REVA UNIVERSITY
Bengaluru, India

SCHOOL OF CIVIL ENGINEERING

B.Tech. in Civil Engineering

HANDBOOK

2017-21

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Rukmini Educational
Charitable Trust

www.reva.edu.in

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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. Kulkarni

Vice Chancellor,
REVA University

Director's Message

The B.Tech in Civil 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 Civil Engineering. There are ample number of courses providing knowledge in specialized areas of Structural Engineering, Water Resources Engineering, Transportation Engineering, Geotechnical Engineering, Surveying and Environmental Engineering etc. facilitating students to choose specialized areas of their interest. Adequate attention is given to provide students the basic concepts.

Civil 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 latest advanced subjects like Town Planning, Urban Transport Planning, Prestressed & Precast Structures, Solid Waste Management, Industrial Waste Water Treatment etc. Thus the Civil Engineering stream is designed to provide you with several options to choose from for your later years. The Indian government having plans to adopt make in India concept in this major is infrastructure development. Hence Infrastructure development sector offers lots of job opportunities for well qualified graduates.

The program is thus designed to expose students to various subjects having hand on applications in planning, design & construction, through outcome based teaching and learning process which emphasizes practical exposure rather than memorization. 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.

If you are interested in any one of the following, then Civil Engineering is the option you should consider.

- **Structural Engineering**- to analyze and design structures, to implement earthquake resisting structures, to maintain quality of construction, to design eco-friendly buildings etc.

- **Water Resources Engineering** - to solve the water for drinking, irrigation etc. To study ground water exploration and recharge.
- **Transportation Engineering**- to resolve the current traffic problems and plan for the future requirements of the society.
- **Environmental Engineering**- to assure and supply the quality drinking water for people and for industries. To protect environment form the air pollution, solid water management and waste water disposal.
- **Geotechnical Engineering**- To study and testing of soils to improve the safe bearing capacity of the soils so that the structure will be safe.

The benefits of choosing Civil Engineering are:

- Flexibility to choose various fields upon graduation.
- Opportunity to work on live problems.
- Opportunity to work on latest technologies.
- Opportunity for designers & planner to plan & design live projects.

I am sure the students choosing B Tech in Civil Engineering in REVA University will enjoy the curriculum, teaching and learning environment, the vast infrastructure and the experienced teachers involvement and guidance. The cirruculum caters to and has relevance to local, regional, national, global developmental needs. We will strive to provide all needed comfort and congenial environment for their studies. Maximum number of courses are integrated with cross cutting issues with relevant to professional ethics, Gender, human values, environment and Sustainability. I wish all students pleasant stay in REVA and grand success in their career.

Dr. Y. Ramalinga Reddy
Director
School of Civil Engineering

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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** (RECT) is a Public Charitable Trust, set up in 2002 with the objective of promoting, establishing and conducting academic activities in the fields of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology, among others. In furtherance of these objectives, the Trust has set up the REVA Group of Educational Institutions comprising of REVA Institute of Technology & Management (RITM), REVA Institute of Science and Management (RISM), REVA Institute of Management Studies (RIMS), REVA Institute of Education (RIE), REVA First Grade College (RFGC), REVA Independent PU College at Kattigenahalli, Ganganagar and Sanjaynagar and now REVA University. Through these institutions, the Trust seeks to fulfill its vision of providing world class education and create abundant opportunities for the youth of this nation to excel in the areas of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology.

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

The Rukmini Educational Charitable Trust drives with the main aim to help students who are in pursuit of quality education for life. REVA is today a family of ten institutions providing education from PU to Post Graduation and Research leading to PhD degrees. REVA has well qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 13,000 students study various courses across REVA's three campuses equipped with exemplary state-of-the-art infrastructure and conducive environment for the knowledge driven community.

ABOUT REVA UNIVERSITY

REVA University has been established under the REVA University Act, 2012 of Government of Karnataka and notified in Karnataka State Gazette No. 80 dated 27thFebruary, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

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

REVA consistently ranked as one of the top universities in various categories because of the diverse community of international students and its teaching excellence in both theoretical and technical education in the fields of Engineering, Management, Law, Science, Commerce, Arts, Performing Arts, and Research Studies. REVA offers 28 Undergraduate Programmes, 22 Full-time and 2 Part-time Postgraduate Programmes, 18 Ph. D Programmes, and other Certificate/ Diploma/Postgraduate Diploma Programmes in various disciplines.

The curriculum of each programme is designed with a keen eye for detail by giving emphasis on hands-on training, industry relevance, social significance, and practical applications. The University offers world-class facilities and education that meets global standards.

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

REVA University recognizing the fact that research, development and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology and other areas of study. The interdisciplinary-multidisciplinary research is given the top most priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano-Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nana Tribology, Fuel Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

The REVA University has also given utmost importance to develop the much required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) department with world class infrastructure, headed by a dynamic experienced Professor& Dean, and supported by well experienced Trainers, Counselors and Placement Officers.

The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognised as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal 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.

REVA organises various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVAMP conducted every year. The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions and variety of cultural events. Another important event is Shubha Vidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also recognised by distributing awards and prizes. The founders have also instituted medals and prizes for sports achievers every year. The physical education department conducts regular yoga class's everyday to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

Vision

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

Misson

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

Objectives

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

ABOUT SCHOOL OF CIVIL ENGINEERING

The School of Civil Engineering is headed by highly experienced Professor and is supported by well qualified faculty members. The school has the state-of-art class rooms and well equipped laboratories. It offers B.Tech and M.Tech programs in various specialized streams. The school also has research program leading to doctoral degree. The curriculum of both graduate and post graduate degree programs have been designed to bridge the gap between industry – academia and hence they are industry application oriented. The B.Tech program aims to prepare human resources to play a leading role in the competitive construction field and excel in their endeavors. The Master's Degree programs focus on research and design in the core and Computer Aided Structural Engineering & Transportation Engineering & Management to supplement and create a sustainable world and to enhance the global quality of life by adopting enhanced techniques of design and application. This is reflected in various core subjects offered within the program. Currently Civil Engineering teaching was limited to planning, analysis, design and execution of different types of infrastructure like buildings, roads, bridges, dams and power plants. However, due to increase of technological sophistication and demand for higher living standards geared up by economic growth and concerns about environmental impact have changed the scope of Civil Engineering. The challenges of today's Civil Engineering infrastructure are much more complex and interdependencies between resources.

- Even though there are a large number of institutions in the country which are producing Civil Engineers, there is acute shortage of quality Civil Engineers. The REVA UNIVERSITY would like to offer Civil Engineering Programme to produce quality engineers who are effective and efficient in problem solving and providing economical and sustainable infrastructural solutions.

VISION

"To produce young Engineers of caliber, who would be committed to their profession with ethics, will be able to contribute to Civil Engineering and allied fields in optimizing usage of resources globally making the world more eco-friendly to live in."

MISSION

- *To make the Department centre of excellence for training the undergraduate students.*
- *To promote involvement of staff and students in research and advanced training.*
- *To develop good understanding skills in student communities about Civil Engineering, ethical practices, automation design and society need centric teaching and learning and imparting value addition skills.*

BoS

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B Tech (Civil Engineering) Program

Programme Overview

- Civil Engineering is a professional engineering discipline that deals with the design, construction, and maintenance of the physical and naturally built environment, including works such as roads, bridges, canals, dams, airports, sewerage systems, pipelines, and railways. In the 18th century, the term civil engineering was coined to incorporate all things civilian as opposed to military engineering. The first engineering school, The National School of Bridges and Highways, France, was opened in 1747.

- The modern day civil engineering graduate should have wider knowledge of civil engineering- surveying grading design, drainage, pavement, water supply, sewer service, dams, electric and communications supply and preparations of construction plans. Civil engineers must possess technical knowledge of geotechnical engineering, structural engineering, environmental engineering, transportation engineering and construction engineering as applied to residential, commercial, and industrial and public works projects of all sizes and levels of construction. In addition, present day civil engineers should be able to use CAD/CAE and Virtual reality tools for design and visualization of complex civil engineering structures. If they possess knowledge of IoT and Artificial intelligence will be an added advantage for maintenance and monitoring of infrastructural projects.

- Employment of civil engineers is projected to grow 11 percent over the next ten years, faster than the average for all occupations. Government of India is investing on infrastructure development to rebuild, repair, and upgrade bridges, roads, levees, dams, airports, buildings, railways, metros and other structures.

- A growing population and urbanization means more buildings, new water systems, roads, waste treatment plants leading to increased demand for Civil Engineers.

- The work of civil engineers will be needed for renewable-energy projects. Thus, as these new projects gain approval, civil engineers will be further involved in overseeing the construction of structures such as wind farms and solar arrays.

- Prospects for Civil Engineers are expected to be good. They will be best for those with training in the latest software tools, particularly for computational design and simulation. Such tools allow engineers and designers to take a project from the conceptual phase till the end. Engineers who have experience or training in three-dimensional printing of concrete structures also will have better job prospects.

- **The School of Civil Engineering at REVA UNIVERSITY offers B. Tech., Civil Engineering –an undergraduate programme** to create motivated, innovative, creative and thinking graduates to fill the roles of civil engineers who can work on various infrastructure projects including construction of buildings.

- The B. Tech., in Civil Engineering curriculum developed by the faculty at the **School of Civil 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 infrastructure sector makes this programme unique.

Program Educational Objectives (PEO's)

The programme educational objectives of the Civil Engineering of REVA University is to prepare graduates

PEO-1	To have successful professional careers in construction industry, government, academia and military as innovative engineers.
PEO-2	To successfully solve engineering problems associated with planning, design & construction of civil engineering projects by executing construction works effectively either leading a team or as a team member
PEO-3	To continue to learn and advance their careers through activities such as participation in professional organizations, attainment of professional certification for life long learning and seeking higher education.
PEO-4	To be active members ready to serve the society locally and internationally and will take up entrpreneurship for the growth of economy and to generate employment.

Program Outcomes (POs)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals for the solution of complex problems in civil Engineering.

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

3. **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.

4. **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.

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

6**. 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.

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

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

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

10. **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.**

11. 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.

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

Programme Specific Outcomes (PSO)

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

- PSO1: Apply knowledge of Construction Engineering, Environmental Engineering, Geotechnical Engineering, Structural Engineering, Surveying, Transportation Engineering and Water Resources Engineering in real time.
- PSO2: Analyse a system, component or process in the knowledge areas of civil engineering in real time problems.
- PSO3: Design a system, component, or process in more than one areas of Civil Engineering.
- PSO4: Conduct investigations and address complex civil engineering problems; utilize and develop innovative tools and techniques that are appropriate in civil engineering discipline.

ADVISORY BOARD

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CBCS (CHOICE BASED CREDIT SYSTEM) AND CAGP (CONTINUOUS ASSESSMENT AND GRADING PATTERN) OF EDUCATION AND ITS ADVANTAGES

CBCS is a proven, advanced mode of learning in higher education. It facilitates students to have freedom in making their own choices for acquiring a Degree / Masters Degree program. It is more focused towards the student's choice in providing a wide range of modules available in a single campus across various disciplines offered by experts in the subjects. It leads to quality education with active teacher-student participation.

Studying under CBCS has following advantages:

- Students may undergo training in cross-disciplinary and multi-disciplinary subjects and acquire more focused and preferred knowledge.
- Students may get more skills from other subject(s) which are required for the career path in addition to their regular subject knowledge.
- Students may get ample opportunities to use the laboratories and gain practical exposure to the much needed modules available in other departments/schools for want of scientific inputs.
- Courses are conducted by subject experts identified on the basis of their experiences. Courses taught by such experts may provide in-depth information and clear understanding of the modules.
- Students may get an opportunity to study courses with other students of different programs and exchange their views and knowledge in a common class room.
- CBCS provides a cross-cultural learning environment.
- Students may benefit much from selecting the right options to successfully face the public service examinations like UPSC, KPSC, IES wherein the knowledge of additional subjects become mandatory for general or optional papers.
- Students are exposed to the culture of universal brotherhood during their campus life.
- Students are allowed to practice various methods of learning a subject.

Summary of REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Four Year Graduate Degree Programs, 2015

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 Core course. 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. O**pen 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 double duration norm, in one stretch to complete B Tech degree, including blank semesters, if any. Whenever a candidate opts for blank semester, he/she has to study the prevailing courses offered by the School when he/she resumes his/her studies.

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 5th week of the beginning of the semester;
- 2nd test for 15 marks at the end of the 10th week of the beginning of the semester; and
- 3rd test for 15 marks at the end of the 15th 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 of the course;
- For the 2nd test it shall be 2nd unit and 1st half of the 3rd unit;
- For the 3rd test the syllabus will be 2nd half of the 3rd unit and complete 4th unit.

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 18th and 19th 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
First Test	2^{nd} half of 5^{th} Week	1^{st} Unit	15	Consolidation of 1^{st} Unit
Allocation of Topics for Assignments / Seminars / Model making*	Beginning of 6^{th} Week	First unit and 1^{st} half of second unit		Instructional process and Continuous Assessment
Submission of Assignments / Conduct of Seminars / Presentation of Model Design*	8^{th} Week	First unit and 1^{st} half of second unit	5	Instructional process and Continuous Assessment
Second Test	2^{nd} half of 10^{th} Week	Second unit and 1^{st} half of third unit	15	Consolidation of 2^{nd} and 3^{rd} Unit
Allocation of Topics for Assignments / Seminars / Model making*	Beginning of 11^{th} Week	3^{rd} unit and 1^{st} half of 4^{th} unit		Instructional process and Continuous Assessment
Submission of Assignments / Conduct of Seminars / Presentation of Model Design*	13^{th} Week	3^{rd} unit and 1^{st} half of 4^{th} unit	5	Instructional process and Continuous Assessment
Third Test	2^{nd} half of 15^{th} Week	Second half of third unit and complete 4^{th} Unit	15	Consolidation of 2^{nd} half of 3^{rd} Unit and entire 4^{th} Unit
Semester end practical examination	16^{th} Week	Entire syllabus	60	Conduct of Semester - end Exams
Preparation for Semester–End Exam	16^{th} , 17^{th} &	Entire Syllabus		Revision and preparation for semester–end exam
Semester End Theory Examination	18^{th} Week & 19^{th} Week	Entire Syllabus	60	Evaluation and Tabulation
	End of 20^{th} 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 days 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 Practical

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 the mid-term test includes performance in the conduction of experiment and write up about the experiment.	10 marks
	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%)
Component– 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.

10.2 Provision to Carry Forward the Failed Subjects / Courses:

The student who has failed in a maximum of 4 courses in odd and even semesters together shall move to next semester of immediate succeeding year of study. And he / she shall appear for Semester End examination of failed courses of previous semesters concurrently with odd semester end examinations and / or even semester end examinations of current year of study. However, he / she shall have to clear all courses of both odd and even semesters of preceding year to register for next succeeding semester.

Examples:-

a. Student "A" has failed in 1 Course in First Semester and 3 Courses in Second Semester. He / she is eligible to seek admission for Third Semester and appear for Semester end examination of 1 failed Course of First Semester concurrently with Third Semester end examination. Likewise, he / she is eligible to appear for Semester end examination of 3 failed Courses of Second Semester concurrently with Fourth Semester end examination. However, he / she has to clear all the failed Courses of First and Second Semesters before seeking admission to Fifth Semester.

b. Student "B" has failed in 2 Courses in Third Semester and 2 Courses in Fourth Semester and has passed in all Courses of First and Second Semesters. He / she is eligible to seek admission to Fifth Semester and appear for Semester end examination of 2 failed Courses of Third Semester concurrently with Fifth Semester end examination. Likewise he / she is eligible to appear for Semester end examination of 2 failed Courses of Fourth Semester concurrently with Sixth Semester end examination. However, he / she is not eligible to seek admission to Seventh Semester unless he / she passes in all the failed courses of Third and Fourth Semesters.

c. Student "C" has failed in 4 Courses in Fifth Semester but has cleared all the courses in Sixth Semester. He / She has also passed all the courses of First to Fourth Semesters. Student "C" is eligible to seek admission for Seventh Semester and appear for Semester end examination of 4 failed Courses of Fifth Semester concurrently with Seventh Semester end examination. However, he / she has to pass all the failed courses of Fifth Semester along with Seventh and Eighth Semesters courses to earn B Tech Degree.

d. Student “D” passed in 1to 4 semesters, but failed in 3 courses of 5th Semester and in 1 course of 6th Semester. He / She has also passed all the courses of First to Fourth Semesters. Student “D” is also eligible to seek admission for 7th Semester and appear for Semester end examination of 3 failed courses of 5th Semester concurrently with 7th Semester end examination and one failed course of 6th Semester concurrently with 8th Semester end examination. However, he / she has to pass all the 3 failed courses of Fifth Semester and 1 course Sixth Semester along with Seventh and Eighth Semester courses to earn B Tech Degree.

10.3. Re-Registration and Re-Admission:

a) In case a candidate’s class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University, such a candidate is considered as dropped the semester and is not allowed to appear for end semester examination 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.

11. Attendance Requirement:

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

11.2. 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.

11.3. 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.

11.4. 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).

11.5. 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.

12. Grade Card and Grade Point

12.1. 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).

12.2. 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).

12.3. 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**

12.4. 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.

Illustration:
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

12.5. 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

13. **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.

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

List of Codes for Programs and Disciplines / Branch of Study

Program Code	Title of the Program	Discipline Code	Name of the Discipline / Branch of Study
BA	Bachelor of Arts	AE	Advanced Embedded Systems
BB	BBM (Bachelor of Business	AI	Advanced Information Technology
BC	B.Com (Bachelor of Commerce)	AP	Advanced Power Electronics
BR	B. Arch (Bachelor of Architecture)	CA	Computer Aided Structural Engineering
BS	B Sc, BS (Bachelor of Science)	CE	Civil Engineering
BT	B. Tech (Bachelor of Technology)	CH	Chemistry
BP	Bachelor of Computer Applications	CO	Commerce
BL	LLB (Bachelor of Law)	CS	Computer Science and Engineering /
MA	Master of Arts	DE	Data Engineering and Cloud Computing
MB	MBA (Master of Business Administration)	EC	Electronics and Communication Engineering
MC	M.Com (Master of Commerce)	EN	English
MS	M. Sc / MS (Master of Science)	MD	Machine Design and Dynamics
MT	M Tech (Master of Technology)	ME	Mechanical Engineering
MC	Master of Computer Applications	EE	Electrical & Electronics Engineering

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3	PSO4
BTEM 15F1 100	CO1	3	3	2	1	2	1							3	1	1	1
	CO2	3	3	2	2	2	2							3	1	1	1
	CO3	3	2	2	2	1	1							3	1	1	1
	CO4	3	3	2	2	1	1							3	2	1	1
BTEC 15F1 200	CO1	3	2	3	1	1	3	-	-	-	-	-	2	3			
	CO2	3	3	2	2	1	1	-	-	-	-	-	2	3			
	CO3	3	3	-	-	1	1	-	-	-	-	-	-	3			
	CO4	3	2	1	1	1	-	-	-	-	-	-	1	3			
BTBE 15F1 300	CO1	3	3	3	3	2								1	1	1	1
	CO2	3	3	3	3	3									1	2	
	CO3	3	2	3	3	3										1	1
	CO4	3	2	3	3	2										1	1
BTCC 15F1 400	CO1	3	3	2	3	3	-	1	-	-	-	-	3	3	3	3	3
	CO2	3	2	2	3	2	-	-	-	-	-	-	3	3	3	3	3
	CO3	2	3	2	1	2	-	2	-	-	-	-	3	3	3	3	3
	CO4	3	2	1	2	2	-	2	-	-	-	-	3	3	3	3	3
BTES 15F1 500	CO1						3	2		3	3		3				
	CO2						3	3		3	3		3				
	CO3						3	2		3	2		3				
	CO4						3	3		3	3		3				

BTTE 15F1 600	CO1	2	1	2		1	1			2	1	2	2	2	2	2	2
	CO2	2	1	2		1	1			2	1	2	2	2	2	2	2
	CO3	2	1	2		1	1			2	1	1	2	2	2	2	2
	CO4	2	1	2		1	1			2	1	2	2	2	2	2	2
BTED 15F1 700	CO1	3	2	3	2									3	3	3	3
	CO2	2	2		2								1	3	3	3	3
	CO3	3	3	2	3	1								3	3	3	3
	CO4	2	2	3	3		2					1	2	3	3	3	3
BTCL 15F1 800	CO1	2	2	2		-	-	-	-	-	-	-	-	3	2	1	2
	CO2	2	3	1		1	-	-	-	-	-	-	-	3	2	1	2
	CO3	2	2	1		1	1	-	-	-	-	-	-	3	2	1	2
BTCL 15F1 900																	
	CO1	2	2	2		-	-	-	-	-	-	-	-	3	2	1	2
	CO2	2	3	1		1	-	-	-	-	-	-	-	3	2	1	2
	CO3	2	2	1		1	1	-	-	-	-	-	-	3	2	1	2
BTEP 15F2 100	CO4	2	2	1		1	-	-	-	-	-	-	-	3	2	1	2
	CO1	3	2	2	1	1	1							3	1	1	1
	CO2	3	3	2	1	2	1							3	1	1	1
	CO3	3	3	2	2	1	1							3	1	1	1
	CO4	3	3	2	1	2	1							3	2	1	1
	CO1	3	3		1									3	3	3	3
	CO2	3	2	1										3	3	3	3

