Management techniques required for a business

4. Discuss various sources of finance to establish a business.

Course Outcomes (Cos):

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

CO1: Outline the basics of Entrepreneurship to identify key startup ideas

CO2: Make use of different Business Models and Planning for establishing a Business.

CO3: Apply the different Operations and Management techniques in setting up a new venture.

CO4: Identify the various sources of finance to establish a business.

Course Contents:

Unit 1

Basics of Entrepreneurship: Concept, knowledge and skills requirement; characteristic of successful entrepreneurs; role of entrepreneurship in economic development; entrepreneurship process; factors impacting emergence of entrepreneurship; managerial vs. entrepreneurial approach and emergence of entrepreneurship.

Unit 2

Starting the venture and Developing Successful Business Ideas: generating business idea – sources of new ideas, methods of generating ideas, creative problem solving, opportunity recognition; environmental scanning, competitor and industry analysis; feasibility study: market feasibility, technical/operational feasibility, financial feasibility; drawing business plan; preparing project report; presenting business plan to investors; Writing a Business Plan, Industry and Competitor Analysis, Developing an Effective Business Model

Unit 3

Functional plans for Managing and Growing an Entrepreneurial Firm: Marketing plan – marketing research for the new venture, steps in preparing marketing plan, contingency planning; organizational plan: form of ownership, designing organization structure, job design, manpower planning; Financial plan: cash budget, working capital, Performa income statement Performa cash flow, perform balance sheet, break even analysis, Preparing for and evaluating the challenges of Growth, Strategies for Firm Growth, Franchising.

Unit 4

Sources of finance: Debt or equity financing, commercial banks, venture capital; financial institutions supporting entrepreneurs; legal issues: intellectual property rights patents, trademarks, copy rights, trade secrets, licensing; franchising

Self-learning component:

The role of ICT and innovation in enhancing organizational performance

Text Books:

1. Entrepreneurship Development, Hisrich, Robert D., Michael Peters and Dean Shepherded, ,Tata McGraw Hill, ND,2007.

2. Entrepreneurship, , Brace R., and R., Duane Ireland, , Pearson Prentice Hall, New Jersy (USA),2015.

Reference Books:

1. Entrepreneurship, Lall, Madhurima, and Shikha Sahai, , Excel Book, New Delhi, 2008.

2.. Entrepreneurship Development and Small Business Enterprises, Charantimath, Poornima, Pearson Education, New Delhi.

Mapping COs with POs Programoutcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	M	L	-	-	L	L	-	M	M	M	M
CO2	L	M	L	-	L	L	L	-	M	M	M	M
CO3	L	L	L	-	L	L	L	-	M	M	M	M
CO4	L	L	L	-		L	L	-	M	M	H	M

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS8033	Ethical Hacking and IT Security Evaluation	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Cryptography and Network Security [B18CS7020]

Course Description

Computers around the world are systematically being victimized by rampant hacking. The goal of the ethical hacker is to help the organization take preemptive measures against malicious attacks by attacking the system himself; all the while staying within legal limits. As technology advances and organization depend on technology increasingly, information assets have evolved into critical components of survival. If hacking involves creativity and thinking 'out-of-the-box', then vulnerability testing and security audits will not ensure the security proofing of an organization. To ensure that organizations have adequately protected their information assets, they must adopt the approach of 'defense in depth'. In other words, they must penetrate their networks and assess the security posture for vulnerabilities and exposure. This course helps develop individuals in the specific network security discipline of Ethical Hacking from a vendor-neutral perspective.

Course Objectives:

The objectives of this course are to:
1. Explain the concepts of Ethical Hacking.
2. Describe the different techniques used in Ethical hacking and security.
3. Discuss different Ethical hacking tools used to perform various activities.
4. Demonstrate the intrusion detection and prevention systems (IDPS).

Course Outcomes:

On completion of this course; the student will be able to:
CO1: Outline the basic concepts of Ethical Hacking.
CO2: Identify the Enumeration Techniques and tools to be used for the given real world applications.
CO3: Make use of the different Ethical hacking and security tools and techniques in the given applic ation.
CO4: Develop an intrusion detection and prevention system (IDPS) for the given application.

UNIT - 1:

Introduction to hacking : Introduction to Hacking , Importance of Security ,Elements of Security ,Phases of an Attack, Types of Hacker Attacks , Hacktivism ,Vulnerability Research, Footprinting: Introduction to Footprinting, Information Gathering Methodology , Footprinting Tools, WHOIS Tools, DNS Information Tools, Locating the Network Range , Meta Search Engines.

UNIT - 2:

Scanning and enumeration: Introduction to Scanning, Objectives, Scanning Methodology, Tools,Introduction to Enumeration, Enumeration Techniques, Enumeration Procedure, Tools.

System hacking: Introduction, Cracking Passwords, Password Cracking Websites, Password Guessing, Password Cracking.

UNIT - 3:

Programming for security professionals: Programming Fundamentals, C language, HTML, Perl,Windows OS Vulnerabilities, Tools for Identifying Vulnerabilities, Countermeasures, Linux OS Vulnerabilities, Tools for Identifying Vulnerabilities, Countermeasures.

UNIT - 4:

Penetration testing: Introduction, Security Assessments, Types of Penetration Testing- Phases ofPenetration Testing, Tools, Choosing Different Types of Pen-Test Tools, Penetration Testing Tools

Self-learning component:

Password Cracking Tools, Password Cracking Counter measures, Escalating Privileges, Executing Applications, Key loggers and Spyware.

Text Books:

1. Ec-Council, “Ethical Hacking and Countermeasures: Attack Phases”, Delmar Cengage Learning, First edition, 2009.

2. Michael T. Simpson, Kent Backman, James E. Corley, “Hands-On Ethical Hacking and Network Defense”, Cengage Learning, First edition, 2012.

Reference books:

1. Patrick Engebretson, “The Basics of Hacking and Penetration Testing – Ethical Hacking and Penetration Testing Made Easy”, Syngress Media, Second Revised Edition, 2013.

2. Jon Erickson, “Hacking: The Art of Exploitation”, No Starch Press, Second Edition, 2008

3. David Kennedy , Jim O'gorman ,Devon Kearns ,Mati Aharoni, “Metasploit: The Penetration Tester's Guide”, William Pollock, First edition, 2011.

4. Vivek Ramachandran, “BackTrack 5 Wireless Penetration Testing Beginner's Guide”, Open source, First edition, September 2011.

5. IBM Systems Journal - End-to-end security, ebook.

Mapping COs with POs (Program outcomes)

Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	H	-	M	-	H	L	-	-	-	-
CO2	-	-	H	-	M	-	H	L	-	-	M	-
CO3	-	-	H	-	M	-	H	L	M	-	-	-
CO4	-	-	H		M	-	H	L	M	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS8034	Cognitive Science and Computing	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Physics [B18CS2020], Object Oriented Programming with Java [B18CS3030], Data Structures [B18CS3040].

Course Description:

Cognitive Science studies various aspects of the mind, such as perception, memory, learning, and reasoning. Cognitive Science is a highly interdisciplinary field of study at the intersection of philosophy, psychology, computer science, neuroscience, linguistics, and anthropology. Cognitive Computing is an experimental process and this course will help the students to understand the overview of deep learning neural networks, general machine learning, and natural language processing. Cognitive computing is closely associated and has significant overlap with the study of artificial intelligence, knowledge representation, linguistics, psychology, and neuroscience.

Course Objectives:

1. Explain the history of cognitive science and cognitive model building approach.

2. Demonstrate the use of cognitive approach and linguistic approach in a real world application.

3. Illustrate the use of cognitive computing techniques in a real world application.

4. Discuss the concepts of Deep Neural Networks and Natural Language Processing.

Course Outcomes (Cos):

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

CO1: Make use of cognitive model building approach in a real world application.

CO2: Develop a real world application by using cognitive approach and linguistic approach.

CO3: Apply cognitive computing techniques using Supervised and Unsupervised Learning.

CO4: Build the application to process the given text data using Natural Language Processing.

Course Contents:

Unit- 1

Introduction to Lossless Compression and Lossy Compression Mathematical Preliminaries for Lossless Compression, Test for Unique Decodability, Uniquely Decodable Codes, Prefix Codes, Kraft MacMillan Inequality, Huffman Coding, Optimality of Huffman Codes, Average Length of Huffman Codes, Extended Huffman Codes, Non binary Huffman Codes, Adaptive Huffman Coding, Golomb Codes, RiceCodes, Tunstall Codes

Unit -2

Motivation for Arithmetic Coding, Coding a Sequence, Generating a Tag, Deciphering the Tag, Generating a Binary Code, Uniqueness and Efficiency of the Arithmetic Code, Algorithm Implementation Issues, Issues related to Integer Implementation, Comparison of Huffman and Arithmetic coding.

Unit- 3

Dictionary Techniques: Static Dictionary Techniques, Adaptive Dictionary Techniques, Universal Compression, LZ, LZW, etc. algorithms. Mathematical preliminaries for Lossy Compression, Conditional Entropy, Average Mutual Information,Differential Entropy, Rate Distortion Theory, Compression Scheme in terms of Conditional Probabilities, Rate distortion function for various sources

Unit- 4

Scalar Quantization: Quantization Problem, Uniform Quantizer, Adaptive Quantization, Jayant Quantizer, Nonuniform Quantization, pdf Optimized Quantization, Companded Quantization, Entropy Coded Quantization

Self-learning components:

MATLAB and R Tool, Analogical Reasoning; Silhouettes and Object Constancy; Memory Effects; Conversational Pragmatics

Text books:

1. Jay Friedenberg and Gordon Silverman, Cognitive Science: An Introduction to the Study of Mind, SAGE Publications, Third edition, 2006.

2. Mark Watson, Introduction to Cognitive Computing: A Guide for Individuals and Small Organizations, First edition, 2012. Ebook available at: https://leanpub.com/cognitive-computing/read.

Reference books:

1. Judith S. Hurwitz, et. al., Cognitive Computing and Big Data Analytics, 1st Edition, WILEY, 2015

2. Wilson, Robert A., & Keil, Frank C. (eds.), The MIT Encyclopedia of the Cognitive Sciences (MITECS), MIT Press,Second edition, 2001

3. Bowerman, Melissa and Stephen C. Levinson, Language Acquisition and Conceptual Development,First edition, Cambridge University Press 2001

4. Springer Journals on Cognitive Science and Technology

5. Elsevier Journals of Cognitive systems Research.

Mapping COs with POs (Program outcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M	L	-	-	-	-	-	L
CO2	H	H	M	M	M	-	-	-	-	-	-	
CO3	M	M	H	M	M	-	-	-	-	-	-	L
CO4	H	H	H	M	M	L	-	-	-	-	-	L

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

B18CS8035	Data Compression	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Data Structures [B18CS3040] Design and Analysis of Algorithms [B18CS4010]

CourseDescription:

This course provides an overview of classical and modern techniques and algorithms of various types data compression. It covers statistical and dictionary methods, lossless and lossy compression algorithms in graphics, video and audio compression. Understand the importance of multimedia in today's online and offline information sources and repositories. Understand how Text, Audio, Image and Video information can be represented digitally in a computer, so that it can be processed, transmitted and stored efficiently. Understand the possibility and limitations of multimedia data compression. Understand the text and image compression techniques. Understand the basic audio and video coding techniques.

CourseObjectives:

The objectives of the course are to;

1. Explain fundamentals of data compression and their applications
2. Demonstrate the use of lossless and lossy compression techniques
3. Discuss different file formats required for compressing image, sound andvideo.
4. Illustrate the use of different scalar quantizationmethods.

Course Outcomes (Cos):

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

CO1: Make use of lossless and lossy compression techniques for real world data.

CO2: Compare performance of Huffman and Arithmetic coding algorithms with respect to the given compressed data using both.

CO3: Apply different Dictionary Techniques to compress the given data.

CO4: Identify a suitable scalar quantization to compress the given real world data.

CourseContent:

Unit-1

Introduction to Lossless Compression and Lossy Compression Mathematical Preliminaries for Lossless Compression, Test for Unique Decodability, Uniquely Decodable Codes, Prefix Codes,

Kraft MacMillan Inequality, Huffman Coding, Optimality of Huffman Codes, Average Length of Huffman Codes, Extended Huffman Codes, Non binary Huffman Codes, Adaptive Huffman Coding, Golomb Codes, RiceCodes, Tunstall Codes

Unit -2

Motivation for Arithmetic Coding, Coding a Sequence, Generating a Tag, Deciphering the Tag, Generating a Binary Code, Uniqueness and Efficiency of the Arithmetic Code, Algorithm Implementation Issues, Issues related to Integer Implementation, Comparison of Huffman and Arithmetic coding.

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Dictionary Techniques: Static Dictionary Techniques, Adaptive Dictionary Techniques, Universal Compression, LZ, LZW, etc. algorithms. Mathematical preliminaries for Lossy Compression, Conditional Entropy, Average Mutual Information,Differential Entropy, Rate Distortion Theory, Compression Scheme in terms of Conditional Probabilities, Rate distortion function for various sources

Unit- 4

Scalar Quantization: Quantization Problem, Uniform Quantizer, Adaptive Quantization, Jayant Quantizer, Nonuniform Quantization, pdf Optimized Quantization, Companded Quantization, Entropy Coded Quantization

Text books:

1.Khalid Sayood, Introduction to Data Compression, 2nd Edition, Morgan KaufmannPublishers

2.David Salomon, Data Compression : The Complete Reference, 2nd Edition,Springer.

3.Mark Nelson and Jean Loup Gailly, The Data Compression Book, 2nd Edition, BPBPublications

Reference books:

1.Salomon.D , Motta, G.Handbook of Data Compression.(2010)Springer

2.The Data Compression Library—Sourcecode.

Mapping COs with POs (Programoutcomes)

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	-	H	H	M	-	L	-	-	-	-
CO2	H	H	M	H	H	M	-	-	-	-	-	-
CO3	H	H	M	H	H	M	-	-	-	-	-	-
CO4	H	H	M	H	H	M	-	-	-	-	-	-

Where, L (Low), M (Medium) and H (High) represents strength of correlation between CO and PO.

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:

- Willingness to learn
- Self motivation
- Team work
- Communication skills and application of these skills to real scenarios
- Requirement of gathering, design and analysis, development and testing skills
- Analytical and Technical skills
- Computer skills
- Internet searching skills
- Information consolidation and presentation skills
- Role play
- 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 Computer Science & Engineering is efficient leaders of repute, who can deal the real time problems with 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, leadership, and strategic management 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 Computer Science & Engineering 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 recognized skill development and industry relationship as its very important activities. Therefore, the University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director has been established 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 various skill/certification programs identified are as follows:

- Big-data and Cloud Computing, Internet of Things (IOT), ORACLE, MYSQL, Advanced Java and Internals of LINUX/UNIX
- Red-hat certified programs on LINUX,
- Management related programs like SAP,ERP and Business Analytics
- Open Source software/hardware, Software Testing
- Advanced networking based CISCO / Microsoft technology.
- Web designing, System administration
- IBM certified programs.

The University has 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.

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Bengaluru, India

School of Electrical and Electronics Engineering

MTech in Power and Energy Systems

Handbook 2018-20

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REVA UNIVERSITY
Bengaluru, India

SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

HANDBOOK

M.Tech in Power and Energy Systems

2018-2020

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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 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. S Y Kulakarni

Vice-Chancellor

Director's Message

The B.Tech in Electrical Engineering 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 core Electrical Engineering. There are ample number of courses providing knowledge in specialized areas of power system, electrical machines, control system, power electronics etc. facilitating students to choose specialized areas of their interest. Adequate attention is given to provide students the basic concepts.

Electrical engineering is one of the earliest to start among the core subjects. The structure of the course has undergone a face-lift with the introduction of subjects from computer science and electronics engineering streams. Thus students in Electrical engineering have the flexibility to broaden their horizons in electronics or software related industries apart from the core related fields. For example, signal processing and communication theory related to mobile technology needs signal processing, robotics require control theory as well as programming skills and integrated circuits need VLSI techniques. Thus the electrical engineering stream is designed to provide you with several options to choose from for your later years. Electrical Engineering use mathematics, electronics, computing techniques and physics to solve real world problems. The Indian government plans to add another 100 GW of generation capacity during 2012-2017 and to pump 1.4 trillion to build national power transmission grid which will enhance inter-regional transmission capacity to 32 GW by 2013. Hence power sector offers lots of job opportunities for well qualified graduates.

The program is thus designed to expose students to various subjects having applications in power sectors, and IT and electronics related industries through outcome based teaching and learning process which emphasizes practical exposure rather than memorization. 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. A variety of activities such as mini projects, seminars, interaction with industries, cultural activities and social activities are in place to shape the all-round development of students.

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.

If you are interested in any one of the following, then EEE is the option you should consider.

- Power sector- to design robust power system, to implement measures to keep the system secure, to maintain quality of power, to mitigate harmonics, to damp oscillations, to design protective measures using relays and circuit breaker etc
- Renewable energy sources- to harness power from renewable sources using power electronics devices, to study integration of these sources with the grid.
- Transport- electric vehicles, vehicle to grid power transactions
- High –Voltage engineering – study of breakdown mechanisms of insulators, search for new types of insulators, development of high voltage testing equipment.
- Power Electronics- design of compact and highly efficient power supplies, battery energy storage system, ultra-capacitor applications, aerospace power requirements, UPS, applications in power system using FACTS devices, interconnection of two regions via HVDC link
- Computer – Developing algorithms to solve complex functions, developing simulation tools to simulate the entire system, applications to SMART grid.

The benefits of choosing Electrical and Electronics Engineering are:

- Flexibility to choose various fields upon graduation.
- Opportunity to work on live problems.
- Opportunity to work on environmental related technologies.
- Opportunity for programmers to develop software for electrical related projects.

I am sure the students choosing B Tech in Electrical and Electronics Engineering in REVA University 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 their studies. I wish all students pleasant stay in REVA and grand success in their career.

Dr. Rajashekar P Mandi

Director, School of Electrical and Electronics Engineering

CONTENTS

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 syrstem 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 Sensor 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, Photoelectrochemical 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 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 addon 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.

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 Defense Dr. Sathish Reddy, Scientific Advisor, Ministry of Defense, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

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 REVOTSAVA 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 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 class's every day 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 standard.

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 SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

1. The School of Electrical Engineering is supported by well qualified and dedicated faculty members. The school of Electrical and Electronics Engineering under REVA University is established in the year 2014 with an aim of developing human resources in the area of Electrical and Electronics Engineering. The School of EEE offers under graduate (UG) course in 'Electrical and Electronics Engineering' and post graduate (PG) course in 'Advanced Power Electronics' along with Doctoral program in various research areas of Electrical Engineering. It has experienced and qualified faculty in various areas such as Power systems, Power Electronics, VLSI, Signal Processing, Embedded Systems, Industrial drives, Energy Systems and Control systems. The school is well equipped with laboratories catering to the development of experiments and projects in the aforementioned areas. The School has state of art computing facilities and latest software. Along with technical skills the School conducts various extracurricular and co-curricular activities to develop overall personality of the students.
2. The faculties have number of publications in reputed national and international journals/conferences. The school is also involved in funded research projects. The other important features of the school are individual counselling of students for academic performance, additional coaching classes for important subjects for all the semesters, soft skill development classes, scientific and student centric teaching-learning process.
3. Student's welfare is given utmost priority here at School of Electrical Engineering. Advanced learning methods are adopted to make learning truly interactive. More focus is on discussion and practical applications rather than rote learning. Notes/hand-outs are given and critical thinking questions are asked to test understanding. Experienced, well qualified and friendly faculties always strive hard to provide best of education to students. This is reflected in various core subjects offered within the program

Vision

The School of Electrical & Electronics engineering aspires to develop excellent human resources with leadership qualities, ethical and moral values, research culture and innovative skills through higher education of global standards

Mission

- To identify and nurture students’ talents to guide them to choose the correct career option
- To mould students to become skilled, ethical and responsible engineers for the betterment of society by establishing academic infrastructures thus developing program specific competencies
- To provide student centric learning and innovative pedagogy inculcating scientific temperament to arouse interest in tackling real world challenges in the field of Electrical, Electronics and Computer Engineering through industry-institute partnership
- To inculcate research bent of mind, social responsibilities, moral values by involving in IEEE activities and other social outreach activities to develop leadership traits.
- To promote team work & entrepreneurship by involving in the multidisciplinary team tasks

Program Overview

Electrical Engineering is a discipline of engineering that utilizes natural resources for generation, transmission and utilization of electric power. In addition, electrical engineering deals with design, analysis, prototyping, manufacturing, and maintenance of electrical generators, electric motors, transformers, transmission and distribution equipment, wiring and lighting and electrical appliances. In the recent past, the use of electronics for control of electrical systems is gaining importance and the discipline is known as Electrical and Electronic Engineering instead of pure Electrical Engineering. It is one of the oldest and broadest engineering disciplines. The present day electrical engineers focus on use of renewable sources like solar photovoltaic, wind and other non-renewable energy sources for power generation.

Electricity became a subject of scientific interest in the late 17th century. Probably the greatest discovery with respect to power engineering came from Michael Faraday who in 1831 discovered that a change in magnetic flux induces an electromotive force in a loop of wire—a principle known as electromagnetic induction that helps explain how generators and transformers work. In 1881, using two waterwheels electricity was produced in the world's first power station at Godalming in England. Thomas Edison produced continuous power using steam power in 1882. At present, electric power is being produced using Thermal, Hydro, Solar, Wind and many other non-renewable and renewable energy sources and at present world's installed capacity of electric power is 16000 GW.

India has one National Grid with an installed capacity of 344.00 GW as on 31 May 2018 out of which 69.02 GW is from renewable energy sources. India's being very active in renewable energy sector would like to achieve an installed total capacity of 175 GW by 31 March 2022, and the central Govt. has set up US$350 million fund to finance the solar projects.

Overall employment of electrical and electronics engineers is projected to grow 7 percent over the next ten years, about as fast as the average for all occupations. At present, the world power sector is facing global warming crisis due to large scale emission of carbon dioxide from thermal power plants. The future is about production of electrical power that is free from production of carbon dioxide, a greenhouse gas responsible for global warming. Thus there is a demand for electrical and electronic engineers who could play key roles in new developments with solar arrays, semiconductors, and wind power technologies. The need to upgrade the nation's power grids will also create demand for electrical engineering services.

The School of Electrical and Electronics Engineering at REVA UNIVERSITY offers B. Tech., Electrical and Electronics –an undergraduate programme to create motivated, innovative, creative and thinking graduates to fill the roles of Electrical Engineers who can conceptualize, design, analyze, develop and produce Electrical Power Systems to meet the modern-day requirements.

The B. Tech., in Electrical and Electronics Engineering curriculum developed by the faculty at the **School of Electrical and Electronics 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 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 power and energy sector makes this programme unique.

ACADEMIC OBJECTIVES

- To encourage faculty to acquire skills to implement novel teaching methods that emphasize critical thinking, self-learning, group discussions and self-appraisal
- To encourage students to take part in paper presentation contests and other co-curricular activities to enhance their skills.
- To provide opportunities for students to carry out mini projects to strengthen their fundamentals.
- To setup high quality research lab in the School.
- To establish industry-university alliance to set up research lab.
- To carry out applied research work and to attract consultancy works.
- To initiate students exchange program with overseas universities.
- To initiate summer industrial training program for students.

Program Educational Objectives (PEO's)

After few years of graduation, the post graduates of M. Tech in Power and Energy Systems will:

- **PEO 1:** Upkeep the knowledge of the latest technology and toolsets in Power and Energy Systems and pursue research in Power Systems and allied areas.
- **PEO 2:** Work as a member of a team for successful career and communicate effectively in multidisciplinary environment with highest ethics to propagate ideas and promote teamwork.
- **PEO 3:** Attain intellectual leadership skills to cater to the changing needs of power and energy industry, academia, society and environment.

Program Outcomes (POs)

On successful completion of the program, the post graduates of M. Tech in Power and Energy Systems will:

- **PO 1:** Design and develop electric power and energy systems.
- **PO 2:** Deliver technological solutions in the field of power systems by assimilating advances in allied disciplines, 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 related to power & energy systems, simulate and experiment the various technological advances in the field of power systems using modern tools and techniques to arrive at feasible & optimal solutions.
- **PO 4:** Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, design renewable energy systems to protect environment and ecosystems, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in power & energy systems
- **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:** Develop innovative and entrepreneurial solutions
- **PO 8:** Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively.

- **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.
- **PO 11:** Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

Program Specific Outcomes (PSO)

On successful completion of the program, the post graduates of M. Tech in Power and Energy Systems will:

- PSO 1: Apply the fundamentals of engineering knowledge to identify, formulate, design, develop and investigate complex engineering problems of power systems, reactive power compensation, power system dynamics, grid integration, renewable energy system, energy efficiency, power quality, power system protection, power electronic controllers, automation & control systems, electrical machines and electric vehicle.
- PSO 2: Apply the appropriate, state of the art techniques, technological advances and modern engineering hardware and software tools in power & energy systems to engage in life-long learning and to successfully adapt in multi-disciplinary environments.

REVA UNIVERSITY
Bengaluru, India

Regulations – M Tech., Degree Program
Academic Year 2018-20 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 – M Tech., Degree Program 2018-20 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 M Tech., Degree programs of REVA University offered during 2018-20

M Tech (Full Time) in:
Artificial Intelligence
Computer Science and Engineering
Computer Aided Structural Engineering
Construction Technology & Management
Digital Communication and Networking
Machine Design
Power Energy & Systems
Transportation Engineering and Management
VLSI and Embedded Systems

Also
M Tech (Part Time) in:
Computer Science and Engineering
VLSI and Embedded Systems

3. Duration and Medium of Instructions:

3.1 **Duration:** The duration of the M Tech degree program shall be **TWO years** comprising of **FOUR** Semesters. A candidate can avail a maximum of 8 semesters - 4 years as per double duration norm, in one stretch to complete M Tech degree. The duration for part time students is **THREE years** and a maximum of 6 years they are required to complete the program.

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: "Finite Element Method of Analysis" in M Tech Civil Engineering program, "Advanced Theory of Vibration" in M 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 / analysing /exploring a real life situation / difficult problems to solve a multivariable or complex engineering problems.

5. Eligibility for Admission:

5.1. The eligibility criteria for admission to M Tech Program (Full Time) of 2 years (4 Semesters) and (Part Time) of 3 years (6 Semesters) are given below:

Sl. No.	Program	Duration	Eligibility
1	Masters of Technology (M Tech) in Artificial Intelligence	4 Semesters (2 years)	B E / B.Tech. in CSE / ISE / TE / MCA / M. Sc. in Computer Science or Mathematics or Information Science or Information Technology with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.
2	M Tech in Computer Science and Engineering	**Full Time** – 4 Semesters (2 years) **Part Time** – 6 Semesters (3 years)	B E / B.Tech. in ECE / IT / EEE / CSE / ISE / TE / MCA / M.Sc. in Computer Science or Mathematics or Information Science or Information Technology with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.
3	M Tech in Computer Aided Structural Engineering Construction Technology & Management Transportation Engineering and Management	4 Semesters (2 years)	BE/ B.Tech. in Civil Engineering with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.
4	M Tech in Power Energy & Systems	4 Semesters (2 years)	BE/ B.Tech. in EE/ EEE/ ECE/ CSE/ MS / M.Sc. in Mathematics/Physics/Electronics / Information Technology or Information Science with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.
5	M Tech in Digital Communication and Networking Machine Design	4 Semesters (2 years)	B E / B.Tech. in ECE /TE / EEE / CSE / ISE / Instrumentation Technology / Medical Electronics/M Sc in Electronics with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University/Institution or AMIE or any other qualification recognized as equivalent there to.
6	M Tech in VLSI and Embedded Systems	**Full Time** – 4 Semesters (2 years) **Part Time** – 6 Semesters (3 years)	B E / B.Tech. in ECE /TE / EEE / CSE / ISE / Instrumentation Technology / Medical Electronics/M Sc in Electronics with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University/Institution or AMIE or any other qualification recognized as equivalent there to.
7	M Tech in Machine Design	4 Semesters (2 years)	BE / B.Tech. in Mechanical/Aeronautical / Automobile / Industrial Production Engineering with a minimum of 50% (45% in case of candidate belonging to

			SC/ST category) marks in aggregate, of any recognized University / Institution or AMIE 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 C**ourses of Study**:

Different C**ourses 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. Minor Project
g. Major Project / Dissertation:

The credits for minor projects, major project/Dissertation will be decided by the respective Schools.

8. Credit and Credit Distributions:

8.1 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.

8.2 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.

8.3 **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**.

9. Assessment and Evaluation

9.1 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 for the 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.**

9.2 The schedule of continuous assessment and examinations are summarized in the following Table below.

Component	Period	Syllabus	Weightage	Activity
IA1	1^{st} Week to 8^{th} Week	First 50% (two units)		Instructional process and Continuous Assessment
	Last 3 days of 8^{th} Week		25%	Consolidation of IA1
IA2	9^{th} week to 16^{th} week	Second 50% (remaining two units)		Instructional process and Continuous Assessment
	Last 3 days of 16^{th} week		25%	Consolidation of IA2
SEE	17^{th} and 18^{th} week			Revision and preparation for Semester end examination
	19^{th} week to 20^{th} week	Entire syllabus	50%	Conduct of semester end examination and Evaluation concurrently
	21^{st} 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 21^{st} 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.

9.3 The Assessment of MOOC and Online Courses shall be decided by the concerned School Board of Studies (BOS).

9.3.1 **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**

9.3.2 **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**

11.3.3 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 / 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**

In case of an integrated course 20% marks be earmarked for laboratory work.

For example:

During IA1

Laboratory work ………………………………. 10 marks

Test (Mid-Term) ……………….…………..15 marks for the first 50% of the theory syllabus

Total ……………………….…… ……..25 marks

During IA2

Laboratory work ………………………………. 10 marks

Test (Mid-Term) ……………….…………..15 marks for the second 50% of theory syllabus

Total ……………………….…… ……..25 marks

SEE to be conducted for theory portions only and assessed for 50 marks

10. Setting Questions Papers and Evaluation of Answer Scripts:

10.1 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.

10.2 The Board of Examiners shall scrutinize and approve the question papers and scheme of valuation.

10.3 There shall be double evaluation, viz, first valuation by the internal evaluator who has taught the course and second evaluation shall be an external examiner who is familiar with the course. The average marks of the two evaluations (internal examiner & external examiner) shall be the marks to be considered for declaration of results.

10.4 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.

10.5 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.

10.6 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.

10.7 The duration for Semester-End practical examination shall be decided by the Controller of Examinations.

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	(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%.

12. All assessments must be done by the respective Schools 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.

13. **Requirements to Pass a Course**

13.1 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 SEE and an overall 40% (IA1+IA2+SEE) in a course is said to be successful.

13.2 **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,	Grade,	Grade Point	Letter

P	G	(GP=V x G)	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=[(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.

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, 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.

b. 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**

c. 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

13.3 **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

14. 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	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).This statement will not contain the list of

DROPPED courses.

b. **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.

Attendance Requirement:

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

15.2 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.

15.3 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

16. Re-Registration and Re-Admission:

16.1 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.

16.2 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.

17. **Absence during Internal Test:**

In case a student has been absent from an internal tests 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 School, for conducting a separate internal test. The Director 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 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.

18. **Eligibility to Appear for Semester End Examination (SEE)**

18.1 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.

18.2 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.

18.3 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.

18.4 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.

19. **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 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.

20. **Provision 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 otherwise considered that the candidate has failed the course. A candidate is required to successfully complete all the courses before submission of major project report or dissertation report.
(It means that the candidate has no restrictions on the number of courses that can be carried forward)

21. **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.

22. **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. Grievance committees will be formed by CoE in consultation with VC

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.

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

Syllabus of Master of Technology (MTech.) in Power and Energy Systems (Full time)

2018 – 20 Batch

School of Electrical and Electronics Engineering

REVA UNIVERSITY, Bangalore -560064

Curriculum- M. Tech (Power and Energy Systems)

Scheme of Instructions

I Semester

Sl No	Sub Code	Subject	HC/SC /OE	L	T	P	Total credit	Contact hrs
1	M18PS1110	Applied Mathematics	HC	4	0	0	4	4
2	M18PS1120	Computer Aided Power System Operation and Analysis	HC	4	1	0	4	6
3	M18PS1130	Power System Protection	HC	4	1	0	5	6
4	M18PS1140	Analysis of Power Converters	HC	4	0	1	5	6
5	M18PS1151	Advanced Electrical Machines	SC	4	1	0	4	6
	M18PS1152	Power system Instrumentation						
	M18PS1153	SCADA and PLC System and Application						
	M18PS1154	Energy Storage Technology						
6	M18PS1161	FACTS Controller	SC	4	1	0	4	6
	M18PS1162	Grid Integration to Renewable Energy System						
	M18PS1163	Reactive Power Management						
	M18PS1164	Recent Trends in Grid Technology (Smart Grid)						
TOTAL CREDITS				**24**	**4**	**1**	**26**	**34**

II Semester

Sl No	Sub Code	Subject	HC/SC /OE	L	T	P	Total credit	Contact hrs
1	M18PS2110	Solar Energy System	HC	4	1	0	5	6
2	M18PS2120	Energy Conservation and Demand side Management	HC	4	0	1	4	6
3	M18PS2130	HVDC Transmission	HC	4	1	0	5	6
4	M18PS2141	Electric vehicle	SC	4	1	0	4	6
	M18PS2142	AC-DC Drives						
	M18PS2143	Advanced Energy Systems						
	M18PS2144	FPGA Application						
5	M18PS2151	Power Quality and Harmonics Mitigation	SC	4	1	0	4	6
	M18PS2152	EMC / EMI / Power Transients						
	M18PS2153	Reliability Engineering						
	M18PS2154	Wind energy System						
6	M18PS2161	Multilevel Inverter	SC	4	0	0	4	4
	M18PS2162	Environmental Impacts of Energy Conversion and Safety						
	M18PS2163	Trouble shooting & Maintenance of equipment						
	M18PS2164	Green Building Technology						
TOTAL CREDITS				**24**	**4**	**1**	**26**	**34**

Semester III

Sl No	Sub Code	Subject	HC/SC /OE	L	T	P	Total credit	Contact hrs
1	M18PS3111	Electricity Regulations	SC	4	0	0	4	4
	M18PS3112	Power System Dynamics and Control						
	M18PS3113	Power Economics & Trading						
	M18PS3114	Project Management & Report writing						
2	-	Open Elective subject offered by other school	SC	4	0	0	4	4
3	M18PS3130	Skill Development Program / Certification program	HC	4	0	0	4	4
4	M18PS3140	Mini Project / Internship	HC	0	0	8	8	16
5	M18PS3150	MOOC/SWAYAM/self study component	SC	2	0	0	2	2
6	M18PS3160	Yoga/Sports/Performing Arts	SC	0	0	2	2	4
TOTAL CREDITS				**14**	**0**	**10**	**24**	**34**

Semester IV

Sl No	Sub Code	Subject	HC/SC /OE	L	T	P	Total credit	Contact hrs
1	M18PS4110	Project Work and Dissertation	HC	0	4	16	20	40
TOTAL CREDITS				**0**	**4**	**16**	**20**	**40**

Scheme and Syllabus For
M. Tech – I/II Semester

Sub Code: **M18PS1110**	**Applied Mathematics**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**0**	**0**	**4**	**4**

Course Objectives:

1. To enable students to understand the numerical techniques of solving of problems
2. To introduce the concept of interpolation technique
3. To introduce the concept of stochastic theory

Course Outcomes:

After the completion of the course the student will be able to:
1. Apply Numerical techniques for solving of problems
2. Apply Spline interpolation technique for solving differential equations.
3. Apply stochastic techniques for cases related to electrical circuits.

Course Contents:

UNIT-I: Numerical Methods: [10Hrs]
Solution of Polynomial equations-Iterative methods for simple roots, multiple roots, complex roots. Iterative methods for a system of nonlinear equations-Newton-Raphson method. Iterative methods for Polynomial equations-Birge-Vieta method, Bairstow method.
Linear algebraic equations and Eigen value problems: - Greschgorin circle, Iteration methods-Gauss-Seidel method. Eigen value problems-Finding all the Eigen value, finding the largest Eigen value, Simple problems and Solutions.

UNIT-II: Spline Interpolation: [10Hrs]
Direct Integration of Second order differential equations-Dahlquist methods, Numerov method-Stability. **Calculus of variations:**-Introduction, Fundamental Theorem Functional of single function, Euler's equation Geodesics-Simple problems

UNIT-III: Integer Arithmetic: [10Hrs]
Euclidean algorithm, the Diophantine equation, Linear congruence-Chinese remaindering Theorem, Fermat's factorization method, Fermat's Little Theorem, Euler's Phi-function-properties-Euler's Theorems, Cryptography

UNIT-IV: Stochastic Processes: [10Hrs]
Overview of Probability-Conditional probability- Random variables & distributions-Binomial, Poisson & Normal distributions- mean and variance, joint Probability density function-Simple

Problems.

Sequences of random variables: limit theorem, central limit theorem, Random processes, Correlation function, Power Spectral densities.

Text Books and Reference Books:

1. M.K. Jain, S.R.K. Iyengar and Jain R.K. "Numerical Methods", 5th Edition, New age International, 2010.
2. M.K. Jain, "Numerical Solution of Differential Equations" 2nd Edition, Wiley Eastern Ltd.
3. Donal E. Kirk, "Optimal Control Theory", Universal Book Stall, Delhi.
4. Erwin Kreyszig, "Advanced Engineering Mathematics", John and Wiley and Sons, 9th Edition.
5. B.S. Grewal, "Higher Engineering Mathematics" 40th Edition Popoulis, "Probability, Random Variables, Statistical Processes" McGraw Hill 4, Edition.
6. Manson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons.

Sub Code: **M18PS1120**	**Computer Aided Power System Operations & Analysis**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To enable students to understand the modern power system operations and control.
2. To model the power system components.
3. To analyze the faults in the power systems.

Course Outcomes:

After learning the course the students should be able to:

1. Model the power system components.
2. Understand the Solution Algorithms -LU Factorization, Bifactorization and Iterative Methods
3. Analyze Symmetrical and Asymmetrical Faults of Large Power Systems

Course Contents:

UNIT-I: **[10 Hrs]**

General Introduction: Modern Power Systems Operation and Control, Different types of Power System Analysis.

AC Power Flow Analysis: Introduction, Modeling of Power System components, Power flow equations, Formation of Ybus Matrix, Power flow solution Algorithms, Newton Raphson load flow method, Fast Decoupled Load Flow Method and DC load flow method, AC-DC System Power Flow Analysis- Sequential and Simultaneous Solution Algorithms

UNIT-II: **[10 Hrs]**

Sparse Matrices: Sparsity directed Optimal Ordering Schemes, Solution Algorithms - LU Factorization, Bifactorization and Iterative Methods

UNIT-III: **[10 Hrs]**

Analysis of Faulted Power System: Symmetrical and Asymmetrical Faults, Zbus Formulation, Short Circuit Analysis of Large Power Systems using Zbus ,Analysis of Open Circuit faults.

UNIT-IV: **[10 Hrs]**

Security Analysis: Basic Concepts, Static Security Analysis at Control Centers, Contingency Analysis, Contingency Selection..

Text Books and Reference Books:

1. A.J. Wood and B.F. Wallenberg, Power Generation Operation and Control, John Wiley & Sons, 1996.
2. C.W. Taylor, Power System Voltage Stability, Mc Graw Hill, 1994.
3. L.Phillipson and H.L.Willis, Understanding Electric Utilities and Deregulation, Marcel Dekker Inc. 1998. 4. J Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd, UK. Voltage stability analysis.

Sub Code: **M18PS1130**	**Power System Protection**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Prerequisites: Power System Protection

Course Objectives:

1. To describe the various schemes of over current protection
2. To analyze distance and carrier protection
3. To familiarize the concepts of Busbar protection
4. To describe the concepts of Numerical protection

Course outcomes:

On completion of this course, students will be able to:

1. Demonstrate the over current protection schemes.
2. Classify various types of distance relays and distance protection schemes
3. Explain the theory behind the bus bar protection
4. Demonstrate the differential schemes for Bus bar Protection
5. Describe the concepts related to Numerical Relays.

Course Contents:

UNIT I: **[11 Hrs]**

Over Current Protection: Introduction, Time - Current characteristics; Current setting; Time setting; Over current protective schemes ; Reverse power or directional relay; Protection of parallel feeders ; Protection of ring feeders ; Earth fault and phase fault protection; Combined Earth fault and phase fault protection scheme ; Phase fault protective scheme directional earth fault relay ; Static over current relays; numerical example for a radial feeder

UNIT II: **[12 Hrs]**

Distance and Carrier Protection of Transmission Lines

Drawback of over Current protection, Introduction to distance relay, Simple impedance relay, Reactance relay, mho relays, Comparison of distance relay. Distance protection of a three Phase line, Reasons for inaccuracy of distance relay reach. Three stepped distance protection, Trip contact configuration for the three Stepped distance protection. Three stepped protection of three phase line against all ten shunt faults, Impedance seen from relay side .Three-stepped protection of double end fed lines-need for carrier. Aided protection, various options for a carrier coupling and trapping the carrier into the desired line section. Unit type carrier aided directional comparison relaying – Carrier aided distance schemes for acceleration of zone II.; numerical example for a typical distance protection scheme for a transmission line.

UNIT III: **[12 Hrs]**

Busbar Protection: Introduction , Differential protection of busbars-external and internal fault - Actual behaviors of a protective CT , Circuit model of a saturated CT , External fault with one CT saturation, Need for high impedance , Minimum internal fault that can be detected by the high ,Stability ratio of high impedance busbar differential scheme, Supervisory relay protection of three phase busbars.

UNIT IV: **[12 Hrs]**

Numerical Protection: Introduction, Block diagram of numerical relay, Sampling theorem Correlation with a reference wave, Least error squared (LES) technique, Digital filtering-numerical over, Current protection, Numerical transformer differential protection, Numerical distance protection of transmission line.

Text Books and Reference Books:

1. Lewis Blackburn, J.” Protective Relaying – Principles and Applications‟ Marcel Dekkar, INC, New York, 2006.
2. Y.G. Paithankar and S.R. Bhide, ‘Fundamentals of Power System Protection’,Prentice Hall of India Pvt. Ltd., New Delhi–110001, 2003
3. P.Kundur, “Power System Stability and Control”, McGraw-Hill, 1993
4. Badri Ram, Vishwakarma, ‘Power System Protection and Switchgear’, Tata McGraw Hill, 2001.

Sub Code: **M18PS1140**	**Analysis of Power Converters**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**0**	**1**	**4**	**6**

Course Objectives:

1. To enable students to understand the various power controlling circuits.
2. To enable students to understand the theory of rectifiers and inverters.
3. To enable students to learn the concept of control of inverters and converters.
4. To enable students to use mathematical concepts into the design of converters.

Course Outcomes:

On completion of this course the students will be able to:

1. Describe the operation of various power electronics based circuits.
2. Differentiate between rectifiers, inverters and dc-dc converters.
3. Apply mathematical concept into the designing of circuits.
4. Relate the concept of resonance into resonant type converters.

Course Contents:

UNIT-I: Line Commutated Converters: [10 Hrs]
Phase control, single phase semi-converter & fully controlled converter, three phase semi controlled & fully controlled converter, dual converters, power factor improvement methods, effect of source inductance, twelve pulse converter and design of converter circuits, LC filter design, regenerative braking using line commutated converter.

UNIT-II: Inverters [10 Hrs]
Principle of operation, performance parameters, single phase bridge inverters and three phase inverters. Voltage Control of Single Phase Inverters**:** Single/multiple, pulse/SPWM/ modified SPWM methods, voltage control of three phase inverter, SPWM/third harmonic PWM/Space vector modulation, harmonic reduction, current source inverter, comparison between VSI & CSI.

UNIT-III: Class D Resonant Inverters [10 Hrs]
Introduction, principle of class D resonant series, parallel and series-parallel circuits.

UNIT-IV: DC-DC Converters [10 Hrs]
Principle of operation, analysis of step-down and step up converters, Isolated converters-flyback, forward, push-pull, half-bridge, full bridge converters, Design Issues.

Text Books and Reference Books:

1. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd Edition, Wiley India Pvt. Ltd, 2011
2. Rashid M.H, "Power Electronics: Circuits Devices and Application Edition, Pearson, 2011.
3. B. K. Bose, "Modern Power Electronics & AC Drives", PHI, 2012.
4. Daniel W. Hart, "Introduction to power Electronics", Prentice Hall, 2011
5. L. Umanand, " Power Electronics, Essentials and Applications", Wiley India Pvt. Ltd
6. Marian K. Kazimierzuk and Dariusz Czarkowski, "Resonant Power Converters", John Wiley, 2011.

Suggested experiments:

1. Study of Performance of 1-ph Semi controlled converter for R-L & RLE Loads(continuous and discontinuous modes)
2. Study of Performance of 1-ph Fully controlled converter for R-L & RLE Loads(continuous and discontinuous)
3. Study of Performance of 3-ph fully and half controlled converter for i) R-L & ii) RLE loads(continuous and discontinuous modes)
4. Simulation of generating pulses with firing angle control scheme
5. Simulation study of BUCK & BOOST Converter s
6. Simulation study of 1-ph Semi controlled converter for R-L Load
7. Simulation study of 1-ph fully controlled converter for R-L load
8. Simulation study of 1-ph fully controlled converter for RLE load
9. Simulation study of 3-ph fully controlled converter for R Load
10. Simulation study of 1-ph Voltage source Inverter
11. Simulation of Integrated DC-DC converter & Inverter –Self study

Sub Code: **M18PS1151**	**Advanced Electrical Machines**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

The course enables students to:

1. Know the concepts of Special type of electrical machines.
2. Learn about the different sensors used in Brushless DC Motors
3. Draw the characteristics of special type electrical machines
4. Understand the different control schemes for and PMSM
5. Model the electrical machines with voltage, current, torque and speed equations.

Course Outcomes:

The student will be able to:

1. Be able to describe the operation of various motors
2. Be able to distinguish among various types of motors
3. Be able to select machines for a specific application.
4. Be able to apply mathematical concept into the design
5. Be able to relate the concept of interaction of magnetic circuit and the concept of power circuit

Course Contents:

UNIT–I: **[10 Hrs]**
Permanent magnet materials and magnetic circuits, permanent magnet brushless dc motors.

UNIT–II: **[10 Hrs]**
Permanent magnet brushless ac motor, axial field permanent magnet motors.

UNIT–III: **[10 Hrs]**
Stepper motors, switched reluctance motors, new topologies of switched reluctance motors.

UNIT-IV: **[10 Hrs]**
Bearingless switch reluctance motor, bearingless induction motor, doubly salient permanent magnet motor.

Text Books and Reference Books:

1. T.J.E. Miller – Brushless PM and Reluctance Motor Drives, clarendon Press Oxford
2. Jacek Gierasewing - P. M. motor technology, Marcel Dekker.
3. R. Krishnan – Electric Motor Drives, PHI.
4. Kelly, Denis - Performance and Control of Electrical Machines.
5. P.C. Sen – Principles of Electrical Machines and Power Electronics.
6. Latest IEEE Transactions on Industry Applications.

Sub Code: **M18PS1152**	**Power System Instrumentation**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To enable students to know the requirements of high power measurements
2. To enable students to understand the applications of CTs and PTs.
3. To enable students to learn the mathematical background of measuring instruments.
4. To enable students to learn the concept of remote monitoring.

Course Outcomes:

On completion of this course the students will be able to:

1. Describe the operation of various measuring instruments for high current and voltage.
2. Understand the application CTs and PTs in measurements.
3. Know the saturation effects on transformer

Course Contents:

UNIT-I: **[10 Hrs]**

Measurement of large currents and voltages, current and voltage transformers, design equations and operational characteristics, error compensation schemes.

UNIT-II: **[10 Hrs]**

Protective CTsand PTs, overload and transient performance, standard specification of instrument transformers.

UNIT-III: **[10 Hrs]**

DC current transformers, measurement of power and energy, torque equation of induction type energy meter, parasitic torque's and their minimization, IS Specifications analog and digital KVA meters.

UNIT-IV: **[10 Hrs]**

Tele-metering, remoteterminal units, data acquisition systems, tri-vector meters, event and disturbance recorders.

Text Books and Reference Books:

1. Cooper Helfrick, "Electrical Instrumentation and Measuring Techniques", Prentice Halln India.
2. D.C. NakraandK. K.Chowdhry,"Instrumentation, Measurement, and Analysis", Tata McGraw Hill Publishing Co.

Sub Code: **M18PS1153**	**SCADA & PLC System and Application**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To describe the various architecture of ICS, PLC, PAC, RTU, DCS
2. To analyze Programmable logic controllers
3. To familiarize the concepts of PLC Architecture
4. To describe the concepts of Creating Ladder diagram.

Course Outcomes:

1. The Students Will be Equipped With the Basic Knowledge of SCADA & PLC
2. The Students Will be Able to write ladder programs.
3. The Students Will be Able to analyze programmable logic controllers.

Course Contents:

Unit I **[10hrs]**
Introduction to SCADA system and ICS, PLC, PAC, RTU, DCS and SCADA, SCADA architecture, SCADA System overview, SCADA functions, SCADA principle of operation, Trends, PC-based control system, developing a control system.

Unit II **[10hrs]**
Introduction to Programmable logic controllers: History, Principles of operation, Types of PLCs, PLC Vs other types of control, Advantages of PLCs. Self-study: Digital logic, Number systems and binary codes: Review

Unit III **[12hrs]**
PLC Architecture: General block diagram, Processors, Power supply, memory systems, analog I/O systems, discrete I/O systems, special function I/O modules, brief overview of architecture of different PLC manufacturers. PLC Programming: Programming methods: Ladder diagrams, Functional Blocks, Sequential Functional Charts, Instruction List, and Structured Text. Self-study: PLC functions: Data transfer, Data manipulation, Program control, Arithmetic, special functions.

Unit IV **[10hrs]**
IEC 1131 standard, Programming languages, software systems (brief coverage). Design Aspects: Flow charts, pseudo code, PLC system and safety, emergency stop, commissioning process, documentation process (brief coverage) Simple programs: ON/OFF control, one short, toggle action, latch up, code conversion, alarm annunciator, etc.
Case study: Creating Ladder diagram from process control descriptions. SCADA & PLC Applications and recent trends

Text Books & References Books:
1. L.A.Bryan, 'Programmable controllers: Theory &Implementation', Industrial Text Company Publications,2nd Edition, 1997
2. Jhon R Hackworth & Frederick D. Hackworth Jr, 'Programmable Logic Controllers: Programming methods and applications', pearson education, 2008
3. W.Bolton,'Programmable Logic Controllers', Elsevier, 4th Edition,2006
4. E.A.Parr, 'Programmable Controllers: An Engineers Guide', Newness, 3rd Edition, 2003
5. https://en.wikipedia.org/wiki/SCADA

Sub Code: **M18PS1154**	**Energy Storage Technology**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To Validate The Necessity Of Energy Storage
2. To Study Various Type Of Batteries
3. To Introduce The Concept Of Liquid Metal Battery
4. To Introduce Key Concept Of Flywheel Storage Systems
5. To Study The Various Forms Of Thermal Energy Storage Technologies

Course Outcomes:

On completion of this course the students will be able to:

1. The Students Will be Equipped With the Basic Knowledge of Energy Storage And Materials Employed
2. The Students Will be Able to Analyze And Illustrate Various Batteries
3. The Course Shall Provide A Robust Technical Foundation For Prospective Energy Engineers Who Would Want To Work In Industries
4. The Course Shall Also Act as a Prerequisite for Advanced Research in Energy Storage Systems

Course Contents:

Unit I: Bird's Eye View of Energy Storage Technologies [10 Hrs]

Need for Energy Storage, Energy Density and Power Density, Ragone Chart, Market Requirement, Materials for Energy Storage, Specifications of Energy Storage Devices, Energy Storage Methods, Mechanical Energy Storage, Pumped Storage, Compressed Air Energy Storage and Flywheel Storage, Electrical Energy Storage Batteries. Redox – Flow Batteries, Super – capacitors and Ultra – capacitors, Thermal Energy Storage , Sensible Heat Storage, Latent Heat Storage.

Unit II: Battery Technology [10Hrs]

History, Inherent Advantages Electro chemical Energy Storage, Classification of Chemical Storage, Solid State Batteries, Elements of Electrochemical Cells, Operation of Electrochemical Cells, Theoretical Cell Voltage and Capacity, Losses in Cell, Cell to Battery, Types of Batteries Lead Acid Battery, NiCad Battery and Lithium Battery, Battery Parameters, Factors Affecting Battery Performance, Charging and Discharging of a Battery, Liquid Metal Battery and Downside of Electro chemical Storage

Unit III: Flywheel Technology [10 Hrs]

Potential and Kinetic Energy, Concept of Inertia and Angular Velocity, Idea of Flywheel, Components of Flywheel and Kinetic Energy Storage, Candidate Materials for Flywheel Rotors, Flywheel Geometry, Material Dependency of Rotor Performance, Radial and Hoop Stress in a Short Hollow Rotating Cylinder, Flywheel Topologies, Pros and Cons of Flywheel Technology, Comparison of Flywheels with Batteries and Ultra capacitors, Applications of Flywheel Technology – UPS, Grid Stabilization and Industrial Applications

Unit IV: Thermal Energy Storage **[10 Hrs]**

Fundamental Terminologies, Sensible Heat Storage Materials, Latent Heat Storage Materials, Active Heat Storage , Active Direct Two Tank Thermal Storage System, Active Indirect Single Tank Thermal Storage System, Steam Accumulators, Passive Heat Storage Technology, Solar Thermo – chemical Energy Storage System, Reversible Chemical Heat Storage Technology, Advantages and Disadvantages of Thermal Energy Storage Systems

Text Books & References Books:

1. Energy Storage – Fundamentals, Materials and Applications by Huggins and Robert; Springer Publications
2. Batteries for Sustainability by Brodd and Ralph Springer Publications
3. Non – conventional Energy Resources (3^{rd} Edition); McGraw Hill Education
4. Energy Storage Systems by Kilkis, Birol and Sadik; Springer Publications
5. National Renewable Energy Laboratory (Online Content, The Government of USA)

Sub Code: **M18PS1161**	**FACTS Controller**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To enable students to understand the limitations with the transmission of bulk power.
2. To enable students to learn the concept of reactive power compensation.
3. To enable students to describe the operation of various compensating devices.
4. To enable students to know the application of power electronic devices for reactive power compensation.

Course Outcomes:

On completion of this course the students will be able to:

1. Describe the need for compensating devices.
2. Differentiate among various reactive power compensation techniques.
3. Apply mathematical concept to the design of reactive power compensation.
4. Develop simulation models of few compensators
5. Develop simulation models of few control strategies for FACTS devices.

Course Contents:

UNIT-I: Introduction: **[10 Hrs]**

Basics of Power Transmission Networks - Control of Power Flow in AC, Transmission Line- Flexible AC Transmission System Controllers. Application of FACTS Controllers in Distribution Systems.

AC Transmission Line and Reactive Power Compensation: Analysis of Uncompensated AC Line, Passive Reactive Power Compensation, Compensation by a Series Capacitor Connected at the Midpoint of the Line Shunt Compensation Connected at the Midpoint of the Line, Comparison between Series and Shunt Capacitor .Compensation by STATCOM and SSSC ,Some Representative Examples

UNIT-II: Static Var Compensator: [10 Hrs]

Analysis of SVC, Configuration of SVC, SVC Controller, Voltage Regulator Design Some Issues, Harmonics and Filtering. Protection Aspects, Modeling of SVC, Applications of SVC.

UNIT-III: Thyristor and GTO Controlled Series Capacitor: [10 Hrs]

Introduction - Basic Concepts of Controlled Series Compensation, Operation of TCSC, Analysis of TCSC, Control of TCSC, Modeling of TCSC for Stability Studies, GTO Thyristor Controlled Series Capacitor (GCSC) , Mitigation of Sub synchronous Resonance with TCSC AND GCSC - Applications of TCSC.

UNIT-IV: Static Synchronous Compensator (STATCOM): [10 Hrs]

Introduction - Principle of Operation of STATCOM, A Simplified Analysis of a Three Phase Six Pulse STATCOM, Analysis of a Six Pulse VSC Using Switching Functions, Multi-pulse Converters Control of Type 2 Converters.

Text Books and Reference Books:

1. K.R Padiyar, “FACTS Controllers in power transmission and distribution”, New Age International.
2. Narain G Hingorani and L. Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems”, Standard Publishers, New-Delhi.
3. Y. H. Song and A. T. Johns, “Flexible AC Transmission System”, Institution of Engineering and Technology.

Sub Code: **M18PS1162**	**Grid Integration to Renewable Energy System**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To study about the integration of various renewable energy sources into the grid.

2. To analyze the grid integration issues of renewable generation and dynamic performance of the network.
3. To illustrate the integration of wind energy system to grid and power quality issues
4. To illustrate the integration of photovoltaics and fuel cells to grid.
5. To interpret standards and Grid interconnection codes.
6. To infer technical challenges, Security and risks in integrating renewable sources to grid.

Course Outcomes:

On completion of this course the students will be able to:

1. Identify various types of grid interfacing technologies.
2. Analyze various grid integration issues with renewable generation sources.
3. Illustrate power quality issues with wind energy converters.
4. Detect the conditions for islanding.
5. Describe the standards and Grid interconnection codes.
6. Identify the security issues and risks in integrating renewable sources to grid.

Course Contents:

Unit I: Introduction to renewable energy grid integration [12Hrs]
Concept of mini/micro grids, and smart grids. Different types of grid interfaces - Issues related to grid integration of small and large scale of synchronous generator based - induction generator based and converter based sources. Principles of Power Injection, Integration of Multiple Renewable Energy Sources.

Unit II: Grid Integration of Wind Energy Systems [12Hrs]
Introduction, Wind Energy Converters, Grid Integration, Power Quality on WECs, Offshore Wind Energy, Future Requirements and Developments.

Unit III: Grid integration of photovoltaic's and Fuel Cells [12Hrs]
Introduction, Photovoltaics Power Plants, Grid Interfacing and Islanding Detection. Fuel Cell Types, Energy Conversion, Grid-connected Applications, Grid Interfacing

Unit IV: Technical Challenges, Security and Risk in Grid Integration of Renewable Energy [12Hrs]
Renewable Energy Growth, Challenges in Distribution Systems, Challenges in Transmission Systems, Security and Risk. Standards and codes for interconnection, interconnection considerations, interconnection examples for alternative energy sources

Textbooks and Reference books:

1. Dilan Jayaweera, "Smart Power Systems and Renewable Energy System Integration", Springer, Studies in Systems, Decision and Control, Volume 57.

2. Integration of Alternative Sources of Energy” by Felix A. Farret and M. Godoy Simoes. 2006, John Wiley and Sons.
3. Ryszard Strzelecki GrzegorzBenysek, “Power Electronics in Smart Electrical Energy Networks”, Springer, Power Systems Series ISSN 1612-1287.
4. Brendan Fox et. al.: Wind Power Integration connection and system operational aspects, IET Power and Energy Series 50 (2007).
5. Marco H. Balderas (ed.): Renewable Energy Grid Integration, (Nova Science Publishers, New York, 2009).

Journals and Magazines:

1. IEEE Transactions on Power Systems.
2. IET Renewable Power Generation.
3. IET GTD (Generation, Transmission and Distribution)

Sub Code: **M18PS1163**	**Reactive Power Management**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Pre-requisites: Power Electronics, Power Quality, Power Systems

Course Objectives:

1. The students are expected to identify the necessity of reactive power compensation
2. They learn to describe load compensation and reactive power control
3. They need to know selection of various types of reactive power compensation schemes in distribution systems.

Course Outcomes:

1. To study about the load compensation.
2. To analyze the operation planning, harmonics, electromagnetic interferences.
3. To study the losses and placement of capacitors for reactive power management.
4. To illustrate the layout of traction systems.

Course Contents:

UNIT I: Load Compensation **[12Hrs]**

Objectives and specifications, reactive power characteristics, inductive and capacitive approximate biasing. Load compensator as a voltage regulator, phase balancing and power factor correction of unsymmetrical loads examples.

UNIT II: Reactive power coordination **[12Hrs]**

Objective-Mathematical modeling, Operation planning, transmission benefits. Basic concepts of quality of power supply disturbances, steady state variations effects of under voltages, frequency, Harmonics, radio frequency and electromagnetic interferences.

UNIT III: Distribution side Reactive power Management **[12Hrs]**

System losses –loss reduction methods, examples. Reactive power planning, objectives, Economics Planning capacitor placement, retrofitting of capacitor banks.

UNIT IV: User side reactive power management **[12Hrs]**

KVAR requirements for domestic appliances, Purpose of using capacitors, selection of capacitors – deciding factors, types of 20 available capacitor, characteristics and Limitations.

Reactive power management in electric traction systems and are furnaces

Typical layout of traction systems, reactive power control requirements, distribution transformers. Electric arc furnaces , basic operations- furnaces transformer –filter requirements – remedial measures, power factor of an arc furnace.

Text Books and Reference Books:

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982
2. Reactive power Management by D.M.Tagare,Tata McGraw Hill,2004.

Sub Code: **M18PS1164**	**Recent Trends In Grid Technology (Smart Grid)**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
2. To familiarize the power quality management issues in Smart Grid.
3. To familiarize the high performance computing for Smart Grid applications.

Course Outcomes:

On completion of this course the students will be able to:

1. Differentiate conventional and smart grid.
2. To learn various smart grid technologies.
3. To select the smart metering system for various applications.

Course Contents:

UNIT I: Introduction to Smart Grid **[12Hrs]**

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.

UNIT II: Smart Grid Technologies **[12Hrs]**

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAR control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).

UNIT III: Smart Meters and Advanced Metering Infrastructure **[12Hrs]**

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection.
P**ower Quality Management In Smart Grid :**Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT IV: High Performance Computing For Smart Grid Applications **[12Hrs]**

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

Text Books and Reference Books:

1. Vehbi C. Güngör, DilanSahin, TaskinKocak, SalihErgüt, ConcettinaBuccella, Carlo Cecati, and
2. Gerhard P. Hancke, Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
3. Xi Fang, Satyajayant Misra, GuoliangXue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey”, IEEE Transaction on Smart Grids,
4. Stuart Borlase “Smart Grid: Infrastructure, Technology and Solutions”, CRC Press 2012.
5. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley.

II SEMESTER

Sub Code: **M18PS2110**	**Solar Energy System**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To Provide An Overview Of The Energy Scenario of The World
2. To Study The Solar Spectrum And Introduce Equipment Used For Measurement Of Solar Radiation
3. To Impart Knowledge About Empirical Estimation of Solar Radiation
4. To Introduce Key Concepts Of Semiconductor Physics Which Helps In The Analysis of Solar Cells
5. To Introduce The Design Aspects of Solar Photovoltaic Cells And Panels
6. To Introduce The Concepts Of Concentrated Photovoltaic Technology

Course Outcomes:

1. The Students Will be Equipped With the Basic Knowledge of Solar Radiation and Measurement
2. The Students Will be Able to Analyze, Design and Fabricate Solar Photovoltaic Cells
3. The Course Shall Provide A Robust Technical Foundation For Prospective Energy Engineers to Evaluate, Commission and Operate Solar Power Plants
4. The Course Shall Also Act as a Prerequisite for Advanced Research in the Domain of Solar Energy and Photovoltaics

Course Contents:

Unit 1: A Reality Check on Energy Resources **[12 Hrs]**

Quantification of Energy Resources, World Energy Requirement, Need for Sustainable Energy Resources, Current Status of Renewable Energy Resources, Position of Existing Solar Photovoltaic (PV) Technologies in the World and Cost Analysis of Solar PV Panels

Solar Radiation & Measurement: The Sun and the Solar Spectrum, Energy from the Sun, Sun – Earth Movement, Angles, Local Apparent Time (LAT), Tracking of the Sun, Empirical Estimation of Solar Radiation, Radiation Measurement Using Pyranometer, Pyrheliometer and Sunshine Recorder

Unit II: Semiconductor Physics **[12 Hrs]**

Semiconductor Materials and Types, Arrangement of Atoms in Space, Arrangement of Electrons in Atoms, Energy Bands and its Formation, Charge Carriers in Semiconductors, Carrier

Concentration and Distribution, Carrier Motion in Semiconductors, Electric Field and Energy Band Bending, Generation of Carriers, Recombination of Carriers and Charge Extraction

Unit III: Solar Cells & Modules: Analysis, Design & Fabrication [12 Hrs]

p – n Junction Diode, p – n Junction Under Equilibrium Condition, p – n Junction Under Illumination, I – V Curve, Equivalent Circuit of Solar Cell and Cell Characteristics – Short Circuit Current, Open Circuit voltage, Fill Factor (FF) and Efficiency, Upper Limits of Cell Parameters, Losses in Solar PV Cells, Minimization of Optical Losses, Effect of Series and Shunt Resistance on Cell Efficiency, Effect of Solar Radiation and Temperature on Cell Efficiency, Dependency of Power Output on Frequency of Incoming Radiation, Design of Cells for High I_{SC}, High V_{OC} and High FF, Analytical Techniques – Solar Simulator for I – V Measurement and Quantum Efficiency Measurement, Series and Parallel Connection of Solar Cells, Mismatch in Cell/ Module, Hotspots, Bypass Diode, Rating of PV Modules and Fabrication of PV Modules

Unit IV: Silicon Wafer – Based & Thin Film Solar Cells [12 Hrs]

Production of Silicon for PV Cells and Approaches, Development of Commercial Silicon Solar Cells, high Efficiency Silicon Solar Cells, Generic Advantages of Thin Film Technology and Applications, Materials for Thin Film Cells, Substrates and Thin Film Deposition Techniques Concentrated Photovoltaics and Emerging Cell Technologies: Light Concentration, Concentration Ratio, Optics for Concentrator PV Technology, Tracking and Cooling Requirements, High Concentration Photovoltaic (HCPV) System and Low Concentration Photovoltaic (LCPV) System, Multi – junction Solar Cells, Organic Solar Cells and Dye – Sensitized Solar Cells (DSC)

Text Books and Reference Books:

1. Solar Photovoltaics – Fundamentals, Technologies & Applications (3rd Edition) by Chetan Singh Solanki; PHI Learning Private Limited
2. Solar Photovoltaic Basics (2015) by Sean White; Routledge Publishers
3. The Physics of Solar Cells by Juan Bisquert; CRC Press
4. Photovoltaics – Design & Installation Manual (2004); New Society Publishers
5. Solar Photovoltaic Technology & Systems: A Manual For Technicians, Trainers & Engineers (2013) by Chetan Singh Solanki; PHI Learning Private Limited
6. Solar Electricity Handbook (2016) by Michael Boxwell; Greenstream Publishing
7. MIT Open Course Ware (Online Content, USA)
8. National Renewable Energy Laboratory (Online Content, The Government of USA)
9. Fraunhofer ISE (Online Content, Germany)
10. pveducation.org (Online Content)

<table>
<tr><td>Sub Code:
M18PS2120</td><td rowspan="2">**Energy Conservation and Demand side Management**</td><td>**L**</td><td>**T**</td><td>**P**</td><td>**C**</td><td>**CH**</td></tr>
<tr><td>Duration: 14 Weeks</td><td>**4**</td><td>**0**</td><td>**1**</td><td>**4**</td><td>**6**</td></tr>
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Course Objectives:

1. To Provide An Overview of energy audit methodology.
2. To Study the energy audit reports and analyze the conservation opportunities.
3. To prepare the detailed energy audit reports.

Course Outcomes:

After learning the course the students should be able to,

1. Identify and assess the energy conservation/saving opportunities in different electric system
2. Identify and assess energy conservation opportunities in thermal system
3. Demonstrate skills required for energy audit and management.
4. Prepare energy flow diagrams and energy audit report
5. Suggest cost-effective measures towards improving energy efficient and energy conservation.

Course Contents:

Unit 1: **[12 Hrs]**

Energy Audit Methodology and recent trends. General Philosophy, need of Energy Audit and Management, EC Act, Definition and Objective of Energy Management, General Principles of Energy Management. Energy Management Skills, Energy Management Strategy. Economics of implementation of energy optimization projects, it's constraints, barriers and limitations, Financial Analysis: Simple Payback, IRR, NPV, Discounted Cash flow; Report-writing, preparations and presentations of energy audit reports, Post monitoring of energy conservation projects, MIS, Case-studies / Report studies of Energy Audits. Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations. Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy. Case studies of implemented energy cost optimization projects in electrical utilities as well as thermal utilities

Unit II: **[12 Hrs]**

Electrical Distribution and Utilization: Electrical Systems, Transformers loss reductions, parallel operations, T & D losses, P.F. improvements, Demand Side management (DSM), Load Management, Harmonics & its improvements, 11 25-30% Energy efficient motors and Soft starters, Automatic power factor Controllers, Variable speed drivers, Electronic Lighting ballasts for Lighting, LED Lighting, Trends and Approaches. Study of 4 to 6 cases of Electrical Energy audit and management (Power factor improvement, Electric motors, Fans and blowers, Cooling Towers, Industrial/Commercial Lighting system, etc.)

Unit III: **[12 Hrs]**

System Audit of Mechanical Utilities: Pumps, types and application, unit's assessment, improvement option, parallel and series operating pump performance. Energy Saving in Pumps

& Pumping Systems. Bloomers (Blowers) types & application, its performance assessment, series & parallel operation applications & advantages. Energy Saving in Blowers Compressors, types & applications, specific power consumption, compressed air system,& economic of system changes. Energy Saving in Compressors & Compressed Air Systems Cooling towers, its types and performance assessment & limitations, water loss in cooling tower.

Unit IV: **[10 Hrs]**

Thermal Systems: Boilers- performance evaluation, Loss analysis, Water treatment and its impact on boiler losses, integration of different systems in boiler operation. Advances in boiler technologies, FBC and PFBC boilers, Heat recovery Boilers- its limitations and constraints.

Text Books and Reference Books:

1. Energy Audit and Management, Volume-I, IECC Press
2. Energy Efficiency in Electrical Systems, Volume-II, IECC Press
3. Energy Management: W.R.Murphy, G.Mckay, Butterworths Scientific
4. Energy Management Principles, C.B.Smith, Pergamon Press
5. Industrial Energy Conservation, D.A. Reay, Pergamon Press
6. Energy Management Handbook, W.C. Turner, John Wiley and Sons, A Wiley Interscience
7. Industrial Energy Management and Utilization, L.C. Witte, P.S. Schmidt, D.R. Brown, Hemisphere Publication, Washington, 1988
8. Hand Book of Energy Audits, Albert Thumann, P.E., C.E.M. William J. Younger, C.E.M., CRC Press

Sub Code: **M18PS2130**	**HVDC Transmission**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To enable students to understand the concepts HVDC transmission and advantages.
2. To enable students to understand the various components of HVDC transmission network
3. To enable students to understand the steady-state performance of the system.
4. To enable students understand the various protective schemes against faults.

Course Outcomes:

At the end of the course a students are able to

1. Identify the key economic advantages of HVDC projects
2. Distinguish among various types of HVDC configurations.
3. Analyze the operation of various converters and their control.
4. Understand the system planning considerations for HVDC transmission.

Course Contents:

UNIT-I: **[12 Hrs]**

Review of HVAC power transmission, limitations, Introduction to HVDC Power transmission Multi-terminal DC Systems: Introduction, Potential applications, types, control and protection. Models for analysis of AC-DC Systems**:** converter models, Converter control model, modeling of DC and AC network.