BTEP 15F2 200	CO3	3	2					1						3	3	3	3
BTCV 15F2 300	CO1	3	3	2	1		2	1				1	3	3	2	2	3
	CO2	3	3	3	1		1					1	2	3	3	2	2
	CO3	3	3	2	1		1	1				1	2	3	3	2	2
	CO4	3	3	1	1		2	1				1	3	3	2	2	1
BTCV 15F2 400	CO1	3	3	2	1		2	1				1	3	3	2	2	3
	CO2	3	3	3	1		1					1	2	3	3	2	2
	CO3	3	3	2	1		1	1				1	2	3	3	2	2
	CO4	3	3	1	1		2	1				1	3	3	2	2	1
BTEE 15F2 500	CO1	3	2	2	2	-	1	-	-	-	-	-	1	3			
	CO2	3	3	1	2	1	1	-	-	-	-	-	-	3			
	CO3	3	2	2	1	1	1	-	-	-	-	-	-	3			
	CO4	3	2	2	2	1	1	-	-	-	-	-	1	3			
BTIC1 5F26 00	CO1						2		3				2	-	-	-	-
	CO2								3		3		2	-	-	-	-
	CO3	2					2		3		2		3	-	-	-	-
	CO4	2					2		3				2	-	-	-	-
BTCE 15F2 700	CO1						3	2		3	3		3				
	CO2						3	3		3	3		3				
	CO3						3	2		3	2		3				
	CO4						3	3		3	3		3				
	CO1	3	3		1									3	3	3	3
	CO2	3	2	1										3	3	3	3

BTEP 15F2 800	CO3	3	2					1						3	3	3	3
	CO4	3	2					1						3	3	3	3
BTEW 15F2 900	CO1	3	2	2	2		1						1	3			
	CO2	3	3	1	2		1							3			
	CO3	3	2	2	1		1							3			
	CO4	3	2	2	2		1						1	3			
BTCE 15F3 100	CO1	3	3	2	2	1	1							3	1	1	1
	CO2	3	3	2	2	1	1							3	1	1	1
	CO3	3	2	1	3	2	1							3	1	1	1
	CO4	3	2	2	2	2	1							3	2	1	1
BTCE 15F3 200	CO1	3	1	2	1					2	2		2	3	1	2	2
	CO2	3	1	2	2					2	2		3	3	1	2	2
	CO3	3	2	3	1					2	2		2	3	1	2	2
	CO4	3	2	3	1					2	2		3	3	1	2	2
BTCE 15F3 300	CO1	3	1	2	1					2	2		2	3	1	2	2
	CO2	3	1	2	2					2	2		3	3	1	2	2
	CO3	3	2	3	1					2	2		2	3	1	2	2
	CO4	3	2	3	1					2	2		3	3	1	2	2
BTCE 15F3 400	CO1	3	3	2	3	3	-	-	-	2	-	-	3	3	3	3	3
	CO2	3	3	2	3	-	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	3	2	1	-	-	-	-	-	-	-	3	3	3	3	3
	CO4	3	3	1	2	-	-	-	-	2	-	-	3	3	3	3	3
	CO1	3	3	1	1	1	2	1		1	2		3	3	3	3	2

BTCE 15F3 500	CO2	3	3	1	2		2	1		1	2		3	3	3	3	2
	CO3	3	3	2	2	2	2	1		1	2		3	3	3	3	2
	CO4	3	3	2	2	2	2	1		1	2		3	3	3	3	2
BTCE 15F3 600	CO1	3	3	2	3	3	-	3					3	3	3	3	3
	CO2	3	3	2	3	2	-	3					3	3	3	3	3
	CO3	3	3	2	2	2	-	2					3	3	3	3	3
	CO4	3	3	2	2	2	-	2					3	3	3	3	3
BTCE 15F3 700	CO1	3	3	2	1	1	1			1	2	2	2	3	2	2	2
	CO2	3	2	1	2	1	2			1	2	3	2	2	3	2	2
	CO3	3	2	1	2	1	2			1	2	3	2	2	3	2	2
	CO4	3	2	1	2	1	2			1	2	3	2	2	3	2	2
BTCE 15F3 800	CO1	3	3	2	-	-	-	-	-	2	-	-	3	3	3	3	3
	CO2	3	3	2	-	-	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	3	3	2	-	-	-	-	2	-	-	3	3	3	3	3
	CO4	3	3	3	2	-	-	-	-	2	-	-	3	3	3	3	3
BTCE 15F4 100	CO1	3	3	1										3	2	1	1
	CO2	3	2	1										3	1	1	1
	CO3	3	3	2	3									3	3	3	2
	CO4	3	3	3	2									3	3	3	1
BTCE 15F4 200	CO1	3	3	2	3	3	-	-	-	2	-	-	3	3	3	3	3
	CO2	3	3	2	3	-	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	3	2	1	-	-	-	-	-	-	-	3	3	3	3	3
	CO4	3	3	1	2	-	-	-	-	2	-	-	3	3	3	3	3
	CO1	3	2	2						2			3	3	3	3	3

BTCE 15F4 300	CO2	3	2	3	2					2			3	3	3	3	3
	CO3	3	2	3	2					2			3	3	3	3	3
	CO4	3	2	3	1					2			3	3	3	3	3
BTCE 15F4 400	CO1	3	3	2	3	3				2			3	3	3	3	3
	CO2	3	3	2	3	2				2			3	3	3	3	3
	CO3	3	3	2	1	2		2		2			3	3	3	3	3
	CO4	3	3	1	2	2		2		2			3	3	3	3	3
BTCE 15F4 500	CO1	2	3	2	1		1	2	1	2	1	1	2	3	3	2	1
	CO2	3	3	3	2		1	2	1	2	1	1	2	3	3	2	1
	CO3	3	3	3	3		1	2	1	2		1	2	3	3	2	1
	CO4	3	3	3	3	2	1	3	1	2	2	2	2	3	3	2	1
BTCE 15F4 600	CO1	3	3	2	3	3		3					3	3	3	3	3
	CO2	3	3	2	3	2		3					3	3	3	3	3
	CO3	3	3	2	2	2		2					3	3	3	3	3
	CO4	3	3	2	2	2		2					3	3	3	3	3
BTCE 17F4 700	CO1	3	3	2	-	-	-	-	-	2	-	-	3	3	3	3	3
	CO2	3	3	2	-	-	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	3	3	2	-	-	-	-	2	-	-	3	3	3	3	3
	CO4	3	3	3	2	-	-	-	-	2	-	-	3	3	3	3	3
BTCE 15F4 800	CO1	3	3	2	-	-	-	-	-	2	-	-	3	2	2	3	3
	CO2	3	3	2	-	-	-	-	-	2	-	-	3	2	2	3	3
	CO3	2	2	2	2	-	-	-	-	2	-	-	2	2	2	2	2
	CO4	2	2	2	2	-	-	-	-	2	-	-	2	2	2	2	2

BTCE 15F5 100	CO1	3	2		3		2	2					2	3	1		
	CO2	3	3	3	2	3	2	2	2	1	2	1	2	3	3	3	3
	CO3	3	3	3	2	3	2	2	2	1	2	1	2	3	3	3	3
	CO4	3	3	3	2	3	2	2	2	1	2	1	2	3	3	3	3
BTCE 15F5 200	CO1	3	3	2	3	3	-	3	-	-	-	-	3	3	3	3	3
	CO2	3	2	2	3	3	-	3	-	-	-	-	3	3	3	3	3
	CO3	1	3	2	2	3	-	3	-	-	-	-	3	3	3	3	3
	CO4	1	3	2	2	2	-	2	-	-	-	-	3	3	3	3	3
BTCE 15F5 300	CO1	3	3				2	3	3	3	3		1	3	3	2	3
	CO2	3	3	3	2	1	2	2	3	2	2			3	2	3	3
	CO3	3	3	3	3		2	3	3	3	3	1	2	3	3	2	2
	CO4	3			3	3	3	3	2	2	3		2	3	3		1
BTCE 15F5 400	CO1	3		2		2	2	3					1	3	2	1	1
	CO2	2	3	1	2		2		2	1		1		2	3	3	2
	CO3	1	1	3	2	3	3	3			1	2	2	3	2	2	1
	CO4	3	2	2	1		2		1		2	3		2	3	3	2
BTCE 15F5 500	CO1	3	3	1	3	2	2	1			2			3	3	3	2
	CO2	3	2	1	3		2	1			2			3	3	3	2
	CO3	3	2	3	3		2	1			2			3	3	3	1
	CO4	3	2	3	3		2	1			2			3	3	3	2
BTCE 15F5 600	CO1	3	3	1		2	2	1					2	3	3		2
	CO2	3	3	1										3	3		
	CO3	3	3	1		3	2						2	3	3		3

	CO4	3	3	1		3	2						2	3	3		3
BCE15F5710	CO 1					3	2	3	2	2		2	2	3	1	1	3
	CO 2	2				2	2	3	1	1		1	2	3	2	1	3
	CO 3	2		2	1	1	1	3	1	1			2	3	2	1	3
	CO 4	3	1		1	1		3	2	1	1		3	3	2	1	3
BTCE15F5720	CO1	3	2	2	1	-	-	-	-	-	-	-	-	3	3	1	2
	CO2	3	3	1	2	1	-	-	-	-	-	-	-	3	3	1	2
	CO3	2	2	-	-	1	1	-	-	-	-	-	-	3	3	1	2
	CO4	2	2	-	1	1	-	-	-	-	-	-	-	3	3	1	2
BTCE15F5730	CO1	3	1	1	2	3				2			3	3	3	3	3
	CO2	3	3	2	3	2				2			3	3	3	3	3
	CO3	3	3	2	1					1			3	3	3	3	3
	CO4	3	3	1	2	3	2	3		2			3	3	3	3	3
BTCE15F5740	CO1	3	1	1	2	3				2			3	3	3	3	3
	CO2	3	3	2	3	2				2			3	3	3	3	3
	CO3	3	3	2	1					1			3	3	3	3	3
	CO4	3	3	1	2	3	2	3		2			3	3	3	3	3
BTCE15F5750	CO1	3					3		2		2		2	3			1
	CO2	3	3			2		2	2	3	3	1		3	3		1
	CO3	3	3		2	2	3	1		3	1	2		3	3	1	2
	CO4	3	3		2	2	1	2	3		3		2	3			2
	CO1	3	2	2						2			3	3	3	3	3
	CO2	3	2	3	2					2			3	3	3	3	3

BTCE 15F4 300	CO3	3	2	3	2					2			3	3	3	3	3
	CO4	3	2	3	1					2			3	3	3	3	3
BTCE 15F5 900	CO1	3	3	1	1	1	2	1	-	1	2	-	2	3	2	2	2
	CO2	3	2	1	2	1	2	1	-	1	2	-	2	3	2	2	2
	CO3	3	2	2	3	1	2	1	-	1	2	-	2	3	2	2	1
BTCE 15F5 300	CO1	3	3				2	3	3	3	3		1	3	3	2	3
	CO2	3	3	3	2	1	2	2	3	2	2			3	2	3	3
	CO3	3	3	3	3		2	3	3	3	3	1	2	3	3	2	2
	CO4	3			3	3	3	3	2	2	3		2	3	3		1
BTCE 15F6 200	CO1	3	3	1	3	2	2	1			2			3	3	3	2
	CO2	3	2	1	3		2	1			2			3	3	3	2
	CO3	3	2	3	3		2	1			2			3	3	3	1
	CO4	3	2	3	3		2	1			2			3	3	3	2
BTCE 15F6 300	CO1	3	3	1	3	2	2	1			2			3	3	3	2
	CO2	3	2	1	3		2	1			2			3	3	3	2
	CO3	3	2	3	3		2	1			2			3	3	3	1
	CO4	3	2	3	3		2	1			2			3	3	3	2
BTCE 15F6 400	CO1	1	2	3		1		2	1	2				3	3	2	3
	CO2	1	2	3		1			1	2				3	3	3	2
	CO3	3	1	3		1				1				3	3	3	1
	CO4	3	1	3		1		1		1				3	3	3	2
	CO1	3	2	2	-	-	-	-	-	2	-	-	3	3	3	3	3

BTCE 15F6 510	CO2	3	2	3	2	-	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	2	3	2	-	-	-	-	2	-	-	3	3	3	3	3
	CO4	3	2	3	1	-	-	-	-	2	-	-	3	3	3	3	3
BTCE 15F6 520	CO1	3	2	2	-	-	-	-	-	2	-	-	3	3	3	3	3
	CO2	3	2	3	2	-	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	2	3	2	-	-	-	-	2	-	-	3	3	3	3	3
	CO4	3	2	3	1	-	-	-	-	2	-	-	3	3	3	3	3
BTCE 15F6 610	CO1	3	2	3	2		2	1	2		3	2		3	3		3
	CO2	3	2	2	3	3	2	3	1	2	3	1	2	3	3	1	3
	CO3	3	3	3	1	3	1	1		1	2	3	2	3	3	1	3
	CO4	2	3	3	2	3	2	3	2	1	1	1	2	3	3	3	3
BTCE 15F6 620	CO1	2	3	1										2	3		
	CO2		2	2										3		1	2
	CO3	1	2					1						2		1	
	CO4	1	2	1										2			1
BTCE 15F6 630	CO1	3	1	1	2					1				3	3	3	3
	CO2	2	2	2	1		1				1		1	3	3	3	3
	C03	3	3	2	2			1			1	1		3	3	3	3
	CO4	3	3	2	2			1			1	1		3	3	3	3
BTCE 15F6 640	CO1	3	1	1	2					1				3	3	3	3
	CO2	2	2	2	1		1				1		1	3	3	3	3
	C03	3	3	2	2			1			1	1		3	3	3	3
	CO4	3	3	2	2			1			1	1		3	3	3	3

BTCE 15F6 650	CO1	3	3	2	3	3		3					3	3	3	3	3
	CO2	3	3	2	3	2		3					3	3	3	3	3
	CO3	3	3	2	2	2		2					3	3	3	3	3
	CO4	3	3	2	2	2		2					3	3	3	3	3
BTCE 15F6 700	CO1	1	2	3				2	1					3	3	2	3
	CO2	1	2	3					1					3	3	3	2
	CO3	3	2											3	3	3	1
	CO4	3	2					1						3	3	3	2
BTCE 15F6 800	CO1	3	3	2	3	3	-	3	-	-	-	-	3	3	3	3	3
	CO2	3	3	2	3	2	-	3	-	-	-	-	3	3	3	3	3
	CO3	3	3	2	2	2	-	2	-	-	-	-	3	3	3	3	3
	CO4	3	3	2	2	2	-	2	-	-	-	-	3	3	3	3	3
BTCE 15F7 100	CO1	3	1	1	2					1				3	3	3	3
	CO2	2	2	2	1		1				1		1	3	3	3	3
	C03	3	3	2	2			1			1	1		3	3	3	3
	CO4	3	3	2	2			1			1	1		3	3	3	3
BTCE 15F7 210	CO1	2	1	1			2	3	1	1	1		2	3	3	2	1
	CO2	3	3	3			2	3	1	1	1		2	3	3	2	1
	CO3	3	3	3	1		2	3	1	1	1		2	3	3	3	1
	CO4	2	3	3	1		2	3	1	1	1		2	3	3	3	1
BTCE 15F7 310	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3
	CO2	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO3	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3

	CO4	3	1	2	1	3	1	2	1			3	3	3	3	3	3
BTCE 15F7 320	CO1	3	3	1	3	2	2	1			2			3	3	3	2
	CO2	3	2	1	3		2	1			2			3	3	3	2
	CO3	3	2	3	3		2	1			2			3	3	3	1
	CO4	3	2	3	3		2	1			2			3	3	3	2
BTCE 15F7 410	CO 1					3	2	3	2	2		2	2	3	1	1	3
	CO 2	2				2	2	3	1	1		1	2	3	2	1	3
	CO 3	2		2	1	1	1	3	1	1			2	3	2	1	3
	CO 4	3	1		1	1		3	2	1	1		3	3	2	1	3
BTCE 15F7 420	CO1	3	3	3	1								3	3	3	3	3
	CO2	3	2	3	2								3	3	3	3	3
	CO3	3	2	3	2								3	3	3	3	3
	CO4	3	2	3	2			1					3	3	3	3	3
BTCE 15F7 430	CO1	3	3	3	1								3	3	3	3	3
	CO2	3	2	3	2								3	3	3	3	3
	CO3	3	2	3	2								3	3	3	3	3
	CO4	3	2	3	2			1					3	3	3	3	3
BTCE 15F7 440	CO1	3	3	2	3	3	-	3	-	-	-	-	3	3	3	3	3
	CO2	3	2	2	3	3	-	3	-	-	-	-	3	3	3	3	3
	CO3	1	3	2	2	3	-	3	-	-	-	-	3	3	3	3	3
	CO4	1	3	2	2	2	-	2	-	-	-	-	3	3	3	3	3
	CO1	3	3	3	2						1		1	3	2	3	2
	CO2	3	3	3	2			2		3	3			3	3	3	2

BTCE 15F7 450	CO3	3	3	2	2		1			2	1			3	3	3	2
	CO4	3	3			2					2	3	2	3	3		1
BTCE 15F7 510	CO1	1	1	1		1		2	1	2				3	3	2	3
	CO2	1	2	3		1			1	2				3	3	3	2
	CO3	3	3	3	1	1		1		1				3	3	3	1
	CO4	3	2	3	1	1		1		1				3	3	3	2
BTCE 15F7 520	CO1	3	3	1		2	2	1					2	3	3		2
	CO2	3	3	1										3	3		
	CO3	3	3	1		3	2						2	3	3		3
	CO4	3	3	1		3	2						2	3	3		3
BTCE 15F7 530	CO1	3	3	1		2	2	1					2	3	3		2
	CO2	3	3	1										3	3		
	CO3	3	3	1		3	2						2	3	3		3
	CO4	3	3	1		3	2						2	3	3		3
BTCE 15F7 540	CO1	3	3	2	3	3	-	-	-	2	-	-	3	3	3	3	3
	CO2	3	3	2	3	2	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	3	2	1	2	-	2	-	2	-	-	3	3	3	3	3
	CO4	3	3	1	2	2	-	2	-	2	-	-	3	3	3	3	3
BTCE 15F7 550	CO1	3	3	2	3	3	-	-	-	2	-	-	3	3	3	3	3
	CO2	3	3	2	3	2	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	3	2	1	2	-	2	-	2	-	-	3	3	3	3	3

BTCE 15F7 800	CO4	3	3	1	2	2	-	2	-	2	-	-	3	3	3	3	3
	CO1	1	2	3				2	1	1				3	3	2	3
	CO2	1	2	3					1					3	3	3	2
	CO3	3	2	3										3	3	3	1
BTCE 15F7 900	CO4	3	2	-	2			1						3	3	3	2
	CO1	3	3	3	3	3							3	3	3	3	3
	Co2	3	3	3	3	3							3	3	3	3	3
	Co3	3	3	3	3	3		3					3	3	3	3	3
BTCE 15F8 100 / BTCE 15F8 200 BTCE 15F8 310	CO4	3	3	3	3	3		3					3	3	3	3	3
	CO	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	3	3											3	3			3
	3	3	1										3	3			3
BTCE 15F8 320	3	3	2			1					1		3	3		1	3
	2	2	1	2	3	2	1	2	1	1		2	3	3	3	2	2
	CO1	2				2		3				2		3	2	1	2
	CO2	2	2	1		2		2						3	2	1	2
BTCE 15F8 330	CO3	2				3		2						3	3	3	1
	CO4	2				3		1						3	3	3	2
	CO1	3	3	2	3	3							3	3	3	3	3
	CO2	3	3	2	3	2							3	3	3	3	3

BTCE 15F8 340	CO3	3	3	2	1	2		2					3	3	3	3	3
	CO4	3	3	1	2	2		2					3	3	3	3	3
	CO1	3	3	3	2						1		1	3	2	3	2
	CO2	3	3	3	2			2		3	3			3	3	3	2
BTCE 15F8 410	CO3	3	3	2	2		1			2	1			3	3	3	2
	CO4	3	3			2					2	3	2	3	3		1
	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3
	CO2	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
BTCE 15F8 420	CO3	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO4	3	1	2	1	3	1	2	1			3	3	3	3	3	3
	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3
	CO2	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
BTCE 15F8 510	CO3	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO4	3	1	2	1	3	1	2	1			3	3	3	3	3	3
	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3
	CO2	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
BTCE 15F8 520	CO3	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO4	3	1	2	1	3	1	2	1			3	3	3	3	3	3
	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3
	CO2	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO3	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO4	3	1	2	1	3	1	2	1			3	3	3	3	3	3
	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3

BTCE 15F8 530	CO2	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
BTCE 15F8 530	CO3	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO4	3	1	2	1	3	1	2	1			3	3	3	3	3	3
	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3
BTCE 15F8 540	CO2	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO3	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO4	3	1	2	1	3	1	2	1			3	3	3	3	3	3
	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3

Mapping of PEOS with Respect to POs & PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
PEO1	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO2	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO3	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO4	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

B. Tech in Civil Engineering
Scheme of Instructions

Sl. No.	Course Code	Course Title	Types of course HC/ SC/OE	Credit Pattern and Value				Weekly Contact Hours	Teaching School/Dept.
				L	T	P	C		
First Semester: CHEMISTRY CYCLE									
1	BTEM15F1100	Engineering Mathematics – I	HC	3	1	0	4	5	Mathematics
2	BTEC15F1200	Engineering Chemistry	HC	2	1	0	3	4	Chemistry
3	BTBE15F1300	Basic Electronics Engineering	HC	2	1	0	3	4	Electronics
4	BTCC15F1400	Computer Concepts & C Programming	HC	2	1	0	3	4	CSE
5	BTES15F1500	Environmental Sciences	FC	1	1	0	2	3	Civil
6	BTTC15F1600	Technical Communication and Documentation	FC	1	1	0	2	3	Humanities
7	BTED15F1700	Computer Aided Engineering Drawing	HC	2	0	2	4	8	Mechanical
8	BTCL15F1800	Chemistry Lab	HC	0	0	2	2	3	Chemistry
9	BTCP15F1900	Computer Programming Lab	HC	0	0	2	2	3	CSE
Total Credits for the First Semester:							25	35	
Second Semester: Chemistry Cycle									
1	BTEM15F2100	Engineering Mathematics – II	HC	3	1	0	4	5	Mathematics
2	BTEP15F2200	Engineering Physics	HC	2	1	0	3	4	Physics
3	BTCV15F2300	Elements of Civil Engineering	HC	2	1	0	3	4	Civil
4	BTME15F2400	Elements of Mechanical Engineering	HC	2	1	0	3	4	Mechanical

5	BTEE15F2500	Basic Electrical Engineering	HC	2	1	0	3	4	Electrical
6	BTIC15F2600	Indian Constitution and Professional Ethics	FC	1	1	0	2	3	Humanities
7	BTCE15F2700	Communicative English	FC	1	1	0	2	3	Humanities
8	BTPL15F2800	Physics Lab	HC	0	0	2	2	3	Physics
9	BTEW15F2900	Basic Electrical Engineering lab and Workshop Practice	HC	0	0	2	2	3	Electrical and Mechanical
Total Credits for the Second Semester:							**24**	**33**	

III SEMESTER

Sl. No	**Course Code**	**Title of the Course**	**HC/FC/SC/OE**	**Pre requisite**	**Credit Pattern & Credit Value**				**Contact Hours / Week**	**Teaching School/Dept.**
					L	**T**	**P**	**Total**		
1	BTCE15F3100	Engineering mathematics-III	HC	BTEM15F1100	3	1	0	4	5	Mathematics
2	BTCE15F3200	Building Materials & Construction Technology	HC	-	2	1	0	3	4	Civil
3	BTCE15F3300	Engineering Earth Science	HC	-	2	1	0	3	4	Civil
4	BTCE15F3400	Surveying	HC	-	2	1	0	3	4	Civil

5	BTCE15F3500	Strength of Materials	HC	BTCV15F2300	3	1	0	3	5	Civil
6	BTCE15F3600	Fluid Mechanics	HC	BTCV15F2300	2	1	0	3	4	Civil
7	BTCE15F3700	Basic Materials Testing Lab	HC	BTCE15F3200	1	0	1	2	3	Civil
8	BTCE15F3800	Surveying Practice Lab	HC	BTCE15F3400	1	0	1	2	3	Civil
Total Credits for the Third Semester								**24**	**31**	

IV SEMESTER

Sl. No	Course Code	Title of the Course	HC/ FC/ SC/ OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours / Week	Teaching School/Dept.
					L	T	P	Total		
1	BTCE15F4100	Concrete Technology & Alternative Building Materials	HC	BTCE15F3200	2	1	0	3	4	Civil
2	BTCE15F4200	Applied Surveying & GIS	HC	BTCE15F3400	2	1	0	3	4	Civil
3	BTCE15F4300	Building Planning & Drawing	HC	BTCE15F3200	1	2	0	3	5	Civil
4	BTCE15F4400	Water Supply Engineering & Introduction to EIA	HC	-	2	1	0	3	4	Civil
5	BTCE15F4500	Basic Structural Analysis	HC	BTCE15F3500	3	1	0	4	5	Civil
6	BTCE15F4600	Hydraulic Machines	HC	BTCE15F3600	3	1	0	4	5	Civil
7	BTCE15F4700	Advanced Surveying Lab	HC	BTCE15F4200	1	0	1	2	3	Civil
8	BTCE15F4800	Engineering Earth Science Lab	HC	BTCE15F3300	1	0	1	2	3	Civil
Total Credits for the Fourth Semester								**24**	**34**	

V SEMESTER

Sl. No	Course Code	Title of the Course	HC/ FC/ SC/ OE	Pre requisite	Credit Pattern & Credit Value L	T	P	Total	Contact Hours/ Week	Teaching School /Dept.
1	BTCE15F5200	Used water treatment & Solid Waste Management	HC	BTCE15F3600	2	1	0	3	4	Civil
2	BTCE15F5300	Transportation Engg-I	HC	-	2	1	0	3	4	Civil
3	BTCE15F5400	Hydrology & Irrigation Engineering	HC	BTCE15F3600	2	1	0	3	4	Civil
4	BTCE15F5500	Geotechnical Engg-I	HC	BTCE15F3600, BTCE15F3500	2	1	0	3	4	Civil
5	BTCE15F5600	Intermediate Structural Analysis	HC	BTCE15F3500	2	1	0	3	4	Civil
6	BTCE15F5710	Design of Masonry Structures	SC	BTCE15F3500	2	1	0	3	4	Civil
	BTCE15F5720	Advanced Surveying		BTCE15F4200	3	1	0	4	5	Civil
	BTCE15F5730	Remote Sensing and GIS		BTCE15F4200	3	1	0	4	5	Civil
	BTCE15F5740	Ground Water Hydraulics		BTCE15F5200	3	1	0	4	5	Civil
	BTCE15F5750	Urban Transport Planning		-	3	1	0	4	5	Civil
7	BTCE15F5800	CAD Lab	HC	BTCE15F3200	3	1	0	4	5	Civil
8	BTCE15F5900	Geotechnical Engineering Lab	HC	BTCE15F5500	1	0	1	2	3	Civil
Total Credits for the Fifth Semester								**26**	**35**	

VI SEMESTER

Sl. No	Course Code	Title of the Course	HC/FC/SC/OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours/ Week	Teaching School/Dept.
					L	T	P	Total		
1	BTCE15F6100	Transportation Engg-II	HC	BTCE15F5300	2	1	-	3	4	Civil
2	BTCE15F6200	Geotechnical Engg-II	HC	BTCE15F5500	2	1	-	3	4	Civil
3	BTCE15F6300	Design of steel structures	HC	BTCE15F3500	2	1	-	3	4	Civil
4	BTCE15F6400	Estimation and project management	HC	-	2	1	-	3	4	Civil
5	BTCE15F6510	Design of Hydraulic structures	SC	BTCE15F3600	2	1	-	3	4	Civil
	BTCE15F6520	Earth and Rock Fill Dams		BTCE15F3600	2	1	-	3	4	Civil
	BTCE15F6610	Repair & rehabilitation of structures		BTCE15F3500	2	1	-	3	4	Civil
	BTCE15F6620	Structural Dynamics		BTCE15F3500	2	1	-	3	4	Civil
6	BTCE15F6630	Earth & Earth retaining structures	SC	BTCE15F5500	2	1	-	3	4	Civil
	BTCE15F6640	Transportation Economics		BTCE15F5300	2	1	-	3	4	Civil
	BTCE15F6650	Air and noise pollution		-	2	1	-	3	4	Civil
	BTCE15F6700	Extensive survey Practice		BTCE15F4200	2	1	-	3	4	Civil
7	BTCE15F6800	HHM Lab	HC	BTCE15F3600	1	0	2	3	3	Civil
Total Credits for the Sixth Semester								**24**	**32**	

VII SEMESTER

Sl. No	Course Code	Title of the Course	HC/FC/SC/OE	Pre requisite	Credit Pattern & Credit Value L	T	P	Total	Contact Hours/Week	Teaching School/Dept.
1	BTCE15F7100	Transportation Engineering-III	HC	BTCE15F6100	2	1	0	3	2	MBA
2	BTCE15F7200	Design & Drawing of RCC & steel Structures	HC	BTCE15F5710, BTCE15F6300	1	1	0	2	1	Civil
3	BTCE15F7310	Design of precast & pre-stressed concrete structures	SC	BTCE15F6300	3	1	0	4	3	Civil
	BTCE15F7320	Advanced Design of Shallow Foundations		BTCE15F6200	3	1	0	4	3	Civil
4	BTCE15F7410	Theory of elasticity	SC	BTCE15F3500	3	1	0	4	3	Civil
	BTCE15F7420	Open channel hydraulics		BTCE15F3600	3	1	0	4	3	Civil
	BTCE15F7430	Foundation engineering in difficult ground		BTCE15F6200	3	1	0	4	3	Civil
	BTCE15F7440	Solid & hazardous waste management		-	3	1	0	4	3	Civil
	BTCE15F7450	Road safety & Management		-	3	1	0	4	3	Civil
5	BTCE15F7510	Design of bridges & water tanks	SC	BTCE15F3500	3	1	0	4	3	Civil
	BTCE15F7520	Matrix methods of structural analysis		BTCE15F3500	3	1	0	4	3	Civil
	BTCE15F7530	Reinforced earth structures		BTCE15F6200	3	1	0	4	3	Civil
	BTCE15F7540	Pavement management system		-	3	1	0	4	3	Civil
	BTCE15F7550	Environmental impact assessment		-	3	1	0	4	3	Civil
6	XXXXXXXXX	Open Elective-II	HC	-	4	0	0	4	4	Civil

7	BTCE15F7800	Concrete & Highway Materials Lab	HC	BTCE15F4100	1	0	1	2	1	Civil
8	BTCE15F7900	Environmental Engineering Lab	HC	-						
Total Credits for the Sixth Semester								**25**	**32**	

VIII SEMESTER

Sl. No	Course Code	Title of the Course	Practical /Term Work / Sessions	Pre requisite	Credit Pattern & Credit Value				Contact Hours/ Week	Teaching School/ Dept.
					L	T	P	Total		
1	BTCE15F8100	Seminar	HC	-	0	0	2	2	0	Civil
2	BTCE15F8200	Project Work	HC	-	0	1	5	6	0	Civil
3	BTCE15F8310	Finite Element Analysis	SC	BTCE15F3500	3	1	0	4	3	Civil
	BTCE15F8320	Ground Improvement Techniques		BTCE15F5500	3	1	0	4	3	Civil
	BTCE15F8330	Industrial Waste Water Treatment		-	3	1	0	4	3	Civil
	BTCE15F8340	Highway Geometric Design		-	3	1	0	4	3	Civil
	BTCE15F8410	Advanced Design of pre-stressed concrete structures	SC	-	3	1	0	4	3	Civil
	BTCE15F8420	Analysis And Design Of Deep Foundation		BTCE15F6200	3	1	0	4	3	Civil
	BTCE15F8430	Earthquake Geotechnical Engineering		BTCE15F6200	3	1	0	4	3	Civil
	BTCE15F8510	Computer Applications in	SC	-	3	1	0	4	3	Civil

		Civil Engineering								
	BTCE15F8520	Environmental Geotechnology		-	3	1	0	4	3	Civil
	BTCE15F8530	Traffic Engineering & Management		-	3	1	0	4	3	Civil
	BTCE15F8540	Earthquake Resistant Design Of Structures		-	3	1	0	4	3	Civil
Total Credits for Eigth Semester								**20**	**24**	
Total credits for all Eight semesters								**192**		

B. Tech in Civil Engineering

DETAILED SYLLABUS

(Effective from Academic Year 2015 - 19)

Semester – I

Course Code: BTEM15F1100	Engineering Mathematics – I	C	L	T	P	CH
Duration: 16 Weeks		3	2	1	0	5

Prerequisites:

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

Course Objectives:

1. To understand the concepts of differential calculus and its applications.
2. To familiarize with partial differentiation and its applications in various fields.
3. To familiarize with linear algebraic applications and different reduction techniques.
4. To familiarize with concept of vector calculus and its applications.

Course Outcomes:

1. Apply the knowledge of differential calculus in the field of wave theory and communication systems.
2. Apply the knowledge of Differential Equations in the field of Engineering.
3. Analyze and implement the concepts of Divergence and curl of vectors which play significant roles in finding the Area and volume of the closed surfaces.
4. Apply the knowledge of convergence of the series, which help in forming JPEG image compression.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BTEM 15F1 100	CO1	3	3	2	1	2	1							3	1	1	1
	CO2	3	3	2	2	2	2							3	1	1	1
	CO3	3	2	2	2	1	1							3	1	1	1
	CO4	3	3	2	2	1	1							3	2	1	1

Course Contents:

UNIT-I: Differential Calculus-I **[14hrs]**

Successive differentiation, standard results, Leibnitz Theorem (without proof) and problems, Taylors series, Maclaurins series expansion, Indeterminate forms and solution using L'Hospital's rule. Tangents and Normal-Cartesian curves, polar curves, Angle between polar curves, Pedal equation for polar curves. Derivative of arc length – concept and formulae without proof, Radius of curvature-Cartesian, parametric, polar and pedal forms**.**

UNIT-II: Differential Calculus-II **[14hrs]**

Curve Tracing-Cartesian, Parametric and polar forms -examples. Applications – Area, Perimeter, surface area and volume. Computation of these in respect of the curves – (i) Astroid(ii) Cycloid and (iii) Cardioids

Partial Differentiation: Partial derivatives-Euler's theorem-problems, total derivative and chain rule, Jacobians-direct evaluation. Taylor's Expansion of function of two variables. Maxima and Minima for a function of two variables.

UNIT-III:Differential Equations : **[14hrs]**

Exact Equations, Equation reducible to Exact form, Orthogonal Trajectories in Cartesian and polar.

Linear Differential Equations: Definitions, Complete solution, Operator D, Rules for finding the complementary function, Inverse operator, Rules for finding the particular integral, Method of variation of parameters, Method of undetermined coefficients, Cauchy's and Legendres linear equations, simultaneous linear equations with constant coefficients.

Non-Linear Differential Equations(*p-y-x* forms):.Equations solvable for *p*, *y* and *x*, Singular solution, Clairauts equation.

UNIT-IV: Vector Calculus **[14hrs]**

Differentiation of Vectors, Curves in space, Velocity and acceleration, Tangential and normal acceleration, Relative velocity and acceleration, scalar and vector point functions-Vector operator del. Del applied to scalar point functions-Gradient, Del applied to vector point function-Divergence and curl.

Applications: Line integral-Circulation-work, Surface integral-Flux, Green's Theorem in the plane, Stokes Theorem, Volume integral, Divergence theorem, Green's Theorem, Irrotational and Solenoidal fields, Orthogonal curvilinear coordinates.

Reference Books:

Text books:

1. B.S. Grewal, Higher Engineering Mathematics, 42nd edition, Khanna Publishers, 2013.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th edition, Wiley Publications, 2012.

Reference Books:

1. B.V. Ramana, “Higher Engineering Mathematics”, 1st edition, Tata McGraw Hill Publications 2010.
2. R.K.Jain and S.R.K.Iyengar, “Advanced Engineering Mathematics”, 4th edition, Narosa Publishing House, 2002.

Course Code: BTEC15F1200	Engineering Chemistry	C	L	T	P	CH
Duration: 16 Weeks		3	2	1	0	4

Prerequisites:

Basics of Pre University Chemistry.

Course Objectives:

1. Applied chemistry covers the very basic knowledge required for Civil Engineering students to understand its importance in technology.
2. Sources of water and its treatment for drinking. Different methods of water treatment.
3. Corrosion and metal finishing, explains why and how materials corrode and its Prevention. It also covers the importance of metal finishing in various industries and fabrication of PCB
4. Polymers are all about the properties of various polymeric materials and their Commercial significance. The chapter reveals about technical and commercial Importance of composite materials.

Course Outcomes:

1. The importance of water treatment for drinking.
2. Corrosion phenomenon and precautions to be taken in the selection of materials in controlling corrosion
3. Fabrication of PCB, an important component for electronic industries
4. Properties of polymers and their applications in various field, also that of composite materials in sports, aviation etc.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BTEC 15F1 200	CO1	3	2	3	1	1	3	-	-	-	-	-	2	3			
	CO2	3	3	2	2	1	1	-	-	-	-	-	2	3			
	CO3	3	3	-	-	1	1	-	-	-	-	-	-	3			
	CO4	3	2	1	1	1	-	-	-	-	-	-	1	3			

Course Contents:

UNIT-I: Cells and Batteries: [**11hrs]**

Introduction to electrochemistry, Basic concepts, Battery characteristics –primary, secondary and reserve batteries, Super capacitors, Lithium batteries.

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-Production of single crystal semiconductor by Crystal pulling technique (Czocharlski method), zone refining of si, antireflective coatings,Construction and working of photovoltaic cells and its applications and advantages using elemental si and semiconductors.

UNIT-II: Corrosion & its control & metal finishing. [10hrs]

Introduction: Electrochemical theory of corrosion, Galvanic series Types of Corrosion- Differential metal corrosion Differential aeration corrosion(Pitting & water line),Stress corrosion (Caustic embrittlement), and Grain boundary corrosion, Factors affecting rate of corrosion-Primary, secondary, pilling bed worth role, Energy concept (Pourbiax) under different pH conditions. Corrosion Studies on Al, Fe with phase diagram Corrosion control: Inorganic coating -Anodizing & Phosphating, metal coating- galivanzing & tinning, cathodic protection, Anodic Protection. Role of secondary reference electrode in corrosion studies (calomel ,Ag/AgCl)

Metal Finishing-Technological importance, significances of polarization. Decomposition potential & overvoltage in electroplating, theory of electroplating. Effect of plating variables on the nature of electrodeposit- electroplating process, Electroplating of gold, Introduction to Electro less plating-Cu.

UNIT-III: Introduction to Nano science and Nanotechnology [11 hrs]

Introduction to Nanomaterials, Properties –optical, electrical, magnetic and thermal .Chemical synthesis of Nanomaterials – sol gel (MOx NPs), phase transfer method (Au NPs). Carbon Nanomaterials-Fullerenes, graphene, CNT. Applications of nano materials- nano catalysis, nano-electronics, energy conversion materials (in batteries, solar cells), nano sensors.

Introduction to electromagnetic spectrum-material analysis, Instrumentation-principle, working and applications of UV-Visible, XRD, SEM.

UNIT-IV: polymers: [10 hrs]

Introduction, Types of polymerization-Addition and Condensation, Ziegler's natta catalyst, molecular weight determination by viscosity method, glass transition temperature, Structure and Property relationship. Synthesis &Applications of -Bakelite, ABS, Nylon6,6, PMMA.

Adhesives-Synthesis and applications of epoxy resins, Polymer composites- Synthesis and applications of Kevlar and Carbon fibers, Conducting polymers-Definition, Mechanism of conduction in polyacetylene , Synthesis & applications of conducting Polyaniline,Polymer liquid crystals, Biopolymers, Polymer membranes-ion exchange & ionic conductivity,

REFERENCES:

1. R.V. Gadag and Nithyananda Shetty, Engineering chemistry, 2, revised, I.K. International Publishing House Pvt. Limited, 2010

2. S.F. Jadhav and H.C. Shashidhara, Engineering Chemistry, Himalaya publishing house, First edition,

96, (2004).

3. B.S. Jai Prakash, R. Venugopal, Shivakumaraiah and Pushpa Iyengar, Chemistry for Engineering Students, Subhas publishers, Third edition, 239, (2010).

4. Mars G. Fontana, Corrosion Engineering, Tata McGraw-Hill publishers, Third edition, 12, (2005).

5. Introduction to Nanotechnology by Charles P. Poole Jr., Frank J. Owens Wiley India Publishers

6. Theory and practice in applied chemistry by O.P. Vermani and Narulla, New age international publications

7. Vogel's text book of quantitative chemical analysis by G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney.

Course Code: BTBE15F1300	**Basic Electronics Engineering**	**C**	**L**	**T**	**P**	**CH**
Duration: 16 Weeks		**3**	**2**	**1**	**0**	**4**

Prerequisites:

Basics of Physics.