UNIT-II: Power Flow Analysis in AC-DC Systems: **[12 Hrs]**

Introduction, Modeling DC links, Solution of DC load flow, per unit for DC quantities, Solutions for AC-DC power flow. Transient Stability Analysis: Converter and Controller models, DC network models, Methods of solution for stability evaluation. Transient Stability improvement using DC link Control.

UNIT-III: Dynamic Stability: **[12 Hrs]**

Power Modulation for damping low frequency Oscillations, Harmonic and Torsional Oscillations Harmonic and Torsional Interactions: Harmonic and Torsional Interactions with HVDC Systems. Measures to m itigate torsional interactions with DC Systems.

UNIT-IV: Simulation of HVDC Systems: **[12 Hrs]**

Introduction, Modelling of Converters and DC systems for Dynamic Digital Simulation Dynamic digital simulation of HVDC Systems Interphase Power Controllers and other FACTS devices.

Text Books and Reference Books:

1. K. R. Padiyar, "HVDC Power Transmission Systems: Technology and System Interactions", New age International, 1st Edition.
2. E. W. Kimbark, "Direct Current Transmission", Vol. I, Wiley Future Science.
3. Arrilaga, "High Voltage Direct Current Transmission", The institute of engineering and technology, 2nd Edition, 2007.

Sub Code: **M18PS2141**	**Electric Vehicle**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To enable students to know the advantages of EVs.
2. To enable students to know the various drive trains
3. To enable students to know the characteristics of various types of batteries.
4. To enable students to know the concept of hybrid electric vehicles.

Course Outcomes:

On completion of this course the students will be able to:

1. Describe the configuration of a typical electric vehicle.
2. Differentiate among different drive trains.
3. Understand the limitations and advantages of various battery chemistries.
4. Develop strategies for charging various types of batteries.
5. Describe the various drive trains of hybrid electric vehicles.

Course Contents:

UNIT-I: Introduction to electric vehicles (EVs): **[12 Hrs]**
Historical perspective. EV advantages and impacts. EV market and promotion: infrastructure needs, legislation and regulation, standardization. Electric vehicle (EV) design options: EV configurations: fixed v s. variable gearing, single- vs. multiple-motor drive, in wheel drives. EV parameters, driving cycles and performance specifications. Choice of system voltage levels: electrical safety and protection.

UNIT-II: Vehicle dynamics and motor drives: **[12 Hrs]**
Road load: vehicle kinetics; effect of velocity, acceleration and grade. EV drivetrain and components. EV motor drive systems: DC drives, induction motor drives, permanent-magnet synchronous motor drives, switched reluctance motor drives. Control strategies.

UNIT-III: Batteries: **[12 Hrs]**
Battery parameters. Types and characteristics of EV batteries. Battery testing and maintenance; charging schemes. Battery monitoring techniques. Open-circuit voltage and ampere- hour estimation. Battery load levelling.

UNIT-IV: Emerging EV technologies: **[12 Hrs]**
Hybrid electric vehicles (HEVs): types, operating modes, torque coordination and control, generator/motor requirements. Fuel cell electric vehicles (FEVs): fuel cell characteristics, hydrogen storage systems, reformers. Alternative sources of power: super- and ultra- capacitors, flywheels.

Text Books and Reference Books:

1. C.C. Chan and K.T. Chau, Modern Electric Vehicle Technology, London: Oxford University Press
2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, New York: RC Press.
3. M. Ehsani, Y. Gao, S .E. Gay and A. Emadi, Modern Electric, Hybrid Electric, and Fuel C ell Vehicles: Fundamentals, Theory and Design, CRC Press.
4. Batteryuniversity.com

Sub Code: **M18PS2142**	**AC-DC Drives**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To enable students to understand the concepts of drives.
2. To enable students to understand the theory of braking of drives
3. To enable students to learn the concept of speed control
4. To enable students to understand the concept of sensor-less speed control

Course Outcomes:

On completion of this course the students will be able to:

1. Describe the dynamics of various motors
2. Describe the operations in various quadrants.
3. Describe the various speed control methods
4. Apply mathematical concepts into the concept of speed control
5. Develop simulation model of speed control of machines.

Course Contents:

UNIT-I: **[12 Hrs]**

Basic concepts, characteristics and operating modes of drive motors, Dynamics of electric drives, Selection of motor and rating, Concept of four quadrant drive, Classification of load and its characteristics.

UNIT-II: DC Motor drive: **[12 Hrs]**

Starting, braking, transient analysis, controlled rectifier and chopper fed DC drives. Induction motor drives: Operation with unbalanced voltage and unbalanced rotor impedances, effect of time harmonics on the motor performance.

UNIT-III: **[12 Hrs]**

Various methods of braking, transient analysis, speed control using change in no. of poles, stator voltage control, variable voltage variable frequency (VVVF) control, rotor resistance control.

UNIT-IV: Switched Reluctance Motor Drive: **[12 Hrs]**

Various drive configurations, Sensor and sensor-less control of SRM, reduction in torque pulsation.

Text Books and Reference Books:

1. G.K. Dubey - Fundamentals of electrical Drives, Narosa Publications.
2. S.K. Pillai - Analysis of thyristor power conditioned motors, University press.

3. Vedam Subramanyam - Electric Drives – concepts and publications, Tata Mc Graw –Hill.
4. R. Krishnan – Electric Motor Drives, Prentice Hall Ltd.
5. W. Leonhard – control of electric drives, Springer-Verlag.
6. T.J.E. Miller – Brushless PM and Reluctance Motor Drives, clarendon Press Oxford.

Sub Code: **M18PS2143**	**Advanced Energy Systems**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To Provide An Overview Hydrogen Extraction Processes
2. To Study The Inherent Risks Associated With Hydrogen Storage and Delivery
3. To Impart Knowledge About Fuel Cell Technologies
4. To Introduce Key Concepts Of Magneto hydrodynamic Power Generation
5. To Introduce general Concepts of Thermoelectric and Thermionic Power Conversion Systems.

Course Outcomes:

On completion of this course the students will be able to:

1. The Students Will be Equipped With the Basic Knowledge Of Hydrogen Production, Storage And Delivery.
2. The Students Will be Able to Illustrate and Analyze Various Fuel Cells And Their Performance.

Course Contents:

Unit 1: Hydrogen Energy [12 Hrs]

Downside of Solar Wind and other Perpetual Energy Technologies, Introduction To Hydrogen Energy, Properties of Hydrogen, Hydrogen as Energy Carrier, Production of Hydrogen – Thermo-chemical method, Electrolysis of Water, Thermolysis of Water and Biophotolysis, Storage and Delivery of Hydrogen, Safety Concerns, Applications and Present Status and The Concept of Hydrogen Economy

Unit 2: Fuel Cells [14 Hrs]

The Concept of Fuel Cell, Potential Applications, Classification of Fuel Cells, Components and Working Principle of Fuel Cells, Efficiency of Fuel Cells, V – I Characteristics of Fuel Cells, Factors Affecting the Performance of Fuel Cells, Phosphoric Acid Fuel Cell, Alkaline Fuel Cells, Direct Ethanol Fuel Cell, Solid Oxide Fuel Cell, Comparative Study of Fuel Cells and Redox – Flow Batteries, Fuel Cell Power Plant, Pros and Cons of Fuel Cells, Environmental Impacts and Current Technological Status

Unit 3: Magneto hydrodynamic Power Conversion Technology **[14 Hrs]**
Idea of Magneto hydrodynamics, Basic Principle of Faraday generator, Hall generator, Construction and Working of MHD Generator, Advantages and Limitations of MHD Systems, MHD Power Generation Systems – Oen Cycle MHD Generating System, Seeded Inert Gas Closed Cycle MHD Generating System, Fast Breeder Reactor Coupled Closed Cycle MHD Generating System

Unit – 4: Thermoelectric Power Conversion Technology **[12 Hrs]**
Introduction, Seebeck Effect in an Elementary Thermocouple, Peltier Eddect, Connstruction and Operation of Thermoelectric Power Generator, Thermal Efficiency, Peltier Cooler, Advantages and Limitations of the Technology, Concept of Thermionic Power Conversion System, Materials Employed and Limitations of the Technology

Text Books and Reference Books:

1. Non – conventional Energy Resources by B. H. Khan (3rd Edition); McGraw Hill Education
2. Introduction To Modern Magneto hydrodynamics (2016) by Sebastien Galtier; Cambridge University Press
3. MHD Power Generation: Selected Problems of Combustion MHD Generators (1975) by R. Bunde, H. Muntenbruch, J. Reeder, R. Volk and G. Zanki; Springer – Verlag
4. MIT Open Course Ware (Online Content, USA)
5. National Renewable Energy Laboratory (Online Content, The Government of USA)

Sub Code: **M18PS2144**	**FPGA Application**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To implement various digital circuits using Programmable Logic Devices.
2. Implement various logical circuits using CMOS circuits

Course Outcomes:

1. Design simple logic circuits using data flow, structural and behavioral modeling concepts.
2. Implement combinational and sequential circuits.
3. Design of logic circuits using CMOS circuits.

Course Contents:

UNIT I: **[12Hrs]**
Programmable logic Devices and their evolution: ROM, PLA, PAL, CPLD, FPGA Features, Architectures and Programming.

Reprogrammable devices, Applications and Implementation of MSI circuits using Programmable logic Devices.

UNIT II: **[12Hrs]**

FPGAs: Field Programmable Gate Arrays- Logic blocks, routing architecture, design flow, technology mapping for FPGAs, Case studies Xilinx XC4000 & ALTERA's FLEX 8000/10000 FPGAs.

UNIT III: **[12Hrs]**

VHDL for Synthesis- Introduction, Behavioral, Data flow, Structural Models, Simulation Cycles, Process, Concurrent Statements, Sequential Statements, Loops, Delay Models, Sequential Circuits, FSM Coding, Library, Packages, Functions, Procedures, Operator Inferencing, Test bench.

UNIT IV: **[12Hrs]**

System Level Design: Controller, data path designing, Functional partition, Digital front end digital design tools for FPGAs. System level design using mentor graphics/Xilinx EDA tool (FPGA Advantage/Xilinx ISE), Design flow using FPGAs. Intel FPGA tools for design and synthesis.
Case studies: Design considerations using FPGAs of parallel adder cell, parallel adder sequential circuits, counters, multiplexers, parallel controllers.

Text Books and Reference Books:

1. Juan Jose Rodriguez Andina, Eduardo de la Torre Arnanz, Maria Dolores Valdes, 'FPGAs: Fundamentals, Advanced Features, and Applications in Industrial Electronics', CRC Press, 2017.
2. Douglas L Perry, 'VHDL', McGraw Hill Education, 2017

Sub Code: **M18PS2151**	**Power Quality and Harmonics Mitigation**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To Provide An Overview power quality technologies.
2. To Study the effect of harmonics on power quality.
3. To study about the various voltage controllers for harmonics mitigation.

Course Outcomes:

1. To analyze the various power quality issues.

2. To design voltage quality controllers.
3. To calculate the harmonics for power quality improvement.

Course Contents:

UNIT I: [12Hrs]
Power quality terminologies Categories & characteristics of power system electromagnetic phenomena for power quality, transients – impulsive & oscillatory, long duration & short duration voltage variations, voltage imbalance, waveform distortion, power frequency variations, power quality terms

UNIT II: [12Hrs]
Harmonics & power electronic converters Calculation of harmonic currents – effects of source unbalance, circuit reactance, dc filter inductance Current harmonics in converter with inductor input filter & capacitor input filter Single phase power conversion – effects of circuit resistance, source reactance, 3rd harmonics currents, reduction of harmonics Harmonic issues for phase controlled thyristors.

UNIT III: [12Hrs]
Effect of harmonics on electrical apparatus Effect of harmonic on Transformer - Harmonics in No-Load Exciting Current, Harmonics due to Inrush Current, DC Magnetization Effect on Capacitor, Induction Motor, protection devices Harmonics in arc furnace loads & thyristor controlled reactor Power Quality in Distributed Generation DG technologies, Interface to the utility system, Impact of distributed generation on power quality, Operating conflicts, DG on distribution networks, Interconnection standards

UNIT IV: [10Hrs]
Voltage quality controllers Shunt controllers: D-SVC, D-STATCOM – operation & control Series controllers: DVR – operation & control.

Text Books and Reference Books:

1. R. Sastry Vedam & Mulukutla S. Sarma, "Power Quality: VAR Compensation in power systems", CRC press 2009
2. Moreno-Munoz, "Power Quality: Mitigation techniques in a distributed environment"
3. Roger C. Dugan, "Electrical Power Systems Quality", 2nd Edition, Tata Mcgraw Hill Publication
4. Derek A. Paice, "Power Electronic converter harmonics: Multipulse methods for clean power", IEEE press, 1995
5. Hirofumi Akagi, Edson Hirokazu Watanabe, Mauricio Aredes, "Instantaneous Power Theory and Applications to Power Conditioning", John Wiley & Sons, 2007

Sub Code: **M18PS2152**	**EMC / EMI / Power Transients**	**L**	**T**	**P**	**C**	**CH**

Duration: 14 Weeks		4	1	0	4	6

Course Objectives:

1. Understand EMI/EMC Concepts, Definitions, and Requirements
2. Explore EMC Methodology, Environments, and Measurements
3. Calculate electromagnetic propagation
4. Understand EMC Modeling and Analysis
5. Analyze EM Propagation and Crosstalk
6. Analyze potential EMI problems by identifying the source, the receptor, and the coupling path

Course Outcomes:

On completion of this course the students will be able to:

1. Construct simple models that describe non-ideal properties for electrical components
2. Understand and analyze the levels of noise affecting the system(with respect frequency range)
3. Analyze the capacitive, inductive and mutual inductive coupling circuits
4. Identify low & high frequency (electric and magnetic) coupling mechanisms and calculate simple examples
5. Design effective shielding devices and filters

Course Contents:

UNIT-I: **[12Hrs]**

EMC standards and Review of EMI theory**:** Introduction to EMI, Sources of EMI, noise pick up modes, reduction techniques for analog circuits, Use of co-axial cables and conducted and shielding of signal lines.

UNIT-II: Emission and reduction techniques: **[12Hrs]**

Radiated noise emission in power electronic equipment, reduction techniques, safety grounds, signal grounds, grounding of cable shields, ground loops, low and high frequency analysis of common mode choke, shielding grounding at high frequencies, guard shields guarded meters.

UNIT-III: Balancing and filtering: **[12Hrs]**

Balancing power supply decoupling, decoupling filters, amplifier decoupling driving capacitive loads, high frequency filtering, system bandwidth, and modulation and coding.

UNIT-IV: Electrostatic discharge: **[12Hrs]**

ESD, Human body model, EMC protection in equipment design, switching interference reduction, susceptibility aspects of power electronic, digital equipment.

Text Books and Reference Books:

1. Otto H. W., "Noise Reduction Techniques in Electronic Systems", 2nd Edition, John Wiley and Sons, 1988.
2. Paul Clayton, "Introduction to Electromagnetic Compatibility", 2nd Edition, Wiley Interscience, 2006.
3. William B. Greason, "Electrostatic Damage in Electronics: Devices and Systems", John Wiley and Sons, 1986
4. Charles H. Roth, Fundamentals of Logic Design (5th ed.), Cengage Learning, 2004.
5. Joseph Di Giacomo, "Digital Bus Hand Book", McGraw Hill Publishing Company, 1990.
6. White, R. J., "Handbook Series of Electromagnetic Interference and Compatibility", Don White consultants Inc.1981.

Sub Code: **M18PS2153**	**Reliability Engineering**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To provide an understanding of quantifying the product behavior in the user conditions.
2. To provide and understanding of the techniques used to improve the life of the product.
3. To have an understanding of environmental external variables and how the products get affected in terms of life expectancy of the product.
4. To provide a comprehensive look at the challenges in engineering problems to provide an effective and efficient solution

Course Outcomes:

1. To determine Life of a typical product.(a)
2. Determine conditions under which the product operates and impact of the environment on the life expectancy of the product. (d, e, f)
3. Apply the quantitative techniques to study the operational phase of a product under different conditions. (g)
4. To determine ways and means to extend the life expectancy of the product. (j, k)
5. To study various Industry segments and understand the applicable reliability figure and also conflicting requirements and compromises. (a, g,)

Course Contents:

Unit-I: Introduction **[11hrs]**

Reliability Definition – Demystifying Related Terms viz- Bath Tub curve, Infant Mortality, Failure Rate, Up time, Down time, Maintainability, MTTF, MTTR, Availability, Reliability

Function – PDF & CDF and Hazard Function. Parallel and serially connected systems and assessment of reliability – Fault Tolerant systems

Unit-II: Design for Reliability **[10hrs]**

Design for Reliability & Reliability Estimation, System Level – Design – Hardware – Software – Improving the reliability

Unit-III: Reliability Assessment **[11hrs]**

Reliability assessment tools and Techniques: Reliability Standards – MIL and ISO

Unit-IV: Failure Modes and Effect Analysis **[10hrs]**

Failure Modes and Effect Analysis – FMEA, FRACAS – Failure Reporting and corrective ACTION SYSTEMS, Reliability Management

Text Books and Reference Books:

1. Hoang Pham, "**Handbook of Reliability Engineering**", Springer Publishing; ISBN 1-85233-453-3,2003

2. Hongzu Wang and Hoang Pham, "**Reliability and Optimal Maintenance**" Springer Book series; ISBN 1-84628-324-8,2006

3. "**Handbook of Reliability Engineering**" by published by the direction of the chief- of the bureau of naval weapons

Sub Code: **M18PS2154**	**Wind Energy System**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**1**	**0**	**4**	**6**

Course Objectives:

1. To Provide An Overview Of The Wind Energy Scenario of The World And India
2. To Introduce The Concepts Of Planetary And Local Winds
3. To Introduce Fundamental Concepts Of Aerodynamics
4. To Provide An Insight Into The Construction And Operation Of Wind Energy Conversion System
5. To Introduce Novel Technologies In Solar Photovoltaics

Course Outcomes:

On completion of this course the students will be able to:

1. The Students Will be Equipped With the Basic Knowledge of Wind Data And Measurement
2. The Students Will be Able to Analyze and Illustrate Wind Power Plants
3. The Course Shall Provide A Robust Technical Foundation For Prospective Energy Engineers to Evaluate, Commission and Operate Wind Power Plants

Course contents:

Unit I: Introduction to Wind Energy **[12 Hrs]**

Historical background, Modern Wind power Industry in India and World, Challenges and Opportunities, Planetary and Local Winds, Distribution of Wind on Earth's Surface, Beaufort scale, Wind Data, Variation of Wind Speed with Height, Anemograph and Anemometer

Concepts of Aerodynamics

Basic Terminologies of Fluid Mechanics, Airfoil, Laminar and Turbulent Airflow, Airflow Around an Airfoil, Extraction of Power From Wind, Betz Criterion, Energy in Wind, Axial Thrust on Turbine Blades, Torque Developed by Turbine and Dynamic Matching For maximum Power Extraction

Unit II: Construction & Operation of Wind Energy Conversion System **[14 Hrs]**

Components of WECS, Tower Foundation, Operation of WECS, Types of WECS – Horizontal Axis Wind Turbine and Vertical Axis Wind Turbine, Types and Configuration of Turbine Blades, Yaw and Pitch Control, Lightning Protection, Braking System, Hydraulic System, Sensors and Communication System and Electrical Systems in WECS, Standards and Certification of Wind Power Plants

Unit III: Generators for Wind Turbine & Speed Control **[12 Hrs]**

Induction Generators, Synchronous Generators, Permanent Magnet DC Generators, Fixed Generator Speed – Fixed Pitch Control, Fixed Generator Speed – Variable Pitch Control, Power Control and Power Curve Analysis, Fixed Speed and Variable Speed Wind Power Plants and Need for Direct – Drive Wind Power Plant

Unit IV: Wind Power Project Development **[14 Hrs]**

Wind Resource Assessment, Site Selection for Wind Power Plants, Site Evaluation, Estimation of Power Production, Meteorological Data, Impacts of Development of Wind Farms, Investment for Wind Power Projects, Operational and Maintenance Cost Evaluation, Payback Analysis and Risk Assessment, Wind Power Policies and Conflicts

Text Books and Reference Books:

1. Wind Power Plants and Project Development(2nd Edition) by Joshua Earnest and Tore Wizelius; PHI Publications
2. Wind Energy Explained (2002) by J. F. Manwell; Wiley Publications
3. Wind Power Plants(2002)by R. Gasch; Springer International Publications
4. Model Predictive Control of Wind Energy Conversion Systems (2016) by Bin Wu and VenkataYaramasu; Wiley publications
5. Handbook of Wind Power Systems(2014) by P.M. Pardalos, Steffen Rebennack, Niko A. Iliadis, Vijay Pappu; Springer International Publications
6. MIT Open Course Ware (Online Content, USA)
7. National Renewable Energy Laboratory (Online Content, The Government of USA)

Sub Code: **M18PS2161**	**Multilevel Inverter**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**0**	**0**	**4**	**4**

Course Objectives:

1. To enable students to know the limitations with the classical inverter.
2. To enable students to describe the operation of various types of multilevel inverters.
3. To enable students to describe the control of multilevel inverter.
4. To enable students to know the voltage imbalance problem in capacitor clamped MLI and mitigation.

Course Outcomes:

On completion of this course the students will be able to:
1. Know the operation of various types of MLI
2. Know various control options for MLI.
3. Apply mathematical concept to minimize THD
4. Develop simulation models of MLI
5. Develop simulation models of PWM strategies.

Course Contents:

UNIT-I: [12 Hrs]
Basic concept of general n-level inverter, comparison of multi-level inverter with two-level inverter advantages and disadvantages, scope and applications of multi-level inverters for high power induction motor drives.

UNIT-II: [12 Hrs]
Types of multi-level inverters: Neutral Point Clamped (NPC),capacitor clamped (flying capacitor), cascaded multi-cell (cascaded H-bridge), hybrid H-bridge, cascaded inverters, dual-inverter fed open end winding induction motor structure, asymmetric dc-link structure, voltage and current controlled PWM techniques used for multi-level inverters.

UNIT-III: [12 Hrs]
Comparative analysis of various PWM control techniques used for multi-level inverters.

UNIT-IV: **[12 Hrs]**

Problems of common-mode voltage generation and dc-link capacitor voltage unbalance in multi-level inverters and various mitigation techniques for these problems in multi-level inverters. Direct conversion drives using SGCT and IGCT.

Text Books and Reference Books:

1. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics: Converters, Applications and Design", John Wiley & Sons
2. B. K. Bose – Power Electronics & AC Drives, Prentice-Hall
3. M. H. Rashid – Power Electronics, third edition, Pearson
4. Recent papers of IEEE Trans. on Power Electronics, IEEE Trans. on Industrial Electronics, IEEE Trans. on Industry Applications, IEEE Trans. on Power Systems, IEEE Trans. on Power Delivery etc.
5. L. Umanand, "Power Electronics, Essentials and applications", Wiley India Pvt. Ltd

Sub Code: **M18PS2162**	**Environmental Impacts of Energy Conversion and Safety**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**0**	**0**	**4**	**4**

Course Objectives:

1. To understand the overall energy generation, availability and consumption in world
2. To understand the pollutants produced by different energy sources.
3. To know the various impacts of pollution produced by conventional energy sources
4. To know the alternate energy sources for the control of environmental pollution.

Course Outcomes:

On completion of this course the student will be able to:

1. Initiate the remedial measures to control the environmental pollution.
2. Reduce the dependence on the polluting energy sources.
3. Search and implement the new renewable alternate energy sources with no or less pollution.
4. Adopt the various techniques to control the pollution.

Course Contents:

UNIT-I: **[12 Hrs]**

Energy Overview: Types of different energy sources and their utilization. Energy characteristics Energy Measures, global energy scenario, Indian energy scenario. Energy characteristics, Energy measures , fundamentals of environment, water cycle , oxygen cycle, carbon cycle , Nitrogen cycle, Phosphorous cycle , Bio-diversity, Environmental aspects of energy utilization, Public health issues related to environmental Pollution.

UNIT-II: **[10 Hrs]**

Air Pollution: Classification of air pollutants, sources of emission and air quality standards – Physical and chemical characteristics – Meteorological aspects of air pollutant dispersion – Factors influencing dispersal of air pollutant – Air pollution dispersion models – Air pollution sampling and measurement – types – Particulate air pollutants

UNIT-III **[10 Hrs]**

Air Pollution Control methods and Water Pollution: Types of controls – Particulate emission control – Gaseous emission control – Sources and classification of water pollutants – Waste water sampling and analysis – Basic process of waste water treatment – Primary treatment – Secondary treatment – Advanced treatment Methods of feed water treatment.

UNIT-IV **[10 Hrs]**

Environmental impact assessment: Air quality and water quality standards – Pollution prevention and control acts – Principles and methodology of Environmental impact assessment, Air and water quality impacts by project types.

Text Books and Reference Books:

1. Abbasi and Abbasi: Renewable Energy Sources: Their Impact on Global Warming and Pollution, PHI, Eastern Economy Edition, 2012
2. C.S. Rao: Environmental Pollution Control Engineering, Wiley Eastern, 1992.
3. Y. Anjaneyulu: Air Pollution and Control Technologies, Allied Publishers, 2002.
4. J. Rau and D.C. Wooten: Environmental Impact analysis Handbook, McGraw Hill, 1980.
5. D.H.T. Liu: Environmental Engineers Handbook, Lewis, 1997.

Sub Code: **M18PS2163**	**Trouble Shooting and maintenance of Electrical Equipment.**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**0**	**0**	**4**	**4**

Course Objectives:

1. To teach safety rules , important tools used in trouble shooting
2. To teach different types of wires & wire splicing, termination.
3. To teach usage of important electrical meters which are used in the process of trouble shooting.
4. To teach probable faults, causes & remedies on some common electrical equipment.

Course Outcomes:

On completion of this course the students will be able to:

1. Understand safety rules , important tools used in trouble shooting
2. Understand different types of wires & wire splicing ,
3. Understand the usage of important electrical meters which are used in the process of trouble shooting.
4. Find out faults, causes and remedies for common electrical equipment.

Course Contents:

Unit 1: Safety rules & Tools **[10Hrs]**

Introduction , safety precautions, safety rules, screw driver , pliers, wire stripper, pocket knife, hammers, chisels, hand & Electric drill, hack saw, Rawlplug tool, neon tester, test lamp, switch board.

Unit II: Wires, wire splicing and termination **[10Hrs]**

Sizes of wires, stranded wires, types of wires, rubber covered, taped, braided, compounded wire, western union splice (joints) DOL starter for 3-Phase Induction motor. Control of Domestic motor- pump set.

Unit III: Usage of meters **[10Hrs]**

Ammeter, voltmeter, ohm meter (multi meter) megger, earth tester. Measurement of Earth resistance.

Domestic wiring, two & 3- way control of a lamp, Fluorescence lamp set, Sodium vapor lamp

Unit IV: Probable Faults, Causes, and remedies on common Electric Equipment's **[12Hrs]**

Mixer grinder, Table fan and ceiling fan, Electric iron, 3-Phase Induction motor,

Text Books and Reference Books:

1. S.L. Uppal, 'Electrical wiring Estimation & costing', Kanna Publications, 5th edition, reprint, 2006
2. Madhvi Gupta, 'Installation, Maintenance & Repair of Electrical Machines & Equipment', Kataria & Sons, 1st Edition, 2014.
3. Philip Kiameh, 'Electrical equipment Hand book trouble shooting & maintenance', McGraw Hill, Chicago, 2003.

Sub Code: **M18PS2164**	**Green Building Technology**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**0**	**0**	**4**	**4**

Course Objectives:

1. Green Technologies is a highly interdisciplinary degree program that emphasizes green systems and the environment, energy technology and efficiency, and sustainability and society

Course Outcomes:

On completion of this course the students will be able to:

1. Identify and compare existing energy codes, green building codes and green rating systems.
2. Recognize and demonstrate methods for green project management

Course Contents:

Unit –I: Green Building: Opportunities and Trends **[12 Hrs]**

Energy Efficient Buildings, Energy Conservation Opportunities in Public and Private Buildings, Zero energy buildings, Financing green buildings, Building enabled by IoT. Role of building design and building services to evaluate the energy performance in buildings. Study of Climate and its influence in building design for energy requirement, Principles of energy conscious design of buildings. Various Energy Efficiency Rating Systems for Buildings- LEEDS, BEE & GRIHA Rating Systems, Energy Conservation Building Code – 2007.Case studies.

Unit –II: Passive & Active Design Technologies **[12 Hrs]**

Building location and orientation, Building layout and massing, Building envelope heat loss/gain and its evaluation, building envelope technologies, Passive heating technologies, Passive cooling technologies, Passive lighting or day lighting. The Heating, Ventilation and Air Conditioning (HVAC) and refrigeration system, Lighting, energy efficient elevators, Plug & process load management. Case study: CII Godrej Green business centre

Unit-III: **Building Management and Automation Technologies** **[12 Hrs]**

Smart sensors, wireless sensors, Integrated communication technologies, Controllers, actuators, BMS Communication and protocols, Internet of Things(IoT) enabled Building management systems

Unit-IV: Renewable energy Integration in buildings **[12 Hrs]**

Rooftop Solar PV, Building Integrated photovoltaic (BIPV), Solar thermal collectors, Wind energy, Thermal storage, battery storage, Smart energy management systems, Ecofriendly captive power generation for factory

Text Books and Reference Books:

1. Green and Smart Buildings: Advanced Technology Options by Nilesh Y. Jadhav
2. Energy Efficient building in India by MiliMajumdar
3. Handbook on Energy Conscious Buildings by J.K. Nayak & J.A. Prajapati
4. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009. ECBC Code 2007 (Edition 2008) published by Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI PUBLICATIONS – GRIHA Rating System, LEEDS Publications
5. Complete Guide to Green Buildings by Trish riley
6. Standard for the design for High Performance Green Buildings by Kent Peterson, 2009

7. Green Building Hand Book by Tomwoolley and Samkimings, 2009.

III Semester

Sub Code: **M18PS3111**	**Electricity Regulations**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**0**	**0**	**4**	**4**

Course Objectives:

1. To provide power factor scenario before Enactment of Electricity act 2003
2. To provide information about regulatory commission and Power trading
3. To understand the necessity of Consumer protection act, Factories Act and workmen compensation act etc.,
4. To make understand need for the formation of BEE.

Course Outcomes:

On completion of this course the students will be able to:
1. To understand the different Electricity act, enactment of electricity act, power trading.
2. To understand the importance and necessity of reducing transmission and distribution loss.
3. To understand relevant acts and rules

Course Contents:

UNIT-I: [10 Hrs]
Power sector scenario before Enactment of Electricity act 2003.Enactment of Electricity act 2003, power trading, open access, Regulatory commission, appellate tribunals, liberating generation plants, from permits (except hydro).

UNIT-II: [12 Hrs]
Electricity reforms envisaged in the country, necessity of forming electricity regulatory commission at the centre and states, enactment of regulatory commission act 1998, Karnataka electricity reforms act 1998, necessity of reducing T&D loss, formulation of uniform structure of tariff, de-linking of generation, transmission and distribution activities.

UNIT-III: [14 Hrs]
Relevant acts, rules, related, important clauses and subjects there on, - in respect of Consumer Protection Act, Factories Act, Workmen Compensation Act, Indian Telegraphic Act Pertaining to Power sector, Companies act, Boiler Safety Act, Right to Information Act and KTPP Act.

UNIT-IV: [12 Hrs]

Energy Conservation Act 2001. Necessity and formation of BEE, Green power/green building concepts, carbon trading and formation of international bodies for protection of environment, CDM technologies. Introduction of friendly measures to encourage independent power producers.

Text Books and Reference Books:

1 .Anita Abraham, “Electricity Rules Cited – Electricity Law Manual”.
2. Various acts and rules as cited.
3. KERC ES&D Code.
4. Condition of Supply of Electricity of Distribution Licenses in various states

Sub Code: **M18PS3112**	**Power System Dynamics and Control**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**0**	**0**	**4**	**4**

Course Objectives:

This course aims to give an insight into:

1. The dynamic models of power system components.
2. Transient response of the system with and without controllers.
3. Analysis and control strategies for the smooth and reliable operation of a power system.

Course Outcomes:

After learning the course the students should be able to:

1. Demonstrate the dynamic models of power system components
2. Select the appropriate model depending on the analysis to be done.
3. Prepare the detailed simulations for single machine and multi-machine systems.
4. Analyze the performance of the system with small signal analysis.
5. Demonstrate the controllers and their significance in power system.

Course Contents:

UNIT:1

Modelling of Synchronous Machine: **[11 Hrs]**

Introduction; Synchronous machine model, Park's Transformation; Analysis of Steady State Performance, Per Unit Quantities, Equivalent Circuits of Synchronous machine, Determination of Parameters of Equivalent Circuits, Measurements for Obtaining Data, Saturation Models, Transient Analysis of a Synchronous Machine.

UNIT-2 **[12 Hrs]**

Excitation and Prime Mover Controllers:

Excitation System; Excitation System Modelling; Excitation Systems- Standard Block Diagram; System Representation by State Equations; Prime-Mover Model and Control System.

Transmission Line, SVC and Loads:

Transmission Line Model; D-Q Transformation using alpha-beta Variables, Static Var Compensators; Load models for analysis.

UNIT-3 **[10 Hrs]**

System Model; Synchronous Machine Model; Application of Model 1.1, Calculation of Initial Conditions, System Simulation, Consideration of other Machine Models; Inclusion of SVC Model

UNIT-4 **[10 Hrs]**

Analysis of Single Machine System:

Small Signal Analysis with Block Diagram Representation, Characteristic Equation (CE) and Application of Routh-Hurwitz Criterion; Synchronizing and Damping Torque Analysis; Small Signal Model, State Equations, Nonlinear Oscillations - Hopf Bifurcation.

Text Books and Reference Books:

1. Power System Dynamics Stability and Control By K R Padiyar, B S Publications
2. Power System Stability & Control, By- P.Kundur, Tata Mcgraw hill
3. Power Systems Analysis by Vijay Vittal, Bergen , Pearson Education
4. Electric machinery and Drive Systems by P C Crause, Viley IEEE Press

Sub Code: **M18PS3113**	**Power Economics and Trading**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**0**	**0**	**4**	**4**

Course Objectives:

1. To provide an overview of power economics and regulation.
2. To study the electricity market and pricing of electricity.
3. To study the transmission planning.
4. To study the power sector restructuring and market reforms.

Course Outcomes:

1. The students will be able to do the pricing of electricity.
2. The students will know the different financing options for the power sector.
3. The students will know about the different tariffs.

Course Contents:

Unit I **[12 Hrs]**

Power sector economics and regulation Typical cost components and cost structure of the power sector, Concept of life cycle cost, methods of calculations of Internal Rate of Return (IRR) and Net Present Value (NPV) of project, Different financing options for the power sector . Different stakeholders in the power sector, Role of regulation and evolution of regulatory commission in India, types and methods of economic regulation, regulatory process in India.

Power Tariff, Consumer tariff structures and considerations, Subsidy and cross subsidy, Government policies in force from time to time. Effect of renewable energy and captive power generation on tariff. Determination of tariff for renewable energy. Non price issues in electricity restructuring, quality of supply and service, standards of performance by utility, environmental and social considerations.

Unit II **[12 Hrs]**

Power sector restructuring and market reform Different industry structures and ownership and management models for generation, transmission and distribution. Competition in the electricity sector- conditions, barriers, different types, benefits and challenges Latest reforms and amendments. Different market and trading models / arrangements, open access, wheeling, banking, key market entities- ISO, Genco, Transco, Disco, Retailco, Power market types, Energy market, Ancillary service market, transmission market, Forward and real time markets, market power and exercising it and its effect on market operations

Unit III **[12 Hrs]**

Electricity Markets and Pricing Electricity price basics, Market operation, Market efficiency, gate closure, settlement process. Market Clearing price (MCP), Zonal and locational MCPs. Dynamic, spot pricing and real time pricing, Dispatch based pricing, Power flows and prices. Optimal power flow, Spot prices for real and reactive power. Unconstrained real spot prices, constraints and real spot prices. Global experience with electricity reforms in different countries.