Course Objectives:

1. To familiarize with the number systems, Boolean algebra and digital circuit design.
2. To understand the diode characteristics and its applications.
3. To learn the working principles of various electronic circuits.
4. To understand the transistor characteristics and its applications.
5. To compare the different biasing methods of transistors.
6. To understand the working of amplifiers and communication systems.
7. To understand the power electronic devices.

Course Outcomes:

1. To Design the digital circuits using various logic gates.
2. To analyze various diode circuits and work on various application based on electronic instruments.
3. To design of amplifier circuit based on BJT and emonstrate the working of amplifiers and the oscillators.
4. To analyze the various communication techniques and Design Zener voltage regulator

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PS O2	PS O3	PS O4
BTBE 15F1 300	CO1	**3**	**3**	**3**	**3**	**2**								**1**	**1**	**1**	**1**
	CO2	**3**	**3**	**3**	**3**	**3**									**1**	**2**	
	CO3	**3**	**2**	**3**	**3**	**3**										**1**	**1**
	CO4	**3**	**2**	**3**	**3**	**2**										**1**	**1**

Course Contents:

UNIT-I: Digital Electronics and Number Systems [14hrs]

Digital Electronics: Introduction, Switching and Logic Levels, Digital Waveform. Number Systems: Decimal Number System, Binary Number System, Octal Number System, Hexadecimal Number System.

Number base conversions: Binary to Decimal, Decimal to Binary, Binary to Octal, Octal to Binary, Binary to Hexadecimal, Hexadecimal to Binary, Decimal to Octal, Octal to Decimal, Decimal to Hexadecimal, Hexadecimal to Decimal, Octal to Hexadecimal, Hexadecimal to octal.

Complement of Binary Numbers. Binary addition, binary subtraction. Boolean Algebra Theorems, De Morgan's theorem. Digital Circuits: Logic gates, NOT Gate, AND Gate, OR Gate, NAND Gate, NOR Gate, XOR Gate, XNOR Gate. Algebraic Simplification, NAND and NOR Implementation NAND Implementation, NOR Implementation. Half adder and Full adder Implementations.

UNIT-II: Semiconductor Diodes and Applications [13hrs]

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, Zener diode voltage regulators: Regulator circuit with no load, Loaded Regulator, Series and Shunt diode Clipping Circuits, Clamping Circuits: Negative and Positive Clamping Circuits, Numerical examples as applicable.

UNIT-III: Bipolar junction Transistors [13hrs]

BJT configuration: BJT Operation, BJT voltages and currents, BJT amplification, Common Base, Common Emitter and Common Collector Characteristics, Numerical examples as applicable.

BJT Biasing: DC load line and Bias Point, Base Bias, Voltage divider Bias, Numerical examples as applicable.

UNIT-IV: Electronic Devices and Applications **[14hrs]**

SCR, controlled rectifier-full bridge type. Oscillators and applications. OPAMP-summer, subtractor, integrator and differentiator, and typical applications in measurements.

Communication system, embedded system, cellular communication, satellite communication, remote sensing. (block diagram approach)

REFERENCE BOOKS:

1. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5th Edition, 2008.

2. D.P. Kothari, I. J. Nagrath, "Basic Electronics", McGraw Hill Education (India) Private Limited, 2014.

Course Code: BTCC15F1400	Computer Concepts and C Programming	C	L	T	P	CH
Duration: 16 Weeks		3	2	1	0	4

Prerequisites:

Nil

Course Objectives:

1. Introduce the fundamentals of computer hardware and software;
2. Provide an understanding of problem solving with computers;
3. Introduce C programming language;
4. Provide a familiarization with the Unix programming environment;
5. Introduceproblem solving through authoring and executing C programs.

Course Outcomes:

A student who successfully completes the course will have the ability to:

1. Use the basic terminology of computer programming; Explain the different Unix commands, their usage and their syntax;
2. Write, compile and debug programs in C language; Use different data types and operators in a computer program;
3. Design programs involving decision structures, loops and functions; Use procedure calls by value and by reference;
4. Use arrays in applications like sorting and searching; Handling strings; Apply the C language knowledge to solve variety of problems.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3	PSO4
BTCC 15F1 400	CO1	**3**	**3**	**2**	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**
	CO2	**3**	**2**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**
	CO3	**2**	**3**	**2**	**1**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**
	CO4	**3**	**2**	**1**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**

Course Contents:

UNIT-I **[11 hrs]**

Introduction to Computer System, Computer Organization, Hardware and Software: Definition of Computer, Early history, Structure of a computer, Information Processing life cycle, Essential computer hardware - Microprocessors, Storage media, Essential computer software, Types and Functions of operating systems, Number systems, Computer processing techniques, Networking.

UNIT-II:Getting started with UNIX – Introduction and Commands: **[10 hrs]**
Introduction to Unix Operating System, Introduction to Basic Command Format, Working with Files, Using the VI text editor, working with Files and Directories, Filename Substitution and Wild Cards, Standard Input, Output & Error, Pipes and redirection, Shell Commands.

UNIT-III: Fundamentals of Problem Solving and Introduction to C Language: **[11 hrs]**
Algorithms and Flow charts, Introduction to C Language – Background, structure of a C Program, Input / Output, Tips and common programming errors, Expressions and Statements, Branching constructs, Looping constructs.

UNIT-IV: More towards C language: **[10 hrs]**
Functions in C, Recursion, Arrays, Strings, Introduction to pointers.

REFERENCE BOOKS:

1. Herbert Schildt, C: The Complete Reference, 4th Edition, Tata McGraw Hill, Published by McGraw-Hill Osborne Media (2000), ISBN 10: 0072121246ISBN 13: 9780072121247

2. Sumitabha Das, UNIX Concepts and Applications, 4th Edition; Tata McGraw-Hill Education **Published Date :** 2006-05-01

3. Reema Thareja, Computer fundamentals and programming in C, Second Edition, Oxford University press, 2016.

4. Kernighan, Dennis Ritchie, The C Programming Language ,2nd edition, Englewood Cliffs, NJ: Prentice Hall, 1988

Course Code: BTES15F1500	Environmental Sciences	C	L	T	P	CH
Duration: 16 Weeks		2	1	1	0	3

Prerequisites:

Pre University Science.

Course Objectives:

1. To gain knowledge on the components of environment and importance of environmental studies.
2. To understand the various types of energy and natural resources.
3. To acquire knowledge with respect to biodiversity, its threats and its conservation and appreciate the concept of ecosystem.
4. To get knowledge about environmental pollution-sources, effects and control measures of environmental pollution.
5. To explore ways for protecting the environment.

Course Outcomes:

On completion of this course the students will be able to:

1. Analyze the environmental conditions and protect it.
2. Find new renewable energy resources.
3. Analyze the ecological imbalances and protect it.
4. List the causes of environmental pollution and design pollution controlled products.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
	CO1						3	2		3	3		3				
	CO2						3	3		3	3		3				

BTES 15F1 500	CO3						3	2		3	2		3				
	CO4						3	3		3	3		3				

Course Contents:

UNIT-I: Introduction:

Basic definitions, Objectives and Guiding principles of Environmental Studies, Components of Environment, Structures of atmosphere, Man-Environment relationship, Impact of Technology on the environment, sustainable environment, Environmental Protection - Role of Government, Initiatives by Non - Governmental Organizations (NGO).

UNIT-II: Energy & Natural Resources:

Energy - Different types of energy, Electro-magnetic radiation. Conventional and Non-Conventional sources - Hydro Electric, Fossil fuel based, Nuclear, Solar, Biomass and Bio-gas. Hydrogen as an alternative future source of Energy, Natural Resources- Water resources, Mineral Resources, Forest Wealth.

UNIT-III: Ecology & Ecosystems:

Ecology- Objectives and Classification, Concept of an ecosystem - structure & function, Balanced ecosystem, Components of ecosystem - Producers, Consumers, Decomposers, Bio-Geo- Chemical Cycles & its Environmental significance (Carbon Cycle and Nitrogen Cycle), Energy Flow in Ecosystem, Food Chains: Types & Food webs Ecological Pyramids.

UNIT-IV: Environmental Pollution:

Introduction, Types, Concepts -Air Pollution, Water Pollution& Noise Pollution. Environmental Degradation- Global Warming, Green Houses Effects, Acid Rain, and Depletion of Ozone Layer.

REFERENCE BOOKS:

1. Benny Joseph, Environmental Studies, Tata McGraw – Hill Publishing Company Limited, 2005
2. Meenakshi P, Elements of Environmental Science and Engineering, Prentice Hall of India Private Limited, New Delhi, 2006
3. Rajagopalan R, Environmental Studies – From Crisis to Cure, Oxford University Press, 2005
4. Raman Sivakumar, Principles of Environmental Science and Engineering, Second Edition, Cengage learning, Singapore, 2005
5. Ranjit Daniels R.J. and JagdishKirshnaswamy, (2009), Environmental Studies, Wiley India Private Ltd., New Delhi, 2009
6. Prakash S.M, Environmental Studies, Elite Publishers, Mangalore, 2007
7. ErachBharucha, Text Book of Environmental Studies, for UGC, University Press, 2005

8. Tyler Miller Jr. G. Environmental Science – Working with the Earth, Eleventh Edition, Thomson Brooks/Cole, 2006

Course Code: BTTE15F1600	Technical Communication and Documentation	C	L	T	P	CH
Duration: 16 Weeks		2	1	1	0	3

Prerequisites:

Pre University English.

Course Objectives:

To make the learning process more practical and participatory.

1. To enhance the process of imparting skills of communication more effective
2. To make the learners aware of the latest communication tools and process.
3. To encourage participation of students and follows an interactive approach.
4. To cater the learners in professionals and academic contexts and in day-to-day interactions.

Course Outcomes:

1. To eradicate their stage fear, able to communicate properly. Students enable to speak, read without any mistakes.
2. To practice LSRW skills and how to use them in a daily life.
3. To exhibits clarity of language, encourages participation of students. And follows an interactive approach.
4. To help standardize the teaching of communication and cater to the learners.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
	CO1	**2**	**1**	**2**		**1**	**1**			**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**
	CO2	**2**	**1**	**2**		**1**	**1**			**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**

BTTE 15F1 600	CO3	**2**	**1**	**2**		**1**	**1**			**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**
	CO4	**2**	**1**	**2**		**1**	**1**			**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**

Course Contents:

UNIT-I : Professional Communication **[5hrs]**

Introduction to Communication: Types of communication, Barriers to communication, Importance of communication, Technical communication.

UNIT-II: Reading: **[5hrs]**

Reading skills, Vocabulary, Jargon, Text component: Of Discourse- Francis Bacon, Unity of Minds - Dr. A.P.J Abdul Kalam.

UNIT- III: Writing: **[5hrs]**

Introduction to writing skills, Common Grammatical errors, Sentence structure, Paragraph writing, Précis, Letter writing, Text component: After Twenty years - O. Henry, The open window- Saki.

UNIT-IV: Listening: **[13hrs]**

Listening skills, Barriers to Listening, Listening Comprehension and Note- Taking Practice in Listening Comprehension, Enhancing Listening skills Text component: The Refund - Fritz Karinthy.

Speaking: Speaking skills, Phonetics, Stress, Rhythm and Intonation, Practice in speaking skills.

REFERENCE BOOKS:

1. Murphy,Raymond, Intermediate English Grammar, Fourth edition, Cambridge University press, New York, 2012
2. Wren &Martin,English Grammar & Composition, Fifth edition, Cambridge University press, New York, 2001
3. Mudambadithaya G.S., English Grammar and composition, Cambridge University press, New York, 2002
4. Lupton, Mary Jane, *Maya Angelou: A Critical Companion*. Westport, Connecticut: Greenwood Press. ISBN 978-0-313-303225, 1998
5. Booher, Diana. (2004),*Booher's Rules of Business Grammar*, OUP Ur, Penny .(2002),*Grammar Practice Activities*, OUP
6. Glendinning, Eric H. and Beverly Holmstrom, Study Reading: A Course in Reading Skills for Academic Purposes, New Delhi: CUP. Langan, John (1996). College Writing Skills. McGraw Hills, 2008.

Course Code: BTED15F1700	Computer Aided Engineering Drawing	C	L	T	P	CH
Duration: 16 Weeks		4	2	0	2	8

Prerequisites:

Building palnning and Drawing

Course Objectives:

1. To comprehend general projection theory, with emphasis on orthographic projection to represent in two-dimensional views (principal, auxiliary, sections).
2. To dimension and annotate two-dimensional engineering drawings.
3. To understand the application of industry standards and best practices applied in engineering graphics.
4. To emphasize freehand sketching to aid in the visualization process and to efficiently communicate ideas graphically.
5. To introduction of CAD software for the creation of 2D engineering drawings.
6. To the theoretical concepts delivered in this course would help the students to understand the sign considerations and tolerances to be used in the design and manufacture of engineering components.
7. To this course will be very much basics for students to learn and wisely apply for the advanced Computer Aided Engineering (CAE) tools such as ABAQUS, ANSYS etc.

Course Outcomes:

1 To understand the concepts of engineering drawing.
2 To understand the concepts of projection of objects in CAD drawing.
3 To draw the sections of various objects in CAD drawing.
4 To draw the isometric projections of various soilds in view of 2D and simple 3D drawings

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
	CO1	**3**	**2**	**3**	**2**									**3**	**3**	**3**	**3**
	CO2	**2**	**2**		**2**								**1**	**3**	**3**	**3**	**3**

BTED 15F1 700	CO3	**3**	**3**	**2**	**3**	**1**								**3**	**3**	**3**	**3**
	CO4	**2**	**2**	**3**	**3**		**2**					**1**	**2**	**3**	**3**	**3**	**3**

Course Contents:

UNIT-I: Introduction to Drawing: 12Hours

Introduction to Engineering Drawing: Introduction, Drawing Instruments and their uses, BIS conventions, Drawing sheets, Lettering, Dimensioning, Scales, regular polygons and its methods, tangents, ellipse, parabola, hyperbola, loci, cycloids, trochoids, epi and hypocycloids, spirals and involutes, helix, Co-ordinate system and reference planes.

Introduction to Software (solid edge): 12Hours

Computer screen, layout of the software, standard tool bar/menus and description of most commonly used tool bars, navigational tools Creation of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend to next ,split, chamfer, fillet, curves, constraints viz. tangency, parallelism, inclination and perpendicularity. Dimensioning, line conventions, material conventions and lettering.

Orthographic Projection: Projection – Orthographic Projection – Planes of Projection – Four quadrants – First-angle projection – Third-angle projection – Reference line – Conventions employed.

Projection of points: Points in different quadrants.

Projection of Straight Lines (First-angle Projection only): Parallel to one or both planes – Contained by one or both planes – Perpendicular to one plane and parallel to other plane – Inclined to one plane and parallel to the other – Inclined to both planes.

Projection of Planes: Types of Planes – Perpendicular Planes – Oblique Planes – Projection of Planes - Parallel to one Plane – perpendicular to both planes – perpendicular to one inclines to other – Oblique planes (only change of position method).

UNIT-II:Projection of Solids: 12Hours

Polyhedra (Cube – Tetrahedron - Prisms and Pyramids) – Solids of revolution(Cone and Cylinder) – Solids in simple position – Axis perpendicular to a plane – Axis parallel to both planes – Axis parallel to one plane and inclined to the other – Axis inclined to both plane (only change of position method).

UNIT-III: Sections of Solids: **12Hours**

Section Planes – Sections – True Shape of Section – Sections of Prisms – Sections of Pyramids – Sections of Cylinders – Section of Cones.Developments of Lateral Surfaces of Solids - Polyhedra (Cube – Tetrahedron - Prisms and Pyramids) – Solids of revolution (Cone and Cylinder) and their Frustums.

UNIT-IV:Isometric Projection: **12Hours**

Isometric axes - Lines and Planes – Isometric Scale – Isometric Projection of Planes – Prisms – Pyramids – Cylinders – Cones – Spheres - Hemi-Spheres - frustums - Combination of Solids (Maximum Three). Conversion of Orthographic Drawing to Isometric View / Pictorial Drawing of a simple Machine Components. Application Drawings: Civil drawing (building plans), electrical symbols and circuits, electronic symbols and circuits and simple assembly drawing (bolt and nut).

REFERENCE BOOKS:

1. N.D.Bhatt and V.M. Panchal, Engineering Drawing, 48th Edition, Charotar Publishing House, Gujarat, 2005.
2. A Primer on Computer Aided Engineering Drawing-2006, Published by VTU, Belgaum.
3. Dr Balaveer Reddy and Co authors, Computer Aided Engineering Drawing, CBS Publications, 2014
4. K.R. Gopalakrishna Engineering Graphics, 32nd Edition,Subhas Publishers, Bangalore 2005.
5. P. S. Gill, Engineering Drawing, 11th Edition, S. K. Kataria & Sons, Delhi2001.

E-Material:

Computer Aided Engineering Drawing- Vol I, (PPT) by Dr. Rajashekar Patil and Prof Gururaj Sharma T

Course Code: BTCL15F1800	Engineering Chemistry Lab	C	L	T	P	CH
Duration: 16 Weeks		0	0	0	2	3

Prerequisites:

Basics of Engineering Chemistry

Course Objectives:

To provide students with practical knowledge of quantitative analysis of materials by classical and instrumental methods for developing experimental skills in building technical competence

Course Outcomes:

On completion of lab course students will have the knowledge in;

1. Handling of Chemicals and COD can be determined.
2. Handling different types of instruments for analysis of materials for better accuracy and precision
3.
4. Carrying out different types of titrations for quantitative estimations of materials.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BTCL 15F1 800	CO1	2	2	2		-	-	-	-	-	-	-	-	3	2	1	2
	CO2	2	3	1		1	-	-	-	-	-	-	-	3	2	1	2
	CO3	2	2	1		1	1	-	-	-	-	-	-	3	2	1	2
	CO4	2	2	1		1	-	-	-	-	-	-	-	3	2	1	2

Course Contents:

LAB EXERCISES

1. Potentiometric estimation of FAS using standard $K_2Cr_2O_7$
2. Conductometric estimation of an acid mixture using standard NaOH solution
3. Determination of pKa of a weak acid using pH meter
4. Determination of molecular weight of given polymer sample using ostmail's Viscometer
5. Colorimetric estimation of copper
6. Determination of COD of the given industrial waste water sample
7. Determination of total and temporary hardness of water using disodium salt of EDTA
8. Estimation of alkalinity of given water sample using standard HCl solution.
9. Determination of Iron in the given haematite ore solution using potassium dichromate
10. Determination of calcium oxide in the given sample of cement by rapid EDTA method
11. Flame photometric estimation of sodium in the given sample of water
12. Electroplating of copper and nickel

REFRENCE BOOKS:

1. Engineering Chemistry of Wiley India Pvt. Ltd., Vairam and others, 2014 edition (second).
2. S. S. Dara, Mukkanti, "Text of Engineering Chemistry", S. Chand & Co, New Delhi, 12th Edition, 2006
3. C. V. Agarwal, C. P. Murthy, A. Naidu, "Chemistry of Engineering Materials", Wiley India, 5th Edition, 2013.

Course Code: BTCP15F1900	**Computer Programming Lab**	C	L	T	P	CH
Duration: 16 Weeks		2	0	0	2	3

Course Objectives:

1. Introduce the Basic Principles of Problem Solving using a Computer;
2. Present and Provide the Programming Constructs of 'C' Programming Language;
3. Provide the skills required to Design, Demonstrate and Implement Computable Problems / Mini-projects / Projects using 'C' Programming Language;
4. Provide the Arena for Development of Analytical, Reasoning and Programming Skills;
5. Set the Strong Foundation for Software Development in the field of Programming and hence to Create high quality 'C' Professionals.

Course Outcomes:

After completion of this course, the students would be able to

1. Understand the Basic Principles of Problem Solving; Study, understand and identify the Representation of Numbers, Alphabets and other Characters in the memory of Computer System;
2. Understand Analyze, Integrate, Apply and Demonstrate Software Development Tools; like Algorithms, Pseudo Codes and Programming Structures;
3. Study, Understand, Analyze and Categorize the logical structure of a Computer Program, and hence to Apply different programming constructs to develop a Computer Program using 'C' Programming

Language; Offer Engineering Solutions to simple (moderate) mathematical and logical problems using ‘C’ Programming Language;

4. Study, Understand, Analyze, Integrate, Classify, Compare and Apply simple Data Structures, Pointers, Memory Allocation and Data Handling through files using ‘C’ Programming Language; Understand and identify the working of different Operating Systems; like Windows and Linux; Enhance their Analytical, Reasoning and Programming Skills;

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO 1**	**P02**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
BTCL 15F1 900	CO1	**2**	**2**	**2**		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**2**
	CO2	**2**	**3**	**1**		**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**2**
	CO3	**2**	**2**	**1**		**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**2**
	CO4	**2**	**2**	**1**		**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**2**

Course Contents:

1. Unix Commands – execution and learn extra options than what is taught in theory
2. How to edit, compile and execute a C program on UNIX using editors like G-edit, K-write, writing a shell program.
3. Programs on data types, operators, expressions
4. Conditional statements – simple if statement, if-else statement, nested if-else, else-if ladder, switch statement
5. Looping statements – for, while and do-while statements
6. Arrays – 1-D and 2-D arrays
7. Programs on Sorting and searching
8. User defined Functions – pass by value, pass by reference, passing arrays to functions
9. Strings – finding length, string concatenation, string compare, substring search, palindromes etc
10. Programs on pointers.