Unit IV **[12 Hrs]**

Transmission Planning and pricing Transmission planning, Different methods of transmission pricing, Different transmission services, Congestion issues and management, Transmission cost allocation methods, Locational marginal price, firm transmission right. Transmission ownership and control, Transmission pricing model in India, Availability based tariff, role of load dispatch centers (LDCs), concept of arbitrage in Electricity markets, game theory methods in Power System, security constrained unit commitment. Ancillary services for restructuring, Forward ancillary service auction. Power purchase agreements.

Text Books and Reference Books:

1. Fundamentals of Power System Economics by D.S. Kirschen and G. Strbac, John Wiley & sons.
2. Electricity Economics Regulation and Deregulation, by G. Rothwell and T Gómez, Wiley – Inter Science
3. Sally Hunt, “Making Competition Work in Electricity”, 2002, John Wiley Inc

4. Electric Utility Planning and Regulation, Edward Kahn, American Council for Energy Efficient Economy
5. "Know Your Power", A citizens Primer On the Electricity Sector, Prayas Energy Group, Pune.
6. Power System Economics Designing markets for Electricity by Steven Stoft, Wiley- inter Science.
7. Market Operations in Electric Power Systems, Forecasting, Scheduling and Risk Management, by M. Shahidepour, Hatim yamin, Zuyi Li, Wiley Inter Science.
8. Deregulation in Power Industry, hand outs of CEP conducted by S.A. Khaparde.
9. Regulation in infrastructure Services: Progress and the way forward - TERI, 2001
10. Maharashtra Electricity Regulatory Commission Regulations and Orders - www.mercindia.com
11. Various publications, reports and presentations by Prayas, Energy Group, Pune www.prayaspune.org
12. Central Electricity Regulatory Commission, Regulations and Orders - www.cercind.org
13. Electricity Act 2003 and National Policies – www.powermin.nic.
14. Bhanu Bhushan, "ABC of ABT - A primer on Availability Tariff" - www.cercind.org

Sub Code: **M18PS3114**	**Project management and report writing**	**L**	**T**	**P**	**C**	**CH**
Duration: 14 Weeks		**4**	**0**	**0**	**4**	**4**

Course Objectives:

1. To Provide an overview of project writing.
2. Understand the stake holders, project meeting management.
3. To study the budgeting projects, cost planning, cost estimating and establishing cost using Microsoft Project.
4. To study the types of reports**, s**cope and style of reports, Narrative reporting, Financial reporting.
5. To enable students to know about Report Structure.

Course Outcomes:

1. The Students will be able to know the types of projects and different project tool.
2. Understand the need for project planning, project selection and prioritization.
3. The students will know about the different tariffs.
4. Helps in improving the skill of writing report.

Unit-1 **[10 Hrs]**

Introduction: Definition of project, characteristics of projects, understand projects, types of projects, scalability of project tools.

Project Selection and Prioritization: Strategic planning process, analysis & objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects.
Planning Projects: developing the project management plan, understanding stake holders, project meeting management, communication needs of global and virtual project teams, Constructing Work Breakdown Structures –planning, definition.

Unit 2 **[10 Hrs]**
Scheduling Projects: purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt Chart, Using Microsoft Project for critical path schedules.
Resourcing Projects: estimate resource needs, creating staffing management plant, critical chain project management (CCPM), compress the project schedule, Using Microsoft Project for resource allocation. Budgeting Projects: Cost planning, cost estimating, establishing cost control, using Microsoft Project for Project Budgets.
Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kickoff: Development of quality concepts, project quality management plan, project quality tools, kickoff project, baseline and communicate project management plan, using Microsoft Project for project baselines.

Unit-3 **[10 Hrs]**
Performing Projects: Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management, Leading and Managing Project Teams – Acquiring, developing, managing and leading the project team, managing stakeholders, managing project conflicts.
Monitoring and progress review: Determining Project Progress and Results: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Using Microsoft Project to monitor and control projects. Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure, celebrate success and reward participant, provide ongoing support.

Unit-4 **[10 Hrs]**
Report Writing: purpose of funder report, the purpose of reporting as part of Monitoring and Evaluation, reporting as part of a project cycle, the purpose of organizational reporting, types of reports**, s**cope and style of reports, Narrative reporting, Financial reporting,
Report Structure: Summary sheet, Executive summary, Main body, Conclusions, recommendations, Supporting materials- Tables, charts, data sheets, etc, Headings, Sub-headings, Language & Vocabulary, Visual design, source documentation.

Text books and reference Books:

1. 'Project management, planning and control' by Albert Lester, 7th Edition Elsevier.
2. 'Handbook on planning, monitoring and evaluating for development results' by United nation development program.

3. 'Contemporary project management' by Timthy. J Kloppenberg , Scont edition, Xavier university, South- western cengage Learning.
4. 'How to write technical reports' by Hering Kutz, Hering Heike , Springer publisher.

ADVISORY BOARD

Sl. No.	Name of Members
1	Dr Adrian Inoinovici, Fellow IEEE, Director, Power Electronics and Green Energy Centre, Sun-Yat-Sen University, China. adrian@hit.ac.il
2	Dr Danny Sutanto, Professor of Power Engineering, School of Electrical, Computer and Telecommunications Engineering, University of Wollongong, Australia. soetanto@uow.edu.au
3	Dr K.W. Eric Cheng, Professor, Director of Power Electronics research Centre, The Hong Kong Polytechnic University, Hong Kong. eeecheng@polyu.edu.hk
4	Mr Amit Kumar Singh, Research Scholar NUS, Singapore, Ex-Scientist B, DRDO. amit.rishu@gmail.com
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REVA University
Bengaluru - 560 064

REVA UNIVERSITY
Bengaluru, India

10 YEARS OF UNIVERSITY RECOGNITION
20 YEARS OF ACADEMIC EXCELLENCE

School of Applied Sciences

M.Sc. PHYSICS

HANDBOOK-2018-2020

Rukmini Knowledge Park
Kattigenahalli, Yelahanka, Bengaluru – 560064

REVA UNIVERSITY
Bengaluru, India

School of Applied Sciences

M. Sc. (Physics)

HAND BOOK

2018

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Registrar
REVA University
Bengaluru - 560 064

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 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. S. Y. Kulkarni

Vice-Chancellor, REVA University

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.

The M.Sc. in Physics 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 of Quantum Mechanics, Electrodynamics, Electronics, Materials Science, etc. Facilitating students to choose specialized areas of their interest. Adequate attention is given to provide students the basic concepts of analysis 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 research experience.

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. Physics, 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.

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 D V Sunitha

Coordinator, M Sc Physics Program

CONTENTS

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 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 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 12000+ students studying in various branches of knowledge at graduate and post graduate level and 302 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 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 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 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 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.

ABOUT 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 achieve excellence in studies and research through pedagogy and support interface between industry and academia

VALUES

- Excellence in all our academic and research endeavour
- 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 values and achievements is a challenge without which neither science nor society can remain healthy" **— Aage Niels Bohr**

M. Sc. (Physics)

Programme Overview

Physics is a natural science. It deals with physical matter and energy; and the natural laws that govern the behavior of matter. The core theories of Physics are: Classical Mechanics, Electromagnetism, Thermodynamics and Statistical Mechanics, Quantum Mechanics and Relativity. There are many more branches of Physics including astronomy.
Physics plays a key role in the future progress of humankind. The physics education and research in all countries is important because:

1. Physics is an exciting intellectual adventure that inspires young people and expands the frontiers of our knowledge about Nature.
2. Physics generates fundamental knowledge needed for the future technological advances that will continue to drive the economic engines of the world.
3. Physics contributes to the technological infrastructure and provides trained personnel needed to take advantage of scientific advances and discoveries.
4. Physics is an important element in the education of chemists, engineers and computer scientists, as well as practitioners of the other physical and biomedical sciences.
5. Physics extends and enhances our understanding of other disciplines, such as the earth, agricultural, chemical, biological, and environmental sciences, plus astrophysics and cosmology - subjects of substantial importance to all peoples of the world.
6. Physics improves our quality of life by providing the basic understanding necessary for developing new instrumentation and techniques for medical applications, such as computer tomography, magnetic resonance imaging, positron emission tomography, ultrasonic imaging, and laser surgery.

Thus, physics 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 and information and communication technologies. The subject of physics has played a major role in the development of country and India has produced 2 Nobel laureates in Physics.

In this context, University across the country offer Physics as a subject at undergraduate and physics as a programme at postgraduate level.

M. Sc. (Physics) at REVA UNIVERSITY has been designed to meet the human resources needs of existing and futuristic research establishments, industries and academic institutions. The programme 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 programme deals with courses in classical mechanics, quantum mechanics, material science, semiconductors, electrodynamics and related areas.

Eligibility for M Sc (Physics) program

Passed Bachelor's Degree of 3 years with Physics as major / optional subject with 45% marks (40% in case of candidate belonging to SC/ST category) of marks in aggregate of any recognized / institution or any other qualification recognized as equivalent there to.

Programme Educational Objectives (PEOs)

The aim of the programme is to produce postgraduates with - advanced knowledge and understanding of Physics; higher order critical, analytical, problem solving and attitudinal skills (transferable) to meet expectations of research establishments, relevant industry and academia or to take up entrepreneurial route. Hence,

The Programme Educational objectives are to prepare the students to:

PEO-1 Pursue higher education through continuous learning with effective communication skills

PEO-2 Have successful professional careers in academia, industry and government

PEO-3 Start own enterprise and provide solutions to scientific research problems

PEO-4 Exhibit skills as a member of a team in national and international organizations with highestethics through lifelong learning

Programme Outcomes (POs)

After undergoing this programme, a student will be able to:

PO1. **Domain knowledge**: Apply the knowledge of physics and fundamentals for the solution of complex problems in day to day life.

PO2. **Problem analysis**: Identify, formulate, research literature, and analyze problems to arrive at substantiated conclusions using principles of physical sciences.

PO3. **Design/development of solutions**: Design solutions for real time problems to meet the specifications with consideration for the public health and safety, the cultural and societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge, for analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage:** Apply appropriate techniques, resources, and IT tools including prediction and modeling to complex activities with an understanding of the limitations.

PO6. Environmental 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 practice.

PO7. Environment and sustainability: Understand the impact of the solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. **Ethics:** Apply ethical principles and commit to ethics, and responsibilities and norms of the professional practice

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO10Communication: Communicate effectively with the professional community and with societyat large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

PO11. **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.

PROGRAM SPECIFIC OUTCOMES

PSO1. Apply the fundamentals of classical mechanics, electrodynamics, Quantum mechanics andcondensed matter physics to understand the energy quantization concepts.

PSO2. Identify and compare the materials best suited for futuristic engineering applications

PSO3. Explore the knowledge of basic concepts of atomic, molecular, nuclear physics to analyse the spectra obtained from various bodies.

PSO4. Demonstrate the knowledge of fundamentals of electronic devices

Mapping of PEOS with Respect to POS

	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3	PSO4
PEO1	**2**	**1**	**1**	**1**	**1**			**1**			**3**	**1**		**2**	
PEO2	**1**		**2**			**1**			**3**			**3**		**2**	
PEO3			**3**		**2**		**2**			**1**			**3**		**1**
PEO4	**1**		**1**		**1**				**3**		**2**	**1**			**3**

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**P 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
M18PH1010 Mathematical Physics	1	3	3		1	1	1			2	3	2	3			
	2	3	3		1	1	1			2	3	2	3			
	3	3	3		1	1	1			2	3	2	3			
	4	3	3		1	1	1			2	3	2	3			
M20PH1020 Classical Mechanics	1	3	3	1	2	2			1			2	3		1	1

	2	3	2	2	2	2			1				3		2	
	3	3	3	2	3	2	1	1	1			2	3			2
	4	3	2	1	1	1			1			2	3		1	1
M18PH1030 Electronic devices	1	3	3		1	1	1			2		1				3
	2	3	3	2	1	2						2				3
	3	3	3	2						2		2				3
	4	3	3	2	1	2						2				3
M18PH1040 Quantum mechanics 1	1	3	3	3	1	1	1			2		3	3			
	2	3	3	3							2	3	3			
	3	3	3							2		3	3			
	4	3	3								2	3	3			
M18PH1050 Mat science Gen	1	3	2	2	2	2	1	1	1			1		3		
	2	3	2	2	2	2	1	1	1			1		3		
	3	3	2	2	2	2	1	1	1			1		3		
	4	3	2	3	3	3	1	1	1			1		3		
M18PH2010 Quantum mechanics II	1	3	3	3	1	1	1				2	3	3			
	2	3	3	3	1	1	1			2		3	3			
	3	3	3		1	1	1				2	3	3			
	4	3	3		1	1	1			2		3	3			
M18PH2020 Statistical mechanics	1	3	3	1	3	2						2	3			
	2	3	3	1	2	1						1	3			
	3	2	3	2	3	3						2	3			
	4	3	2	1	2	2						2	3			
M18PH2030 Condensed matter Gen	1	3	2		1	1	1			2	1	1	3			
	2	3	2		1	1	1			2	1	1	3			
	3	3	2		1	1	1			2	1	1	3			
	4	3	2		1	1	1			2	1	1	3			
M18PH2040 Atomic molecular physics	1	3	2	1	2	2			1			2			3	
	2	3	2	2	2	2			1						3	
	3	3	3	3	3	3	1	1	1			2			3	
	4	2	2	1	1	1			1			2			3	
M18PH2051 Electronics I	1	3	3	3		1	1	1		2		1				3

	2	3	3	3	1	2						2				3
	3	3	3	3								2				3
	4	3	3	3	1	2						2				3
M18PH2052 Condensed matter physics I	1	3	2	1	2	2			1	1		2		3		
	2	3	3	3	3	3	1	1	1	1		2		3		
	3	3	2	2	2	2			1	1				3		
	4	2	2	1	1	1			1	1		2		3		
M18PH2053 Material science I	1	3	3		1	1	1									3
	2	3	2	2	2	2			1							3
	3	3	2	1	2	2	1		1							3
	4	3	2	2	2	2			1							3
18PH3010 Electrodynamics	1	3	2		1	1	1			2	1	1	3			
	2	3	2		1	1	1			2	1	1	3			
	3	3	2		1	1	1			2	1	1	3			
	4	3	2		1	1	1			2	1	1	3			
M18PH3020 Nano science and Nano technology	1	1	2	2	2	2	1	1	1			1		3		
	2	1	2	2	2	2	1	1	1			1		3		
	3	1	2	2	2	2	1	1	1			1		3		
	4	1	2	3	3	3	1	1	1			1		3		
M18PH3030 Nuclear & particle physics	1	3	3	2	3	2	1					2			3	
	2	3	3	2	3	2		1	1			2			3	
	3	3	3	1	3	3						2			3	
	4	3	3	1	2	2		1							3	
M18PH3041 Electronics II	1	2	3							2		1				3
	2	2	3	2	1	2						2				3
	3	2	3	2								2				3
	4	2	3	2	1	2						2				3
M18PH3042 Condensed matter physics II	1	3	2	1	2	2			1	1		2		3		
	2	3	2	2	2	2			1	1				3		
	3	3	3	3	3	3	1	1	1	1		2		3		
	4	2	2	1	1	1			1	1		2		3		
M18PH3043	1	3	2	2	2	2	1	1	1			1				3

Material science II																
	2	2	2	2	2	2	1	1	1			1				3
	3	3	2	2	2	2	1	1	1			1				3
	4	3	2	3	3	3	1	1	1			1				3
M18PH3051 Electronics III	1	2	3	3						2		1				3
	2	2	3	3	1	2						2				3
	3	2	3	3								2				3
	4	2	3	3	1	2						2				3
M18PH3052 Condensed matter physics III	1	3	3	1	3			1		1	1	1		3		
	2	3	3	1	3			1		1	1	1		3		
	3	3	3	1	3			1		1	1	1		3		
	4	3	3	1	3	3		1		1	1	1		3		
M18PH3053 Material science III	1	2	2	2	2	1	1	1			1	2				3
	2	2	2	2	2	1	1	1			1	1				3
	3	2	2	2	2	1	1	1			1	1				3
	4	2	3	3	3	1	1	1			1	1				3

M Sc (Physics) Program

Scheme of Instruction

(effective from Academic Year 2018-19)

SEMESTER-I

Sl. No.	Course Code	Title of the Course	Type of Course	Credit Pattern & Credit Value				Contact Hours
				L	T	P	Total	
1	M18PH1010	Mathematical Physics	HC	3	1	0	4	5
2	M18PH1020	Classical Mechanics	HC	3	1	0	4	5
3	M18PH1030	Electronic devices	HC	3	1	0	4	5
4	M18PH1040	Quantum Mechanics I	HC	3	1	0	4	5
5	M18PH1050	Material Science (General)	HC	3	1	0	4	5
	Practical Courses							
6	M18PH1060	General Physics lab - I	HC	0	0	3	3	5
7	M18PH1070	Electronics lab	HC	0	0	3	3	5
		Total Credits		**15**	**5**	**6**	**26**	**35**

SEMESTER-II

Sl. No.	Course Code	Title of the Course	Type of Course	Credit Pattern & Credit Value				Contact Hours
				L	T	P	Total	
1	M18PH2010	Quantum Mechanics II	HC	3	1	0	4	5
2	M18PH2020	Statistical Mechanics	HC	3	1	0	4	5
3	M18PH2030	Condensed matter physics (General)	HC	3	1	0	4	5
4	M18PH2040	Atomic and Molecular Physics	HC	3	1	0	4	5
5	M18PH2051	Electronics - I : Digital Electronics	SC#					
6	M18PH2052	Condensed Matter Physics - I	SC#	2	1	0	3	4
7	M18PH2053	Material Science - I	SC#					
8	M18PH2060	Music, Dance, sports, Theater, Yoga	RULO	0	0	2	2	3
9	M18PH2070	Skill development Programme	RULO	0	0	2	2	3
	Practical Courses							
10	M18PH2080	General Physics lab - II	HC	0	0	3	3	5
11	M18PH2090	Atomic and Molecular Physics	HC	0	0	3	3	5
		Total Credits		**10**	**5**	**8**	**25**	**36**

Note: #Soft Core (SC): Student shall opt for one SC of his/her choice which will be continued in higher semesters also.

SEMESTER-III

Sl. No.	Course Code	Title of the Course	Type of Course	Credit Pattern & Credit Value				Contact Hours
				L	T	P	Total	
1	M18PH3010	Electrodynamics	HC	2	1	0	3	4
2	M18PH3020	Nano-science and Nanotechnology	HC	2	1	0	3	4
3	M18PH3030	Nuclear and Particle physics	HC	2	1	0	3	4
4	M18PH3041	Electronics – II: Electronic Communication Systems	SC#	3	1	0	4	5
5	M18PH3042	Condensed Matter Physics - II	SC#					
6	M18PH3043	Material Science- II	SC#					
7	M18PH3051	Electronics – III: Linear integrated circuits	SC#	3	1	0	4	5
8	M18PH3052	Condensed Matter Physics - III	SC#					
9	M18PH3053	Material Science - III	SC#					
10	M18PH3060	Astrophysics	OE#	3	1	0	4	5
	Practical Courses							
11	M18PH3070	General Physics lab - III	HC	0	0	3	3	5
12	M18PH3081	Electronics Lab	SC#	0	0	3	3	5
13	M18PH3082	Condensed Matter Physics						
14	M18PH3083	Material Science						
		Total Credits		**15**	**6**	**6**	**27**	**37**

Note: i) # OE is Open Elective Course offered for students of other Schools; the students of M Sc – Physics shall take any ONE of the OE course offered by other Schools.

ii) *Soft Core (SC): Students shall have to continue the Soft Core opted during the Second Semester

SEMESTER-IV

Sl. No.	Course Code	Title of the Course	Type of Course	Credit Pattern & Credit Value				Contact Hours
				L	T	P	Total	
1	M18PH4010	Major Project	HC	0	0	10	10	20
2	M18PH4020	MOOC/SWAYAM/ Internship	RULO	0	0	4	4	-
3	M18PH4030							-
		Total Credits		**0**	**0**	**18**	**18**	**20**
		Total Credits of I to IV Semesters						

Note: * The students shall undergo Internship during summer vacation and mid-term vacation soon after Second and Third Semester exams are completed and present the report on the Internship undergone during the Fourth Semester for evaluation.

Semester-wise Summary of Credit Distribution

Semesters	No. of Credits	No. of Hours
First Semester	26	35
Second Semester	25	36
Third Semester	27	37
Fourth Semester	18	28
Total Credits	**96**	**136**

Distribution of Credits Based on Type of Courses

Semester	HC	SC	OE	RULO	TOTAL
I	26	-	-	-	26
II	18	3	-	4	25
III	12	11	4	-	27
IV	14	-	-	4	18
Total	**70**	**14**	**4**	**8**	**96**

HC=Hard Core; SC=Soft Core; OE=Open Elective;
RULO=REVA Unique Learning

Distribution of Credits Based on L: T: P

Semester	L	T	P	Total	Total Hours
I	15	5	6	26	35
II	10	5	8	25	36
III	15	6	6	27	37
IV	0	0	18	18	28
Total	**40**	**16**	**40**	**96**	**136**

M. Sc., (PHYSICS) Program

DETAILED SYLLABUS

FIRST SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH1010	**MATHEMATICAL PHYSICS**	HC	3	1	0	4	5

Course Objectives:

To make the students understand the basics of mathematical functions necessary for formulating physical systems and phenomena observed in day to day life.

Course Outcomes:

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

1. Apply the mathematical skills to solve quantitative problems in the study of physics.
2. Solve the problems related to vectors and matrices for various applications.
3. Express a physical law in terms of tensors.
4. The student shall be able to apply coordinate transforms to solve the physical problems expressed in tensors.
5. Apply the suitable mathematical special function to solve the physics problems.

Course Content:

Unit-1:

Vectors: Review of Vector Algebra, Gradient, Divergence, Curl, Vector Integration, Gauss's Theorem, Stokes's Theorem, Gauss's Law, Laplace equation and Poisson's Equation, Applications of vectors.

12 hrs

Unit - 2:

Matrices: Basic Definitions, Equality, and Rank, Matrix Multiplication, Addition , Inner Product, Matrix Inversion, Orthogonal, Hermitian, and unitary matrices; Diagonalization of Matrices, Matrix representation of linear operators, Eigen values and eigenvectors, characteristic equation of matrix, Cayley-Hamilton theorem, applications of matrices in physics. **12 hrs**

Unit - 3:

Tensors: Curvilinear coordinates, Coordinate transformation in linear spaces, Kronecker delta, definition and types of tensors: contravariant and covariant tensors, symmetric and antisymmetric tensors, Tensor algebra: equality, addition and subtraction, tensor multiplication, outer product; contraction of indices, inner product, quotient theorem, metric tensor**,** Christoffel symbols. Tensors applications in physics**.** **12hrs**

Unit - 4:

Special functions: Differential equations, Hermite and Lagaurre functions: Partial differential equations, Separation of variables- Helmholz equation in cylindrical and spherical polar coordinates. Differential equations: Regular and irregular singular points of a second order ordinary differential equation. Series solutions–Frobinius method. Linear independence of solutions-Wronskian. Hermite functions: Generating functions, Recurrence relations, Rodrigues representation, Orthogonality. Laguerre functions: Differential equation-Laguerre polynomials, Generating function, Recurrence relations, Rodrigues representation, Orthogonality, Associated Laguerre functions and its general properties. **12 hrs**

Reference Books:

1. Mathematical methods for physicists, Arfken G. B and Weber H.J, 4th Edition, Prism Books Pvt Ltd, India (1995).
2. Mathematical Physics, Sathya Prakash, Sultan Chand and Sons, (1985).
3. Mathematical Physics, Chattopadhyaya P.K, Wiley Eastern, (1980).
3. Methods of Mathematical Physics, Bose H.K and Joshi M.C, Tata McGraw Hill, (1984).
1. Vector Analysis, Murray R Spiegel, Schaum's Outline Series, McGraw Hill International Book Company, Singapore (1981).
2. Tensor Analysis — Theory & Applications. Sokolnikoff LS, 211: Edition, John Wiley Sons (1964).
3. Mathematical Methods in the Physical Sciences, Mary L. Boas, 2nd Edition, John Wiley & Sons (1983)

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH1020	CLASSICAL MECHANICS	HC	3	1	0	4	5

Course Objectives:

- To give students a solid foundation in classical mechanics.
- To introduce general methods of studying the dynamics of particle systems.
- To give experience in using mathematical techniques for solving practical problems.
- To lay the foundations for further studies in physics and engineering.

Course Outcomes:

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

1. Apply the Lagrangian methods to analyze and explain the problems in classical Mechanics
2. Apply the concept of Central force problem to analyze and explain the problems Classification of orbits, Kepler's laws in planetary motion.
3. Apply the concept of Hamilton's equations to derive the expression for different principles in classical mechanics
4. Analyse the concept of mechanics of rigid bodies to demonstrate and explain the precession of rotation of earth and Rutherford's scattering in determination of structure of atoms
5. Communicate scientific information of classical mechanics.

Course Content:

Unit - 1:

The Lagrangian method: Constraints and their classifications. Generalized coordinates. Virtual displacement, D'Alembert's principle and Lagrangian equations of the second kind. Examples of

(I) Single particle in (a) Cartesian coordinates, (b) Spherical polar coordinates and (c) Cylindrical polar coordinates, (II) Atwood's machine. Derivation of Lagrange equation from Hamilton principle. Importance and simple applications of Lagrangian formulism, Symmetry and conservation laws, cyclic coordinates. **12 hrs**

Unit - 2

Central force problem: Motion of a particle in a central force field, Conservation of energy and angular momentum, classification of orbits, stability of orbits, Kepler's laws of planetary motion. Scattering in a central potential in Laboratory and centre of mass frames, Impact parameter, Total and differential cross section, Rutherford scattering. **12 hrs**

Unit - 3:

Hamilton's equations: Generalized momenta. Hamilton's equations. Examples (i) the simple harmonic oscillator. (ii) Hamiltonian for a free particle in different coordinates. Cyclic coordinates. Physical significance of the Hamiltonian function. Derivation of Hamilton's equations from a variational principle. Generating functions (Four basic types), examples of Canonical transformations, Poisson brackets; properties of Poisson brackets, angular momentum and Poisson bracket relations. Equation of motion in the Poisson bracket notation. The Hamilton-Jacobi equation; the example of the harmonic oscillator treated by the Hamilton-Jacobi method. **12 hrs**

Unit - 4

Mechanics of rigid bodies: Degrees of freedom of a free rigid body, Angular momentum and kinetic energy of rigid body. Fixed and moving coordinates, coriolis force, coriolis force acting on falling body. Moment of inertia tensor, principal moments of inertia, products of inertia, the inertia tensor. Euler equations of motion for a rigid body. Torque free motion of a rigid body. Precession of earth's axis of rotation, motion of symmetrical top-rotational motion. **12 hrs**

References:

1. Classical mechanics, H. Goldstein, C. Poole, J. saflco. 3rd edition. Pearson Education inc. (2002).
2. Classical mechanics. K. N. Srinivasa Rao, University press (2003).
3. Classical mechanics, N. C. Rana and P.S. Joag Tata McGraw-Hill (1991).
4. Classical dynamics of particles and systems, J. B. Marion, Academic press (1970).
5. Introduction to Classical mechanics. Takwale and Puranik, Tata McGraw-hill (1983)
6. Classical mechanics, L. D. Landau and E. M. Lifshitz, 4th edition, Pergamon Press (1985).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH1030	ELECTRONIC DEVICES	HC	3	1	0	4	5

Course Objectives:

- To understand the basic working of Semiconducting devices and Linear Integrated Circuits.
- To give an emphasis to the student to know the various semiconductor devices and its working.
- To give clear understanding of various fabrication techniques of semiconducting devices.
- To introduce the basic building blocks of linear integrated circuits.

Course Outcomes:

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

1. Analyse the BJT circuits, operation and its characteristics.
2. Design a DC bias circuitry of BJT, UJT and SCR.
3. Construct an OPAMP circuit for different applications.
4. Develop the prototypes of electronic devices.
5. Solve real time examples of BJT, UJT, SCR and OPAMP.
6. Able to describe various opto-electronic devices.

Course Content:

Unit - 1:

Transistors: Transistor configurations and characteristics, Methods of biasing-fixed bias, collector to base bias and voltage divider bias, DC and AC load line, Transistor as an amplifier-Single stage and multistage amplifier, frequency response, Push-pull amplifier, Astable multivibrator using transistors, Voltage regulator using transistors. **12 hrs**

Unit - 2:

Thyristors: Types of thyristors, working and characteristics of Silicon Controlled Rectifier (SCR), SCR power controller, Characteristics and application of Triac, Working and characteristics of Uni-junction Transistor (UJT), UJT relaxation oscillator. **12 hrs**

Unit - 3:

Operational amplifier: Block diagram of an operational amplifier, Characteristics of an ideal operational amplifier, Parameters of an op-amp, Operational amplifier as a feedback amplifier: Inverting and Non-inverting amplifiers, Applications of an operational amplifier: Instrumentation amplifier, Square wave and sine wave generator, Active filters- First order Butterworth low pass and high pass filter, phase shift oscillator. **12 hrs**

Unit - 4:

Optoelectronic devices: Photo resistor (LDR)–dark resistance and material constant, Principle and working of a photodiode, Principle and working of Light emitting diode, factors affecting the efficiency of LED, Phototransistor- structure and working, Semiconductor laser- basic structure and working. **12 hrs**

Reference Books:

1. Basic Electronics and Linear Circuits, NN Bhargava, DC Kulashreshtha and SC Gupta,Tata Mc Graw Hill.
2. Electronic Devices and Circuits: An Introduction, Allen Mottershead**,** Prentice Hall of India.
3. Semiconductor Optoelectronic Devices, Pallab Bhattacharya, Pearson education, Asia.
4. Electronic Principles, A P Malvino, (Sixth Edition, 1999), Tata McGraw Hill, New Delhi.
5. A Text Book of Basic Electronics, RS Sedha, S Chand & Company Ltd.
6. Op-Amps and Linear Integrated Circuits, Remakant A Gayakwad, (Third Edition, 2004), Eastern Economy Edition.
7. Linear Integrated Circuits, D Roy Choudhury and Shail Jain, New Age International Limited.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH1040	QUANTUM MECHANICS – I	HC	3	1	0	4	5

Course Objectives:

- To illustrate the inadequacy of classical theories and the need for a quantum theory.
- To explain the basic principles of quantum mechanics.
- To develop solid and systematic problem solving skills.
- To apply quantum mechanics to simple systems occurring in atomic and solid state physics.

Course Outcomes:
On successful completion of this course, the student shall be able to:

1. Understand the mathematical representations and analysis used in quantum mechanics.
2. Postulate the basics of quantum mechanics.
3. Apply Schrodinger wave equation for one dimensional problem like, particle in a box, hormonic Oscillator etc.
4. Solve numerical based on angular momentum and spin operators.
5. Analyze the result obtained in Stern-Gerlach experiment.
6. Solve three dimensional problems in quantum mechanics.

Course Content:

Unit - 1

Introduction: Dual nature of matter and waves, Double-slit experiment for photons and electrons as an illustration. Fundamental Postulates of Quantum Mechanics. Review of Linear vector spaces in Dirac Bra-Ket notation. Position and momentum representations. Wavefunctions. Superposition principle. probability densities, probability current. Expectation values. Commutators. Eigenvalues

and eigenvectors of a complete set of mutually commuting operators. Waves, wave packets, phase velocity and group velocity. Canonically conjugate variables, General uncertainty principle. Hamiltonian, Schrodinger's equation. Ehrenfest's Theorem. Continuity equation. **12 hrs**

Unit - 2

Exactly solvable problems in one-dimension*:* Bound states, examples of particle in a box, rectangular potential wells, Simple Harmonic Oscillator: wave function and operator approach. particle in a spherically symmetric potential, Rigid rotator, hydrogen atom.
Unbound states, Scattering in one-dimension. Examples of scattering from a one-dimensional rectangular potential well and barrier, Tunneling, Transmission and Reflection co-efficients. Ramsauer - Townsend effect, Alpha decay, cold emission of electron in a metal. **12 hrs**

Unit - 3

Angular Momentum and spin*:* Angular momentum operators and their Algebra. Eigen functions and Eigen values of $\mathbf{L}^2$ and $\mathbf{L}_z$ using Schrodinger wave mechanics and matrix mechanics. angular momentum operators.
Uncertainty relations. Stern-Gerlach experiment and the concept of spin, Pauli-spin matrices. Addition of angular momentum of two or more particles. **12 hrs**

Unit - 4:

Exactly solvable problems in three dimensions*:* Wave function of a free particle in Cartesian, cylindrical and spherical coordinates. Bound state problems. Examples of a particle confined in a box, cylindrical and spherical well. Simple harmonic oscillator in 3-dimensions. Two-particle bound state problems. Reduction to a one-particle problem. Schrodinger's equation for the hydrogen atom and its solution, properties of its wave functions. **12 hrs**

Reference Books:

1. E. Merzbacher, Quantum Mechanics. 3rd edition, John Wiley(1994).
2. V.K. Thankappan, Quantum Mechanics, Wiley Eastern (1985).
3. P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, TMH(1977).
4. R.L.Liboff, Introduction to Quantum Mechanics, Pearson Education(2003).
5. R. Shankar,Principles of Quantum Mechanics,2nd edition, Plenum US (1994).
6. A Ghatak and S Lokanathan, Quantum Mechanics, Theory and Applications, Macmillan(2004).

7. LI Schiff, Quantum Mechanics, 3rd ed. McGraw-Hill(1968).
8. J.J. Sakurai, Modern Quantum Mechanics, Addison Wesley (1985).
9. B.Bransden, C.Joachain, Quantum Mechanics, 2nd ed, Pearson/Prentice Hall, (2000).
10. J.S.Townsend, A Modern Approach to Quantum Mechanics, 2nd ed, McGraw Hill.
11. C.Cohen-Tannoudji, B.Diu, F.Laloe, Quantum Mechanics (2 vol. set), Wiley Interscience (1996).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH1050	MATERIAL SCIENCE (GENERAL)	HC	3	1	0	4	5

Course Objectives:

- To introduce the basic principles underlying the behavior of materials.
- To provide scientific foundation for understanding the relations among material properties, microstructure, and behavior of materials.
- To make the students familiar with the vocabulary for the description of the empirical facts and theoretical ideas about the various levels of structure from atoms through defects in crystals to larger scale morphology of practical materials.

Course Outcomes:

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

1. Explain the relationship between a material's microstructure and its properties.
2. Explain how the presence and properties of defects can affect the strength of a material.
3. Distinguish between elastic and plastic behavior of materials.
4. Apply the knowledge of phase diagrams to synthesize different phases of materials.

Course Content:

Unit - 1:

Formation and structure of materials

Introduction to material science- engineering materials- structure - property relationship. Review of ionic, covalent and molecular bindings- bond angle, bond length and bond energy. Lattice energy – Jones potential. Closed pack structures- packing efficiency and density of materials.

Crystal morphology - symmetry elements - crystal systems. Point group symmetry- derivation of point groups- elementary ideas on space groups. Principles of X-ray powder diffraction method, interpretation of powder photographs and powder metallurgy. **12 hrs**

Unit - 2:

Crystal imperfections and diffusion in solids:

Review of crystalline imperfections- schottky and Frenkel defects- equilibrium concentrations. Line imperfections- edge and screw dislocations-interactions of dislocations. Surface imperfections- grain boundary- tilt and twin boundaries- volume imperfections.

Diffusions in solids - Fick's law of diffusion- Solution to Ficks law - error function. Determination of diffusion co-efficients; diffusion couple. Applications based on second law Atomic model of diffusion-electrical conductivity of ionic crystals. **12 hrs**

Unit - 3:

Elastic and plastic behavior of materials

Atomic model of elastic behavior- the modulus as a parameter in design- rubber like elasticity-anelastic behavior – viscosity behavior. Fracture of materials – ductile and brittle fracture – ductile brittle transition- protection against fracture.