Recommended Learning Resources:

1. Herbert Schildt, C: The Complete Reference, 4th Edition, Tata McGraw Hill
2. Sumitabha Das, UNIX Concepts and Applications, 4th Edition; Tata McGraw Hill
3. Reema Thareja, Computer fundamentals and programming in C.
4. Kernighan, Dennis Ritchie, The C Programming Language ,2nd edition, Englewood Cliffs, NJ: Prentice Hall, 1988
5. http://c-faq.com/index.html
6. Paul Deitel, C How to Program, 7th Edition, Deitel How to Series.

SEMESTER II

Course Code: BTEM15F2100	**Engineering Mathematics – II**	C	L	T	P	CH
Duration: 16 Weeks		4	3	1	0	5

Prerequisites:

Differential Equations and Linear Algebra

Course Objectives:

1. How to solve linear Partial Differential Equations with different methods.
2. Find the magnitude, direction and component form of displacement vectors.
3. To study and understand the application approach of the concepts of Vector calculus.
4. Introduce students to some physical problems in Engineering models that results in partial differential equations.

Course Outcomes:

1. Classify partial differential equations and transform into canonical form.
2. Use vector models for applications of velocity, force, work, finding angles between vectors, and projections.
3. Solve civil engineering problems by using vector concept.
4. Solve linear partial differential equations of both first and second order.

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO 1**	**P 0 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO2**	**PSO3**	**PSO4**
BTEM 15F2 100	CO1	3	2	2	1	1	1							3	1	1	1
	CO2	3	3	2	1	2	1							3	1	1	1
	CO3	3	3	2	2	1	1							3	1	1	1

	CO4	3	3	2	1	2	1							3	2	1	1

Course Contents:

UNIT-I: Linear Algebra **[14hrs]**

Elementary row and column operations on a matrix, Rank of matrix, Normal form, Inverse of a matrix using elementary operations, Solution of a system of non-homogeneous equations by Gauss elimination and Gauss –Jordan methods. Reduction to diagonal form, Reduction of a quadratic form to canonical form, orthogonal transformation and congruent transformation. Rayleigh Power method to find the largest eigen value and corresponding eigen vector.

UNIT-II : Integral Calculus **[14hrs]**

Differentiation under the integral sign – simple problems with constant limits. Reduction formulae for the integrals of $\sin^n x$,$\cos^n x \sin^n x \cos^n x$and evaluation of these integrals with standard limits - Problems.

Multiple Integrals **–** Double integrals, change of order of integration, double integrals in polar coordinates, area enclosed by plane curves, Beta and Gamma functions – definitions- relation between beta and gamma functions and problems.

Applications: Volume of solids, Change of variables, Area of a curved surface, Calculation of mass.

UNIT-III: Partial Differential Equation **[14hrs]**

Introduction: Formation of Partial differential equations, Solutions of non-homogeneous PDE by direct integration, Solutions of homogeneous PDE involving derivatives with respect to one independent variable, Solution of Lagranges linear PDE, Solutions of PDE by product method,

Applications: vibrations of a stretched string-Wave equation, one dimensional heat flow. Laplace equation using separation of variables.

UNIT-IV: Laplace Transforms: **[14 hrs]**

Introduction, definition, Transforms of elementary functions, properties of Laplace Transforms, Transforms of derivatives, Transforms of integrals, evaluation of integrals by Laplace transforms, Transforms of periodic functions, Unit step functions and unit impulse functions.

Inverse Laplace transforms- Problems, convolution theorem-problems, solution of linear differential equation using Laplace transforms, simultaneous linear equations, Applications of Laplace transforms.

Text books:

1. B.S. Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 42nd edition, 2013.
2. Erwin Kreyszig, “Advanced Engineering Mathematics”, Wiley Publications, 9th edition, 2012.

Reference Books:

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 Publishing House, 4th edition, 2002.

Course Code: BTEP15F2200	Engineering Physics	C	L	T	P	CH
Duration: 16 Weeks		3	2	1	0	4

Prerequisites:

Basics of Pre University Physics.

Course Objectives:

1. To make a bridge between the physics fundamentals which they studied in schools and their applications which they are going to study in Civil Engineering.
2. To be acquainted with the basic concepts of properties of fluids, pressure and its measurements.
3. To get exposed to basic concepts of elastic properties of solids, vibrations & To Know about the different types of kinematic motions

Course Outcomes:

Understand the Concepts of Kinematics

1. Understand the advanced concepts of wave mechanics.
2. Understand and demonstrate different applications of Laser and optical fibers.
3. Understands the concepts of conductors and nano materials.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTEP 15F2 200	CO1	**3**	**3**		**1**									**3**	**3**	**3**	**3**
	CO2	**3**	**2**	**1**										**3**	**3**	**3**	**3**
	CO3	**3**	**2**					**1**						**3**	**3**	**3**	**3**

Course Contents::

UNIT-I:Wave mechanics: [10hrs]

Introduction to Wave mechanics, Wave particle dualism. de-Broglie hypothesis,Matter waves and their characteristic properties. 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. Relation between group velocity and particle velocity, Expression for de-Broglie wavelength using the concept of group velocity. Heisenberg's uncertainty principle ,its significance and its applications(non existence 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. Numericals.

UNIT-II: Lasers and optical fibers:[11hrs]

LasersInteraction between radiation and matter (induced absorption, spontaneous and stimulated emission). Expressionfor 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 oflaser system, Construction and working of Carbon Dioxide (CO_2) laser & semiconductor laser. Applications: Holography (recording and reconstruction of images) and its applications, Numericals.
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). Advantages and limitations of optical communications, Numericals.

UNIT-III: Electrical properties of conductors and superconductors: [10hrs]
Electrical Conductivity in Metals, Drude-Lorentz classical free electron theory,drift velocity, mean free path, mean collision time and relaxation time.Expression for electrical conductivity in metals,Effect of impurity and temperature on electrical resistivity in metals,Failures of classical free electron theory. Quantum free electron theory, Fermi-Dirac statistics, Fermi level, Fermi energy and Fermi factor, Variation of Fermi factor with energy and temperature, Density of states (qualitative explanation), effective mass, Merits of Quantum free electron theory, Numericals.
Superconductors: Temperature dependence of resistivityin superconductors, variation of critical field with temperature,Properties of superconductors (Isotope effect, Meissner effect, Silsbee effect), Types of superconductors, BCS theory, Applications of super conductors,Maglev vehicle and superconducting magnet.

UNIT-IV: Ultrasonics, Dielectric and Nanomaterials: **[11hrs]**
Ultrasonics: Production of ultrasonics by piezoelectric method, Measurement of velocity of ultrasonics in solid andliquid, Non-destructive testing of materials using ultrasonics.
Dielectricmaterials: Electric dipole and dipole moment, electric polarization (P), dielectric susceptibility (χ,), dielectric constant, relation between χ and P,Electrical polarization mechanisms (electronic,ionic, orientational, space charge polarization),Expression for internal fieldin one-

dimensional solid dielectrics, Ferro, Piezo and Pyro electric materials – their properties and applications, Numericals.
Nanomaterials: Introduction to nanoscience, nanomaterials and their applications, Synthesis of nano materials using bottom-up method (arc method), top-down methods (ball milling method), Carbon Nanotubes: properties andapplications.

Text books:
1. R.K Gaur and S.L. Gupta, Engineering Physics, Dhanpat Rai Publications (P) Ltd, New Delhi.
2. M.N. Avadhanulu and P.G. Kshirsagar, S. Chand and Company, A text book of Engineering Physics, New Delhi.
3. Solid State Physics, S.O. Pillai, New Age International publishers, New Delhi.

Reference Books:
1. Laser Fundamentals, William T. Silfvast, 2nd Edition, Cambridge University press, New York (2004).
2. Fundamentals of Physics, 6th Edition, D. Halliday, R. Resnick and J. Walker, John Wiley and Sons, New York (2001).
3. Introduction to Solid State Physics,7th Edition Charls Kittel, Wiley, Delhi (2007).
4. Arthur Beiser, Concepts of modern Physics, Tata McGraw Hill publications, New Delhi.

Course Code: BTCV15F2300	Elements of Civil Engineering	C	L	T	P	CH
Duration: 16 Weeks		3	2	1	0	4

Pre University Physics

Course Objectives:

1. To understand a broad concept of engineering mechanics.
2. To understand the basics of composition of coplanar forces.
3. To understand the concept of equilibrium of coplanar forces.
4. To provide an overview of centroid of plane area & Moment of Inertia of plane area.

Course Outcomes:

1. Describe the moment of force and couples and equivalent force-couple system.
2. Solve numerical problems on composition of coplanar concurrent and non-concurrent force system.
3. Solve numerical problems on equilibrium of coplanar force system.
4. Locate the centroid and moment of inertia of different geometrical Shapes.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3	PS O4
BTCV 15F2 300	CO1	3	3	2	1		2	1				1	3	3	2	2	3
	CO2	3	3	3	1		1					1	2	3	3	2	2
	CO3	3	3	2	1		1	1				1	2	3	3	2	2
	CO4	3	3	1	1		2	1				1	3	3	2	2	1

Course Contents:

UNIT-I **[14hrs]**

Introduction to basic civil engineering – Scope of civil engineering, role of civil engineer, branches of civil engineering (brief discussion 2 to 3 hours only)

Engineering mechanics

Basic idealizations - Particle, Continuum and Rigid body; Force and its characteristics, types of forces, Classification of force systems; Principle of physical independence of forces, Principle of superposition of forces, Principle of transmissibility of forces; Newton's laws of motion, Introduction to SI units, Moment of aforce, couple, moment of a couple, characteristics of couple, Equivalent force - couple system, Resolution of forces, composition of forces; Numerical problems on moment of forces and couples and equivalentforce - couple system.

UNIT-II **[14hrs]**

Analysis of Force Systems

Composition of forces - Definition of Resultant, Composition of coplanar -concurrent force system, Parallelogram Law of forces, Principle of resolved parts, Numerical problemson composition of coplanar concurrent force systems, Composition of coplanar - non-concurrent force system, Varignon'sprinciple of moments; Numerical problems on composition of coplanar concurrent force systems.

UNIT-III **[14hrs]**

Equilibrium of coplanar forces

Definition of static equilibrium and Equilibrant, Conditions of staticequilibrium for different coplanar force systems, Lami's theorem, Concept of Free Body Diagram, Numericalproblems on equilibrium of coplanar – concurrent and non concurrent force systems.

UNIT-IV **[14hrs]**

Centroid and Moment of Inertia

Centroid: Introduction to the concept, Centroid of plane figures, Locating the centroid of triangle, semicircle,quadrant of a circle and sector of a circle using method of integration, Centroid of composite sections; Numerical problems.

Moment of Inertia: Introduction to the concept, Rectangular and polar moment of inertia, Radius of gyration,Perpendicular axis theorem and Parallel axis theorem, Moment of Inertiaof rectangle, circle, semi-circle, quarter circle and triangle from method of integration, Moment of inertia of composite areas, Numerical problems.

Text Books:

1. M. N. Shesha Prakash and Ganesh B. Mogaveer, **“Elements of Civil Engineering and Engineering Mechanics”**, PHI Learning, 3rd Revised edition
2. A. Nelson, **“Engineering Mechanics-Statics and Dynamics”**, Tata McGrawHill Education Private Ltd, New Delhi, 2009
3. S. S. Bhavikatti, **“Elements of Civil Engineering”**, New Age InternationalPublisher, New Delhi, 3rd edition 2009.

Reference Books:

1. S. Timoshenko, D.H. Young and J.V. Rao, **“Engineering Mechanics”**, TATA McGraw-Hill Book Company, New Delhi
2. Beer FP and Johnston ER, **“Mechanics for Engineers- Dynamics andStatics”**, 3rd SI Metric edition, Tata McGraw Hill. - 2008
3. Shames IH, **“Engineering Mechanics–Statics & Dynamics”**, PHI–2009.

Course Code: BTME15F2400	Elements of Mechanical Engineering	C	L	T	P	CH
Duration: 16 Weeks		3	2	1	0	4

Course Objectives:

1. To develop the basic knowledge of working of various turbines and IC engines
2. To incorporate the concepts of metal joining process, their applications and power transmission modes like belt drives, gears and gear trains
3. To understand various mechanical machines and operations.
4. Introduce about lubrication and its importance.
5. To understand basic power transmission concepts.

Course Outcomes:

The student will be able to

1. Apply the concepts of working principle of turbines in the power plants and also of the IC engines in the basic design of the vehicles
2. Have a basic knowledge of metal joining and power transmission and apply them in some basic requirements
3. Gain the knowledge about machine tools and cutting operations.

4. Gain the knowledge about belt and gear drive power transmission.

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO 1**	**P02**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
BTCV 15F2 400	CO1	3	3	2	1		2	1				1	3	3	2	2	3
	CO2	3	3	3	1		1					1	2	3	3	2	2
	CO3	3	3	2	1		1	1				1	2	3	3	2	2
	CO4	3	3	1	1		2	1				1	3	3	2	2	1

Course Contents:

UNIT–I:

Properties of steam - Introduction**,** Steam formation, Types of steam. Steam properties, Specific Volume, Enthalpy and Internal energy, Steam table and simple numerical problems

Steam Generators – classification, Lancashire boiler, Babcock and Wilcox boiler, Boiler mountings, accessories and applications

Turbines- Introduction to turbines & prime movers, Classification of turbines, Working principle and applications of impulse and reaction steam turbines, gas turbines (open and closed cycle type) and water turbines (Pelton wheel, Francis and Kaplan), Compounding of impulse turbine

UNIT–II:

Internal Combustion Engines – Introduction, Classification of IC engines, parts of IC engine, Working principle of four stroke (petrol and diesel) and two stroke petrol engines, differences between 4 Stroke & 2 Stroke engines and petrol & diesel engines, Numerical problems on power and efficiencies.

Refrigeration and Air conditioning- Introduction, Principle of refrigeration, parts of refrigerator, Principle and working of vapor compression refrigeration and vapor absorption refrigeration.Refrigerants, Properties of refrigerants, Refrigerating effect, Ton of Refrigeration, COP, Relative COP, UNIT of Refrigeration, Principle and applications of Room air conditioners.

UNIT–III:

Machine Tools- Introduction, working principle and classification of lathe, drilling and milling machines, major parts of a lathe and their functions, lathe operations on lathe - Specifications of lathe, parts of radial drilling machines, drilling operations, parts of horizontal milling machines, milling operations.

Metal joining processes- Introduction, classification of metal joining processes, method of welding (Electric Arc welding), soldering and brazing and their differences.

UNIT-IV:

Lubrication- Necessity, types of lubrications, properties of good lubricant.

Bearings- Classification and application of bearings only.

Power Transmission- Introduction totransmission systems and its classification, types of Belt Drives**,** Definitions of Velocity ratio, angle of contact Creep and slip, Idler pulley, stepped pulley, fast & loose pulley, simple problems.

Gears - Definitions, Spur gear terminology, Types and applications of Gears.

Gear Trains – Simple and compound gear trains, Simple problems on gear trains.

Text Books:

1. K.R. Gopalkrishna, A Text Book of Elements of Mechanical Engineering –Subhash Publishers, Bangalore.
2. Kestoor Praveen and M.R. Ramesh Elements of Mechanical Engineering –2nd Edition, Suggi Publications**,** 2011,

Reference Books:

SKH Chowdhary, AKH Chowdhary , Nirjhar Roy, The Elements of Workshop Technology - Vol I & II , 11th edition 2001, Media Promotors and Publishers, Mumbai.

Course Code: BTEE15F2500	**Basic Electrical Engineering**	**C**	**L**	**T**	**P**	**CH**
Duration: 16 Weeks		**3**	**2**	**1**	**0**	**4**

Course Objectives:

1. To establish a broad concept of various types of generation of electricity.
2. To make students understand the basics of representation of electrical quantities and relationship among them.
3. To provide an overview of various types of electrical apparatus.
4. To introduce the concept of domestic wiring and importance of safety and sensing devices.
5. To provide an insight into various sources of power generation.

Course Outcomes:

On completion of this course the students will be able to:

1. Describe the operation and control of various types of generation of electricity
2. Describe the principle of operation of electrical apparatus
3. Differentiate between single and three phase systems
4. Solve simple mathematical relationships related to electrical apparatus. Relate the applications of electronic devices and sensors in practical life.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3	PSO4
BTEE 15F2 500	CO1	**3**	**2**	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**3**			
	CO2	**3**	**3**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**			
	CO3	**3**	**2**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**			
	CO4	**3**	**2**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**3**			

Course Contents:

UNIT-I: Introduction to Electrical Parameters [11hrs]

Concept of Alternating Voltage and Current, Sinusoidal functions-specifications, Phasor representation, concept of impedance, admittance, conductance and susceptance –series and parallel circuits of RLC. Concept of power and power factor. Kirchoff's laws and network solutions. Electromagnetic induction-laws, direction & magnitude of indused emf, mmf, permeability, reluctance and comparison of electric and magnetic circuits. Self and mutual inductance of a coil, coupling coefficients. Concept of energy storage in L & C, resonance between L &C. Generation of three phase voltages, star-Wye configurations, relation between line and phase quantities and expression for power.

UNIT-II: Electrical Apparatus [11hrs]

DC generator, DC motor- concept of force, torque and mechanical work. Single and three phase induction motors, shaded pole motor, universal motor, stepper motor: Basic construction, principle of operation and applications. Single and three-phase transformers: Principle, emf equation.

UNIT-III: Generation & Distribution: [10hrs]

Block diagram representation of generation, transmission and distribution.Current generation and transmission scenario,need for transmission at high voltage. Block diagram representation of thermal, hydel, nuclear, diesel and renewable power plants. Concept of smart-grid and role of ICT in smart-grid.

UNIT-IV: Tariff, Protective Devices and Sensors [10hrs]

Tariff schemes, basic concepts of domestic wiring and types, earthing, protective fuses, MCB. Sensors: pressure sensor, strain gage, proximity sensor, displacement sensor, rotary encoder and ultrasonic sensors (applications in relevant disciplines- ref to 8 and 9)

References:

1. Theodore Wildi,"Electrical Machines, Drives, and Power Systems",Pearson Education, 5th Edition, 2007
2. Hughes, "Electrical Technology", International Students 9th Edition, Pearson, 2005
3. Kulshreshtha C,"Basic Electrical Engineering"Tata McGraw Hill, 2nd Edition, 2011
4. Mittle V.N. and A. Mittal, "Basic Electrical Engineering" Tata McGraw Hill, 2nd Edition, 2005
5. Kothari D.P., L.J. Nagrath"Basic Electrical Engineering",Tata McGraw Hill, 2009

6. Robert L. Boylestad and Louis Nashelsky, “Introduction to Electricicty, Electronics and Electromagnetics” Prentice Hall, 5th edition, 2001
7. Introduction to smart grid:
http://www.occ.ohio.gov/publications/electric/Smart_Grid_An_Introduction.pdf
8. Role of ICT in smart grid:
http://users.atlantis.ugent.be/cdvelder/papers/2010/develder2010sgc.pdf

Course Code: BTIC15F2600	**Indian Constitution and Professional Ethics**	**C**	**L**	**T**	**P**	**CH**
Duration: 16 Weeks		**2**	**1**	**1**	**0**	**3**

Prerequisites:

Basics of Social Sciences

Course Objectives:

1. Discuss the Fundamental Rights, Duties and other Rights which is been given by our law.
2. Explain the practicality of Constitution perspective and make them face the world as a bonafide citizen.
3. Acquire knowledge about ethics and also know about professional ethics.
4. Explore ethical standards followed by different companies.

Course Outcomes:

1. Interpret the fundamental rights and human rights.
2. Explain the duties of a citizen and more importantly practice it in a right way.
3. Get exposed about professional ethics and know about etiquettes about it.
4. Acquire the knowledge of ethical standards of different companies which will increase their professional ability.

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO 1**	**P 0 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PS O2**	**PS O3**	**PS O4**
BTIC15F2600	CO1						2		3				2	-	-	-	-
	CO2								3		3		2	-	-	-	-
	CO3	2					2		3		2		3	-	-	-	-
	CO4	2					2		3				2	-	-	-	-

Course Contents:

UNIT-I:Constitution of India : [13 hrs]

Definition,Making of Indian Constitution, Preamble to the Constitution of India, Fundamental Rights under Part III; Rights to Equality, Right to Freedom, Right against Exploitation, Rights to Freedom of Religion, Cultural and Educational Rights, Constitutional Remedies. Fundamental Duties of the Citizen, Significance and Charecteristics.Elements of National Significance; National Flag, National Anthem, National Emblem.