Plastic deformation by slip – the shear strength of perfect and real crystals- CRSS- the stress to move a dislocation – work hardening and dynamic recovery. Methods of strengthening crystalline materials against plastic deformation- strain hardening, grain refinement, solid solution strengthening, precipitation strengthening. **12 hrs**

Unit - 4:

Phase diagrams and phase transformations

Phase diagrams- the phase rule and it's applications to binary alloy systems- isomorphous, eutectic and peritectic - the lever rule. Typical phase diagrams-Pb-Sn, Fe-C systems. Heat treatment processes-annealing, hardening and tempering.

Phase transformations- Nucleation and growth- nucleation kinetics – transformations in steel. Solidification and crystallization- recovery, recrystallization and gain growth. Microstructure-single phase materials, phase distribution precipitates and eutectoid decomposition- examples of modifications of microstructure. **12 hrs**

Reference Books:

1. Elements of material science and engineering, **Lawrence H. Van Vlack Addison Wesley** (1975).
2. Material science and engineering, **V. Raghavan**, Prentice Hall (1993)
3. Nature of chemical Bond, **L Pauling**, Oxford and IBH (1960)
4. An introduction to crystallography, **F.C. Phillips**, Longman (1970)
5. Crystallography applied to solid state physics, **Verma and srivastava** New age international (2005)
6. Introduction to solid Solid state physics**, C. kittel,** Wiley Eastern (1993)
7. The structure and properties of Materials vol I- IV- **Rose, Shepard** and wulff (1987)
8. Introduction to solids**, L. V Azaroff, Mc Graw** Hill (1977)
9. Foundation of material science and engineering, William **F. Smith,** Mc Graw Hill international Editions (1988)
10. Solid state Physics Source Book- **Sybil P Parker** (Ed), Mc Graw Hill (1987).
11. Solid state phase transformations, **V. Raghavan**, Prentice hall (1991).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH1060	GENERAL PHYSICS LAB - I (PRACTICAL)	HC	0	0	3	3	5

Course Objectives:

- To make the student familiarize with the basics of experimental physics.
- To enable the student to explore the concepts involved in the thermodynamics and heat.
- To make the student understand the basic concepts in modern optics.
- To allow the student to understand the fundamentals of instruments involved.

Course Outcomes:

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

1. Verify various laws of physics related to optics.
2. Determine the physical parameters through experiments.
3. Analyze the concepts of physics through experiments.

Course Content:

LIST OF EXPERIMENTS:

1. Determination of rigidity modulus and moment of inertia using Torsional pendulum for two different materials.
2. Measurement of resistivity of a semiconductor by Four probe method at different temperature and determination of energy gap.
3. Determination of grating constant and wavelength of LASER light by using grating.
4. Design of CE transistor amplifier.
5. Determination of Stefan's constant and Verification of Stefan's fourth power law by electrical method.
6. Determination of Energy band gap of two different semiconductors.
7. Determination of solar constant.
8. Thermal Conductivity of a rod by Forbe's method.
9. Determination of temperature sensitivity of a thermocouple and its Calibration.
10. Determination of wavelength of sodium light by Michelson's interferometer.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH1070	ELECTRONICS LAB (PRACTICAL)	HC	0	0	3	3	5

Course Objectives:

- To familiarize the students with the basics of electronics.

- To enable the students to explore the concepts involved in the oscillators.
- To make the students understand the basic concepts in ICs and digital devices.
- To allow the students to understand the fundamentals of multi-vibrators.

Course Outcomes:

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

1. Analyse the characteristics of MOSFET and SCR.
2. Verify the outputs of astable, monostable and VCO circuits using ICs.
3. Design and construct the Single Stage BJT and FET Amplifier circuits.
4. Design voltage regulator using Zener diode and regulated power supply using IC.

Course Content:

List of Experiments:

1. Experiment on UJT and its applications.
2. Astable, monostable and bistable multivibrator using IC 555 timer.
3. Voltage controlled oscillator using IC741 and 555.
4. Zener diode characteristics and voltage regulation.
5. Study of FET characteristics and its applications in amplifier.
6. Study of MOSFET characteristics and its applications as amplifier.
7. Characteristics and applications of SCR.
8. Monostable multivibrator using IC 74127.
9. Design of regulated power supply.
10. Solving Boolean expressions.

SECOND SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH2010	QUANTUM MECHANICS –II	HC	3	1	0	4	5

Course Objective:

To familiarize students with the advanced quantum mechanical concepts for better understanding of behavior of sub-atomic particles.

Course Outcomes:

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

1. Solve Schrodinger wave equations for a particle in a 3-D box.
2. Apply Schrodinger wave equation for Hydrogen atom.
3. Understand Symmetry in quantum mechanics.
4. Apply approximation methods for quantum mechanical problems.
5. Understand the concepts of relativistic quantum mechanics.

Course Content:

Unit – 1:

The Schrodinger equation in three dimensions: separation of Schrodinger equation in Cartesian coordinates. Free particle in 3-d box – Effects of the exclusion principle on non-interacting fermions in a box. central potential and consequences of rotational invariance – separation of variables r, Φ, Θ; radial equation.

The hydrogen atom – radial equation; energy spectrum; degeneracy of the spectrum; radial wave functions and probability density P(r) for finding the electron at a distance from the center; evaluation of expectation values of r^n. **12 hrs**

Unit – 2:

Symmetry in quantum mechanics: Spatial transition and conservation of linear momentum**.** Discrete symmetries: parity and time reversal. Permutation symmetry: symmetric and anti symmetric wave functions for two identical particles, slater determinant and pouli exclusion principle. Exited states of helium atom: ortho and para helium atom.

Approximation methods – I: The variational method: variation theorem, application of variation theorem, application of variational approach to ground states of (i) Hydrogen atom and (ii) Helium atom. The WKB method: one dimensional case, approximate solutions turning pints and connection formulae, tunneling through a barrier. **12 hrs**

Unit – 3:

Approximation methods -II:

Time independent perturbation theory: Perturbation theory for non degenerate states, examples: linear and quadratic stark effects (i) in hydrogen atom, (ii) a particle moving in a 1-d harmonic oscillator. Degenerate perturbation theory, examples: linear stark effect, Normal Zeeman effect.

Time dependent perturbation theory: Time dependent perturbation series. Harmonic perturbation; transition probability, Fermi golden rule, example: sinusoidal perturbation on 1-d simple harmonic oscillator.

Scattering experiments and cross sections: potential scattering, Born approximation, validity of born approximation, Scattering in a central potential, examples: screened coulomb field. **12 hrs**

Unit – 4:

Relativistic quantum mechanics: Klein Gordan equation for a free particle and its drawbacks; probability density. Dirac equation for free particle, properties of Dirac matrices, solutions of free particle Dirac equation- ortho normality and completeness, spin of the Dirac particle, negative energy sea, covariant form of Dirac equation. Velocity operator of a free Dirac particle and Zitterbeagung.

Non relativistic limit of Dirac equation for a free particle moving in a central potential – spin – orbit energy. Dirac particle under the influence of a uniform external magnetic field – magnetic moment for the Dirac particle. **12 hrs**

Reference Books:

1. Quantum mechanics, **B.H. Bransden and Joachain,** 2nd Edition Pearson Education (2004).
2. Introduction to Quantum mechanics, **David J. Griffiths**, 2nd Edition, Parson Education (2005).
3. Modern Quantum mechanics**, J.J. Sakurai**, Pearson Education, (2000).
4. Quantum mechanics, V.K Thankappan, 2nd Edition 2004.
5. Quantum mechanics, **Stephen Gasiorowicz**, john Wiley (2003).
6. Relativistic Quantum mechanics and Relativistic Quantum fields, J.D. Bjorken and S.D. Drell, Mc. Graw-hill,New York (1968).
7. Quantum mechanics, **L.ISciff Mc. Graw-hill**, (1955).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH2020	STATISTICAL MECHANICS	HC	3	1	0	4	5

Course Objectives:

- To make students understand the basics of Thermodynamics and Statistical systems.
- To make students understand the various laws of thermodynamic.
- To acquire the knowledge of various statistical distributions.
- To comprehend the concepts of enthalpy, phase transitions and thermodynamic functions.

Course Outcomes:

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

1. Solve day-to-day life selected problems using thermodynamics laws.
2. Analyse various distribution laws.
3. Apply the concepts to test distribution laws.
4. Apply the distribution laws to solve physical problems.

Course Content:

Unit – 1:

Thermodynamics preliminaries: A brief overview of thermodynamics, Maxwell's relations, specific heats from thermodynamic relations, the third law of thermodynamics. Applications of thermodynamics: Thermodynamic description of phase transitions, Surface effects in condensation. Phase equilibria; Equilibrium conditions; Classification of phase transitions; phase diagrams; Clausius-Clapeyron equation, applications. Van der Wall's equation of state. Irreversible thermodynamics—Onsager's reciprocal relation, thermoelectric phenomenon, Peltier effect, Seebeck effect, Thompson effect, systems far from equilibrium. **12 hrs**

Unit – 2:

Classical statistical mechanics: The postulate of equal a priori probability; The Liouville theorem; the microcanonical ensemble, canonical ensemble, Grand canonical ensemble, mean value and fluctuations, Entropy and thermodynamic probability, Reduction of Gibbs distribution to Maxwell and Boltzmann distribution, Entropy of an ideal gas; Gibbs paradox; Law of the equipartition theorem; Sackur-Tetrode formula, Molecular partition function, translational and rotational and vibrational partition function and applications to solids. Chemical equilibrium. **12 hrs**

Unit – 3:

Quantum statistical mechanics: The postulates of quantum statistical mechanics. Symmetry of wave functions. The Liouville theorem in quantum statistical mechanics; condition for statistical equilibrium; Ensembles in quantum mechanics; The quantum distribution functions (BE and FD); the Boltzmann limit of Boson and Fermion gases; the derivation of the corresponding distribution functions.

12 hrs

Unit – 4:

Applications of quantum statistics: Equation of state of an ideal Fermi gas (derivation not expected), application of Fermi-Dirac statistics to the theory of free electrons in metals, degeneracy and magnetic susceptibility. Application of Bose statistics to the photon gas, derivation of Planck's law, comments on the rest mass of photons, Thermodynamics of Black body radiation. Bose-Einstein condensation

12 hrs

Reference Books

1. Agarwal B.K. and Eisner M., Statistical mechanics, New Age International Publishers, 2000.
2. Roy S.K., Thermal physics and statistical mechanics, New Age International Pub., 2000.
3. Huang K., Statistical mechanics, Wiley-Eastern, 1975.
4. Laud B.B., Fundamentals of statistical mechanics, New Age International Pub.,2000.
5. Schroeder D.V., An introduction to thermal physics, Pearson Education New Delhi, 2008
6. Salinas S.R.A., Introduction to statistical physics, Springer, 2004.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH2030	**CONDENSED MATTER PHYSICS (General)**	HC	3	1	0	4	5

Course Objectives:

- To understand the basic knowledge on crystal structures and systems.
- To understand the various process techniques available of X-Ray Crystallography.
- To comprehend the concepts of superconductivity and magnetic properties of solids.

Course Outcomes:

On successful completion of this course, the students shall be able to:

1. Formulate basic models of lattice vibrations for describing the physics of crystalline materials.
2. Develop a relation between band structure and the electrical/optical properties of a materials.
3. Analyze the concepts of superconductivity
4. Analyze of the variation of Fermi energy with temperature and impurity concentration in the case of impurity semiconductors.

Course Content:

Unit -1:

X-ray crystallography: Crystalline state. Reference axes, equation of a plane, Miller indices. External symmetry of crystals; symmetry operations. Two and three dimensional point groups. Lattices; two dimensional lattices, choice of unit cell. Three-dimensional lattices; crystal systems and Bravais lattices. Screw and glide operations. Space groups; analysis of the space group symbol. Diffraction of Xrays by crystals: Laue equations. Reciprocal lattice. Bragg equations. Equivalence of Laue and Bragg equations. Atomic scattering factor (qualitative). **12 hrs**

Unit - 2:

Experimental techniques: Brief introduction to Laue, Oscillation, Weissenberg, Powder and Counter methods. Using synchrotron radiation for structure studies.

Electron and neutron diffraction: Basic principles. Differences between them and X-ray diffraction. Applications (qualitative).

Crystal growth: Crystal growth from melt and zone refining techniques. Liquid crystals: Morphology. The smectic (A-H), nematic and cholesteric phases. Birefringence, texture and X-ray studies in these phases. Orientational order and its determination in the case of nematic liquid crystals. **12 hrs**

Unit -3:

Magnetic properties of solids: Diamagnetism and its origin. Expression for diamagnetic susceptibility, Paramagnetism. Quantum theory of Paramagnetism. Brillouin function. Ferromagnetism. Curie-Weiss law. Spontaneous magnetization and its variation with temperature. Ferromagnetic domains. Antiferromagnetism. Two sub-lattice model. Susceptibility below and above Neel's temperature.

Superconductivity: Experimental facts. Type I and type II semiconductors. Phenomena logical theory. London equations. Meissner effect. High frequency behavior. Thermodynamics of superconductors. Entropy and Specific heat in the superconducting state. Qualitative ideas of the theory of superconductivity. **12 hrs**

Unit - 4:

Semiconductors: Intrinsic Semiconductors. Crystal structure and bonding. Expressions for carrier concentrations. Fermi energy, electrical conductivity and energy gap in the case of intrinsic semiconductors. Extrinsic Semiconductors; impurity states and ionization energy of donors. Carrier concentrations and their temperature variation. Qualitative explanation of the variation of Fermi energy with temperature and impurity concentration in the case of impurity semiconductors.

12 hrs

Reference Books:

1. Stout G.H. and Jensen L.H., X-ray structure determination, MacMillan, USA, 1989.
2. Ladd M.F.C. and Palmer R.A., Structure determination by X-ray crystallography, Plenum Press, USA, 2003.
3. Buerger M.J., Elementary crystallography, Academic Press, London.
4. Dekker A.J., Solid state physics, Prentice Hall, 1985.
5. Kittel C., Introduction to solid state physics, 7th Edn., John Wiley, New York, 1996.
6. Mckelvey J.P., Solid state and semiconductor physics, 2nd Edn., Harper and Row, USA, 1966.
7. Streetman B.G., Solid state electronic devices, 2nd Edn., Prentice-Hall of India, New Delhi, 1983.
8. De Gennes P.G. and Prost J., The physics of liquid crystals, 2nd Edn., Clarendon Press, Oxford, 1998.
9. Wahab M.A., Solid state physics, Narosa Publishing House, New Delhi, 1999.
10. Azaroff L.V., Introduction to solids, McGraw-Hill Inc, USA, 1960.
11. Pillai S.O., Solid state physics, New Age International Publications, 2002.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH2040	ATOMIC AND MOLECULAR PHYSICS	HC	3	1	0	4	5

Course Objectives:

- To develop a basic understanding of physics of atoms and molecules: definitions, units, laws and rules.
- to gain an ability of basic problems analyzing and solving in physics of atoms and molecules
- to realize a role and practical application of physics of atoms and molecules in the modern world

Course Outcomes:

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

1. Analyze the concepts of atomic models, spectra of one and two valance electron atoms.
2. Analyze the behaviour of atoms in external applied electric and magnetic field.
3. Differentiate rotational, vibrational, electronic and Raman spectra of molecules.

4. Describe electron spin and their spectroscopic applications.
5. Formulate and solve the problems related to different spectroscopic systems.

Course Content:

Unit – 1:

Atomic Physics: Brief review of early atomic models of Bohr and Sommerfeld. One electron atom: Quantum states, Atomic orbitals, spectrum of hydrogen, Rydberg Atoms (brief treatment), Relativistic corrections to spectra of alkali atoms: Spin-orbit interaction and fine structure in alkali spectra. Lamb shift in hydrogen (qualitative Discussion only). **12 hrs**

Unit – 2:

Two electron atom: Ortho and Para states and role of Pauli principle, level schemes of two electron atoms. Perturbations in the spectra of one and two electron atoms: Zeeman effect, Paschen- Back effect, Stark effect in hydrogen spectra. Hyperfine interactions and 21cm line of hydrogen. Many electron atoms: Central field approximation. LS and JJ coupling schemes, Multiplet splitting and Lande interval rule. **12 hrs**

Unit – 3:

Molecular Physics A: Brief treatment of chemical bonds: covalent, ionic, Vanderwaal's interactions. The Born-Oppenheimer approximation (qualitative treatment), diatomic molecule as a rigid rotator, rotational spectra of rigid and non-rigid rotator, intensities of rotational lines. Microwave spectroscopy- principle and technique Types of rotors: Eigen values of Linear, Symmetric top, Asymmetric top and Spherical top molecules. Raman spectroscopy: Theory of Raman effect, experimental techniques, rotational Raman spectra of diatomic and linear polyatomic molecules.

12 hrs

Unit – 4:

Molecular Physics B: Diatomic molecule as a simple harmonic oscillator, anharmonicity, Morse potential curves, vibrating rotator: energy levels and vibration spectra, PQR branches in rovibronic spectra, experimental technique and IR spectrometer. Comparison of vibration and Raman spectra.

Electronic spectra of diatomic molecules: Vibrational structure, rotational structure in electronic spectra, intensity of vibrational lines in electronic spectra, Frank-Condon principle, dissociation and pre-dissociation, fluorescence and phosphorescence. **12hrs**

Reference Books:

1. Introduction to Atomic spectra- H.E.White.
2. Fundamentals of molecular spectroscopy, C B Banwell.
3. Spectroscopy Vol I, II & III, Walkere and Straughen.
4. Physics of atoms and molecules, Bransden and Joachain, (2nd Edition) Pearson Education, 2004.
5. Fundamentals of Molecular Spectroscopy, Banwell and Mccash, Tata McGraw Hill, 1998.
6. Modern Spectroscopy, J.M. Hollas, John Wiley, 1998.
7. Molecular Quantum Mechanics, P.W. Atkins and R.S. Friedman. Third Edition, Oxford Press(Indian Edition), 2004.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH2051	ELECTRONICS-I (DIGITAL ELECTRONICS)	SC	2	1	0	3	4

Course Objectives:

- To understand number systems and codes and their application to digital circuits.
- To gain knowledge of Boolean algebra, Karnaugh maps and its application to the design and characterization of digital circuits.
- To know the mathematical characteristics of logic gates.
- To design and analyze a given combinational or sequential circuit using Boolean Algebra as a tool to simplify and design logic circuits.
- To understand the logic design of programmable devices, including PLDs
- To design various synchronous & Asynchronous counters and Universal Shift Registers.

Course Outcomes:
On successful completion of this course, the student shall be able to:

1. Translate from one number system to its equivalent other number system and perform its arithmetic operations.
2. Explain TTL and CMOS construction, working, characteristics and applications.
3. Explain the use of implementation of logic circuits.
4. Draw the logic circuits by simplifying Boolean expressions using theorems, laws and K-map.
5. Analyse the operation of Combinational and Sequential logic circuits.
6. Explain DAC and ADC, types, specifications and applications.

Course Content:

Unit - 1:

Number Systems and Logic families: Decimal, Binary, octal, and hexa-decimal number systems, binary arithmetic. Number base conversion, Complements Codes: Binary code, excess-3 code, gray code, error detection and correction codes.
Positive logic and Negative Logic, AND, OR, NOT,NAND,NOR, X-OR GATE, INHIBIT CIRCUIT, Significance and type like TTL, CMOS, interface with different logic families, application relevant information, electrical characteristics. **12 hrs**

Unit - 2:
Boolean operations and expressions: Introduction, Logic Operators, Postulates and theorems, properties –Product of Sums and Sum of Products– Karnaugh Map method – Two, three, four, five variable K-maps, Converting Boolean expressions to Logic and Vice versa, NAND and NOR implementation – Don’t-Care conditions – The tabulation method. **12 hrs**

Unit - 3:

Combinational and Sequential circuits: Half and full Adder – Half and full Subtracter – Binary parallel adder – BCD Adder, Decimal adder – Magnitude comparator – Encoders & Decoders – Multiplexers–De-multiplexer Latches, Flip-flops, SR, JK- Flip-flop, JK Master-Slave, D, T flip-flops, counters, synchronous and asynchronous counters, ripple counters, registers, shift registers, timing sequences.

12 hrs

Unit - 4:

A/D and D/A conversion circuits: Introduction, Digital to Analog Converters D/A converter Specifications, Types of D/A converters, Mode of Operation, BCD Input D/A converter, Integrated Circuit D/A Converters, D/A converter Applications, A/D converters, A/D Converter Specifications, A/D Converter Technology, Types of A/D converters, Integrated Circuit A/D Converters, A/D converter Applications

Basics of microprocessor and microcontroller: Architecture of 8085, Architecture of 8051. **12 hrs**

Reference Books:

1. John F. Wakerly, "Digital Design" 4 thedition,Pearson/PHI,2008.
2. John, M Yarbrough, "Digital Logic application and design", Thomson Learning, 2006.
3. Charles H, Roth, "Fundamentals of Logic Design", Thomson Learning, 2013.
4. Donald P, Leach and Albert Paul Malvino, " Digital Principles and Applications", 6th edition, TMH,2006.
5. Thomas L. Floyd, " Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011
6. Donald D, Givone, "Digital Principles and Design', TMH, 2003.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH2052	CONDENSED MATTER PHYSICS - I	SC	2	1	0	3	4

Course Objectives: To familiarized students with:

- Defects, types of defects and how defects are formed.
- Luminescence and its mechanism.
- Lattice formation and deformation, energy band structure and classification of materials based on energy gap.
- Preparation of thin films and study of their structural characteristics.

Course Outcomes:

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

1. Analyse defects in crystals.
2. Illustrate Photoconductivity, Luminescence- fluorescence, Phosphorescence, Thermoluminescence, Photoluminescence, Electroluminescence; Mechanisms.
3. Analyse Short range order- Long range order.
4. Design semiconductor devices.

Course Content:

Unit -1:

Disordered systems: Point defects-shallow impurity states in semiconductors-Localized lattice vibrational states in solids-Vacancies, interstitials in ionic crystals- Color centers in ionic crystals- Types of Color centers- methods of production-mechanism - Characteristic absorption bands, Properties of Color centers- Models and Applications.

Photoconductivity, Luminescence- fluorescence, Phosphorescence- Thermoluminescence, Photoluminescence, Electroluminescence; Mechanisms. Imperfections in crystals, Mechanism of plastic deformation in solids, Stress and strain fields of screw and edge dislocations, Elastic energy of dislocations. **12 hrs**

Unit – 2:

Disorder in Condensed Matter : Introduction- Short range order- Long range order- Ordered lattice-Disordered lattice- Compositional. disorder- Topological disorder-Magnetic disorder-Localized states-Anderson Model- Density of states. Concept of glass- Glass transition- Atomic correlation function and structural description of glasses and liquids. Amorphous semiconductors: Classification, band structure- electronic conduction- Optical absorption-Switching. Transport in disordered lattices-Transport in extended states, Fixed range and variable range hopping- conductivity in impurity bands and in amorphous semiconductors-Applications. **12 hrs**

Unit – 3:

Semiconductors: Structure of typical semiconductors- Fermi energy expression in Intrinsic and extrinsic semiconductors- its variation with temperature and impurity concentration- Law of mass action- Charge neutrality equation- mobility- diffusion- generation- recombination of Carriers in Semiconductors- Conductivity equation- carrier Life time- Haynes-Shockley experiment- Hall effect in semiconductors- Determination of dell coefficient in intrinsic, n-type and p-type semiconductors.

12 hrs

Unit – 4:

Films and Surfaces: Thin films Methods of preparation: Thermal evaporation- sputtering- DC, AC, diode, triode, magneton, ion beam sputtering, Laser and electron beam evaporation technique.

Chemical vapor deposition. Characterization of thin films- film thickness: optical methods-interferometry- Fizeau fringes- FECO Method. Mechanical techniques- Stylus method-weight measurement and crystal oscillators. Structural characterization Scanning electron microscopy, Transmission Electron microscopy and Atomic Force Microscopy. Mechanical properties- Internal stress and strain analysis. Electrical properties of thin films- Measurement of resistivity by four frobe method, thin film resistors (Conduction in metal and non metallic films) Magnetic properties- film size effect on MS- films for memory devices. **12 hrs**

Reference Books:

1. Solid State Physics, A. J. Dekker, McMillan India Ltd, 2003.
2. Luminescence of Solids, D. R. Vij, Plenum Press, 1998.

3. Elementary dislocation theory, J. Weertman and J.R. Weertman, New York ; Macmillan 1964
4. Crystallography Applied to Solid State Physics, Verma and Srivasthava, 2nd Edition. New age International publishers, 2001.
5. Introduction to Solid State Physics, C. Kittel, 7"' Edition, John Wiley and Sons 1996.
6. Thin Film phenomenon, K.L. Chopra, McGraw Hill Book Company, 1969.
7. Introduction to solid state theory**,** Otfried Madelung, Springer series. 1996.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH2053	MATERIAL SCIENCE –I	SC	2	1	0	3	4

Course Objectives:

1. To focus on the structural, electronic and magnetic properties of metals, alloys, super conductors, semi-conductors and dielectric materials.
2. To discuss and understand various applications of the above materials in different fields.

Course Outcomes:

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

1. Explain the Structure, types of metals and alloys.
2. Analyze the effect of doping and mobility of charge carriers in semiconductors.
3. Analyze the concept of dielectrics and magnetic materials phenomena.
4. Analyze the Properties of Magnetic Materials based on resonance and spin configurations.

Course Content:

Unit - 1:

Metals: Review of free electron theory and Fermi distribution function, Structure andtypes of metals, Electronic properties of metals- electrical and thermal conductivity, Widemann- Franz law, temperature and impurity effects. Heat capacity of metals- debye's model of specific heat-contribution of free electrons to heat capacity- dispersion relation- acoustic and optical modes-thermal expansion-an harmonic interactions, Galvanomagnetic effects in metals.

Alloys: Solid solutions - substitutional and interstitial. Hume Rothery rules. Super lattice- long range order theory. Diffusion in alloys- Darkens equation. Some special alloys-ferrous and nonferrous, super alloys. **12 hrs**

Unit - 2:
Semiconductors: Review of band theory of solids, direct and indirect band gaps, charge carrier in intrinsic semiconductor. Extrinsic semiconductor- effect of doping and mobility of charge carriers. Methods of doping- alloying, diffusion and ion implantation. Preparation of semiconductor single crystals.

Superconductivity: Superconducting tunneling phenomena. AC and DC Josephson effect. Applications-Superconducting magnets, super density switches.

SQUID. HTS superconductors - materials preparation and structure. **12 hrs**

Unit - 3:

Dielectrics and Ferroelectrics

Dielectrics: Review of dielectric polarization- internal field and macroscopic field. The Complex dielectric constant-dielectric losses and relaxation time-Debye equations- Theory of electronic polarization and optical absorption. Dielectric function» LST Relationship, dielectric breakdown-general applications of dielectric materials. Ferroelectrics Piezoelectric, pyroelectric and ferroelectric materials- transducer and detector applications, Classification of ferroelectrics.

Ferro electricity in KDP and barium titanate- order—disorder and displacement theories. Thermodynamics of ferroelectric phase transitions. **12 hrs**

Unit - 4:

Magnetic Materials and Magnetic Resonance:

Magnetic Materials: Review of dia, para and ferro- magnetic materials, Spontaneous Magnetization—temperature dependence- gyromagnetic experiments. Origin of Ferromagnetic domains- anisotropy of magnetostriction and Bloch wait energies. Antiferromagnetic and ferrimagnetism- Subiattice mode|~ Neel's theory. Neutron Diffraction in magnetic structure analysis. Hard and soft magnetic materials-areas of Their application.

Magnetic Resonance: Elements of theory of nuclear magnetic resonance (NMR)-rate of energy absorption- spin lattice and spin-spin relaxation- Bloch equations, Principles of ESR, NOR and Mossbauer techniques, typical areas of application. **12 hrs**

Reference Books:

1. Introduction to Properties of Materials — D. Rosenthal and R M Asirnov, East West (1974).
2. Elements of Materials Science and Engineering- L H Van Vlack, Addison Wesley (1975).
3. Introduction to solid state Physics,C. Kittle, Wiley Eastern (1993).
4. Solid State Physics, A. J. Dekker, Mc Milan India (2005).
5. Introduction to solids, L V Azaroff , Mc Graw Hill (1977).
6. Electronic Materials, S. Muraka , Academic Press (1989).
7. Superconductivity and Superconducting Materials- A. V. Narlikar and S. N. Ekbote , South Asian Publications (1983).
8. Semiconductor Physics- P S Kireev, Mir Publishers (1975).
9. Solid State and semiconductor Physics, John Mckelvey, Harper and Low (1969).
10. Modern Magnetism- L F Bates, Cambridge University Press(1963).
11. Electronic Properties of Materials Ver, Hummel, Springer lag (1985).
12. Physics of dielectric Materials- *13* Tareev, Mir Publishers (1979).
13. Magnetic Resonance- C P Slichter , Harper and Row (1985).
14. NQR Spectroscopy, SSP Suppl. I T P Das and E. L. Hahn, Academic Press (1957).
15. Mossbauer Effect and its Applications, V G Bhide, Tata McGraw Hill (1973).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH2060	MUSIC / DANCE / SPORTS / THEATER / YOGA	RULO	0	0	2	2	3

Note: Music, Dance, and Theater courses are offered by the School of Performing Arts, whereas the Sports and Yoga courses are offered by the Department of Physical Education. The students have to choose any **ONE** of these courses.

A. YOGA FOR HEALTH

Course Objectives:

Following are the Course Objectives.

- To prepare the students for the integration of their physical, mental and spiritual faculties;
- To enable the students to maintain good health;
- To practice mental hygiene and to attain higher level of consciousness;
- To possess emotional stability, self control and concentration; and
- To inculcate among students self discipline, moral and ethical values.

Course Outcomes:

On completion of the course learners will be able to:

1.Practice yoga for strength, flexibility, and relaxation.
2.Learn techniques for increasing concentration and decreasing anxiety
3.Become self disciplined and self-controlled
4.Improve physical fitness and perform better in studies
5.Gain self confidence to face the challenges in the society with commitment to serve the society

Course Contents

Unit-I:

Yoga: Introduction, Tips from Sage Patanjali's Yoga Sutras
Surya Namaskara:- 10 counts,12 counts,16 counts

Unit-II:

Asanas: Sitting- Vajrasana, Dandasana, Padmasana, Matsyasana, Ardha Matsyendrasana, Suptavajrasana, Paschimottasana, Bakasana, Simhasana, Shirasasana.

Asanas: Standing- Tadasana, Trikonasana, Parshwa konasana, Veerabadrasana, Parivrutta trikonasana.

Unit-III:

Asanas: Prone Position- Bhujangasana, Dhanurasana, Shalabhasana.

Asanas: Supine Position- Sarvangasana, Sethubandha sarvangasana, Halasana, Karnapeedasana.

Mudras- Dhyana mudra, Chinmaya mudra, Namaste mudra, Nasika mudra

Unit-IV:

Pranayams:- Ujjayi, Nadi Shodhana, Anuloma – Viloma, Basthrika, Bhramari, Sheethali

Dhyana & its types

Competition format, Rules and their interpretations

B. SPORTS (VOLLEYBALL)

Course Objectives:

1. To learn the rules, fundamental skills, and strategies of volleyball.
2. To develop skills in passing, setting, serving, spiking, and blocking.
3. To learn basic offensive and defensive patterns of play.
4. To develop a positive attitude towards volleyball as a lifetime sport and to improve physical fitness through participation in volleyball.

Course Outcomes:

On completion of the course learners will be able to:

1. Learn basic skills and knowledge associated with volleyball.
2. Apply these skills while playing volleyball and exhibit improved performance
3. Improve physical fitness and practice positive personal and lifestyle.
4. Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Course Contents:

Unit-I

- **Introduction about Volleyball**
- Players Stance, Receiving and passing
- The Volley (Overhead pass), The Dig (Underhand pass), Service Reception

Unit-II

- Service- Under Arm Service, Tennis Service, Side Arm Spin Service, Round Arm Service, High spin service, Asian serve / American serve (floating)
- Setting the ball- Set for attack, Back set, Jump set

Unit-III

- Smash/Spike- Straight smash, Body turn smash, Wrist outward smash, Wrist inward smash
- Block- Single block, Double block, Three-man block
- Rolls- Overhead pass & back rolling, One hand underhand pass with side rolling, Forward dive

Unit-IV

- Attack Combination, Defense Systems, Libero play
- Court marking, Rules and their interpretations and Duties of officials

C. SPORTS (BASKETBALL)

Course Objectives:

1. To learn the rules, fundamental skills, and strategies of Basketball
2. To develop technical skills in passing, in ball handling, individual offense, individual defense, rebounding, screen, team offense, team defense and fast break.
3. To learn basic offensive and defensive strategies of play.
4. To develop a positive attitude towards Basketball as a lifetime sport and to improve physical fitness through participation in Basketball.
5. To develop positive understanding and appreciation of the basketball game.

Course Outcomes:

On completion of the course learners will be able to:

1. Learn basic skills and knowledge associated with basketball.
2. Apply these skills while playing basketball and exhibit improved performance
3. Improve physical fitness and practice positive personal and lifestyle.
4. Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Course Contents:

Unit-I

- Basketball: Introduction
- Grip; Player stance- Triple threat stance and Ball handling exercises
- Passing (Two hand/one hand)- Chest pass, Bounce Pass, Over head pass, Underhand pass, Hook Pass, Behind the back pass, Baseball pass, Side arm pass and passing in running.
- Receiving-Two Hand receiving, One hand receiving, Receiving in stationary position, Receiving while jumping, Receiving while running.

Unit-II

- Dribbling- How to start dribble, How to stop dribble, High / Low dribble with variations
- Shooting- Layup shot and its variations, One hand set shot, One hand jump shot, Free throw, Hook shot, Tip-in shot.

- Stopping- Stride/Scoot, Pivoting and Faking /Feinting footwork.

Unit-III

- Rebounding- Defensive rebound, Offensive rebound, Box out, Rebound Organization.
- Individual Defensive- Guarding the man with the ball and without the ball.
- Offensive drills, Fast break drills, Team Defense/Offense, Team Tactics

Unit-IV

- Court marking, Rules and their interpretations

D. SPORTS (FOOTBALL)

Course Objectives:

1. To learn the rules, fundamental skills, and strategies of football.
2. To develop skills in passing, receiving, controlling the ball, dribbling, shielding, shooting, tackling, beating a defender and heading in football.
3. To learn basic offensive and defensive patterns of play
4. To use different parts of the body in utilizing the above skills while playing football
5. To develop a positive attitude towards football as a lifetime sport and to improve physical fitness through participation in football.

Course Outcomes:

On completion of the course learners will be able to:

1. Learn basic skills and knowledge associated with football.
2. Apply these skills while playing football and exhibit improved performance
3. Use the knowledge and understanding to perform, refine and adapt the above skills and related skills with precision, accuracy, fluency and clarity in any situation.
4. Improve physical fitness and practice positive personal and lifestyle.
5. Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Course Content:

Unit-I

Football: Introduction

Kicks- Inside kick, Instep kick, Outer instep kick, Lofted kick, Chipping, Volley, Half Volley

Trapping- Trapping rolling the ball, Trapping bouncing ball with sole

Unit-II

- Dribbling- With instep and outer instep of the foot.
- Heading- From standing, running and jumping.
- Feinting- With the lower limb and upper part of the body.

Unit-III

- Tackling- Simple tackling, Slide tackling.
- Throw-in- Standing and Sliding
- Goal Keeping- Collection of balls, Ball clearance, throwing and deflecting.