UNIT-II:Union and State : [10 hrs]

Organs of the Government; Legislature, Executive and Judiciary. Union and State Excecutives : President, Vice President, Prime Minister, Supreme Court, Cabinet, Governor, Councill of Ministers, Electoral process, Election Commission. Right to Information (RTI), Consumer and Consumer Protection.

UNIT III:Ethics: [13hrs]

Meaning, Definition, Evoltion, Need of ethics,Aristotlean Ethics, Utilitarianism, Katianism, Professional Ethics, Personal Ethics and Business Ethics, Ethical Standards, Duties of Employers and Employees.

UNIT IV:Engineering Ethics: [10hrs]

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

Reference books :

1. M V Pylee, An introduction to Constitution of India
2. M Govindarajan, S Natarajan, V S Senthil Kumar, Engineering

Course Code: BTCE15F2700	Communicative English	C	L	T	P	CH
Duration: 16 Weeks		2	1	1	0	3

Prerequisites:

Pre University English.

Course Objectives:

ls
in English.

2. To emphasize specially the development of speaking skills amongst learners of Engineering and Technology.
3. To ensure that learners use the electronic media such as internet and supplement the learning materials used in the classroom.
4. To inculcate the habit of reading and writing leading to effective and efficient communication.

Course Outcomes:

1. Speak clearly, confidently, comprehensibly, and communicate with one or many listenersusingappropriate communicative strategies.
2. Write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide
3. Vocabulary range, organizing their ideas logically on a topic.
4. Read different genres of texts adopting various reading strategies.Listen/view and comprehend different spoken discourses/excerpts in different accents.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BTCE 15F2 700	CO1						3	2		3	3		3				
	CO2						3	3		3	3		3				
	CO3						3	2		3	2		3				
	CO4						3	3		3	3		3				

Course Contents:

UNIT-I: **[7hrs]**

Text Component: Lamb to the Slaughter -Roald Dahl, My Mother's Hands-Robert Fontaine, Communicative Component: ,E-Mail Etiquette: Objective, Drafting, Language, Presentation Skills.

UNIT-II: **[7hrs]**

Text Component: ,Poor Girl-Maya Angelou ,A Glowing Future -Ruth Rendell, Communicative Component**:** *Employment Related Communication***,** Curriculum vitae and cover letters, Facing interviews.

UNIT-III: **[7hrs]**

Text Component**:** A Story of an Hour -Kate Chopin;,Communicative Component: *Writing:*Note taking/Note making, Report writing, Persuasion skills.

UNIT-IV: **[7hrs]**

Text Component: La Belle Dame Sans Merci- John Keats,Communicative Component: **Oral** *Communication:* Understanding Communication-Greeting, Introducing one self – others –in formal and informal contexts , Making Requests, Asking for and Giving Permission, Offering Help, Giving Instructions and Directions.

Reference Books:

1. Murphy,Raymond, Intermediate English Grammar,New York1998.
2. Wren &Martin ,English Grammar & Composition, New York 2001.
3. Mudambadithaya G.S., English Grammar and composition 2002
4. Digne, Flinders and Sweeney Cambridge University press2010
5. Lupton, Mary Jane . Maya Angelou: A Critical Companion. Westport, Connecticut:Greenwood Press. ISBN 978-0-313-303225, 1998
6. Booher, Diana. , Booher's Rules of Business Grammar, OUP 2004
7. Ur, Penny ,Grammar Practice Activities, OUP 2002
8. Wren &Martin,English Grammar & Composition, New York 2001
9. Joan Van Emden and Lucinda Becker Palgrave. Effective Communication for Arts and Humanities Students. Macmillan.
10. Glendinning, Eric H. and Beverly Holmstrom, Study Reading: A Course in Reading Skills for Academic Purposes, New Delhi: CUP. 2008
11. Langan, John, College Writing Skills. McGraw Hills 1996.

Course Code: BTPL15F2800	Engineering Physics Lab	C	L	T	P	CH
Duration: 16 Weeks		2	0	0	2	3

Course Objectives:

1. To make the students gain practical knowledge of Physics to co-relate with the theoretical studies.
2. To provide students with a theoretical and practical knowledge of Physics.
3. To achieve perfectness in experimental Skills and the study of practical applications improve confidence and ability to develop and fabricate engineering and technical equipments.
4. Students should be getting idea of basic electronic circuits, optical instruments and will be able to carry out experiments in optics and verify other important laws of Physics.

Course Outcomes:

At the end of the course a students are able to

1. Develop skills to apply practical knowledge of Physics in real time solution.
2. To understand and verify different laws of Physics using some simple experiments.
3. To design simple electrical circuits and analyze obtained result. Ability to use the knowledge acquired for different applications and projects.
4. Ability to apply knowledge of basic electronics in making simple circuits using diodes and transistors and analyze the responses.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BTEP 15F2 800	CO1	**3**	**3**		**1**									**3**	**3**	**3**	**3**
	CO2	**3**	**2**	**1**										**3**	**3**	**3**	**3**
	CO3	**3**	**2**					**1**						**3**	**3**	**3**	**3**
	CO4	**3**	**2**					**1**						**3**	**3**	**3**	**3**

Course Contents:

List of Experiments:

1. Determination of wavelength of the given laser using diffraction grating.

2. I-V characteristics ofZener-diode – (determination of knee voltage breakdown voltage and forward resistance).
3. Determination of Planck’s constant using LED.
4. Determination of energy gap of a semiconductor.
5. Measurement of dielectric constant by charging and discharging method.
6. Determination of Fermi energy of copper.
7. I-V characteristics of NPN-Transistor in C-E mode. (Determination of knee voltage input resistance, output resistance, current gain and current amplification factor breakdown).
8. Photo diode characteristics (I-V characteristics in reverse bias, variation of photocurrent as a function of intensity and reverse voltage).
9. Determination of Young’s modulus of the material by single cantilever method/uniform bending method.
10. Determination of resonant frequency, band width and quality factor of the given LCR series and parallel resonance circuits.
11. Determination of rigidity modulus of the material and moment of inertia of an irregular body using Torsional pendulum.
12. Measurement of numerical aperture and attenuation in optical fibers. (Demo Expt.)
13. Determination of electrical resistivity by four probe method. (Demo expt.)
14. Measurement of velocity of ultrasonics in the given liquid-acoustic grating method. (Demo Expt.)

Text Books:

1. C. L. Arora, “Practical Physics”, S. Chand & Co., New Delhi, 3rd Edition, 2012.
2. Vijay Kumar, Dr. T. Radhakrishna, “Practical Physics for Engineering Students”, S M Enterprises, 2nd Edition, 2014.

Reference Books:

1. C.F. Coombs,"Basic Electronic Instrument Handbook", McGraw-Hill Book Co., 1972.
2. C.H. Bernard and C.D. Epp, John Wiley and Sons, "Laboratory Experiments in College Physics" Inc., New York, 1995.

Course Code: BTEW15F2900	**Basic Electrical Engineering Lab and Workshop Practice**	**C**	**L**	**T**	**P**	**CH**
Duration: 16 Weeks		**2**	**0**	**0**	**2**	**3**

Prerequisites:

Basic Electrical and Electronics Engineering

Course Objectives:

1. To establish a broad concept of various types of electrical apparatus and instrumentation.
2. To provide hands on experience with electrical apparatus.
3. To train students to read and understand schematics so as to make connection.
4. To train students in collecting and interpreting experimental data.

Course Outcomes:

1. Recognize various symbols in a schematic and make connection as per the schematic
2. Make use of various measuring instruments to collect experimental data
3. Relate experimental results with theoretical analysis.
4. Demonstrate the ability to critically evaluate the performance of an electrical apparatus.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTEW 15F2 900	CO1	3	2	2	2		1						1	3			
	CO2	3	3	1	2		1							3			
	CO3	3	2	2	1		1							3			
	CO4	3	2	2	2		1						1	3			

Course Contents:

List of experiments -Electrical

1. Electronic tools introduction: ammeter, voltmeter, CRO.(demo)
2. Home electrical wiring demonstration: energy meter, MCB, tube light wiring.
3. Study of mutual induction effect.
4. Home electrical wiring demonstration: short circuit, series and parallel operation of load.
5. Electrical safety training: electrical activities to avoid shocks and importance of earthing, role of fuse, working of MCB.
6. Single phase transformer: study of polarity, turns ratio, losses, open circuit and closed circuit test
7. Diode rectifier applications: half wave & full wave rectifier, ripple factor calculations.
8. Thyristor applications: half wave & full wave rectifier (demo)
9. Sensor experiments: ultrasonic sensor, pressure sensor, LDR, opto coupler.

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WORKSHOP PRACTICE	
Objectives	1. To train students in metal joining process like welding, soldering etc. 2.To impart skill in fabricating simple components using sheet metal.

	3.To cultivate safety aspects in handling of tools and equipment.
Expected outcome	On completion of this course, the students will be able to 1.Welding and soldering operations. 2.Fabrication of simple sheet metal and wood parts.
Course Contents:	
UNIT-I	Welding Shop
1.Instruction of standards and reading of welding drawings. 2.Making Butt joint, Lap joint, Corner joint.	
UNIT-II	Sheet Metal and Soldering shop
1.Making of Cube, Prism, Cone, Cylinder, Funnel using development of lateral surfaces. 2. Instruction of standards and reading of soldering tools. 3.Soldering of sheet metal models.	
UNIT-III	Fitting/Carpentering
1.Introduction to Fitting tools. 2.Making V Joint, Square Joint. 3.Introduction to carpentry tools. 4.Making T Joint, Dovetail Joint.	
UNIT-IV	BOSCH Tools
1.Demonstration of all BOSCH tools and their applications.	

Text Books:

Workshop Manual Prepared by REVA University Staff	
Mode of Evaluation	Tutorials/Class Tests/Lab exam

BTCE15F3100	**Engineering Mathematics -III**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

BTCE15F1100, BTCE15F2100

Course Objectives:

To study and understand the application approach of the concepts of Numerical methods, curve fitting, and statistics.

Course outcomes:

At the end of the course the students would

1. Be capable of mathematically formulating certain practical problems.
2. Recognize and understand the methodologies of various numerical techniques and associated error estimation analysis.

3. Understand the importance of statistical analysis in engineering and other fields, the nature of uncertaintly and the concept of propability, numerical techniques for solving first-order differential equations.
4. Be able to solve the problems in dynamics of rigid bodies, optimization of orbit's and vibration problems.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F3 100	CO1	3	3	2	2	1	1							3	1	1	1
	CO2	3	3	2	2	1	1							3	1	1	1
	CO3	3	2	1	3	2	1							3	1	1	1
	CO4	3	2	2	2	2	1							3	2	1	1

UNIT - I: Numerical Methods

Introduction, solution of algebraic and transcendental equation, Bisection method, Regula false method.

Finite differences and Interpolation :-Forward and Backward differences , Newton's forward and Backward interpolation formulae, Divided differences-Newton's divided difference formula, Lagrange's Interpolation formula and Inverse Interpolation formula and Problems.

UNIT-II: Curve Fitting

Introduction, graphical Method, Principles of Least Squares, Method of Least squares, fitting of other curves, Methods of group averages, fitting a parabola, Method of Moments

UNIT-III: Probability and Information Theory:

Introduction, Principal of counting, and combinations, basic terminology, definition and probability, set notations. Addition law of probability, independent events, multiplication law of probability, Baye's Theorem, Random variables, Discrete Probability distribution, continuous probability distribution, Expectation, variance, Moments generating functions, Probability generating functions, repeated trials, Binomial distribution, Poisson Distribution, Normal Distribution.

UNIT-IV: Sampling and inference:

Introduction, sampling distribution, standard error, testing of hypothesis, errors, level of significance, tests of significance, confidence limits, simple sampling of attributes, test of significance for large samples, comparison of large samples, sampling of variables, central limit theorem, confidence limits, test of significance for means of two large samples, sampling variables, student-t- distribution, significance test of a sample mean, significance test of difference between sample means, chi-square test, goodness of fit.

Text Books:

1. B.S.Grewal, "Higher Engineering Mathematics" Khanna Publishers, latest edition
2. Erwin Kreyzig, "Advanced Engineering Mathematics", Wiley Pub lications, Latest edition

Reference Books:

1. B.V.Ramana, Higher Engineering Mathematics", Ist edition, Tata McGrraw Hill Publications,2010
2. R.K.jain and S.R.K.Iyengar, "Advanced Engineering Mathematics" ,Narosa Publishing House, 4th Edition

BTCE15F3200	**Building Materials & Construction Technology**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**2**	**1**	**0**	**3**	**4**

Prerequisites:

None

Course Objectives:

1. To learn about types of bricks, stones, cement and Concrete
2. To understand about types of foundations and brick and stone masonry.
3. To know about the lintels, stairs, roofs, doors and windows.
4. To understand the concepts of flooring and plastering.

Course Outcomes:

1. To identify the types of foundations and construction process.

2. To assess the different types of members of structures.
3. To Provide Suitable doors and windows
4. To carry out the Suitable type of paints.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F3 200	**CO1**	3	1	2	1					2	2		2	3	1	2	2
	CO2	3	1	2	2					2	2		3	3	1	2	2
	CO3	3	2	3	1					2	2		2	3	1	2	2
	CO4	3	2	3	1					2	2		3	3	1	2	2

Course contents

UNIT1: Foundation and Masonry

Function and requirements of a good foundation, Types of foundations, Preliminary investigation of soil, Safe Bearing Capacity of Soil, Introduction to spread, combined, strap, mat and pile foundations. (Basic Concepts and Sketches only)

Classification of Masonry, Definition of terms used in Masonry, Introduction to classification and qualities of bricks, Bonds in Brick work - English Bond, Flemish Bond, Reinforced Brick Masonry, Common building stones, their properties and uses, Classification of stone masonry, Joints in stone masonry, load bearing, cavity and partition walls.

UNIT2: Arches, Lintel, Balcony, Roofs and Floors

Elements of an arch, Classification of arches, Definition and classification of Lintels, Definition and functions of Chejja, Canopy & Balcony. Types of Roofs & Roofing materials, Flat roof (RCC), Types of pitched roofs, Wooden truss, Steel truss, Types of flooring, Factors affecting selection of flooring materials. (Classification and sketches only)

UNIT3: Doors, Windows , Stairs and plastering

Location of doors and windows with a plan of typical residential building (line diagram only), Definition of technical terms, Types of Doors, Types of windows, Varieties of materials for doors and windows & properties of wood. Definition of technical terms related to stairs, Types of Stairs, Geometrical design of RCC Dog legged and open well stairs (Plan and sectional elevation).Purpose of plastering, Materials of plastering, Methods of plastering, Defects in plastering,

UNIT4: Painting and Miscellaneous topics

Types of Paints, Constituents of paints, Purpose of Painting, Defects in Painting, Application of Paints to new and old surfaces.

Properties and uses of plastics, aluminum, glasses, varnishes, Introduction to smart materials and its application, Introduction to formwork and scaffolding, Formwork details for RCC Column, Beams and Floors, Shoring and under pinning, Damp Proofing - Causes of Dampness, Effects of Dampness, Methods of Damp Proofing

REFERENCE BOOKS

1. Rangawala P.C, Engineering Materials, Charter Publishing House, Anand, India.
2. Sushil Kumar, Engineering Materials, Standard Publication and Distributors, New Delhi.
3. M..S. Shetty, S. Chand and Co, Concrete technology – Theory and practice, New Delhi, 2002.
4. P.G. Varghese,A Text Book Building Materials, Prentice-Hall of India Pvt. Ltd., Publication.
5. Mohan Rai and M.P. Jain Singh, Advances in Building Materials and Construction publication by CBRI, Roorkee.
6. byNeville A.M and Brooks J.J , Concrete Technology ELBS Edition, London
7. byGambhir M.L, Concrete Technology–Dhanpat Rai and Sons, New Delhi.
8. C B Kukreja and Ravi Chawla, Material Testing Laboratory Manual by Standard Publishers Distributors, New Delhi.
9. H.M. Raghunath, Strength of Materials Lab Testing, Theory & Problems, New Age International (P) Ltd, 2010, New Delhi.

BTCE15F3300	**Engineering Earth Science**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**2**	**1**	**0**	**3**	**4**

Course Prerequisite: PUC with Science

Course Learning Objectives:

- To learn about Geomorphology and interior of the Earth.
- To study the origin, properties and uses of minerals.
- To study the origin, properties and uses of rocks.
- To study the causes and effects of earth quakes.
- To understand the various structures developed in rocks.
- To know the Geological details in the selection of dam and tunnel sites.
- To study the groundwater formation, exploration and exploitation.
- To study the Geomatics and its applications in the field.

Course Outcome:
At the end the course the students

1. Students will have knowledge about Engineering properties of Rocks and their Minerals.
2. Student will be appraised about Dam, reservoir, tunnel
3. Student will understand about Earthquake phenomena.
4. Student will able to carry out Physical exploration CE304.5 Student will able to estimate various geological parameters by use of modern tools & techniques

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F3 300	CO1	3	1	2	1					2	2		2	3	1	2	2
	CO2	3	1	2	2					2	2		3	3	1	2	2
	CO3	3	2	3	1					2	2		2	3	1	2	2
	CO4	3	2	3	1					2	2		3	3	1	2	2

Course Contents:

UNIT-I: **12hrs**

Introduction: Role of Earth Science in Civil Engineering Practices, Understanding the earth, interior of the earth, composition and density of crust, mantle and core layers.

Mineralogy: Quartz Group (Glass); Feldspar Group (Ceramic wares and Flooring tiles); Kaolin (Paper, paint and textile); Asbestos (AC sheets); Carbonate Group (Cement) ; Gypsum (POP, gypsum sheets, cement); Mica Group (Electrical industries); Ore minerals - Iron ores (Steel); Chromites (Alloy); Bauxite (aluminum); Chalcopyrite (copper). Mineral properties, composition and uses, in the manufacture of construction materials of above minerals.

Petrology: Strength Characteristics of rocks - Compressive, Tensile and Shear strengths and Hardness. Formation, Classification of Engineering properties and uses of rocks in construction : Igneous Rocks - Granite, Dolerite, Gabbro, Basalt; Sedimentary rocks - Sandstone, Shale, Limestone, Laterite; Metamorphic rocks - Gneiss, Quartzite, Slate, Charnockite: Decorative stones - Porphyries, Marble and Quartzite.

UNITII:12hrs

Geomorphology: Geomorphological agents: River valley, Drainage development and patterns; Coastlines and their engineering considerations , deserts and its features. Rock weathering and its effect on Civil Engineering projects;

Seismology: Introduction, seismic waves, Engineering problems related to Earthquakes, Earthquake intensity, causes and effects, Seismograph: , Seismic zones- World and India, Tsunami. Reservoir Induced Seismicity, Plate Tectonics.

Unit-III: 12hrs

Rock Mechanics: Concept of stress and strain, deformation of rocks, Development of Joints, Folds, Faults and Unconformity and their impact on the selection of sites for Dams, Reservoirs, Tunnels, Highways and bridges.

Construction Materials: Introduction, Selection of good quality rocks based on geological and engineering properties for use in the construction of Dams, Roads, Railway lines; Flooring slabs, Masonry, aggregates; Decorative stones-Colour, texture, hardness and durability.

Unit -IV: **12hrs**

Hydrogeology: Hydrological cycle, Occurrence of Groundwater in different terrains - Weathered, Hard and Stratified rocks. Groundwater pollution, Groundwater Exploration-Electrical Resistivity Method, Resistivity curves, Aquifer and its types, Springs and Artesian Wells, Rain water harvesting and recharge of Groundwater, Sea water intrusion and remedies.

Toposheets and Geological Maps: Study of Toposheets, Geological maps, Use of maps in Civil Engineering, Disaster Management – types of Disasters early warning system and their mitigation.

References:

1) Principles of Engineering Geology and Geotechnics by Dimitri P Krynine and William R Judd, CBS Publishers and Distributors, New Delhi.
2) Earthquake Tips - Learning Earthquake Design and Construction by C V R Murthy Published by National Information Centre of Earthquake Engineering, Indian Institute of Technology, Kanpur.
3) Bureau of Indian Standards, IS: 1893, IS: 4326, IS: 13827, IS: 13828, IS: 13920, IS: 13925, IS: 15662-2006.
4) Principles of Engineering Geology by K V G K Gokhale, BS Publications, Hyderabad
5) Fundamentals of Geology by A B Roy, Narosa Publishing House, New Delhi
6) Text book of Remote Sensing and Geographical information System by M Anji Reddy, BS Publications, Hyderabad
7) Physical Geology by Arthur Holmes, Tata Mac Grow Hill, New Delhi
8) Ground Water by K. Todd, Tata Mac Grow Hill, New Delhi
9) Structural Geology by M P Billings, CBS Publishers and Distributors, New Delhi
10) Engineering Geology by D. Venkata Reddy, New Age International Publications, New Delhi

BTCE15F3400	Surveying	L	T	P	C	Hrs/Wk
Duration:16 Wks		2	1	0	3	4

Prerequisites:

Basic Mathematics, and Basic science

Course Objectives:

1. To provide basic knowledge about principle of surveying for location, design and construction of engineering projects and also study about chain and compass surveying.
2. To develop skills for using surveying instruments including levelling instruments, plane tables etc.
3. To develop skills for using theodolite instruments to find horizontal and vertical angles and determine the elevation and distances.
4. To make students to set out various types of curves.

Course Outcomes:

1. Gain the basic surveying and application of chain and compass surveying for various different conditions.
2. Gained the ability to use plane table and levelling equipment with their accessories and to meet various requirements.
3. Gain the ability to use of theodolite to measure angles, elevation and distances.
4. Set out horizontal and vertical curves for various engineering projects.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BTCE 15F3 400	CO1	3	3	2	3	3	-	-	-	2	-	-	3	3	3	3	3
	CO2	3	3	2	3	-	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	3	2	1	-	-	-	-	-	-	-	3	3	3	3	3

	CO4	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**3**	**3**	**3**	**3**

UNIT – I: Introduction to Surveying

Importance of surveying to Civil Engineering – Definition– Classification– Concepts of plane and geodetic surveying – Principles of surveying –Plans and maps – Surveying equipments, their type and uses (Chain, Tape, Ranging rod, Cross staff, Optical square, Prism square, Offset rod) – Obstacles in chain surveys. Meridians, Bearings, Dip, Declination, Local attraction - Chain & Compass traverse, Local attraction, Calculation of bearings and included angles with numerical examples

UNIT – II: Plane Table Surveying and Levelling

Plane table surveying – Methods of plotting – Radiation, Intersection, Traversing and Resection – Two and Three point problem and solutions

Levelling – Principles and basic definitions – Types of Levels – Types of adjustments and objectives – Types of levelling – Simple, Differential, Fly, Reciprocal, Profile, Cross sectioning – Booking of levels – Rise & fall and H. I methods – Contours and their characteristics – Methods of contour plotting – Interpolation – Grade contour – application of contours. Numerical examples on levelling and calculation of reservoir capacity,.

UNIT – III: Theodolite Survey, Trignometric Levelling and Tacheometry

Theodolite – Types of adjustments and objectives - Horizontal and Vertical angle measurements by repetition and reiteration – Trigonometric levelling - Single and Double plane for finding elevation of objects – Application of tacheometry– Finding constants K & C – Computation of distances and elevations using Tacheometric methods, only concepts.

Calculation of areaand Volumes- calculation of area using cross staff surveying-coordinates method -Simpson’s and Trapezoidal rules and use of Digital Planimeter-Measurement of volume by Trapezoidal and Prismoidal formula – Volume calculation from spot levels and contour plans. Problems on Railway and Highway embankments.

UNIT – IV : Curves

Simple curve-Elements of simple curves, Designation of a curve, setting out simple curve by offsets from long chord and offsets from chords produced, Setting out simple curve by Rankine’s method, Numerical problems. Compound Curve- Tabulation and setting out of compound curve, Reverse curve, transition curve, combined curve and vertical curves, numerical examples.

Text Books:

1.Punmia B C., “Surveying”, Vol. 1 & 2, Laxmi Publications Pvt. Ltd., New Delhi. 2009

2.T P Kanetkar & S P Kulkarni., “Surveying”, Vol. 1 & 2, Tata McGraw Hill Publishing Co. Ltd, New Delhi. 2009.

Reference Books:

1.S K Roy, “Fundamentals of Surveying”, Prentice Hall of India, New Delhi. 2009

2.S K Duggal, “Surveying”, Vol. 1, Tata McGraw Hill Publishing Co. Ltd., New Delhi. 2008.

3.M. Chandra, “Plane Surveying”– New age international (P) Ltd.

BTCE15F3500	Strength of Materials	L	T	P	C	Hrs/Wk
Duration :16 Wks		2	1	0	3	4

Prerequisites:

Applied Physics, and Engineering Mechanics.

Course Objectives:

1. About the basic concepts of simple stresses, strains and elastic constants, composite bars and temperature stresses in simple and compound bars.
2. About bending moment and shear force of various beams
3. About bending and shear stresses in beams subjected to simple bending and deflections in loaded statically determinate beams
4. About torsional stress induced in circular members and critical buckling load of prismatic columns with different end conditions.

Course Outcomes:

1. To has the concepts of simple stresses, strains and elastic constants and able to analyse stresses in composite bars and temperature stresses in simple and compound bars.
2. To compute shear force and bending moment of different types of loadings of various beams
3. To compute bending and shear stresses in beams subjected to simple bending slope and deflection in loaded statically determinate beams
4. To compute torsional stress induced in circular members and critical buckling load of prismatic columns with different end conditions.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PS O2	PS O3	PS O4
BTCE 15F3 500	CO1	**3**	**3**	**1**	**1**	**1**	**2**	**1**		**1**	**2**		**3**	**3**	**3**	**3**	**2**
	CO2	**3**	**3**	**1**	**2**		**2**	**1**		**1**	**2**		**3**	**3**	**3**	**3**	**2**
	CO3	**3**	**3**	**2**	**2**	**2**	**2**	**1**		**1**	**2**		**3**	**3**	**3**	**3**	**2**
	CO4	**3**	**3**	**2**	**2**	**2**	**2**	**1**		**1**	**2**		**3**	**3**	**3**	**3**	**2**

Course Contents:

UNIT 1: Simple Stresses and Strains:
Introduction, Properties of Materials, Stress, Strain, Hooke's law, Poisson's Ratio, Stress–Strain Diagram for structural steel and non ferrous materials, Principle of superposition, Total elongation of tapering bars of circular and rectangular cross sections, volumetric strain, expression for volumetric strain, Elastic constants, Relationships among elastic constants, Stresses in composite bars, Thermal stresses in simple and compound bars.

UNIT 2:Bending moment , shear force and deflections in beams
Introduction, Types of beams, loadings and supports, Shearing force, Bending moment, Sign convention, Relationships among loading intensity, shear force and bending moment, Shear force and bending moment equations and diagrams for cantilever beams, simply supported beams and overhanging beams considering point loads, UDL, UVL and Couples.
Deflection of beams
Introduction – Definition of slope, deflection and elastic curve, Derivation of differential equation of flexure (Euler-Bernoulli equation), Sign convention, Slope and deflection of statically determinate beams by the method of singularity functions(Macaulay's method).

UNIT 3: Compound Stresses , Bending and shear stresses in beams
Compound Stresses: Introduction, Stress components on inclined planes, General two dimensional stress system, Principal planes and stresses.
Introduction – Bending stress in beam, Assumptions in simplebending theory, Simple bending equation, section modulus, Flexural rigidity, Modulus of rupture. Expressionfor horizontal shear stress in beam, Shear stress diagram for homogeneous rectangular,symmetrical 'I' and 'T' beam sections.
UNIT 4:Torsion of circular shafts:
Introduction – Pure torsion-torsion equation of circular shafts, Strength and stiffness, Torsional rigidity and polar modulus, Powertransmitted by shaft of solid and hollow circular sections.
Elastic stability of columns:
Introduction – Short and long columns, Euler's theory on columns, Effective length, slenderness ratio, buckling load, Assumptions and derivation of Euler's Buckling load for different end conditions, Limitations of Euler's theory.

TEXT BOOKS:
1. Beer & Johnston, Mechanics of Materials
2. James M. Gere, Mechanics of Materials, (5th Edition), Thomson Learning
3. Singer, Strength of Materials, Harper and Row Publications.
4. Timoshenko and Young, Elements of Strength of Materials, Affliated East-West Press.

REFERENCE BOOKS:
1. Basavarajaiah and Mahadevappa, Strength of Materials, University Press (2009).
2. B.C Punmia Ashok Jain, Arun Jain, Mechanics of Materials, Lakshmi Publications, New Delhi.
3. Subramanyam, Strength of Materials, Oxford University Press, Edition 2008

BTCE15F3600	Fluid Mechanics	L	T	P	C	Hrs/Wk
Duration :16 Wks		**2**	**1**	**0**	**3**	**4**

Prerequisites:

Applied Physics

Course Objectives:

1. Understand the flow of fluids in motion, kinematics and dynamics, its properties and familiarize with Bernoulli's Energy Equation and Venturimeter.
2. Understand the types of losses in pipe flow, estimate the major loss and minor loss due to sudden expansion and pipe networks.
3. Understand various types of notches and weirs and their applications and estimate the flow of fluid in channels.
4. Learn the geometric properties and designing of open channels to carry uniform flow and for most economical conditions of channels

Course Outcomes:

1. Know the types of flow of fluids in motion, kinematics and dynamics, its properties and solve the numerical with Bernoulli's Energy Equation and Venturimeter.
2. Know about the types of losses in pipe flow, estimate the major loss and minor loss due to sudden expansion and pipe networks.
3. Know various notches and weir and their applications in estimating the flow of fluid in channels.
4. Know the geometric properties and designing of open channels to carry uniform flow and conditions for most economical channels.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BTCE 15F3 600	CO1	3	3	2	3	3	-	3					3	3	3	3	3
	CO2	3	3	2	3	2	-	3					3	3	3	3	3
	CO3	3	3	2	2	2	-	2					3	3	3	3	3
	CO4	3	3	2	2	2	-	2					3	3	3	3	3

Course Contents:

UNIT-1: BASIC PROPERTIES OF FLUIDS

Introduction, Definition of Fluid, Systems of units, properties of fluid: Mass density, Specific weight, Specific gravity, Specific volume, Viscosity, Cohesion, Adhesion, Surface tension,& capillarity. Newton's law of viscosity (theory & problems).Capillary rise in a vertical tube and between two plane surfaces (theory only).

PRESSURE AND ITS MEASUREMENT

Definition of pressure, Pressure at a point, Pascal's law, Variation of pressure with depth. Types of pressure. Vapour pressure. Measurement of pressure using simple, differential & inclined manometers (theory & problems). Introduction to Mechanical and electronic pressure measuring devices. .

HYDROSTATIC PRESSURE ON SURFACES

Basic definitions, equations for hydrostatic force and depth of centre of pressure for Vertical and inclined submerged laminae (plane and curved) - Problems.

UNIT-2: KINEMATICS OF FLOW

Introduction, methods of describing fluid motion, definitions of types of fluid flow, streamline, path line, stream tube. Three dimensional continuity equation in Cartesian Coordinates (derivation only). General Continuity equation (problems). Velocity potential, Stream function, Equipotential line, Stream line- problems, Physical concepts of Stream function. Introduction to flow net.

DYNAMICS OF FLUID FLOW

Introduction, Energy possessed by a fluid body. Euler's equation of motion along a streamline and Bernoulli's equation. Assumptions and limitations of Bernoulli's equation. Momentum equation problems on pipe bends.

UNIT-3: PIPE FLOW

Introduction, losses in pipe flow, Darcy-Weisbach equation for head loss due to friction in a pipe. Pipes in series, pipes in parallel, equivalent pipe, pipe networks-problems. Minor losses in pipe flow, equation for head loss due to sudden expansion- problems.

UNIT-4: UNIFORM FLOW IN OPEN CHANNELS

Introduction, Geometric properties of Rectangular, Triangular, Trapezoidal and Circular channels. Chezy's equation, Manning's equation-problems. Most economical open channels-Rectangular, Triangular, Trapezoidal and Circular channels- problems.

TEXT BOOKS:

1. R.K.Rajput, S.Chand & Co, 'A Textbook of Fluid mechanics & Hydraulic Machines'-, New Delhi, 2006.
2. N.Narayana Pillai, 'Principles of Fluid Mechanics and Fluid Machines'- Universities Press (India), Hyderabad, 2009 Edition.
3. Madan Mohan Das, 'Fluid Mechanics and Turbomachines'- PHI Learning Pvt. Limited, New Delhi. 2009 Edition.

REFERENCE BOOKS:

1. Bruce R. Munson,Donald F.Young, Theodore H. Fundamentals of Fluid Mechanics' –Okiishi, Wiley India, New Delhi, 2009 Edition.
2. Edward j.Shaughnessy, jr; Ira m. Katz 'Introduction To Fluid Mechanics' –:; James p Schaffer, Oxford University Press, New Delhi, 2005 Edition.
3. R.K.Bansal, 'Text Book Of Fluid Mechanics& Hydralic Machines'- Laxmi Publications, New Delhi, 2008 Edition.
4. Streeter, Wylie, 'Fluid Mechanics' –Bedford New Delhi,2008(Ed)

BTCE15F3700	**Basic Material Testing Lab**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**1**	**0**	**1**	**2**	**3**

Prerequisites:

Building Materials and Strength of Materials.

Course Objectives:

1. Ability to apply knowledge of mathematics and engineering in calculating the mechanical properties of structural materials
2. To provide an opportunity to learn how to measure hardness of ferrous and non-ferrous materials.
3. To study the behaviour of mild steel under impact load, torsion, tension, compression and shear.
4. To study the behaviour of wood under compression and bending.

Course Outcomes:

1. Reproduce the basic knowledge of mathematics and engineering in finding the strength in tension, compression, shear and torsion.
2. Measure the hardness of ferrous and nonferrous metals.
3. Identify, formulate and solve engineering problems of structural elements subjected to flexure.
4. Analyse the behaviour of wood under compression and bending test.

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO 1**	**P 02**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
BTCE 15F3 700	CO1	**3**	**3**	**2**	**1**	**1**	**1**			**1**	**2**	**2**	**2**	**3**	**2**	**2**	**2**
	CO2	**3**	**2**	**1**	**2**	**1**	**2**			**1**	**2**	**3**	**2**	**2**	**3**	**2**	**2**
	CO3	**3**	**2**	**1**	**2**	**1**	**2**			**1**	**2**	**3**	**2**	**2**	**3**	**2**	**2**
	CO4	**3**	**2**	**1**	**2**	**1**	**2**			**1**	**2**	**3**	**2**	**2**	**3**	**2**	**2**

Laboratory Experiments:

1. Tension test on Mild steel and HYSD bars.
2. Compression test of Mild Steel, Cast iron and Wood.
3. Torsion test on Mild Steel circular bar
4. Bending Test on Wood under two point loading
5. Shear Test on Mild steel.
6. Impact Test on Mild Steel (Charpy & Izod)
7. Tests on Bricks and Tiles
8. Tests on Fine aggregates – Moisture content, Specific gravity, Bulk density, Sieve analysis and Bulking
9. Tests on Coarse aggregates – Absorption, Moisture content, specific gravity, Bulk density and Sieve analysis.
10. Demonstration of Strain Gauges.

Reference Books:

1. Davis, Troxell and Hawk, Testing of Engineering Materials, International Student Edition – McGraw Hill Book Co, New Delhi.
2. Fenner, Mechanical Testing of Materials, George Newnes Ltd. London.
3. Holes.K.A, Experimental Strength of Materials, English Universities Press Ltd. London. Relevant IS Codes.
4. M.L.Gambhir, Concrete Manual, Dhanpat Rai & Sones, New Delhi.

BTCE15F3800	**Surveying Practice Lab**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**1**	**0**	**1**	**2**	**3**

Prerequisites:

Applied Surveying

Course Objectives:

1. To understand basics of linear and angular measurements in field using surveying equipment's.
2. To use compass for setting out of various civil engineering works involving linear and angular measurements.
3. Levelling techniques and contour map development.
4. To set out simple and compound curves by different methods.

Course Outcomes:

1. Develop skills of using instruments for distance measurement and angular measurements.
2. Develop skills to use theodolite for horizontal and vertical angle measurements.
3. Develop skill to measure distance and angle by single plane and double plane methods.
4. Develop skill to setting out simple and compound curves by different methods.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
BTCE 15F3 800	CO1	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**3**	**3**	**3**	**3**
	CO2	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**3**	**3**	**3**	**3**
	CO3	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**3**	**3**	**3**	**3**
	CO4	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**3**	**3**	**3**	**3**

LIST OF PRACTICALS:

1. To measure distance between two points using direct ranging, to set out perpendiculars at various points on given line and thus to calculate the area of a plot by cross-staff survey.
2. Measurement of bearing of the sides of a closed traverse using prismatic compass.
3. To locate points using Radiation and Intersection method of plane tabling and to solve 3-point problem in plane tabling using Bessel’s graphical solution.
4. To determine difference in elevation between two points using fly levelling & to conduct Fly back levelling to check the accuracy of levelling work. Booking of levels using both H I & Rise and fall methods.
5. To conduct profile levelling for water supply/sewer line and to draw the longitudinal section to determine the depth of cut/fill for a given gradient.
6. Measurement of horizontal angles using method of Repetition and reiteration & measurement of vertical angles using Theodolite.
7. To determine the distance & elevation of an object using single plane and double plane methods.

Text Books:

1. Punmia B C., “Surveying”, Vol. 1 & 2, Laxmi Publications Pvt. Ltd., New Delhi. 2009
2. T P Kanetkar & S P Kulkarni., “Surveying”, Vol. 1 & 2, Tata McGraw Hill Publishing Co. Ltd, New Delhi. 2009.

Reference Books:

1. S K Roy, “Fundamentals of Surveying”, Prentice Hall of India, New Delhi. 2009
2. S K Duggal, “Surveying”, Vol. 1, Tata McGraw Hill Publishing Co. Ltd., New Delhi. 2008.
   A. M. Chandra, “Plane Surveying”– New age international (P) Ltd.

SYLLABUS IV SEMESTER

BTCE15F4100	Concrete Technology & Alternative Building Materials	L	T	P	C	Hrs/Wk
Duration :16 Wks		2	1	0	3	4

Prerequisites:

Civil engineering materials and Engineering Construction.

Course Objectives:

1. To learn about different alternative building materials and its characteristics
2. To understand about properties of lime-pozzolana cements
3. To know the factors and properties of structural masonry and equipment for the production of alternative materials.
4. To understand the different alternative building technology and cost effective building design.

Course Outcomes:

1. Have learnt about different alternative building materials.
2. Be able to understand properties of lime-pozzolana cements.
3. Be able identify the equipment's for the alternative building materials.
4. Able to explain the different technology and their design.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F4 100	CO1	3	3	1										3	2	1	1
	CO2	3	2	1										3	1	1	1
	CO3	3	3	2	3									3	3	3	2
	CO4	3	3	3	2									3	3	3	1

Course Contents:

UNIT1:Cement and Aggregates:

Cement and aggregates, Chemical composition, hydration of cement, Types of cement, manufacture of OPC by wet and dry, process (flow charts only) .Testing of cement and grades of cement, Quality of mixing water. Fine aggregate testing, deleterious materials. Coarse aggregate – Importance of size, shape and texture. Grading of aggregates - Sieve analysis, specific gravity, Flakiness and elongation index, crushing, impact and abrasion tests.

UNIT :Properties of concrete:

Workability - factors affecting workability, Measurement of workability, Segregation and bleeding, Process of manufactures of concrete: Batching, Mixing, Transporting, Placing, Compaction and Curing, RMC concrete.

Chemical admixture, Mineral admixtures, Factors affecting strength, w/c ratio, gel/space ratio, maturity concept, Effect of aggregate properties, relation between compressive strength, and tensile strength, bond strength, modulus of rupture, Accelerated curing, aggregate - cement bond strength, Testing of hardened concrete by various methods.

Elasticity - Relation between modulus of elasticity and Strength, factors affecting modulus of elasticity, Poisson's Ratio, Shrinkage and creep concepts only.

UNIT3:Durability of Concrete and mix design:

Durability - definition, significance, permeability, Sulphate attack, Chloride attack, carbonation, freezing and thawing, Factors contributing to cracks in concrete - plastic shrinkage, settlement cracks, construction joints, Thermal expansion, transition zone, structural design deficiencies.

Concept of Concrete Mix design, variables in proportioning, exposure conditions, Procedure of mix design as per IS 10262, Numerical examples of Mix Design**.**

UNIT4:Alternative building materials:

Energy in building materials, Environmental issues concerned to building materials, Global warming and construction industry, Environmental friendly and cost effective building technologies, Characteristics of building different blocks for wall, Alternative for wall construction, Types, Construction method, Masonry mortars,

Ferro-cement - materials, techniques of manufacture, properties and. Fiber reinforced concrete - Fibers types and properties, Self compacting concrete concept, materials, tests, properties, application and Typical mix.(theoretical concepts only). Nansu method of mix design for SCC (procedure only)

REFERENCE BOOKS:

1. M.S.Shetty, **Concrete Technology -Theory and Practice**, S.Chandand Company, New Delhi.
2. Neville, A.M **Properties of Concrete**, ELBS, London
3. A.R.Santhakumar, "**Concrete Technology**", Oxford University Press (2007)
4. N Krishnaraju, **Design of Concrete Mixes**, Sehgal Educational Consultants & Publishers Pvt. Ltd, Faridabad.
5. "**Recommended guidelines for concrete mix design**" - IS: 10262, BISPublication.
6. K.S. Jagadish, B.V.Venkatarama Reddy & K S NanjundaRao, Alternative building materials and technologies, New Age International Publishers Ltd, New Delhi.
7. Relevant IS Codes
8. Gambhir, M.L., Concrete Manual: Laboratory Testing for Quality Control of *Concrete*, 4th Edn., Dhanpat Rai and Sons, Delhi, 1992.