Unit-IV

- Ground marking, Rules and their interpretations

E. SPORTS (TRACK AND FIELD)

Course Objectives:

1. To teach students the skilled techniques in sprints, relay running, hurdles, long jump, high jump, and shot put and practice them.
2. To develop competence among students in demonstrating all the techniques covered in the course.
3. To make students understand some of the scientific and empirical principles and their rationale underlying the development of skilled performance.
4. To inculcate among students the habit of team work and cooperative learning and develop competence in detecting / correcting technique errors.
5. To develop a positive attitude towards sports in general and athletics in particular and to improve physical fitness through participation in various athletic games / sports activities.

Course Outcomes:

On completion of the course learners will be able to:

1. Display competencies in executing basic techniques and skills associated with select track and field events.
2. Develop basic skills and techniques to improve one's running posture and take-off position for different jumps.
3. Learn regular practice of select track and field events and improve physical fitness
4. Appreciate track and field events by applying sports science knowledge to explain the execution of the events.

Course Content:

Unit-I

Athletics: Introduction

Track Events - Steeple Chase, Race Walking, Middle and Long distance races

Race walking - Technique, Faults and Officiating.

Middle and Long distance races – Technique and Training

Unit-II

Jumping Events - High Jump and Triple Jump: Basic Skills and techniques

High Jump - Straddle Roll & Flop Technique, Approach, Take-off, Technique in the air, Clearance over the bar & Landing

Triple Jump – Hop, Step and Jump Technique, Approach, Take-off & Landing

Unit-III

Throwing Events - Discus Throw and Hammer Throw: Basic Skills and techniques

Discus Throw - Standing and Rotatory techniques, Grip, Stance, Rotation Technique, Power stance, Release and Reverse (Follow through)

Hammer Throw - Grip, Swings, Rotation foot work, Release and Follow through

Unit-IV

Rules, Officiating and Marking - Ground / Sector Marking, Interpretation of Rules.

Reference Books

(Athletics Part-I and Athletics Part-II)

1. Arthur E. Ellison (ed) (1994). Athletic Training and Sports Medicine.
2. Ballisteros, J.M. (1998). Hurdles Basic Coaching Manual, IAAF.
3. Bosen K.O. (1993). Teaching Athletics Skills and Technique.
4. Bosen K.O. (1990). Study Material on Hurdles for the Regular Course Students.
5. Doherty K. (1995). Track and Field Omni book.
6. Martin, David E. Peter N. Coe (1991). Training Distance Runner.
7. Howard S. (1981). Science of Track and Field Athletics.
8. Briggs Graeme (1987). “Track and field coaching Manual”, Australian Track and Field Coaches Association. Rothmans Foundation National Sports Division.
9. Carr, Gerry (1999). “Fundamentals of Track and Field. Track Athletics 1 Title G.V. 1060 5.e. 368.
10. I.A.A.F. Level-II (2001). Text Book on Jumping Event.
11. Jarver, Jesse (1987). “The Jumps”, Track and Field Coaching Manual Australia.

F. DRAMATICS

Pre-requisites: Students with background in Theatre Arts/ Keen interest in Dramatics.

Course Objectives:

- To imbibe the acting skills.
- To understand the broader applications of theatre studies in allied arts forms.
- To be able to use body language for better communication.
- Students shall also be able to understand voice modulation and Navarasas.

Course Outcomes:

On successful completion of this course, students should be able to:

- Freely express improvisation in non-verbal communication.
- Shall hone good acting skills and be able to emote better.
- Be able to put up a theatre act and play a key role.
- Be able to differentiate good acting and understand the importance of good lyrics, stage crafting, music, dance, costume and lighting.

Course Content:

UNIT – 1

Working on Body:
Body and its analysis. Understanding physical abilities (Anga, Pratyanga and Upanga). Challenges of the body. Using body as metaphor and language. The class's bodies as a collective, an ensemble, a collaborative team.

UNIT – 2
Sound and Movement:
Awareness of creating sound patterns, voice modulations, rhythm in speech and diaologues. Understanding the rhythm and patterns of movements like walking, framing, shaping, primitive and animal movements.

UNIT – 3
Characterization and Improvisation:
Observation of people around. Getting into the role and living it. Developing a character from establishment (pace and rhythm). Improvisation techniques of body and mind.

UNIT – 4
Group work and Production:
Develop a theme, concept or a play and include all the theatre skills, stage craft, costuming and put up an act. Choosing theme and characters.

Reference Books:

1. All about Theatre – Off stage – Chris Hogget.
2. Rangadalli Anataranga – K V Subbanna
3. The Indian Theatre – Hemendranath Das Gupta.
4. A Practical handbook for an Actor – Milisa Bruder, ee Milchel Cohn, Madeleine Oliek et al, Zigler Publisher.

G. INDIAN CLASSICAL DANCE FORMS (Bharathanatyam, Kuchipudi ,Mohiniyattam)
Prerequisites: Background of classical dance training or any other dance forms.
Note: Non-classical dancers can also join.
Course Objectives:

- To develop an understanding about the Indian classical dance forms and its universal application.
- To be able to understand the fine nuances of Classical dance.
- To understand the importance of health through Indian classical dance, strengthen the body capacity.
- To understand mythology and its characters in Indian classical dance form through lessons of Abhinaya.

Course Outcomes:

- To be able to identify and appreciate the classical dance forms.
- To be able to execute basics of Adavus with finesse.
- To be able to express through abhinaya.
- To be able to perform to perform the fundamentals in the chosen dance form.

Course Content:

Unit 1
An introduction to Indian classical dance forms: Bharatanatyam, Kuchipudi, Mohiniyattam.
Unit 2
Learning of Fundamentals: Exercises and Adavus- I (Bharathanatyam , Kuchipudi, Mohiniyattam).
Unit 3
Adavus –II (Bharathanatyam , Kuchipudi, Mohiniyattam)
Unit 4
Learn a basic composition in the chosen dance form.

Reference Books:

1. Indian classical dance forms –U S Krishna Rao,U K Chandrabhaga Devi
2. Classical Dances –Sonal Mansingh, Avinash Parischa
3. Kuchipudi – Sunil Kothari
4. Bharatanatyam An in depth study- Saroja vydyanathan
5. Mohiniyattam – Bharathi Shivaji

H. PERCUSSION INSTRUMENT (TABLA AND MRIDANGAM)

Pre-requisites: Students with background in Percussion instruments and knowledge of Rhythm/ Keen interest in studying Mridagam / Tabala.

Course Objectives:

- To understand the Rhythmology.
- To understand the importance of Laya, Taala.
- To be able to understand the fine finger techniques of playing the instrument.

Course Outcomes:

On successful completion of this course, students should be able to:

- To be able to set instrument to Sruthi.
- To be able to play the fundamentals on instrument.
- To be able to learn and perform a particular taala.

Course Content:

UNIT 1

1. Introduction to Musical Instruments
2. Percussion Instruments
3. Mridangam and its History

UNIT 2

1. Introduction to Tala System
2. Definitions of 5 jaathis and their recitation
3. Adi Talam and its various forms
4. Definitions and recitation of different gathis

UNIT 3

1. Tisra Jaathi
2. Khanda Jaathi
3. Misra jaathi
4. Sankeerna Jaathi

UNIT 4
1. Learning of Jathi Formation
2. Basic jathis
3. Jathis for Dance forms
4. Some Basic Definitions of Korvai, Teermanam etc.,

Reference Books:

1. Mridangam- An Indian Classical Percussion Drum – Shreejayanthi Gopal
2. Theory and practice of Tabala – Sadanand Naimpally.
3. Theory and practice of Mridangam – Dharmala Rama Murthy
4. The Art of the Indian Tabala – Srdjan Beronja.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH2070	SKILL DEVELOPMENT	RULO	0	0	2	2	3

Note: The students will have to undergo Skill Development course being conducted by Training and Placement cell of the University.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH2080	GENERAL PHYSICS LAB - II (PRACTICAL)	HC	0	0	3	3	5

Course Objectives:

- To achieve perfectness in experimental skills and the study of practical applications will bring more confidence and ability to develop and fabricate engineering and technical equipments.
- Design of circuits using new technology and latest components and to develop practical applications of engineering materials and use of principle in the right way to implement the modern technology.

Course Outcomes:

On Successful completion of this course, students shall be able to:

1. Infer the result of related experiments.
2. Employ the different tools and techniques to get the data/readings related to the experiments.
3. Explore the fundamental physics behind many scientific discoveries through hands on experience

List of Experiments:

1. Determination of difference in wavelengths of D_1 and D_2 lines using Michelson interferometer.
2. Active low pass and high pass filter using op-amp.
3. Determination of Fermi Energy of given conductor/semiconductor.
4. Experiment with GM counter.
5. Determination of Ferroelectric phase transition and verification Curie Weis law.
6. Measurement of thickness of thin wire using Laser source.
7. Determination of size of the particles using Laser.
8. Determination of velocity of ultrasonic waves in liquid.
9. Determination of Red berg constant.
10. Verification of photoelectric equation and determination photonic work function and Planck's constant.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH2090	ATOMIC AND MOLECULAR PHYSICS (PRACTICAL)	HC	0	0	3	3	5

Course Objectives:

- To achieve perfectness in experimental skills and the study of practical applications will bring more confidence and ability to develop and fabricate engineering and technical equipments.
- Design of circuits using new technology and latest components and to develop practical applications of engineering materials and use of principle in the right way to implement the modern technology.

Course Outcomes:

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

1. Verify the spectroscopic phenomenon of physics through experimentation.
2. Infer results of the experiments connected with interaction of electric and magnetic fields with atoms and molecules.
3. Distinguish the band, line and Raman spectrum through the experimentation.

List of Experiments

1. CCD spectrometer to record absorption bands of Iodine molecule.
2. CCD spectrometer to record band spectrum of AlO.
3. Analysis of band spectrum of PN molecule.
4. Analysis of Rotational Raman spectrum of a molecule.
5. Determination of separation between etalon plates using Fabry-Perot interferometer experiments.
6. Zeeman effect.
7. Determination of e/m ratio of an electron by Millikan's oil drop experiment.
8. Study of intensity distribution of elliptically polarized light.
9. Study of elliptically polarized light using Babinet compensator.
10. Determination of thickness of mica sheet using Edser Butler Fringes.

THIRD SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3010	ELECTRODYNAMICS	HC	2	1	0	3	4

Course Objective:

To introduce students the principles and applications of Electrostatics, Magneto-statics, Electrodynamics and Electromagnetic waves.

Course Outcomes:

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

1. Apply reasoning skills to model and solve problems related to electrostatics
2. Formulate problems within magnetostatics and stationary current distributions and solve.
3. Demonstrate the understanding of Faraday's laws and Maxwell's equations and physics concepts in Electrodynamics.
4. Derive expressions for the energy both for the electrostatic and magneto-static fields by using Poynting's theorem and Maxwell's equations.
5. Analysis and explain wave guides and Electromagnetic radiation by using concepts of electrostatics, magneto statics and Maxwell's equations.
6. Communicate scientific information in electrostatics, magneto statics, electrodynamics and electromagnetic radiation in oral, written, and graphical formats.

Unit -1:

Electrostatics: Divergence and curl of electrostatic field, Gauss law in integral and differential forms, Poisson and Laplace equations, Boundary conditions and uniqueness theorem, electrostatic potential energy and energy density of a continuous charge distribution. Multipole expansion of the potential and energy of a localized charge distribution, monopole and dipole terms, electric field of a dipole, dipole-dipole interaction. Electrostatic fields in matter, polarization, macroscopic field equations, electrostatic energy in dielectric media. **12 hrs**

Unit - 2:

Magnetostatics: Current density, continuity equation, magnetic field of a steady current, the divergence and curl of **B**, Ampere's law, magnetic vector potential, multipole expansion of vector potential of a localized current distribution, magnetic moment. Torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits. Magnetic fields in matter, macroscopic equations, magneto static boundary conditions, magnetic scalar potential. Energy in the magnetic field. **12 hrs**

Unit -3:

Electrodynamics: Faraday law of induction, displacement current, Maxwell's equations. Vector and scalar potentials. Gauge transformations, Lorentz gauge, Coulomb gauge. Poynting's theorem and conservation of energy and momentum for a system of charged particles and electromagnetic fields.

Electromagnetic Waves: Plane waves in non-conducting and conducting medium, skin depth. Linear and circular polarizations. Reflection and refraction of plane waves at a plane interface, total internal reflection, reflection from a surface of a metal. **12 hrs**

Unit 4:

Wave guides: Fields at the surface and within a conductor, cylindrical cavities and wave guides, modes in rectangular wave guide.

Electromagnetic radiation: Retarded Potentials. Radiation from an oscillating dipole, liner antenna. Lenard-Wiechert potentials, potentials for a charge in uniform motion, power radiated by an accelerated charge at low velocities, Larmor's formula , radiation from a charged particle with collinear velocity and acceleration, Bremsstrahlung radiation, radiation from a charged particle moving in a circular orbit, cyclotron and synchrotron radiation.

Plasma Physics: Plasma behavior in magnetic field, plasma as a conducting fluid-magneto hydrodynamics, magnetic confinement-Pinch effect. **12 hrs**

References:

1. Classical Electrodynamics: J.D.Jackson , Wiley Eastern Ltd., Bangalore (1978)
2. Introduction to Electrodynamics: D.J.Griffiths, Prentice Hall of India, Ltd., New Delhi (1995).
2. Electro magnetics: B.B. Laud. Wiley Eastern Ltd., Bangalore (1987)
3. Classical Electromagnetic Radiation: J.B. Marion, Academic press, NewYork (1968).
4. Classical Electrodynamics; S P Puri, Tata McGraw –Hill Publishing Company Ltd., New Delhi, (1990).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3020	NANOSCIENCE AND TECHONOLOGY	HC	2	1	0	3	4

Course Objectives:

- To understand the fundamental concepts behind nanoscience and nanotechnology.
- To familiarize with various processing techniques available for synthesis of nanostructure materials.
- To acquire the knowledge of various nanomaterial characterization methods.
- To get familiarized with the various analytical techniques.
- To understand the properties of nanomaterials.

Course Outcomes:

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

1. Analyze the fundamental principles of nanotechnology and apply to different applications
2. Apply physics concepts to the nano-scale and non-continuum domain.
3. Demonstrate state-of-the-art nano-fabrication methods to prepare nano particles

4. Evaluate processing conditions to functional nanomaterials
5. Evaluate current constraints, such as regulatory, ethical, political, social and economical, encountered when solving problems in living systems.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3030	ELECTRONICS - II (ELECTRONIC COMMUNICATION SYSTEMS)	HC	2	1	0	3	4

Course Objectives:

- To study the general properties of nucleus.
- To study the nuclear forces and nuclear reactions.
- To introduce the concept of elementary particles.

Course Outcomes: On successful completion of this course, the student shall be able to
1.Explain various types of nuclear of reactions
2.Construct nuclear and semi-conductor detectors
3.Apply various models to study nuclear decay
4.Apply basic laws of particle physics and macroscopic physics phenomena in determination of particle properties and properties of processes in the subatomic world

Course Contents:

Unit 1

Interaction of charged particles: energy loss of heavy charged particles in matter, Bethe-Bloch formula, energy loss of fast electrons, Bremstrahlung.
Interaction of gamma rays: photo electric, Compton, and pair production processes. Gamma ray attenuation- attenuation coefficients, absorber, mass thickness, cross sections.
Nuclear reactions: cross section for a nuclear reaction, Differential cross section, Q-value of reaction, threshold energy, Direct and compound nuclear mechanisms, Bhor's independence hypothesis and experimental verification.
Nuclear fission: energy released in fission, neutron cycle in a thermal reactor and four factor formula.
12 hrs

Unit 2
Nuclear forces: characteristics of nuclear forces, short range, saturation, chare independence and exchange characteristics ,Ground state of deuteron, Relation between the range and the depth of the potential using square well potential, Yukawa's theory of nuclear forces (qualitative only)
Nuclear detectors: scintillation detectors- NaI(Tl), plastic scintillation- scintillation spectrometer.
Semiconductor detectors: Surface barrier detectors, Li ion drift detectors, relation between applied voltage and the depletion region in junction detectors, counter telescopes, particle identification, and position sensitive detector. **12 hrs**
Unit 3
Nuclear models and nuclear decay:
Liquid drop model: Semiemphirical mass formula, stability of nuclei against beta decay, mass parabola.

Fermi gas model: Kinetic energy for the ground state, asymmetry energy.

Shell model: evidence for magic numbers, prediction of energy levels in an infinite square well potential, spin orbit interaction, prediction of ground state spin parity and magnetic moment of odd nuclei, Schmidt limit.

Beta decay: Fermi's theory of beta decay, curie plots and ft values, selection rules.

Gamma decay: Multi polarity of gamma rays, selection rules, internal conversion (qualitative only). **12 hrs**

Unit 4

Elementary particle physics: types of interactions between elementary particles, hadrons and leptons, detection of neutrinos.

Symmetries and conservation laws: conservation of energy, momentum, angular momentum, charge and isospin, parity symmetry, violation of parity in week interactions, lepton number conservation, lepton family and three generations of neutrinos. Conjugation symmetry, CP violation in week interactions.

Strange particles, conservation of strangeness in strong interactions, Baryon number conservation, Gell-Mann Nishijima formula, eight fold way (qualitative only), Quark model, quark content of baryons and mesons, color degree of freedom, standard model (qualitative only). **12 hrs**

References:

1. Introduction to Nuclear Physics H.Enge: Addison Wesley, 1971.
2. Atomic and Nuclear Physics, S. N. Goshal vol II 2000.
3. Introductory Nuclear Physics Kenneth S. Krane: John Wiely and Sons, 1987.
4. The Atomic Nuclease Evans R.D. : Tata Mc. Graw hill, 1955.
5. Nuclear Physics, R R Roy and Nigam: Wiley-eastern Ltd 1983.
6. Nuclear physics an introduction, S.B. Patel: New age international (P) limited 2000.
7. Radiation Detection and Measurements, G.F. Knoll: 3rd edition, John Wiely and sons, 2000.
8. Nuclear Radiation Detectors, S.S. Kapoor and V.S Ramamurthy: Wiley and sons. Introduction to High Energy Physics D.H. Perkins: Addison Wesley, London, 2000.
9. Introduction to Elementary Particles, D.Griffiths: John Wiley1984.
10. Nuclear Interactions, S.de Benedetti: John Wiley, New York, 1964.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3041	ELECTRONICS - II (ELECTRONIC COMMUNICATION SYSTEMS)	SC	3	1	0	4	5

Course Objectives:

- To understand the fundamental concepts of communication systems.
- To understand and compare different analog modulation schemes.
- To understand and compare different digital modulation schemes.
- To understand the design tradeoffs and performance of communications systems.

Course Outcomes:

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

1. Analyze the working of amplitude and frequency modulated communication systems.

2. Analyze various sampling methods and its reconstruction.
3. Analyze various modulation schemes in digital communication system
4. Construct various channel coding and decoding schemes such as Hadamard code, Hamming code, Cyclic Codes, Convolution coding.

Course Content:

Unit - 1: Analog communication systems

AM Transmitters and Receivers: Generation of AM, low level and high level modulation, comparison of levels, AM transmitter block diagram, DSB S/C modulator. AM Receiver: Tuned radio frequency (TRF) receiver. Super heterodyne receiver, RF section and characteristics, mixers, frequency changing and tracking, IF rejection and IF amplifiers. Detection and automatic gain control (AGC), AM receiver characteristics. **12 hrs**

Unit - 2:

FM Transmitters and Receivers FM Transmitters: Basic requirements and generation of FM, FM Modulation methods: Direct methods, Variable capacitor Modulator, Varactor Diode Modulator, FET Reactance Modulator, Transistor Reactance Modulator, Pre-emphasis, Direct FM modulator, FM Receivers: Limiters, single and double-tuned demodulators, balanced slope detector, Foster-Seely or Phase Discriminator, De-emphasis, ratio Detector, Block diagram of FM Receivers, RF Amplifiers, FM Receiver characteristics. **12 hrs**

Unit - 3: Digital communication systems

Analog to Digital Conversion Noisy communications channels, The sampling Theorem, low pass signals and band pass signals, pulse Amplitude modulation, channel bandwidth for a PAM signal, Natural sampling, Flat top sampling, signal recovery & holding, Quantization of signal, Quantization error, pulse code modulation (PCM), Delta Modulation, adaptive delta modulation. Digital Modulation Techniques: Binary phase shift keying, differential phase shift keying, differential encoded PSK, QPSK, Quadrate Amplitude shift keying (QASK) Binary frequency shift keying. **12 hrs**

Unit - 4:

Information Coding and Decoding: Coding for error detection and correction, Block coding – coding, anticoding, Hadamard code, Hamming code, Cyclic Codes, Convolution coding and decoding, Viterbi algorithm, Shannon Fano and Hoffman Codes. **12 hrs**

Reference Books:

1. Principles of Communication Systems – H Taub& D. Schilling, GautamSahe. TMH, 2007 3rd Edition.
2. Principles of Communication Systems - Simon Haykin. John Wiley, 2r" Edition,
3. Electronics & Communication System - George Kennedy and Bernard Davis, 4th Edition TMH 2009
4. Analog Communications- KN Hari Bhat & Ganesh Rao, Pearson Publications, 2nd Edition 2008.
5. Analog and Digital Communication – K. Sam Shanmugam, Willey ,2005
6. Electronics Communication Systems-Fundamentals through Advanced-Wayne Tomasi, 5th Edition, 2009, PHI.
7. Lathi "Modern Digital and Analog Communication Systems," Oxford University Press.

8. B. Sklar, “Digital Communications: Fundamentals and Applications,” Pearson Education.
9. S. Haykin, “Digital Communication,” John Willey.
10. R.P. Singh and S.D. Sapre, “Communication Systems: Analog and Digital,” Tata McGraw-Hill.
11. Digital Communications - John G. Proakis .Masoudsalehi – 5th Edition, McGraw-Hill, 2008.
12. Digital Communication - Simon Haykin, Jon Wiley, 2005.
13. Digital Communications - Ian A. Glover, Peter M. Grant, Edition, Pearson Edu., 2008.
14. Communication Systems-B.P. Lathi, BS Publication, 2006.
15. Principles of communication systems - Herbert Taub. Donald L Schiling, Goutam Sana, 3rd Edition, Mc. Graw-Hill, 2008.
16. Digital and Analog Communicator Systems - Sam Shanmugam, John Wiley, 2005.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3042	CONDENSED MATTER PHYSICS –II	SC	3	1	0	4	5

Course Objectives:

The course is to understand the basic knowledge on magnetic, dielectric and electric properties of material, types of magnetic and dielectric materials and their applications.

Course Outcomes:

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

1. Differentiate types of magnetic materials.
2. Analyze ESR and EPR spectral data.
3. Understand classical and quantum theory of dielectrics.
4. Classify ferroelectric crystals.

Course Content:

Unit - 1:

Ferromagnetism : Review of Weiss theory of ferromagnetism, its successes and failures, Heisenberg exchange interaction, exchange integral, exchange energy, Ising model, Spin waves (one dimensional case only), quantization of spin waves and magnons, density of modes, thermal excitation of magnons and Bloch $T^{3/2}$ law, specific heat using spin wave theory. Band theory of ferromagnetism. Ferromagnetic domains, hysteresis curve, magneto crystalline anisotropy energy, Bloch wall.

Ant ferromagnetism: Characteristic property of anti ferromagnetic substance, Neutron diffraction experiment. Two sub-lattice model molecular field theory of anti ferromagnetism, Neel temperature, Susceptibility below and above Neel temperature.

Ferrimagnetism: Ferrimagnetic order, ferrites, Curie temperature and susceptibility of ferrimagnets.

12 hrs

Unit - 2:

Magnetic Resonance : Basic principles of paramagnetic resonance, spin-spin and spin–lattice relaxation, susceptibility in a.c. magnetic field power absorption, equations of Bloch, steady state solutions, determination of g-factor, line width and spin –lattice relaxation time, paramagnetic resonance and nuclear magnetic resonance. Effect of crystal field on energy levels of magnetic ions (qualitative). Spin- Hamiltonian, zero field splitting. **12 hrs**

Unit - 3:

Dielectrics: Review of basic formulae, dielectric constant and polarizability, local field, Clausius-Mossotti relation, polarization catastrophe. Sources of polarizability, Dipolar polarizability: dipolar dispersion, Debye's equations, dielectric loss, dipolar polarization in solids, dielectric relaxation. Ionic polarizability. Electronic polarizability: classical treatment, quantum theory, interband transitions in solids. **12 hrs**

Unit - 4:

Ferroelectrics: General properties of ferroelectrics, classification and properties of representative ferroelectric crystals, dipole theory of ferroelectricity, dielectric constant near Curie temperature, microscopic source of ferroelectricity, Lydane –Sachs-Teller relation and its implications, thermodynamics of ferroelectric phase transition, ferroelectric domains, Piezoelectricity and its applications. **12 hrs**

Reference Books:

1. The Physical Principles of Magnetism : A. H. Morrish, John Wiley & sons, New York (1965)
2. Solid State Physics : A. J. Dekker, Macmillan India Ltd., Bangalore (1981)
3. Introduction to Solid State Physics : 5th Edn C. Kittel, Wiley Eastern Ltd., Bangalore (1976)
4. Elementary Solid State Physics : M. A. Omar, Addison-Wesley Pvt. Ltd., New Delhi (2000)
5. Introduction to Magnetic Resonance: A. Carrington and A. D. Mclachlan, Harper & Row, New York, (1967).
6. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi (2009).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3043	MATERIAL SCIENCE - II	SC	3	1	0	4	5

Course Objectives:

This course provides the knowledge about the processing, characterization and testing of Polymers, ceramics and glass materials.

Course Outcomes:

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

1. Synthesize the polymers, ceramics and glasses.
2. Explain the applications of composite material related to polymers, ceramics and glasses
3. Analyze the Properties of polymers, ceramics and glasses
4. Analyze the defects and inabilities of polymers, ceramics and glasses for industrial applications.

Course Content:

Unit-1:

Elements of Polymer Science: Monomers- Polymers- Classification of polymers Synthesis of polymers-chain polymerization, step Polymerization, industrial polymerization methods. Average molecular weight-weight, number and viscosity, size of polymer molecule. Microstructure of polymers- chemical, geometric, random alternating, block and graft polymers, stereo regular polymers. Phase transition-polymer melting and glass transition; polymer crystallinity- degree of crystallinity, crystallization and stereo isomerism. Processing of Plastic Materials- inoculating- compression, injection blow, extrusion, spinning. **12 hrs**

Unit-2:

Ceramics and Glasses: Ceramics and their structure- Silicate structure, Preparation-Forming and thermal treatments, Classification of ceramics- traditional and engineering. Dielectric, ferroelectric and piezoelectric properties of ceramics with specific examples, Ceramic magnets, Mechanical properties- strength, toughness. Fatigue failure, abrasion. Basic refractory materials.

Glasses: Preparation and structure, Types of glasses- borates silicate, oxide, metallic and semiconducting glasses; tempered glass and cnernically strengthened glass. **12 hrs**

Unit-3:

Composite Materials: General Introduction, matrix Materials- polymer, metals, ceramics, Reinforcing materials- fibers, particles. Concrete-concrete making materials, structure, composition. properties and applications. Polymer-concrete composites, fabrication, structure, interface, properties, applications of polymer matrix composites, metal matrix composites, ceramic matrix composites and carbon fiber composites, wood-plastic composites, dispersion strengthened. Particle reinforced, fiber and laminate reinforced composites with fabrication, interface, properties and applications. **12 hrs**

Unit-4: Testing of Materials: Mechanical Testing - Universal Testing Machine. Hardness- Brinnel, Vicker and Rockwell, impact testing and Fatigue Testing. Optical Microscopy- Metallurgical Microscopes-sample preparation and grain size Measurements. Electron microscopy-Transmission microscopy (TEM), scanning microscopy (SEM)- principle, sample preparation techniques and applications. non Destructive Testing- Ultrasonic Testing, X-ray radiography. Neutron radiography.

12 hrs

Reference Books:

1. Textbook of Polymer Science**. Fred. W. Billmeyer** John Wiley 8. Sons, Inc. (1984)
2. Polymer Science, **V.R. Gowariker, N. V. Vistrwanathan, Jayadev Shreedhar**, Wiley Eastern (1937)
3. Electronic properties of Materials- **Rolf E. Hummel, Springer Verlag**, Springer Verlag (1985)
4. Foundations of Materials Science and Engineering- **William F. Smith**, McGraw Hill international Editions, (1988)
5. Elements of Materials Science and Engineering. Lawrence **H. Van Vlack,** Addison Wesley (1975)
6. Introduction to Ceramics**- W D Kingery, H K Bower and U R Uhlman,** John Wiley (1960)
7. Ultrasonic **B. Carlin** , Mc. Graw Hill (1950).
8. Principles of Neutron Radiography- **N D Tyufyakav and A S Shtan**, Amerind Publishers (1979)
9. Applied X-rays- **George L Clark**, Mc. Graw Hill, (1955)
10. Testing of Metallic Materials**— AVK Suryanarayan** , Prentice Hall India, (1990)
11. Physical Metallurgy Part I, **R W Cahn and P Haasen** (Ed), North.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3051	ELECTRONICS - III (LINEAR INTEGRATED CIRCUITS)	SC	3	1	0	4	5

Course Objectives:

- To analyze and design various applications using Op-amp.
- To design and construct waveform generation circuits.
- To design timer, analog and digital circuits using op-amps.
- To design combinational logic circuits using digital ICs.

Course Outcomes:

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

1. Differentiate between an ideal and practical characteristics of op-amp.
2. Explain the frequency response of an opamp compensator networks.
3. Analyze linear applications of op-amp circuits such as integrator, differentiator log and antilog networks.
4. Analyze the basic function of comparators and convertors using OPAMP.

Course Content:

Unit – 1:

THE PRACTICAL OP-AMP (741): Input offset voltage, input bias current, input offset current. Total output offset voltage, thermal drift, error voltage, variation of OP-AMP parameter with temperature & supply voltage. Supply voltage rejection ration (SVRR), CMRR-Measurement of OP-AMP parameters. **12 hrs**

Unit - 2:

FREQUENCY RESPONSE OF AN OP-AMP: Frequency response compensator networks. Frequency response of internally compensated OP-AMP & non-compensated OP-AMP. High frequency OP-AMP equivalent circuit, open loop voltage gain as a function of frequency. Slew rate, causes of slew rates and its effects in application. **12 hrs**

Unit - 3:

OPERATIONAL AMPLIFIER CONFIGURATIONS & LINEAR APPLICATION:

Open loop OP-AMP configurations- The differential amplifier, inverting amplifier, non-inverting amplifier, negative feedback configurations - inverting and non-inverting amplifiers, voltage followers & high input impedance configuration, differential amplifiers, closed loop frequency response & circuit stability, single supply operation of OP-AMP, summing, scaling and averaging amplifier, voltage to current & current to voltage converters, integrators & differentiators, logarithmic & anti logarithmic amplifiers. **12 hrs**

Unit – 4:

COMPARATORS & CONVERTERS: Basic comparator & its characteristics, zero crossing detector, voltage limiters, clippers & clampers, small signal half wave & full wave rectifiers, absolute value detectors, sample and hold circuit. **12 hrs**

Reference Books:

1. OP-AMP and linear integrated circuits 2nd edition, PLHI by Ramakant A. Gayakwad.
2. Design with operation amplifiers and Analog Integrated circuits by Sergei Franco.
3. Integrated Electronics: Analog and Digital circuits & system by Millman & Halkias.
4. Linear Integrated Circuits by D.R. Chaudhary (WEL).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3052	CONDENSED MATTER PHYSICS - III	SC	3	1	0	4	5

Course objectives:

- Structural analysis is the first step in the characterization of any material.
- The atomic structure of a material depends on the method of synthesis and on various parameters involved in the technique.
- This course will introduce the fundamental concepts of crystal structure and to understand the diffraction principle and use of X-rays.
- To understand the symmetry and space groups.
- To know about lattice representation and reciprocal lattices.
- To determine and analyze the crystal structure using x-ray diffraction.

Course outcomes: On successful completion of this course, the student shall be able to:

1) Illustrate reciprocal lattice.
2) Understand the theoretical framework like symmetry and space groups.
3) Illustrate different X-ray analysis methods
4) Characterize the crystal using X-ray diffraction experiments.

Course Content:

Unit -1:

Reciprocal lattice: Elementary considerations, graphical construction, vector algebraic discussion, relation between direct and reciprocal cells, interpretation of Bragg's law using reciprocal lattice concept, general spacing formula, transformation equations and their importance. **12 hrs**

Unit - 2:

The Laue method: Reciprocal lattice construction, instrumentation, flat plate cameras, front reflection region, appearance of photographs, back reflection region, appearance of photographs. Rotating crystal methods: Reciprocal lattice construction, instrumentation, cylindrical camera, mounting and adjustment of crystal, interpretation of photographs, unit cell determination, indexing procedure. **12 hrs**

Unit - 3:

Moving film methods: Weissenberg method, reciprocal lattice construction for zero level and higher levels, indexing procedure, interpretation of photographs. Single crystal diffracto-meter: Reciprocal lattice construction, parafocussing and goniometry, intensity measurements. **12 hrs**

Unit - 4:

Powder method: X-ray powder photographic methods, instrumentation, diffraction geometry, measurement of Bragg angles and interplanar spacings, index of power patterns, analytical and graphical methods, precise lattice parameter determination, characteristics of powder pattern lines, application to identification of solid solution and phase changes, line broadening and particle size measurements, interpretation of powder photographs of unknown system, powder diffractometer and applications. **12 hrs**

Reference Books:

1. Elements of X-ray Crystallography, L.V. Azaroff: McGraw Hill, New York, 1968.
2. An introduction to Crystallography, Michael M Wooffen: Cam bridege University Press, 1997
3. Crystal growth Processes and methods, Santhana Raghavan and Ramaswamy: KRU Publications, Kumbakonam.
4. Crystallography for solid state physics, Verma and Srivastava: New age international Ltd. 1997.
5. Solid State Physics, Charles Kittel: Wiley Eastern, 1984.
6. X-ray crystallography, M.J.Burger: John Wiley, New York, 1952.
7. Crystalline Solids, Duncan M and C. Mike: Nelson, London, 1973.
8. The powder method in X-ray cryst. L.V. Azaroff and M.J.Burger: McGraw Hi11s, 1958.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3053	MATERIAL SCIENCE - III	SC	3	1	0	4	5

Course Objectives:

This course provides the knowledge about the optical, dielectric and mechanical properties of materials. Effect of structure of materials on the properties is also discussed in detail.

Course Outcomes:

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

1. Characterize optical and dielectric properties of metals & non-metals through the spectroscopic techniques.
2. Analyze the properties like Luminescence and photoconductivity of metals & non-metals.
3. Design the metals and non-metals having the properties of stress & strain, elasticity, Plastic deformation.
4. Explain the effect of temperature on the properties of metals and alloys.
5. Explain to use the techniques of measurements & instruments.

Course Content:

Unit-1:

Optical and dielectric properties of materials: Theory of electronic polarization and optical absorption, ionic polarization, orientationl polarization. Optical phonon model in an ionic crystal; Interaction of electromagnetic waves with optical modes, polarization, Dispersion curves of transverse optical (TO) phonon and optical photon in a diatomic ionic crystal, LST relation; Metal-insulator transition. UV-VIS, IR, FTIR and Raman spectroscopy. Optical properties of metals & nonmetals-Luminescence, photoconductivity. **12hrs**

Unit -2:

Electrical properties of crystalline, nanocrystalline and polymeric materials: Resistivity variation in metals, alloys, semiconductors and nanocrystalline materials, electrical conduction in ionic ceramics, clay materials and conducting polymers. Two-probe and four probe techniques, DC and AC conductivity measurements.

Mechanical Properties of metals and ceramics: Concepts of stress & strain, stress-strain behavior, elasticity, Plastic deformation, Hardness-Knoop & Vicker's hardness test. **12 hrs**

Unit - 3:

Thermal properties of metals & alloys: Temperature effects on the intensities of Bragg reflections. Influence of temperature on diffraction of X-rays: Normal coordinates of lattice vibration and X-ray scattering from a vibrating lattice and origin of thermal diffuse spots. First order TDS. Debye-Waller factor' Debye's method of calculating isotropic temperature factor for a cubic crystal. DTA, TGA, DSC (Outline only). Annealing processes, Heat treatment of steels, mechanism of hardening. Quenching, thermal stresses. **12 hrs**

Unit - 4:

Structure - Property correlation, Correlation of structure with physical properties of materials, application prospects of materials in different areas.

Basic concepts of measurements & instruments: Static characteristics of instruments, accuracy & precision, sensitivity, reproducibility, errors, Transducers, classification & selection criteria, principles of piezoelectric, photoelectric, thermoelectric transducers, resistance temperature transducers (RTD), Thermister, strain gauge, load cells, LVDT Electronic instruments for measurement, Digital voltmeter, principles of electronic multimeter, digital multimeter, Q-meter, Electronic LCR meter, Frequency & time interval counters. **12 hrs**

Reference Books:

1. Introduction to Ceramics by W. D. Kingery, H. K. Bowen and D. R. Uhlmann, John Wiley & Sons.
2. Diffraction analysis of the microstructure of materials by E. J. Mittemeijere and P. Scardi, Springer
3. Materials Science & Engineering by William D. Callister, John Wiley & Sons, Inc.
4. Modern techniques of surface science by D. P. Woodruff & T. A. Delchar, Cambridge University Press.
5. X-ray spectroscopy by B. K. Agarwal, Springer-Verlag.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3060	ASTROPHYSICS	OE	4	0	0	4	4

Course Objectives:

- To study the astrophysical universe, ranging from solar system objects through stars, to galaxies and the structure of the universe as a whole.
- To understand the principles and methods of modern astrophysics.

Course Outcomes:

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

1. Describe the laws that govern the astrophysical phenomena.
2. Explain the nature and properties of compact astrophysical objects.
3. Elaborate astrophysical observations and measurements.
4. Discuss the principles of formation of the Planets and Comets.

Course Content:

Unit -1:

Basic concepts of Astronomy: Co-ordinate system, Time system-Solar and Sidereal times, Apparent and Absolute magnitudes, Trigonometric Parallax, Atmospheric extinction, Optical telescopes and their characteristics, Modern Optical telescopes, Astronomical Instruments – Photometer, Photographic plates, Spectrographs, Charge Coupled Detector. 12 hrs

Unit – 2:

Stellar properties: Observational properties of stars – spectral and luminosity classification of stars- H-R Diagram, Saha Equation, , Star Formation - Jeans mass, Jeans Length and Free fall timescale, Main Sequence Evolution, Mass- luminosity relation, White Dwarfs – Chandrasekhar's Limit, Neutron Stars, Pulsars, Supernovae, Stellar Black holes. 12 hrs

Unit - 3:

Solar system: Overview of Sun, Solar Interior structure- Core, Radiative zone and Convective Zone, solar atmosphere-photosphere, Chromospheres, Properties of Interior planets and exterior planets satellites of planets, Kuiper Belt objects, Oort Cloud, Theories of formation of the solar system.

12 hrs

Unit – 4:

Stellar structure: Hydrostatic Equilibrium, Mass conservation, Luminosity gradient equation, Temperature gradient Equations, Lane – Emden equation for polytrophic stars and its physical solution, estimates of central pressure and temperature, Radiation pressure, equation for generation and luminosity, equation of temperature gradient for radiative and convective equilibrium, Schwarzschild criterion, gas pressure and radiation pressure, Linear Model and its properties, Volt – Russell theorem, Zero age main sequence, Mass – Luminosity relation. 12 hrs

Reference Books:

1. Ostlie and Carroll: Introduction to Modern Astrophysics, Addison Wesley (II Edition), 1997
2. Kristian Rohlf : Tools of Radio Astronomy, Springer
3. John D. Krauss : Radio Astronomy, II Edition, Signet.
4. F. Shu : The Physical Universe, University So Press, 1987.

5. M. Schwarzschild : Structure and Evolution of Stars, Dover.
6. R. Kippenhahn and Weigert A.: Stellar Structure and Evolution, Spinger Verlag, 1990.
7. C.J. Hansen and Kawaler S.D.: Stellar Interiors: Physical Principles, Structure and Evolution, Spinger Verlag, 1994.
8. M. S. Longair: High Energy Astrophysics, CUP.
9. Kitchin C R : Stars, Nebulae and the Interstellar Medium, Taylor and Francis Group, 1987.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3070	GENERAL PHYSICS LAB –III (PRACTICAL)	HC	0	0	3	3	5

Course Objectives:
To introduce the basic concepts of physics through hands on experience and impart experimental skill to students

Course Outcomes:
On successful completion of this course, the student shall be able to:

1. Conduct the experiments related to different Physics laws and theories.
2. Employ the different tools and techniques to get the data/readings related to the experiments.
3. Verify the fundamental physics behind many scientific discoveries through hands on experimentation.

Course Content:

LIST OF EXPERIMENTS:

1. Hall effect experiment:- Determination of charge carrier density.
2. Spatial and temporal coherence of He-Ne laser.
3. Verification of Mallu's law.
4. Experiments with lasers and reflection grating.
5. To photograph the spectra of Fe (standard) and Cu arc using CDS spectrograph and to determine the wavelengths of Cu spectrum using Hartman formula.
6. Determination of laser light wavelength using Lloyd's mirror.
7. Determination of Numerical aperture in an optical cable.
8. Laser light attenuation in an optical cable.
9. Refractive index of liquids/solids using laser light.
10. Diffraction of laser light through two closely spaced circular apertures.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3081	ELECTRONICS LAB (PRACITICAL)	SC	0	0	3	3	5

Course Objectives:

The study of this course aims to:

1. Provide a strong foundation on Linear Circuits.
2. Familiarize students with applications of various IC's.
3. Have a broad coverage in the field that is relevant for engineers to design linear circuits using Op-amps.
4. Familiarize the conversion of data from Analog to Digital and Digital to Analog.

Course Outcomes:
On successful completion of this course, the student shall be able to:

1. Analyze the functioning of basic electronic circuits of AM and FM modulation and demodulation through experimentation using discrete electronic components.
2. Verify sampling theorem by experiment.
3. Verify different modulation and demodulation techniques through experimentation.
4. Draw the outputs of various angle modulation and demodulation systems
5. Verify the outputs of ASK, FSK, PSK circuits.

Course Content:

List of Experiments:
Analog and Digital communication lab
1. Amplitude modulation and demodulation.
2. DSB SC modulation and demodulation.
3. SSB SC modulation and demodulation.
4. Frequency modulation and demodulation.
5. Pre Emphasis-De Emphasis circuits.
6. Verification of sampling theorem.

7. PAM generation and reconstruction.
8. PWM AND PPM: generation and reconstruction
9. Delta and Adaptive delta modulation.
10. TDM of two band limited signals.
11. ASK generation and detection.
12. FSK generation and detection.
13. PSK generation and detection.
14. Line coding and decoding.

LIC Lab:
1. OP-AMP as square wave generator.
2. Schmitt trigger.
3. Voltage regulator
4. UJT relaxation oscillator
5. OP-AMP as active integrator and differentiator.
6. Design and test the operation of 4 Bit DAC using R-2R ladder network and OP-AMP MA741.
7. Design a second order Butterworth active low pass filter and high pass filter.
8. Design Schmitt trigger and test the circuit for the given values of UTP and LTP using OP-AMP MA741.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3082	CONDENSED MATTER PHYSICS LAB (PRACTCAL)	SC	0	0	3	3	5

Course Objectives:

- To make the student familiarize with the basics of materials.
- To enable the student to explore the concepts involved in the X-ray diffraction.
- To make the student understand the basic concepts in absorption and Infrared spectroscopy.
- To allow the student to understand the fundamentals of Hysteresis.

Course Outcomes:

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

1. Identify the phase and phase purity of the crystal.
2. Determine particle size, stress and strain using PXRD.
3. Analyse of Thermoluminescence glow curve using ORIGIN software.
4. Determine of Curie temperature using B-H curve of a Ferromagnetic material (both hard and soft).
5. Calibrate of electromagnet and magnetic susceptibility determination of magnetic salts ($MnSO_4$, $MnCl_2$) by Quincke's method.
6. Study I-V characteristics of any given materials.

Course Content:

LIST OF EXPERIMENTS:

1. Analysis of X-ray powder Diffractogram (NaCl).
2. Analysis of X-ray powder Diffractogram (KCl).
3. Determination of particle size, stress and strain using PXRD.
4. Analysis of single crystal rotation photograph.
5. Determination of Reitveld refinement parameter using full proof suit software.
6. Determination of energy gap by using absorption spectra.
7. Analysis of Thermoluminescence glow curve using ORIGIN software.
8. Determination of Curie temperature using B-H curve of a Ferromagnetic material (both hard and soft).
9. Calibration of electromagnet and magnetic susceptibility determination of magnetic salts ($MnSO_4$, $MnCl_2$) by Quincke's method.
10. Study of I-V characteristics of given materials.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH3083	MATERIAL SCIENCE LAB (PRACTICAL)	SC	0	0	3	3	5

Course Objectives:

- To make the student familiarize with the basics of materials science.

- To enable the student to explore the concepts involved in the X-ray diffraction.
- To make the student understand the basic concepts in absorption and Infrared spectroscopy.
- To allow the student to understand the fundamentals of Hall effect and Hysteresis.

Course Outcomes:

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

1. Demonstrate different experimental techniques.
2. Experiment with X – ray diffractometer to determination the phase of the nano materials.
3. Analyze the thermoluminescence glow curves of different phosphor materials
4. Test I-V properties of thin films through experiment.

Course Content:

LIST OF EXPERIMENTS:

1. Synthesis of nanomaterial by solution combustion technique.
2. Synthesis of nanomaterial by hydrothermal technique.
3. Synthesis of material by solid state synthesis technique.
4. Analysis of X-ray powder Diffractogram.
5. Determination of energy gap by using absorption spectra (UV-visible spectrometer).
6. Analysis of Thermoluminescence glow curve using Origin software.
7. B-H curve of a Ferromagnetic material (both hard and soft).
8. Calibration of electromagnet and magnetic susceptibility determination of magnetic salts ($MnSO_4$, $MnCl_2$) by Quincke's method.
9. Study of I-V characteristics of given material.
10. Analysis of single crystal rotation photograph.

FOURTH SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH4010	MAJOR PROJECT	HC	0	0	10	10	20

Objective:

To carry out the research under the guidance of supervisor and in the process learn the techniques of research.

Course Outcomes:

On successful completion of the project, the student shall be able to:

1. Familiarize with literature search
2. Conduct the experiments related to research and formulate computational techniques
3. Interpret the scientific data.
4. Write report and defend the research findings.

Project:

Each student will choose the topic of research particularly from any area of soft cores studied and work under the guidance of allocated faculty member. The project shall preferably be application oriented or industry need based that could be useful to the society. In case of industry need base project the student may opt co-supervisor from the concerned industry. The student will have to make a preliminary survey of research done in broad area of his/her area of interest and decide on the topic in consultation with his/her supervisor(s). The project work floated should be completed within 16 weeks and project report has to be submitted within the stipulated date by the University/ within 18 weeks whichever is earlier. The student has to meet the concerned supervisor(s) frequently to seek guidance and also to produce the progress of the work being carried out. The student should also submit progress report during 5th week and 10th week of the beginning of the semester and final draft report with findings by 15th week. After the completion of the project the student shall submit project report in the form of dissertation on a specified date by the School.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M18PH4020	MOOC/SWAYAM/ INTERNSHIP	RULO	0	0	4	4	4

Note: Students shall choose to take up any online course of four credits as guided by the school or shall have to undergo internship of four weeks duration, the details of which are provided here under.

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.

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.

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 Physics is 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 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 FACULTY MEMBERS

Sl. No	Name of the Teacher	Designation	Contact No.	E-mail
1	Dr. D. V. Sunitha	Associate Professor & Co-ordinator	7760884884	sunithadv@reva.edu.in
2	Mrs. Bharathi Devi	Associate Professor	9886189024	bharathidevi@reva.edu.in
3	Dr. Madesh Kumar	Associate Professor	9341271290	madeshkumar@reva.edu.in
4	Dr. Jayadev Pattar	Associate Professor	9620305750	jayadevpattar@reva.edu.in
5	Dr.S.Naresh Kumar	Associate Professor	8867445995	s.nareshkumar@reva.edu.in
6	Dr.P.Anjaneyulu	Associate Professor	9741965325	p.njaneyulu@reva.edu.in
7	Mrs.Usha.S K	Assistant Prof.	9481033638	ushask@reva.edu.in
8	Dr. Prakash Babu	Assistant Professor	9916322600	prkashbabu.d@reva.edu.in
9	Mr. G Ranjith Kumar	Assistant Professor	9449441201	ranjithk@reva.edu.in
10	Dr. K Munirathnam	Assistant Professor	9164040013	kmunirathnam@reva.edu.in
11	Mr.Deepak.K	Assistant Professor	8892926677	deepak@reva.edu.in
12	Dr.Hareesh K	Assistant Professor	9986996834	hareesh.k@reva.edu.in

DO'S AND DON'TS

DO'S

1. Maintain discipline and respect the rules and regulations of the university
2. Be regular and punctual to classes
3. Study regularly and submit assignments on time
4. Be respectful to your colleagues/friends and hostel staff/management.
5. Read the notice board (both at your college and the hostel) regularly.
6. Utilize your Personal Computer for educational purpose only.
7. Follow the code of conduct.
8. Visit Health Center on the campus whenever you are unwell.
9. Be security conscious and take care of your valuables especially Cash, Mobile Phones, Laptop and other valuables.
10. Carry your valuables along with you whenever you proceed on leave/vacation.
11. Use electric appliances, lights and water optimally.
12. Keep the campus clean and hygienic.

DON'TS

1. Ragging inside / outside the campus.
2. Possession of Fire arms and daggers etc.
3. Use of Alcohols, Toxic drugs, sheesha, gutkha and hashish/heroin etc.
4. Use of Crackers, explosives and ammunition etc.
5. Smoking and keeping any kind of such items.
6. Misusing college & hostel premises/facilities for activities other than studies.
7. Playing loud music in the room which may disturb studies of colleagues / neighbors.
8. Making noise and raising slogans.
9. Keeping electrical appliances, other than authorized ones.
10. Involvement in politics, ethnic, sectarian and other undesirable activities.
11. Proxy in any manner.
12. Use of mobiles in the classrooms.

Note: 1. Rules are revised / reviewed as and when required.
2. Healthy suggestions are welcome for betterment of Institution

Registrar
REVA University
Bengaluru - 560 064

REVA UNIVERSITY
Bengaluru, India

SCHOOL OF PERFORMING ARTS & INDIC STUDIES

Master of Performing Arts Program

MPA

Handbook

2018-2020

REVA UNIVERSITY
Bengaluru, India

SCHOOL OF PERFORMING ARTS

Master of Performing Arts (MPA) Program

Hand Book

2018-2020

Rukmini Knowledge Park,
Kattigenahalli, Yelahanka, Bangalore-560064
Phone No: +91-080-66226622, Fax: 080-28478539

Rukmini Educational Charitable Trust

www.reva.edu.in

Registrar
REVA University
Bengaluru - 560 064

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 ourfuture generation to be ethically, morally and intellectually elite. They practice the art of teaching witha 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 gapbetween 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. S. Y. Kulkarni

Vice-Chancellor, REVA University

DIRECTORS MESSAGE

The freedom that students are getting to choose their careers now is much broader than ever before. Unconventional career choice is the new way, and the Gen Y is all about wonderful creativity. School of Performing Arts, aims to benchmark itself in the area of Music, Dance and Theatre courses from the Diploma to Research level degrees. Indian tradition in which Music and Dance plays a pivotal role is a major attraction and a focus of study for not only Indians but westerners too, for, one finds it very scientific and vast area for inter-disciplinary research activities. Department is well equipped to meet the traditional and modern needs of both Indian and foreign nationals. The performing wing of the school shall aim to churn out the most sought after performers and especially thinking dancers. The syllabi is world class and prepares students not just as performers but also in the areas like research, Art Management, Personality development, soft skills, Music, Nattuvangam, Theatre studies and other allied art forms, apart from bringing in internationally acclaimed artistes for workshops,guest lectures and interactive sessions. The field work and Dissertation makes the course rigorous and unparalleled.

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

I take this as my privilege to welcome the artistes and connoisseurs to come and explore the finer aspects and unexplored world of Performing Arts at REVA University

Dr Vasanth Kiran
Director, School of Performing Arts

CONTENTS

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 inthe 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 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 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.

The University is presently offering 24 Post Graduate Degree programs, 21 Degree programs in various branches of studies and has 14000+ students studying in various branches of knowledge at graduate and post graduate level and 410 Scholars pursuing research leading to PhD in 21 disciplines. It has 900+ well qualified, experienced and committed faculty members of whom majority aredoctorates in their respective areas and most of them are guiding students pursuing research leading toPhD.

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 choicein 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 educationthrough 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 supportedby 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 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 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.

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 Universityon 6^{th} 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 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 classes everyday to students, faculty members, administrative staff and their family members and organises 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 honoured with many more such honors and recognitions.

ABOUT SCHOOL OF PERFORMING ARTS

India proudly treasures the rich heritage and culture which is unparalleled and incomparable. Indian arts play a pivotal role and Performing Arts stands as testimonial to the richness. Performing Arts which comprises of Music, Dance and Theater are in demand for career choice now like never before. REVA-SPA offers a unique challenging Performing Arts programs which prepares you future ready. The aim is to bring in holistic view to the performing arts education in India, which is predominantly missing. The school of Performing Arts offers courses like Certificate, Diploma, MPA (Masters of Performing Arts) and Ph. D programs. Our Syllabus is world class and is benchmarked. The SPA is in beautiful campus of REVA University, which has received Best Campus awards in India and Best upcoming university awards. Performing Arts school would also concentrate on collaborating with universities abroad for short terms and semester exchange programs and also introduce Indian Performing Arts to the foreign students. Internationally acclaimed artistes visit campusoften as visiting faculty members and guest lectures to interact with students. The performing wing at school of Performing Arts will have performing opportunities all over the country and abroad. Students can expect to become thinking artistes and professional in approach. The seminars, workshops, guest classes would make them ready to face the world of Arts that is an amalgamation of a spectrum of experiences and choices.

USP of Programs run by School of Performing Arts

- Full time dedicated and highly experienced dance and music faculty members.
- Exclusively dedicated floor for School of Performing Arts in the Rukmini Knowledge Park campus.
- Well-equipped library with hand picked books and Sanskrit Volumes on treatises in Dance, Music and Theatre along with News Papers, Journals, Magazines, Books, e-resources etc., on Performing Arts.
- Audio and Video Facility in all the classrooms.
- Aesthetically designed and acoustically planned classrooms with Modern German Dance flooring for injury free dancing.
- World Renowned artists as Visiting Lecturers and Adjunct Faculty.
- World renowned Artists for lecture demonstratins and Workshops under “Kala Gnana”, monthly series conducted in the School of Performing Arts for the benefit of Students.

- Training and exposure to Research and Publications – students are trained by their mentors on presenting their research papers in confereneces and seminars. They are also trained to publish research papers in reputed journals.
- Certification and training programs for CBSE UGC NET exam.
- Training in Sanskrit, Telugu and Kannada as part of their curriculum.
- Language Labs
- Well equiped Psychology Labs
- Well planned and challenging syllabus.
- Performing opportunities at the prestigious Festivals in India and Abroad as part of Performing wing of the School of Performing Arts.
- State of the Art facilities for Locker rooms, Changing rooms and Green rooms.
- Mandatory Mentor and Mentee sessions by faculty members every week every week for the benefit of the students.
- Dediacted auditoriums with International standards.
- Global program with an opportunity to pursue a short term or a semester in one of our partnered Universities in USA, Europe etc.,
- Oportunity to also participate in Inetr University competetions at State, National and International leves representing the University.
- Dedicated Skill Development cell that focusses on career oriented Programs exclusive for Performing Arts Students.
- Special Training in Allied forms like Stage Craft, Sound System, Lighting, make up and Costumes etc.
- Every year field Trips for the stduents along with the faculty members to Historically rich Art places.
- Mandatory Internship Programs for UG and PG Students.

VISION

School of Performing Arts aims to be Centre of Excellence in Performing Arts through high quality education, research, innovation, creativity, extension and collaboration and prepare students who would be great performers and innovators and create global village of peace and prosperity by spreading the message of Indian culture and tradition.

MISSION

- To impart holistic performing arts education by matching the contemporary world requirements with traditional pedagogical techniques.
- Attract and develop talented and committed human resource and provide an environment conducive to research, innovation and team spirit.
- Develop excellent infrastructural facilities; facilitate effective interaction among faculty and students with other schools and promote inter disciplinary learning and research environment.
- Practice and promote high standards of professional artistry with ethics and enrich personality traits of students to become great performers coupled with moral values.
- Foster networking with alumni, artists and art institutions across the world and other stake holders and spread the message of Indian culture and tradition for global peace and prosperity.

ADVISORY BOARD

SL No.	Name
1.	Dr. S Ramaswamy, Professor[Retd] Bangalore University, Bangalore
2.	Dr. V. S. Sreedhara, Professor of English , NLSUI, Bangalore
3	Dr. Shivalinga Swamy, Associate Professor and HoD of English, Tumkur University, Tumkur
4.	Dr. Etienne Rassendren, Professor, Dept of English, St Joseph's College[Auto], Bangalore
5	Dr. C. P. Ravichandra, Professor, Dept of English, Mysore University, Mysore
6	Dr. Rajendra Chenni, Professor. Dept of English, Kuvempu University, Shimogga
7	Prof. S. Narayanan, Professor [Retd], Kongadiappa College, Doddabalapura

"Education is the manifestation of the perfection already in man"

- Swami Vivekananda

The ladder of success is best climbed by stepping on the rungs of opportunity.

- Ayn Rand

I think of science fiction as being part of the great river of imaginative fiction that has flowed through English literature, probably for 400 or 500 years, well predating modern science.

- J. G. Ballard

Literature adds to reality, it does not simply describe it. It enriches the necessary competencies that daily life requires and provides; and in this respect, it irrigates the deserts that our lives have already become.

- C. S. Lewis

Literature is the art of discovering something extraordinary about ordinary people, and saying with ordinary words something extraordinary.

- Boris Pasternak

Master of Performing Arts (MPA) Program

Programme Overview

Performing Arts discipline deals with human life and human experience qualitatively. Humanities investigates how do human beings behave? Why do they behave this way? How do human beings interact with each other? How do human beings interpret the world around them? And what kind of political, social and cultural institutions do they form?

The field of humanities include Modern languages, Classical languages, Linguistics, Literature, History, Jurisprudence, Philosophy, Archaeology, Comparative religion, Ethics, History, criticism and theory of the arts, Perforing Arts, Journalism, Psychology, Political science and such subject areas.

Theatre, music, dance, and other kinds of performances are present in all human cultures. The history of music and dance date back to pre-historic times. In India, religion, philosophy and myth cannot be divorced from their art forms. Dance, Drama and music are tied inextricably to ceremony of any kind. Bharatnatyam, Kathakali, Kathak, Manipuri, Odissi, Kuchipudi, Sattriya, Mohiniyattam are some of the classical Dance forms of India. Similarly, the classical music forms of India are Hindustani Classical Music and Carnatic Classical Music, in addition, there are hundreds of regional music formsand there are many musical instruments to compose and play music. Koodiyattam, Yakshagana, Swang, Bhand Paather, Ankiya Naat Bhaona, Tamasha, Therukoothu, Jatra are some of theatre forms of India. In addition, there are puppet forms. They all adhere to the canons of classical dance laid down in the Natya Shastra, a second century C.E. text ascribed to the sage Bharata, to whom it was supposedly revealed by the Creator, Brahma.

Performing arts in India and its practitioners are referred to as being part of the "entertainment industry." This indicates a paradigm shift in the manner in which the arts is being viewed by society. The message apparent by the shift is that the audience now expects that the Arts must entertain in the manner defined by the entertainment industry, and they must form part of an organized industry. The performing arts industry in India reached INR236 billion in 2012 and is expected to witness a CAGR of 2.5% over 2012—2018 to reach INR275 billion in 2018. The industry will primarily be driven by new and innovative forms of fund raising by theater and dance groups and a growing demand for Indian culture at an international level.

At present more than 400 million youth are below 18 years of age and they have varied aspirations. A significant number of them would like to work in entertainment industry.

In this context, a Post Graduate Program in Performing Arts offered by **REVA UNIVERSITY** is relevant to meet the future human resources requirement of Entertainment Industry and also safe guard Indian tradition and culture.

Programme Educational Objectives (PEOs)

This Post- Graduate programme of 4 semesters in Performing Arts is to ensure that the student learns the subject of ance, music and other forms of performing arts in their specialized field both theoretically and practically. It is to ensure the overall holistic development of the dancer and performer. Being a dancer in today's competitive World is not travelling around and performing, but also about the communication skills that are required and the technical knowledge in their respective subject that one must possess to make them stand out in the crowd. This programme would instill in them an enthusiasm to teach the subject, ensure that they become professional performers, and trigger in them the inquisitiveness to be Research Scholars for their Doctoral Thesis in the future

The Programme Educational Objectives are to prepare the students to:

1. Perform as Dancers/Musicians/Actors in entertainment sector
2. Work as creative directors, choreographers, producers of art and entertainment programmes
3. To work as managers, academicians, administrator or entrepreneurs with strong ethics and communication skills
4. Pursue higher education and research in reputed institutes at national and international level
5. Aware of environmental, legal Issues, cultural and constitutional obligations
6. Adopt lifelong learning for continuous improvement

Programme Outcomes (POs)

This MPA programme ensures the students to gain knowledge both in the theory and the practical aspects of Indian Classical Dance of their specialization. The courses and the examinations in each semester make them well equipped to take Dance at the Research level for their Doctoral pursuance in future.

After undergoing this programme, a student will be able to:

1. Perform as an artist, particularly as a Dancer
2. Act as a Choreographer
3. Write drama and act
4. Use modern technologies for enhancing the performance of entertainment industry
5. Direct and produce relevant products for entertainment industry
6. be qualified Teachers and Practitioners in the chosen field of dance
7. Choose appropriate online programmes for further learning, participate in seminars and conferences
8. Manage information, develop technical reports and make presentations
9. Lead a team to successfully complete a project and communicate across teams and set up his/her own enterprise
10. Conduct himself / herself as a responsible citizen

Program Specific Outcomes (PSO)

After successful completion of the program, the graduates shall be able to:

1. Visualise, Create, Design and Critically Analyse dance, music and theatre projects
2. Apply appropriate performing arts techniques and produce high quality productions and expressions of art

2. Use higher order critical, analytical skills to solve a new problem in multi-disciplinary and inter-disciplinary fields of Performing Arts.

MPA (Master of Performing Arts) Program

Scheme of Instruction

(effective from Academic Year 2018-19)

Sl. No	Course Code	Course Title	Course Type	Credit Pattern and Credit Value L	T	P	Total	No. of Hrs
FIRST SEMESTER								
1.	M18PA1010	Dance History	HC	4	0	0	4	4
2.	M18PA1020	English & Communications- I	HC	3	0	0	3	3
3.	M18PA1031	Fundamentals –Kuchipudi - (Adugulu, Jathulu, Vinayaka Kouthvam, Jathiswaram) - Practical – 1	SC	0	0	3	3	6
4.	M18PA1032	Fundamentals – Bharathanatyam - (Adavus, Alarippu and Jatiswaram) – Practcial 1	SC					
5.	M18PA1041	Items – Kuchipudi - (Poorvarangam, Shabdam, Ramadasu/Annamacharya Keertana) - Practical – 2	SC	0	0	3	3	6
6.	M18PA1042	Items – Bharathaatyam - (Shabdam, Kriti) – Practical 2	SC					
7.	M18PA1050	Slokas (Natya Sastram) - Practical – 3	HC	4	0	0	4	4
8.	M18PA1060	Music - 1 (Theory and practical)	HC	1	0	2	3	4
9.	M18PA1070	Kannada	HC	2	0	0	2	2
10.	M18PA1080	Yoga / Sports	RULO	0	0	2	2	3
		Total Credits	-	14	0	10	24	29
SECOND SEMESTER								
1	M18PA2010	Art History and Choreography	HC	4	0	0	4	4
2	M18PA2020	English & Communications - II	HC	3	0	0	3	3
3	M18PA2031	Items- Kuchipudi- (Tarangam, Keertana / Kriti, Thillana) -Practical – 2	SC	0	0	4	4	6
	M18PA2032	Items- Bharathanatyam- (Varnam(Pada or tana), Thillana) - Practical – 2	SC					

4		M18PA2041	Items-Kuchipudi- (Ashtapadi, Javali, Padam) - Practical – 2	SC	0	0	4	4	6
		M18PA2042	Items – Bharathanatyam -(Javali and Padam)	SC					

5	M18PA2050	Slokas (Abhinaya Darpanam) -	HC	4	0	0	4	4
6	M18PA2060	Music – 2 (Theory and Practical)	HC	1	0	2	3	4
7	M18PA2070	Sanskrit	HC	2	(	0	2	2
		Total Credits	-	14	0	10	24	29
TH	RD SEMESTER							
1	M18PA3010	Aesthetics in Dance	HC	3	0	0	3	3
2	M18PA3020	Research	HC	3	0	0	3	3
3	M18PA3030	Methodology	HC	3	0	0	3	3
4	M18PA3041	Arts Management	SC					
	M18PA3042	Bhama Kalapam- Kuchipudi-Practical – 1	SC	0	0	3	3	5
5	M18PA3050	Items-Bharathanatyam- Daru orSwarajati Varnam	HC	0	0	3	3	3
6	M18PA3060	Individual Choreography -Practical – 2	HC	1	0	2	3	4
7	M18PA3070	Slokas (Natya sastra andAbhinaya Darpanam)	HC	2	0	0	2	2
8	M18PA3081		OE					
9	M18PA3082	Telugu	OE	2	0	2	4	5
10	M18PA3083	Classical	OE					
		Dance	-	14	0	10	24	28
FO	RTH SEMESTER	Mrudangam						
1	M18PA4010	Dramatics	HC	3	0	0	3	3
2	M18PA4020	Total Credits	HC	1	0	2	3	4
3	M18PA4030	Dance Writing and	HC	1	0	2	3	4
4	M18PA4040	BiographiesAshta Nayikas -	HC	1	0	2	3	4
5	M18PA4050	Practical -1	HC	0	0	4	4	6
6	M18PA4060	Navarasas - Practical - 2	HC	0	0	8	8	-
		Nattuvangam - Practical –	-	6	0	18	24	21
		3Group Choreography	rs				96	

MPA (Master of Performing Arts) Program

Detaled Syllabus

(effective from Academic Year 2018-19)

SEMESTER-I

Course Code	Duration	Course Title		L	T	P	C
M18PA1010	20 Weeks	DANCE HISTORY	HC	4	0	0	4

Course Objectives:

- To enable the dancers/artist of School of Performing Arts to gain knowledge in the History and the Development of Dance from a bird's eye view.
- To inculcate the habit of reading and writing Dance and Art Papers, Journals, Blogs, Articles and Reviews for their academic betterment.

Course Outcomes:

On completion of the course learners will be able to:

- Speak clearly, confidently, comprehensibly and communicate with the World the History and the aspects of the Dance.
- To be able to write Research papers in their chosen field of Dance with a strong base of history knowledge that helps them to analyse the great and rich cultural and dance heritage of our country.

Course Contents:

UNIT	DESCRIPTION	TOPICS
1	Evolution of Dance	1. Definitions of Dance 2. Dance in Stone, Bronze and Iron Age periods 3. Dances in Vedic period 4. Dance in today's scenario
2	Natya Sastra, & Tandava, Lasya, and Dasaroopakas: Introduction	1. Natya Sastra -11 Aspects: Origin of Natyaveda and Natya Sastra, Rasa, Bhava , Abhinaya, Dharmi, Vritti, Pravritti, Siddhi, Swara, Atodyam, Ganam, Rangam, Margi and Desi 2. Tandava - 7 types 3. Lasya - Types Each aspect of the above applying to dance drama in detail 4. Dasaroopakas

3	Contribution of Dynasties and Sources of Dance	1. Primary Sources: Literary, Inscriptional, Monumental, Architectural, Archaeological, Paintings, and manuscripts 2. Secondary sources 3. Dynasty origin and reigns: Genealogy, Key Emperors, Patronage to art, Trade and socio economic strategies, Downfall, Architectures of the dynasties
4	Sculpture and Iconography	1. Definitions 2. Iconography in India 3. Buddist iconography 4. Jain iconography 5. Shaiva iconography 6. Vaishnava Iconography 7. Shakti Iconography

Course Code	Duration	Course Title		L	T	P	C
M18PA1020	20 Weeks	ENGLISH AND COMMUNICATIONS - 1	HC	3	0	0	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts develop their basic communication skills in English.
- To inculcate the habit of reading and writing Dance and Art Papers, Journals, Blogs, Articles and Reviews for their academic betterment.

Course Outcomes:

On completion of the course learners will be able to:

- Speak clearly, confidently, comprehensibly and communicate with one or many listeners using the appropriate communicative strategies.
- Write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas, logically on the topic.

Course Contents:

UNIT	Description	Topics
1	Communication Skills and Functional English	1. Basics of Communication 2. Verbal and Non – Verbal Communication 3. Barriers of effective communication 4. Tenses 5. Conditional Statements 6. Auxiliaries (Modal and Primary)
2	Listening and Reading Skills	1. Definitions (Listening and Reading) 2. Types of Listening 3. Barriers to effective listening 4. Types of Reading 5. Techniques of Effective Reading 6. Reading Tasks (Critical and Inferential)
3	Academic Writing – 1	1. Paragraphs 2. Summarizing 3. Project Reports
4	Skills – 1	1. Emails 2. Article/Review/ Research paper 3. Mail etiquette 4. Applying for grants/programmes

Course Code	Duration	Course Title		L	T	P	C
M18PA1031	20 Weeks	FUNDAMENTALS - KUCHIPUDI (Adugulu, Jathulu, Vinayaka Kouthvam, Jathiswaram) PRACTICAL - 1	SC	0	0	3	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the basics and fundamentals in the practical and performing aspects of the dance form that they are specializing.
- To teach students the items in dance and also the technical aspects of the items which include taalam, music, literature and the spiritual and philosophical depths in it.

Course Outcomes:

On completion of the course learners will be able to:

- Perform the fundamentals and the items that they have learned.
- Will be able to further teach the items and also understand the intricacies in choreographing such items in future.

Course Contents:

UNIT	Description	Topics
1	Fundamentals	1. Basic exercises in standing, sitting, running, stretching and sleeping postures 2. 1st half steps in Chaturasra Jaathi 3. 2nd half steps in Tisra, Chaturasra, Khanda, Mishra and Sankeerna Jaathis
2	Jathis	4. 12 jathis in Chaturasra jaathi 5. Recitation of the steps and Jathis with Thaalam and nattuvangam
3	Items – 1	6. Jathiswaram – 1
4	Items - 2	7. Kouthvam – 1

Course Code	Duration	Course Title		L	T	P	C
M18PA1032	20 Weeks	**FUNDAMENTALS – BHARATANATYAM (Adavus, Alaripu, Jatiswaram) – PRACTICAL -** 1	SC	0	0	3	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the basics and fundamentals in the practical and performing aspects of the dance form that they are specializing.
- To teach students the items in dance and also the technical aspects of the items which include taalam, music, literature and the spiritual and philosophical depths in it.

Course Outcomes:

On completion of the course learners will be able to:

- Perform the fundamentals and the items that they have learned.
- Will be able to further teach the items and also understand the intricacies in choreographing such items in future.

Course Contents:

UNIT	Description	Topics
1	Fundamentals	1. Basic exercises in standing, sitting, running, stretching and sleeping postures 2. Taddadavu 3. Natadavu 4. Paraval Adavu 5. Kudduthu mettadavu 6. Mettadavu 7. Mandi adavu 8. Teerumana Adavu 9. Tataitham adavu 10. Kathi adavu
2	Jathis	11. Jathis in all Jaathis 12. Recitation of the steps and Jathis with Thaalam and nattuvangam
3	Items – 1	13. Alaripu – 1
4	Items - 2	14. Jathiswaram – 1

Course Code	Duration	Course Title		L	T	P	C
M18PA1041	20 Weeks	ITEMS - KUCHIPUDI (Poorvarangam, Shabdam, Ramadasu / Annamacharya Keetana) PRACTICAL - 2	SC	0	0	3	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the basics and fundamentals in the practical and performing aspects of the dance form that they are specializing.
- To teach students the items in dance and also the technical aspects of the items which include taalam, music, literature and the spiritual and philosophical depths in it.

Course Outcomes:

On completion of the course learners will be able to:

- Perform the fundamentals and the items that they have learned.
- Will be able to further teach the items and also understand the intricacies in choreographing such items in future.

Course Contents:

UNIT	Description	Topics
1	Items – 1	1. Poorvarangam – 1
2	Items – 1	2. Shabdam – 1
3	Items – 1	3. Annamacharya/ Ramadasa keertana – 1
4	Nattuvangam	4. Nattuvangam for the items learned in the respective semester

Course Code	Duration	Course Title		L	T	P	C
M18PA1042	20 Weeks	ITEMS - Bharathanatyam (Shabdam, Kriti) – Practical - 2	SC	0	0	3	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the basics and fundamentals in the practical and performing aspects of the dance form that they are specializing.
- To teach students the items in dance and also the technical aspects of the items which include taalam, music, literature and the spiritual and philosophical depths in it.

Course Outcomes:

On completion of the course learners will be able to:

- Perform the fundamentals and the items that they have learned.
- Will be able to further teach the items and also understand the intricacies in choreographing such items in future.

Course Contents:

UNIT	Description	Topics
1	Items – 1	1. Shabdam – 1
2	Items – 2	2. Kriti – Anupallavi, Pallavi
3	Items –3	3. Kriti – Charanam
4	Nattuvangam	5. Nattuvangam for the items learned in the respective semester

Course Code	Duration	Course Title		L	T	P	C
M18PA1050	20Weeks	SLOKAS (NATYA SASTRAM) PRACTICAL - 2	HC	4	0	0	4

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the shloka aspects from the textual traditions in Dance in both the practical and the theory concepts.
- To teach students the depth of the technicalities in dance through varied dance scriptures and make them adept in the recitation of the shlokas.

Course Outcomes:

On completion of the course learners will be able to:

- Recite the shlokas of all the technicalities of dance.
- To be able to enact the shlokas through the body movements for better understanding.

Course Contents:

UNIT	Description	Topics
1	Natyarambha Shloka and Paada bhedas	1. Natyarambha Shlokam 2. 6 types of Paada Bhedas
2	Hasta Bhedas	3. Asamyuta Hastas 4. Samyuta Hastas
3	Nritta Hastas	5. Nritta Hastas
4	Bhedas	6. Shiro 7. Greeva 8. Drishti 9. Urah 10. Parshva 11. Kati

Course Code	Duration	Course Title		L	T	P	C
M18PA1060	20 Weeks	MUSIC – 1 (Theory & Practical)	HC	1	0	2	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the music aspects from the textual traditions in Dance in both the practical and the theory concepts.

- To teach students the depth of the technicalities in music through varied music scriptures and make them adept in the recitation of the songs in the Carnatic style of music.

Course Outcomes:

On completion of the course learners will be able to:

- Sing the technical aspects of Carnatic Music.
- Will be able to sing the songs that are taught as items in the practical papers of the respective semesters.

Course Contents:

UNIT	Description	Topics
1	Fundamentals – 1	1. Sarali Varasagalu 2. Janti Varasagalu
2	Fundamentals – 2	3. Madhyasthyi varasagalu 4. Alamkaragalu
3	Fundamentals – 3	5. Swarapallavi
4	Nattuvangam and tattukazhi	6. Learn to play Nattuvangam and Tattukazhi required for Dance

Course Code	Duration	Course Title		L	T	P	C
M18PA1070	20 Weeks	KANNADA	HC	2	0	0	2

Course Objectives:

- To enable the dancers/artist of School of Performing Arts develop their basic communication skills in Kannada.
- To inculcate the habit of reading and writing Kannada which is the State language of Karnataka.

Course Outcomes:

On completion of the course learners will be able to:

- Speak clearly, confidently, comprehensibly and communicate with one or many listeners using Kannada language.
- Write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas, logically on the topic.

Course Contents:

UNIT	Description	Topics
1	Fundamentals – 1	1. Kannada varnamale 2. Swara Vyanjana
2	Fundamentals – 2	3. Ottakshara 4. Gunintakshara
3	Word and Sentence formations	5. 2,3,4 lettered word formations 6. Simple sentence formations
4	General Knowledge	Prominent names, Places and Current Affairs

Course Code	Duration	Course Title		L	T	P	C	CH
M18PA1071/5	20 Weeks	**YOGA / SPORTS**	RULO	0	0	4	4	6

A. YOGA FOR HEALTH

Course Objectives:

Following are the Course Objectives.

- To prepare the students for the integration of their physical, mental and spiritual faculties;
- To enable the students to maintain good health;
- To practice mental hygiene and to attain higher level of consciousness;
- To possess emotional stability, self control and concentration; and
- To inculcate among students self discipline, moral and ethical values.

Course Outcomes:

On completion of the course learners will be able to:

- Practice yoga for strength, flexibility, and relaxation.
- Learn techniques for increasing concentration and decreasing anxiety
- Become self disciplined and self-controlled
- Improve physical fitness and perform better in studies
- Gain self confidence to face the challenges in the society with commitment to serve the society

Course Content:

Unit-I:

Yoga: Introduction, **Surya Namaskara:-** 12 counts

Unit-II:

Asanas: Sitting- Vajrasana, Dandasana, Padmasana, Matsyasana, Paschimottasana, Shirasasana.

Asanas: Standing- Tadasana, Trikonasana, Parshwa konasana, Veerabadrasana.

Unit-III:

Asanas: Prone Position- Bhujangasana, Dhanurasana.

Asanas: Supine Position- Sarvangasana, Halasana.

Mudras- Dhyana mudra, , Namaste mudra, Nasika mudra

Unit-IV:

Pranayams:- Anuloma – Viloma, Basthrika, Bhramari.

Dhyana & its types: Competition format, Rules and their interpretations

B. VOLLEYBALL

Course Objectives:

To learn the rules, fundamental skills, and strategies of volleyball

1. To develop skills in passing, setting, serving, spiking, and blocking.
2. To learn basic offensive and defensive patterns of play.
3. To develop a positive attitude towards volleyball as a lifetime sport and to improve physical fitness through participation in volleyball.

Course Outcomes:

On completion of the course learners will be able to:

1. Learn basic skills and knowledge associated with volleyball.
2. Apply these skills while playing volleyball and exhibit improved performance
3. Improve physical fitness and practice positive personal and lifestyle.
4. Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Course Content:

Unit-I

- Introduction about Volleyball
- Players Stance, Receiving and passing
- The Volley (Overhead pass), The Dig (Underhand pass), Service Reception

Unit-II

- Service- Under Arm Service, Tennis Service, Side Arm Spin Service, Round Arm Service, High spin service, Asian serve / American serve (floating)
- Setting the ball- Set for attack, Back set, Jump set

Unit-III

- Smash/Spike- Straight smash, Body turn smash, Wrist outward smash, Wrist inward smash
- Block- Single block, Double block, Three-man block
- Rolls- Overhead pass & back rolling, One hand underhand pass with side rolling, Forward dive

Unit-IV

- Attack Combination, Defense Systems, Libero play
- Court marking, Rules and their interpretations and Duties of officials

C. BASKETBALL

Course Objectives:

1. To learn the rules, fundamental skills, and strategies of Basketball
2. To develop technical skills in passing, in ball handling, individual offense, individual defense, rebounding, screen, team offense, team defense and fast break.
3. To learn basic offensive and defensive strategies of play.
4. To develop a positive attitude towards Basketball as a lifetime sport and to improve physical fitness through participation in Basketball.
5. To develop positive understanding and appreciation of the basketball game.

Course Outcomes:

On completion of the course learners will be able to:

1. Learn basic skills and knowledge associated with basketball.
2. Apply these skills while playing basketball and exhibit improved performance
3. Improve physical fitness and practice positive personal and lifestyle.
4. Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Course Content:

Unit-I

- Basketball: Introduction
- Grip; Player stance- Triple threat stance and Ball handling exercises
- Passing (Two hand/one hand)- Chest pass, Bounce Pass, Over head pass, Underhand pass, Hook Pass, Behind the back pass, Baseball pass, Side arm pass and passing in running.

- Receiving-Two Hand receiving, One hand receiving, Receiving in stationary position, Receiving while jumping, Receiving while running.

Unit-II

- Dribbling- How to start dribble, How to stop dribble, High / Low dribble with variations
- Shooting- Layup shot and its variations, One hand set shot, One hand jump shot, Free throw, Hook shot, Tip-in shot.
- Stopping- Stride/Scoot, Pivoting and Faking /Feinting footwork.

Unit-III

- Rebounding- Defensive rebound, Offensive rebound, Box out, Rebound Organization.
- Individual Defensive- Guarding the man with the ball and without the ball.
- Offensive drills, Fast break drills, Team Defense/Offense, Team Tactics

Unit-IV

- Court marking, Rules and their interpretations

D. FOOTBALL

Course Objectives:

1. To learn the rules, fundamental skills, and strategies of football.
2. To develop skills in passing, receiving, controlling the ball, dribbling, shielding, shooting, tackling, beating a defender and heading in football.
3. To learn basic offensive and defensive patterns of play
4. To use different parts of the body in utilizing the above skills while playing football
5. To develop a positive attitude towards football as a lifetime sport and to improve physical fitness through participation in football.

Course Outcomes:

On completion of the course learners will be able to:

1. Learn basic skills and knowledge associated with football.
2. Apply these skills while playing football and exhibit improved performance
3. Use the knowledge and understanding to perform, refine and adapt the above skills and related skills with precision, accuracy, fluency and clarity in any situation.
4. Improve physical fitness and practice positive personal and lifestyle.
5. Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Course Content:

Unit-I

1. **Football: Introduction**

- Kicks- Inside kick, Instep kick, Outer instep kick, Lofted kick, Chipping, Volley, Half Volley
- Trapping- Trapping rolling the ball, Trapping bouncing ball with sole

Unit-II

- Dribbling- With instep and outer instep of the foot.
- Heading- From standing, running and jumping.
- Feinting- With the lower limb and upper part of the body.

Unit-III

- Tackling- Simple tackling, Slide tackling.
- Throw-in- Standing and Sliding
- Goal Keeping- Collection of balls, Ball clearance, throwing and deflecting.

Unit-IV

- Ground marking, Rules and their interpretations

E. ATHLETICS (TRACK AND FIELD)

Course Objectives:

1. To teach students the skilled techniques in sprints, relay running, hurdles, long jump, high jump, and shot put and practice them.
2. To develop competence among students in demonstrating all the techniques covered in the course.
3. To make students understand some of the scientific and empirical principles and their rationale underlying the development of skilled performance.
4. To inculcate among students the habit of team work and cooperative learning and develop competence in detecting / correcting technique errors.
5. To develop a positive attitude towards sports in general and athletics in particular and to improve physical fitness through participation in various athletic games / sports activities.

Course Outcomes:

On completion of the course learners will be able to:

1. Display competencies in executing basic techniques and skills associated with select track and field events.
2. Develop basic skills and techniques to improve one’s running posture and take-off position for different jumps.
3. Learn regular practice of select track and field events and improve physical fitness
4. Appreciate track and field events by applying sports science knowledge to explain the execution of the events.

Course Content:

Unit-I

- Athletics: Introduction
- Track Events - Steeple Chase, Race Walking, Middle and Long distance races
- Race walking - Technique, Faults and Officiating.
- Middle and Long distance races – Technique and Training

Unit-II

- Jumping Events - High Jump and Triple Jump: Basic Skills and techniques
- High Jump - Straddle Roll & Flop Technique, Approach, Take-off, Technique in the air, Clearance over the bar & Landing
- Triple Jump – Hop, Step and Jump Technique, Approach, Take-off & Landing

Unit-III

- Throwing Events - Discus Throw and Hammer Throw: Basic Skills and techniques
  - Discus Throw - Standing and Rotatory techniques, Grip, Stance, Rotation Technique,Power stance, Release and Reverse (Follow through)
- Hammer Throw - Grip, Swings, Rotation foot work, Release and Follow through

Unit-IV

- Rules, Officiating and Marking - Ground / Sector Marking, Interpretation of Rules.

Reference Books

1. Arthur E. Ellison (ed) (1994). Athletic Training and Sports Medicine.
2. Ballisteros, J.M. (1998). Hurdles Basic Coaching Manual, IAAF.
3. Bosen K.O. (1993). Teaching Athletics Skills and Technique.
4. Bosen K.O. (1990). Study Material on Hurdles for the Regular Course Students.
5. Doherty K. (1995). Track and Field Omni book.
6. Martin, David E. Peter N. Coe (1991). Training Distance Runner.
7. Howard S. (1981). Science of Track and Field Athletics.
8. Briggs Graeme (1987). “Track and field coaching Manual”, Australian Track and Field Coaches Association. Rothmans Foundation National Sports Division.
9. Carr, Gerry (1999). “Fundamentals of Track and Field. Track Athletics Title G.V. 1060 5.e. 368.
10. I.A.A.F. Level-II (2001). Text Book on Jumping Event.
11. Jarver, Jesse (1987). “The Jumps”, Track and Field Coaching Manual Australia.

SEMESTER-II

Course Code	Duration	Course Title		L	T	P	C
M18PA2010	20 Weeks	ART HISTORY AND CHOREOGRAPHY	HC	4	0	0	4

Course Objectives:

- To enable the dancers/artist of School of Performing Arts to gain knowledge in the History and the Development of Dance and it's choreography in a detailed way.
- To be able to choreograph their own items including the right amount of technicalities and understanding them from the Sastra point of view.

Course Outcomes:

On completion of the course learners will be able to:

- Speak clearly, confidently, comprehensibly and communicate with the World the History and the aspects of the Dance and its choreographic techniques.
- To be able to choreograph their own items including the right amount of technicalities and understanding them from the Sastra point of view.

English & Communications - II

Course Contents:

UNIT	DESCRIPTION	TOPICS
1	Evolution of Choreography	1. Definition of Choreography 2. History of Choreography 3. Principles and Objectives of Choreography 4. Bandhas in Natya Sastra
2	Subjects of Choreography	5. Selection of Subjects 6. Musical Treatment of Subjects 7. Past, present and future of Choreography
3	Dance Dramas and Film Choreography	8. Choreography in Indian Films 9. Choreography in Classical based films 10. Dance drama Traditions of India.

4	Biographies	11. Biographies of famous Choreographers 12. Vedic period to modern age choreography

Course Code	Duration	Course Title		L	T	P	C
M18PA2020	20 Weeks	ENGLISH AND COMMUNICATIONS-II	HC	3	0	0	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts develop their basic communication skills in English.
- To inculcate the habit of reading and writing Dance and Art Papers, Journals, Blogs, Articles and Reviews for their academic betterment.

Course Outcomes:

On completion of the course learners will be able to:

- Speak clearly, confidently, comprehensibly and communicate with one or many listeners using the appropriate communicative strategies.
- Write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas, logically on the topic.

Course Contents:

Unit	**Description**	**opics**
1	Language in Use	1. Vocabulary Building 2. Functional Words 3. Idioms and Phrasal verbs 4. Homonyms and Homophones
2	Employability Skills	1. CV and Resume Preparation 2. Body language and gestures 3. Attitude and behaviour 4. Group Discussions 5. Presentation Skills

3	Academic Writing – 2	1. Essays 2. Letter Writing 3. Proposals
4	Personality Development Skills – 2	1. Personality Development 2. On and off stage presentation skills 3. Public Speaking Skills 4. Dining Etiquette

Course Code	Duration	Course Title		L	T	P	C
M18PA2031	20 Weeks	ITEMS – KUCHIPUDI (Tarangam, Keetana / Kriti, Thillana) PRACTICAL-2	HC	0	0	4	4

Course Objectives:

- To enable the dancers/artist of School of Performing Arts to have a strong foundation in the basics and fundamentals in the practical and performing aspects of the dance form that they are specializing.
- To teach students the items in dance and also the technical aspects of the items which include taalam, music, literature and the spiritual and philosophical depths in it.

Course Outcomes:

On completion of the course learners will be able to:

- Perform the fundamentals and the items that they have learned.
- Will be able to further teach the items and also understand the intricacies in choreographing such items in future.

Items- Bharathanatyam- (Varnam (Pada or tana), Thillana) - Practical – 2

Course Contents:

UNIT	Description	Topics
1	Jathis	1. 2^{nd} half jathis in Tisra, khanda, Mishra and Sankeerna
2	Items – 3	2. Tarangam – 1
3	Items – 3	3. Thillana – 1
4	Nattuvangam	4. Nattuvangam for all the jathis and items learned in the semester

Course Code	Duration	Course Title		L	T	P	C
M18PA2032	20 Weeks	ITEMS -BHARATHANATYAM (Varnam- Pada or Tana, Thillana) - PRACTICAL – 2	HC	0	0	4	4

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the basics and fundamentals in the practical and performing aspects of the dance form that they are specializing.
- To teach students the items in dance and also the technical aspects of the items which include taalam, music, literature and the spiritual and philosophical depths in it.

Course Outcomes:

On completion of the course learners will be able to:

- Perform the fundamentals and the items that they have learned.
- Will be able to further teach the items and also understand the intricacies in choreographing such items in future.

Course Contents:

UNIT	Description	Topics
1	Items – 2	1. Varnam – half
2	Items – 2	2. Varnam – other half
3	Items – 2	5. Thillana – 1
4	Nattuvangam	6. Nattuvangam for all the jathis and items learned in the semester

Course Code	Duration	Course Title		L	T	P	C
M18PA2041	20 Weeks	ITEMS – KUCHIPUDI (Javali, Padam) PRACTICAL – 2	HC	0	0	4	4

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the basics and fundamentals in the practical and performing aspects of the dance form that they are specializing.
- To teach students the items in dance and also the technical aspects of the items which include taalam, music, literature and the spiritual and philosophical depths in it.

Course Outcomes:

On completion of the course learners will be able to:

- Perform the fundamentals and the items that they have learned.
- Will be able to further teach the items and also understand the intricacies in choreographing such items in future.

Course Contents:

UNIT	Description	Topics
1	Items –1	1. Astapadi – 1
2	Items – 2	2. Javali – 1
3	Items – 3	3. Padam – 1
4	Nattuvangam	6. Nattuvangam for the items learned in the respective semester

Course Code	Duration	Course Title		L	T	P	C
M18PA2042	20 Weeks	ITEMS - BHARATHANATYAM (Ashtapadi, Javali, Padam) PRACTICAL-2	HC	0	0	4	4

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the basics and fundamentals in the practical and performing aspects of the dance form that they are specializing.
- To teach students the items in dance and also the technical aspects of the items which include taalam, music, literature and the spiritual and philosophical depths in it.

Course Outcomes:

On completion of the course learners will be able to:

- Perform the fundamentals and the items that they have learned.
- Will be able to further teach the items and also understand the intricacies in choreographing such items in future.

Course Contents:

UNIT	Description	Topics
1	Items – 1	1. Ashtapadi – 1
2	Items – 2	2. Javali – 1
3	Items – 3	3. Padam – 1
4	Nattuvangam	4. Nattuvangam for the items learned in the respective semester

Course Code	Duration	Course Title		L	T	P	C
M18PA2050	20 Weeks	SHLOKAS (Abhinaya Darpanam)	HC	4	0	0	4

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the shloka aspects from the textual traditions in Dance in both the practical and the theory concepts.
- To teach students the depth of the technicalities in dance through varied dance scriptures and make them adept in the recitation of the shlokas.

Course Outcomes:

On completion of the course learners will be able to:

- Recite the shlokas of all the technicalities of dance.
- To be able to enact the shlokas through the body movements for better understanding.

Course Contents:

UNIT	Description	Topics
1	Hasta Bhedas	1. Asamyuta Hastas 2. Samyuta Hastas
2	Viniyogas	3. Hasta viniyogas
3	Paada Bhedas	4. Paada Bhedas
4	Different Hasta Bhedas	5. Dasavatara 6. Devatha 7. Chaturvarna 8. Navagraha

Course Code	Duration	Course Title		L	T	P	C
M18PA2060	20 Weeks	MUSIC-2 (Theory and Practical)	HC	1	0	2	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the music aspects from the textual traditions in Dance in both the practical and the theory concepts.
- To teach students the depth of the technicalities in music through varied music scriptures and make them adept in the recitation of the songs in the Carnatic style of music.

Course Outcomes:

On completion of the course learners will be able to:

- Sing the technical aspects of Carnatic Music.
- Will be able to sing the songs that are taught as items in the practical papers of the respective semesters.

Course Contents:

UNIT	Description	Topics
1	Fundamentals – 2	1. Geetham and Varnam
2	Fundamentals – 2	2. Jathi Sollu 3. Jaathi Sollu
3	Fundamentals – 2	4. Yathis
4	Own Composition	5. Should be able to construct Jathis of their own and also notate them

Course Code	Duration	Course Title		L	T	P	C
M18PA2070	20 Weeks	SANSKRIT	HC	2	0	0	2

Course Objectives:

- To enable the dancers/artist of School of Performing Arts develop their basic understanding skills in Sanskrit.
- To inculcate the habit of reading and writing Sanskrit that would be helpful for their dance presentations and choreographies.

Course Outcomes:

On completion of the course learners will be able to:

- Speak clearly, confidently, comprehensibly and communicate with one or many listeners using Kannada language.
- Write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas, logically on the topic.

Course Contents:

UNIT	Description	Topics
1	Introduction	1. Sanskrit as language 2. Akshara mala 3. Transliteration
2	Fundamentals	4. Guninta Akshara 5. Samyukta akshara 6. Numbers from 1 to 100
3	Vyakarana	7. Grammar with Verbs or Dhatus 8. Shabdas for all genders ending with a , e , u
4	General Knowledge	Prominent names, Places and Current Affairs

Course Code	Duration	Course Title		L	T	P	C
M18PA2080	20 Weeks	MOOC/SWAYAM/ Edx / HARVARD ONLINE COURSES	HC	2	0	0	2

Students will have to compulsorily study ONE Online Course of TWO credits on the advice of the School any time during the period of the program being studied and obtain credits which will be counted in the Second Semester and entered in the Credit Card of respective student.

Course Code	Duration	Course Title		L	T	P	C
M18PA2090	20 Weeks	SKILL DEVELOPMENT (Designing and Multi Media)	HC	2	0	0	2

Students will have to compulsorily undergo ONE Skill Development training in Designing and Multi Media of TWO credits conducted either by the School of Performing Arts or by REVA University Skill Development Centre during Second Semester.

SEMESTER-III

Course Code	Duration	Course Title		L	T	P	C
M18PA3010	20 Weeks	AESTHETICS IN DANCE	HC	3	0	0	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts to gain knowledge in the History and the Development of Dance and its aesthetics.
- To be able to choreograph their own items including the right amount of technicalities and understanding them from the Sastra point of view.

Course Outcomes:

On completion of the course learners will be able to:

- Speak clearly, confidently, comprehensibly and communicate with the World the History and the aspects of the Dance and its aesthetics..
- To be able to read research materials and write their research papers from the vast amount of Cultural knowledge that is available.

Course Contents:

UNIT	DESCRIPTION	TOPICS
1	Rasa Theory - 1	1. Bharata's Rasa Theory
2	Rasa Theory – 2	2. Abhinava Gupta's Rasa theory 3. Bhoja's Rasa Theory
3	Sanchari	4. Concept of Sanchari related to Dance
4	Philosophy and Spirituality	5. Hinduism and its relationship to Dance 6. Spiritual aspects of dance and other arts.

Course Code	Duration	Course Title		L	T	P	C
M18PA3020	20 Weeks	RESEARCH METHODOLOGY	HC	3	0	0	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts to gain knowledge in the Research and its allied aspects related to Dance.

- To be able to deliver the theoretical aspects of Research that would help them in their Doctoral Thesis in future.

Course Outcomes:

On completion of the course learners will be able to:

- Speak clearly, confidently, comprehensibly and communicate with the World the Research aspects of dance.
- To be able to read research materials and write their research papers from the vast amount of Cultural knowledge that is available.

Course Contents:

UNIT	DESCRIPTION	TOPICS
1	Research Methodology: Foundations and Sources of data	1. Definitions 2. Literature Review 3. Primary Sources 4. Secondary Sources
2	Research Process	5. Selection of Subjects 6. Preparation of Synopsis 7. Research Work
3	Data Collection	8. Data Collection Methods - Observation - Experimentation - Survey 9. Tools for Data Collection - Questionnaire - Interview 10. Field Work 11. Data Processing and Analysis
4	Report Writing and Bibliography	12. Planning Report writing 13. Research Report Format 14. Organisation of Report and Report Writing 15. Footnotes and Bibliography - Reference Books and Journals - Supportive Materials - Audio Visual equipment - E-resources

Course Code	Duration	Course Title		L	T	P	C
M18PA3030	20 Weeks	ARTS MANAGEMENT	HC	3	0	0	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts to gain knowledge in the management and its allied aspects related to Dance.
- To be able to deliver the theoretical aspects of Marketing and Branding that would help them to emerge as holistic artists.

Course Outcomes:

On completion of the course learners will be able to:

- Speak clearly, confidently, comprehensibly and communicate with the World about themselves.
- To be able to apply for programmes, grants, scholarships and all the allied aspects related to dance and giving hands on experience.

Course Contents:

UNIT	DESCRIPTION	TOPICS
1	Arts Administration	1. Arts Administration 2. Audience development 3. Programme Planning
2	Budget Management	4. Budget Management 5. Fund Raising 6. Grantsmanship in Arts
3	Legal Aspects and Marketing	7. Arts Administration 8. Policies and Legal Aspects 9. Marketing Concepts 10. Advertisements and Public Relations
4	Dance Company Management	11. Dance Company Management in India 12. Dance Company Management abroad

Course Code	Duration	Course Title		L	T	P	C
M18PA3041	20 Weeks	ITEMS – KUCHIPUDI (Bhama Kalapam) PRACTICAL-1	HC	0	0	3	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the basics and fundamentals in the practical and performing aspects of the dance form that they are specializing.
- To teach students the items in dance and also the technical aspects of the items which include taalam, music, literature and the spiritual and philosophical depths in it.

Course Outcomes:

On completion of the course learners will be able to:

- Perform the fundamentals and the items that they have learned.
- Will be able to further teach the items and also understand the intricacies in choreographing such items in future.

Course Contents:

UNIT	Description	Topics
1	Bhama Kalapam	1. Poorvarangam 2. Jada Vrittantham 3. Pravesha Daruvu 4. Rave Madhavi 5. Samvadam -1
2	Bhama Kalapam	6. Siggayanoyamma 7. Madana Daruvu 8. Samvadam – 2 9. Perichina pattucheeralu
3	Bhama Kalapam	10. Vadamela Pove 11. Lekha 12. Shakunalu 13. Raajeevakshudu
4	Bhama Kalapam	14. Ennadu rani vadavu 15. Karpuragandhitho 16. Samvadam – 3 17. Bangaru Poola tho 18. Mangalam

Course Code	Duration	Course Title		L	T	P	C
M18PA3042	20 Weeks	ITEMS – BHARATHANATYAM (Varnam – Daru or Swarajathi Varnam) – PRACTICAL	HC	0	0	3	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the basics and fundamentals in the practical and performing aspects of the dance form that they are specializing.
- To teach students the items in dance and also the technical aspects of the items which include taalam, music, literature and the spiritual and philosophical depths in it.

Course Outcomes:

On completion of the course learners will be able to:

- Perform the fundamentals and the items that they have learned.
- Will be able to further teach the items and also understand the intricacies in choreographing such items in future.

Course Contents:

UNIT	Description	Topics
1	Items – 1	1. Varnam – 1/3
2	Items – 2	2. Varnam – 2/3
3	Items – 3	3. Varnam – 3/3
4	Nattuvangam	4. To do Nattuvangam for the item learned

Course Code	Duration	Course Title		L	T	P	C
M18PA3050	20 Weeks	INDIVIDUAL CHOREOGRAPHY PRACTICAL-2	HC	0	0	3	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the basics and fundamentals in the practical and performing aspects of the dance form that they are specializing.

- To teach students the items in dance and also the technical aspects of the items which include taalam, music, literature and the spiritual and philosophical depths in it.

Course Outcomes:

On completion of the course learners will be able to:

- Perform the fundamentals and the items that they have learned.
- Will be able to further teach the items and also understand the intricacies in choreographing such items in future.

Course Contents:

UNIT	Description	Topics
1	Selection	1. Selection of theme 2. Analysis and report
2	Music	3. Music for the theme 4. Choreography
3	Costumes and properties	5. Selection of costumes 6. Selection of Properties
4	Recitation	7. Recitation and Presentation

Course Code	Duration	Course Title		L	T	P	C
M18PA3060	20 Weeks	SLOKAS (Natya Sastra and Abhinaya Darpanam) – THEORY AND PRACTICAL	HC	1	0	2	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the shloka aspects from the textual traditions in Dance in both the practical and the theory concepts.
- To teach students the depth of the technicalities in dance through varied dance scriptures and make them adept in the recitation of the shlokas.

Course Outcomes:

On completion of the course learners will be able to:

- Recite the shlokas of all the technicalities of dance.
- To be able to enact the shlokas through the body movements for better understanding.

Course Contents:

UNIT	Description	Topics
1	Chari	1. Bhoumi Charis 2. Akasiki Charis
2	Mandala	3. Mandala Bhedas
3	Abhinaya	4. Mukhaja
4	Bhedas	5. Bhru 6. Drishti 7. Puta 8. Kapola 9. Adhara 10. Greeva

Course Code	Duration	Course Title		L	T	P	C
M18PA3070	20 Weeks	TELUGU	HC	2	0	0	2

Course Objectives:

- To enable the dancers/artist of School of Performing Arts develop their basic understanding skills in Telugu.
- To inculcate the habit of reading and writing Telugu that would be helpful for their dance presentations and choreographies.

Course Outcomes:

On completion of the course learners will be able to:

- Speak clearly, confidently, comprehensibly and communicate with one or many listeners using Telugu language.
- Write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas, logically on the topic.

Course Contents:

UNIT	Description	Topics
1	Introduction	1. Telugu as language 2. Akshara mala
2	Fundamentals	3. Guninta Akshara 4. Vothulu 5. Numbers from 1 to 100

3	2, 3, 4 lettered words	6. 2, 3, 4 lettered words
4	General Knowledge	Prominent names, Places and Current Affairs

Course Code	**Duration**	**Course Title**		**L**	**T**	**P**	**C**
M18PA3080	20 Weeks	SKILL DEVELOPMENT (Indian Classical Dance Make up)	HC	2	0	0	2

Students will have to compulsorily undergo ONE Skill Development training in Indian Classical Dance Make up of TWO credits conducted either by the School of Performing Arts during Third Semester.

SEMESTER-IV

Course Code	Duration	Course Title		L	T	P	C
M18PA4010	20 Weeks	DANCE WRITING AND BIOGRAPHIES	HC	3	0	0	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts to gain knowledge in the History and the Development of Dance and it's legends in a detailed way.
- To be able to choreograph their own items including the right amount of technicalities and understanding them from the Sastra point of view.

Course Outcomes:

On completion of the course learners will be able to:

- Speak clearly, confidently, comprehensibly and communicate with the World the History and the aspects of the Dance and its legends.
- To be able to write and understand about the legendary personalities and their works.

Course Contents:

UNIT	DESCRIPTION	TOPICS
1	Dance Criticism	1. Criticism 2. News paper articles
2	Essay writing	3. Theoretical writing 4. Essay writing
3	Western ballet	5. Origin of western ballet 6. Development of western ballet 7. South Indian dance Dramas
4	Biographies	8. Biographies of legendary Gurus and Performers

Course Code	Duration	Course Title		L	T	P	C
M18PA4020	20 Weeks	ASHTA NAYIKAS PRACTICAL - 1	HC	1	0	2	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the basics and fundamentals in the practical and performing aspects of the dance form that they are specializing.
- To teach students the items in dance and also the technical aspects of the items which include taalam, music, literature and the spiritual and philosophical depths in it.

Course Outcomes:

On completion of the course learners will be able to:

- Perform the fundamentals and the items that they have learned.
- Will be able to further teach the items and also understand the intricacies in choreographing such items in future.

Course Contents:

UNIT	Description	Topics
1	Nayikas	1. Study of Nayikas
2	Nayakas	2. Study of Nayakas
3	Rasa	3. Concept of rasa in Nayikas and nayakas
4	Choreography	4. Choreographing each Rasa with a concept and analysis.

Course Code	Duration	Course Title		L	T	P	C
M18PA4030	20 Weeks	NAVARASAS PRACTICAL - 2	HC	1	0	2	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the basics and fundamentals of the aspects of the Navarasas or the nine emotions.
- To teach students the different varieties and ways to express the navarasas and also enlighten them about the varied texts that discuss the navarasas.
- **Course Outcomes:**

On completion of the course learners will be able to:

- Perform the different aspects of Navarasas that would be useful for their presentations and performances.
- The students would also have a deep understanding about the Rasa Theory and the Aesthetics of Dance.

Course Contents:

UNIT	Description	Topics
1	Introduction to Navarasas	1. Introduction to Navarasas 2. Asta Rasas of Natya Sastra 3. Shanta Rasa
2	Major Rasas	1. Sringara and its varieties 2. Roudra and its varieties 3. Veera and its varieties 4. Bhibatsa and its varities
3	Minor Rasas	1. Hasya and its varieties 2. Karuna and its varieties 3. Bhaya and its varieties 4. Adbhuta and its varieties
4	Different texts on Navarasas	1. Abhinaya Darpana 2. Dasa roopaka and its rasas 3. Bhoja’s Sringara Prakasa 4. Mythology and Nava Rasas

Course Code	Duration	Course Title		L	T	P	C
M18PA4040	20 Weeks	NATTUVANGAM PRACTICAL - 3	HC	1	0	2	3

Course Objectives:

- To enable the dancers/artist of School of Performing Arts have a strong foundation in the basics and fundamentals in the practical and performing aspects of the dance form that they are specializing and Nattuvangam.

- To teach students the Nattuvangam in dance and also the technical aspects of the items which include taalam, music, literature and the spiritual and philosophical depths in it.

Course Outcomes:

On completion of the course learners will be able to:

- Perform the fundamentals and the items that they have learned with Nattuvangam
- Will be able to further teach the items and also understand the intricacies in choreographing such items in future.

Course Contents:

UNIT	Description	Topics
1	Concept of Nattuvangam	4. Understanding the concept of Nattuvangam
2	Jaathi	5. Jaathi 6. Jathi 7. Korvai
3	Taalam	5. System of taalam
4	Own Choreography	6. Creating own jathis and performing

Course Code	Duration	Course Title		L	T	P	C
M18PA4050	20 Weeks	GROUP CHOREOGRAPHY	HC	0	0	4	6

Course Code	Duration	Course Title		L	T	P	C
M18PA4060	20 Weeks	FIELD TRIP & DISSERTTION	HC	0	0	8	8

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 theprospective 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 invarious student clubs which helps in developing team culture, variety of job skills and overall personality.

The need of the hour in the field of performing arts is 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 Performing Arts 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

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1	Dr. Vasanth Kiran	Director	vasanthkiran@reva.edu.in	9886998990
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