Sood, Hemant, Mittal L N and Kulkarni P D, **Laboratory Manual on Concrete Technology** CBS Publishers, New Delhi, 2002.

BTCE15F4200	Applied Surveying & GIS	L	T	P	C	Hrs/Wk
Duration :16 Wks		2	1	0	3	4

Prerequisites:

Basic Mathematics, and Basic science

Course Objectives:

1. To provide basic knowledge about principle of surveying for location, design and construction of engineering projects and also study about chain and compass surveying.
2. To develop skills for using surveying instruments including levelling instruments, plane tables etc.
3. To develop skills for using theodolite instruments to find horizontal and vertical angles and determine the elevation and distances.
4. To make students to set out various types of curves.

Course Outcomes:

1. Gain the basic surveying and application of chain and compass surveying for various different conditions.
2. Gained the ability to use plane table and levelling equipment with their accessories and to meet various requirements.
3. Gain the ability to use of theodolite to measure angles, elevation and distances.
4. Set out horizontal and vertical curves for various engineering projects.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3	PS O4
BTCE 15F4 200	CO1	3	3	2	3	3	-	-	-	2	-	-	3	3	3	3	3
	CO2	3	3	2	3	-	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	3	2	1	-	-	-	-	-	-	-	3	3	3	3	3
	CO4	3	3	1	2	-	-	-	-	2	-	-	3	3	3	3	3

UNIT – I : Introduction

General requirements and specifications for engineering project surveys, reconnaissance. Preliminary and locations survey for highway, earthen bund and canals. (brief types and concepts only)

Setting out of Construction works-Setting out of a bridge, determination of the length of the central line and the location of piers, Setting out of a tunnel – surface setting out and transferring the alignment underground.

EDM: Principles of EDM's. Total Station-salient features and capabilities. Digital levels-salient features and capabilities.

UNIT – II: Hydrographic Survey and Aerial Photogrammetry

Hydrographic Survey- horizontal and vertical control. Soundings and location Shoreline and river survey, Methods of soundings, equipments, three point problem. Tidal and Stream Discharge measurement

Aerial Photogrammetry -Introduction, Principle, Uses, Aerial Camera, Aerial Photographs, Definitions, Scale of vertical and tilted photograph, ground co-ordinates, ground control procedure for aerial survey.

UNIT – III : **Remote Sensing and GPS**

Definition and concepts. Concept of signatures. Multi-spectral concept. Remote sensing systems. Remote sensors and platforms. Data products generation and analysis. Application of remote sensing in agriculture, water resources, wet land management, land cover/use mapping and forestry. Global Positioning System-Advantages of GPS, Components of GPS-Space, control and user segments. Relative and differential positioning. Factors affecting GPS, GPS applications.

Unit 4: GIS

Introduction to GIS, GIS terminology, concepts, Geographic data-data input, processing – data base structure-vector and raster data structure, database management-layer concepts, spatial manipulation and analysis and graphical output and visualization.

Use of GIS in Management and monitoring of land, air, change detection, water and pollution studies, conservation of resources, geological applications, coastal zone management - Limitations.

Text Books:

1. Punmia B C., "Surveying", Vol. 1 & 2, Laxmi Publications Pvt. Ltd., New Delhi. 2009

2. T P Kanetkar & S P Kulkarni., "Surveying", Vol. 1 & 2, Tata McGraw Hill Publishing Co. Ltd, New Delhi. 2009.

3.Anji Reddi, "Remote Sensing and GIS", BS publications, 2001

Reference Books:

1. S K Roy, "Fundamentals of Surveying", Prentice Hall of India, New Delhi. 2009

2.S K Duggal, "Surveying", Vol. 1, Tata McGraw Hill Publishing Co. Ltd., New Delhi. 2008.

3.M. Chandra, "Plane Surveying"– New age international (P) Ltd.

BTCE15F4300	Building Planning & Drawing	L	T	P	C	Hrs/Wk
Duration :16 Wks		1	2	0	3	5

Prerequisites:

Prerequisite: Building Material and Construction Technology

Course Objectives:

1. Preparation of drawings of building components
2. Functional design of buildings (residential, public and industrial)
3. Development of plan, elevation and sectional views, water supply, sanitary and electrical layouts of residential buildings given line diagram.
4. To develop line diagrams for non-residential buildings

Course Outcomes:

1. Able to prepare drawings of building components
2. Able to carry out functional design of buildings (residential, public and industrial)
3. Able to develop plan, elevation and sectional views of residential buildings given line diagram. To prepare water supply, sanitary and electrical layouts.
4. Able to develop line diagrams for non-residential buildings Using drafting software.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BTCE 15F4 300	CO1	3	2	2						2			3	3	3	3	3
	CO2	3	2	3	2					2			3	3	3	3	3
	CO3	3	2	3	2					2			3	3	3	3	3
	CO4	3	2	3	1					2			3	3	3	3	3

Course Contents:

UNIT-1

Preparation of geometrical drawing of components of buildings i) Stepped wall footing and isolated RCC column footing, ii) Fully paneled and flush doors, iii) Half-paneled and half-glazed window, iv) RCC dog legged and open well stairs, v) Steel truss.

UNIT-2

Functional design of building (Residential, Public and Industrial), positioning of various components of buildings, orientation of buildings, building standards and bye-laws, set back distances and calculation of carpet area, plinth area and floor area ratio.

UNIT-3

Development of plan, elevation, section and schedule of openings from the given line diagram of residential building: i) Two bed room building, ii) Two-storeyed building.

Preparation of water supply, sanitary and electrical layouts for a given single line diagram.

UNIT-4

Functional design of buildings using inter-connectivity diagrams (bubble diagram), development of line diagram for following buildings i) Primary health centre, ii) Primary school building, iii) College canteen iv) Office building.

Note: The drawings shall be prepared using AUTOCAD or any other drafting software.

Examination & Evaluation:

1. Based on manual drawing practice & submission of drawing sheets of Unit I & Unit-II C1 Assessment has to be done.

1. Based on manual drawing practice & submission of drawing sheets of Unit III & Unit-IV C2 Assessment has to be done.
2. C3 examination must be with Auto CAD 3hours lab examination for UNIT-III & UNIT-IV only (TWO problems must be given one from UNIT-III (35 Marks) , One from UNIT-IV 15 Marks . UNIT-III (Plan – 10 marks, front elevation- 5 marks, Sectional elevation – 10 marks , dimensioning – 5 marks and Schedule of openings – 5 marks)

REFERENCE BOOKS:

1. Shah M.H and Kale C.M, **Building Drawing**, Tata Mc-Graw Hill Publishing co. Ltd., NewDelhi.
2. Gurucharan Singh, **Building Construction,** Standard Publishers &distributors, New Delhi.
3. **National Building Code**, BIS, New Delhi.
4. 4. N.Kumarswamy and A. Kameswara Rao, **Building Planning And Drawing,** Chartor Publishing House Pvt. Ltd.
5. Dr.*Balagopal and T.S.Prabhu*, ***Building Drawing and Detailing*** - *Spades Publishers*, Calicut.

BTCE15F4400	Water Supply Engineering & Introduction to EIA	L	T	P	C	Hrs/Wk
Duration :16 Wks		2	1	0	3	4

Prerequisites:

Water and Waste Water Engineering

Course Objectives:

1. Identify the various Water sources, water borne diseases, types of pumps for rural water supply and Water treatment methods to control contamination of water.
2. Describe Principles of rural sanitation and rain water harvesting.
3. Identify the Methods of communicable diseases and Refuse collection system
4. Describe the Milk Sanitation principle and identify the insects control measures.

Course Outcomes:

1. Understanding the concepts of protected water supply. Estimate water demand for a particular town and forecast the population.
2. Exposure to various sources of water, the methods of collection and its conveyance and Calculate the economical diameter of rising main.
3. Ability to identify the various physical chemical and biological parameters of water and the drinking water standards. Select and design appropriate water treatment unit processes.
4. Understanding the concepts of EIA and the methodology of preparation of a systematic EIA report. Exposure to standard laboratory methods of water quality analysis.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO	PSO2	PSO3	PSO4
BTCE 15F4 400	CO1	3	3	2	3	3				2			3	3	3	3	3
	CO2	3	3	2	3	2				2			3	3	3	3	3
	CO3	3	3	2	1	2		2		2			3	3	3	3	3
	CO4	3	3	1	2	2		2		2			3	3	3	3	3

Course Contents:

UNIT-I: INTRODUCTION : Need for protected water supply, Concepts of rural water supply scheme, Types of water demands- domestic demand in detail, institutional and commercial, public uses, fire demand, per capita consumption and design period –factors affecting, population forecasting, Numerical on population forecast, different methods with merits &demerits- variations in demand of water, peak factors.

Sources and Collection of Water

Surface and subsurface sources – suitability with regard to quality and quantity, Intake structures – different types, sketches, factors of selection and location of intake

UNIT-II:CONVEYANCE OF WATER: Pipes – Design of the economical diameter for the rising main; Pipe appurtenances, various valves, type of fire hydrants, pipe fitting, layout of water supply pipes in buildings; systems of water supply, methods of layout of distribution systems.

QUALITY OF WATER: Objectives of water quality management, Water quality parameters – Physical, chemical and Microbiological, Sampling, Water quality analysis (IS: 3025 and IS: 1622), Drinking water standards BIS & WHO guidelines. Health significance of Fluoride, Nitrates and heavy metals like Mercury, Cadmium, Arsenic etc and toxic / trace organics, water borne diseases, Objectives of Water Treatment, Flow chart of treatment units.

UNIT-III:WATER TREATMENT :

Aeration- Principles, types; Sedimentation- theory, types, Coagulant aided sedimentation-jar test, feeding, flash mixing and clariflocculator; Filtration-theory, types, construction, operation and maintenance of filters; Disinfection- theory, types, minor methods, treatment of swimming pool water; Design criteria of all treatment units, numerical

Miscellaneous treatments -Softening- definition, lime soda process, zeolite process, RO and membrane techniques, - removal of colour, odour and taste, Fluoridation and Defluoridation

UNIT-IV:INTRODUCTION TO EIA :

Environment Impact Assessment, step by step procedure for conducting EIA , Rapid and comprehensive EIA, EIS, FONSI, Need for EIA, , Limitations of EIA, Methodologies- adhoc, checklist, matrix, networks, index, overlay, simulation modeling

EIA guidelines for Development Projects, Public participation in Project activities, Case Studies.

TEXT BOOKS

1. S.K.Garg, Water supply Engineering –Khanna Publishers
2. B C Punima and Ashok Jain, Environmental Engineering I
3. Peavy, H.S., Rowe, D.R., and Tchobanoglous, G., Environmental Engineering - (1986), Mc Graw Hill Book Co.
4. Anjaneyalu Y; BS Publications, Environmental Impact Assessment- Hyderabad.

REFERENCES

1. Manual on Water supply and treatment –CPHEEO, Ministry of Urban Development, New Delhi

2. Hammer, M.J., (1986), Water and Wastewater Technology –SI Version, 2nd Edition, John Wiley and Sons.
3. Karia, G.L., and Christian, R.A., (2006), Wastewater Treatment – Concepts and Design Approach, Prentice Hall of India Pvt. Ltd., New Delhi.
4. Sincero, A.P., and Sincero, G.A., (1999), Environmental Engineering – A Design Approach– Prentice Hall of India Pvt. Ltd., New Delhi.
5. E.W.Steel,Mc Ghee, Terence -'Water Supply Engineering and Sewerage; Mc.Graw Hill
6. Fair, Geyer and Okun-'Water and Wastewater Engineering: Water Supply and Wastewater Removal, 3rd Edition, John Wiley and Sons.
7. Larry. W .Canter, Environmental Impact Assessment, Mc Graw Hill Publications.
8. Ministry of Environment and Forests Notification on EIA of Developments Projects.

BTCE15F4500	Basic Structural Analysis	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	3	4

Prerequisites:

Strength of Materials

Course Objectives:

1. To learn the basics of structures and present the concept of moment area method, conjugate beam method and unit load method to compute slopes and deflections.
2. Present systematic approach for analysing three hinged and two hinged arches.
3. Compute the moments of statically indeterminate structures by consistent deformation method, Clapeyron's theorem of three moments and slope deflection method.
4. Explain and demonstrate the concept involved in the analysis of indeterminate structures by moment distribution method and Kani's method.

Course Outcomes:

1. Enumerate the concept involved in analysingstructures by moment area method, conjugate beam method and unit load method.
2. Describe arches and explain the various parameters involved in analysing three hinged and two hinged arches.
3. Analyse statically indeterminate structures using consistent deformation method, Clapeyron's theorem of three moments and slope deflection method.
4. Represent the concept involved in moment distribution method and Kani's method and be able to apply for practical problems.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 02	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3	PS O4
BTCE 15F4 500	CO1	**2**	**3**	**2**	**1**		**1**	**2**	**1**	**2**	**1**	**1**	**2**	**3**	**3**	**2**	**1**
	CO2	**3**	**3**	**3**	**2**		**1**	**2**	**1**	**2**	**1**	**1**	**2**	**3**	**3**	**2**	**1**
	CO3	**3**	**3**	**3**	**3**		**1**	**2**	**1**	**2**		**1**	**2**	**3**	**3**	**2**	**1**
	CO4	**3**	**3**	**3**	**3**	**2**	**1**	**3**	**1**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**1**

Course Contents:

UNIT 1:Introduction: Conditions of equilibrium, Degrees of freedom, Linear and Nonlinear Structures, One, Two, Three-dimensional structural systems, Determinate and indeterminate structures , Static and Kinematic indeterminacy, and simple numerical examples. Strain energy and complementary strain energy, Strain energy due to axial load, bending and shear, Law of conservation of energy, Principle of virtual work, First and second theorems of Castigliano, Maxwell's theorem of reciprocal deflection, Betti's law.(theoretical concepts only)

UNIT 2:Slope and Deflection of Beams
Moment area method, Conjugate beam method, unit load method, simple Numerical examples.
Deflection of Trusses:
Unit load method, simple Numerical examples.

UNIT 3:Three-hinged arches
Three hinged circular and parabolic arches with supports at same level and different levels, Determination of normal thrust, radial shear and bending moment, Numerical problems.
Two-hinged arches:
Two hinged parabolic arch and circular arch, Numerical problems.

UNIT 4:Analysis of statically indeterminate beams:
Analysis of propped cantilever and fixed beam by consistent deformation methods, Analysis of continuous beams by Clapeyron's theorem of three moments, Numerical Problems.

TEXT BOOKS:

1. Devdas Menon, Structural Analysis Narosa Book Distributors Pvt Ltd. (2009).
2. Reddy C. S., Basic Structural Analysis Tata McGraw Hill, New Delhi.
3. Pandit and Gupta, Theory of Structures, Vol. – I, Tata McGraw Hill, New Delhi.
5. B.C. Pumia, R.K., Jain, Strength of Materials and theory of structures Vol I & II, Laxmi Publication New Delhi

REFERENCE BOOKS:

1. Norris and Wilbur, Elementary Structural Analysis, International Student Edition, McGraw Hill Book Co., New York
2. Wang and Chu Kia, Intermediate Structural Analysis by McGraw Hill, New York.
3. R C Hibbeler, Structural Analysis Prentice Hall, New Jersey.

BTCE15F4600	Hydraulic Machines	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	3	4

Prerequisites:

Fluid Mechanics

Course Objectives:

1. Impulse momentum equation and its applications related to Impact of jet on vanes-Flat and Curved – Stationary and moving, Concept of velocity triangles, Work done and efficiency related problems.
2. Introduction to turbines, Classifications, theory, equation for work done and efficiency, design parameters related Pelton, Francis and Kaplan.
3. To learn about performance evaluation of turbines, water hammer in pipes and its estimation.
4. Centrifugal pump, definition, description and general principal of working and related problems.

Course Outcomes:

1. Impulse momentum equation and its applications and learn how to find the magnitude and direction of force excreted by a jet of water on fixed and moving vane and also on a series of flat and curved vanes
2. Determination of work done and efficiency of various types of turbines.
3. How to evaluate the performance of various types of turbines (Impulse and Reaction turbines).
4. Designing and performance evaluation of Centrifugal pumps.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3	PSO4
BTCE 15F4 600	CO1	3	3	2	3	3		3					3	3	3	3	3
	CO2	3	3	2	3	2		3					3	3	3	3	3
	CO3	3	3	2	2	2		2					3	3	3	3	3
	CO4	3	3	2	2	2		2					3	3	3	3	3

Course Contents:

UNIT-1: IMPACT OF JET ON VANES

Introduction, Impulse- Momentum equation. Direct impact of a jet on a stationary flat plate, Oblique impact of a jet on a stationary flat plate, Direct impact on a moving plate, Direct impact of a jet on a series of flat vanes on a wheel. Conditions for maximum hydraulic efficiency. Impact of a jet on a hinged flat plate- problem. Force exerted by a jet on a fixed curved vane, moving curved vane. Introduction to concept of velocity triangles, Impact of jet on a series of curved vanes-numerical examples.

UNIT-2: PELTON WHEEL

Introduction to Turbines, Classification of Turbines. Pelton wheel- components, working and velocity triangles. Maximum power, efficiency, working proportions- problems.

KaplanTurbine-Theory, equation for the work done and efficiency, design parameters, problems. Components, Working and Velocity triangles, Properties of the Turbine, Discharge of the Turbines, Number of Blades-numerical examples.

UNIT-3: PERFORMANCE OF TURBINES

Draft tubes types, equation for efficiency, problems.Cavitations in turbines, governing of turbines. Specific speed of a turbine, Equation for the specific speed and problems. Unit quantities of a turbine, definitions, equations and problems. Characteristics curves of turbines, general layout of hydroelectric plants.Water hammer in pipes, equation for pressure rise due to gradual valve closure & sudden closure for rigid and elastic pipes numerical examples.

UNIT-4: CENTRIFUGAL PUMPS

Introduction, Classification, Priming, methods of priming. Heads and Efficiencies. Equation for work done, minimum starting speed, velocity triangles. Multistage Centrifugal Pumps (Pumos in Series and Pumps in parallel). Characteristic Curves for a Single stage Centrifugal Pumps- numerical examples.

TEXT BOOKS:

1. R.K.Rajput, S.Chand & Co, 'A Textbook of Fluid mechanics & Hydraulic Machines'- New Delhi, 2006 Edition.
2. R.K.Bansal, ' Text Book Of Fluid Mechanics& Hydralic Machines'Laxmi Publications, New Delhi, 2008 Edition.
3. Madan Mohan Das, 'Fluid Mechanics and Turbomachines'- PHI Learning Pvt. Limited, New Delhi. 2009 Edition.

REFERENCE BOOKS:

1. Robert w. Fox: Philip j. Pritchard: Alan t. 'Introduction to Fluid Mechanics' –McDonald, Wiley India, New Delhi, 2009 Edition.
2. Edward j.Shaughnessy,jr; Ira m. Katz 'Introduction To Fluid Mechanics' – James p Schaffer, Oxford University Press, New Delhi, 2005 Edition.
4. Dr. P.N. Modi& Dr S.M. Seth, 'Hydraulics and Fluid Mrchanics' –Standard Book House- New Delhi. 2009 Edition.

BTCE17F4700	Advanced Surveying Lab	L	T	P	C	Hrs/Wk
Duration :16 Wks		1	0	1	2	3

Prerequisites:

Applied Surveying

Course Objectives:

1. To understand basics of linear and angular measurements in field using surveying equipment's.
2. To use compass for setting out of various civil engineering works involving linear and angular measurements.
3. Levelling techniques and contour map development.
4. To set out simple and compound curves by different methods.

Course Outcomes:

1. Develop skills of using instruments for distance measurement and angular measurements.
2. Develop skills to use theodolite for horizontal and vertical angle measurements.
3. Develop skill to measure distance and angle by single plane and double plane methods.
4. Develop skill to setting out simple and compound curves by different methods.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 02	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PS O2	PS O3	PS O4
BTCE 17F4 700	CO1	3	3	2	-	-	-	-	-	2	-	-	3	3	3	3	3
	CO2	3	3	2	-	-	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	3	3	2	-	-	-	-	2	-	-	3	3	3	3	3
	CO4	3	3	3	2	-	-	-	-	2	-	-	3	3	3	3	3

LIST OF PRACTICALS:

1. To determine the tacheometric constants and to determine distance and elevation of an object using tacheometric methods (elevated/depressed LOS).
2. To set a simple curve by offsets from long chord and offsets from chords produced.

3.To set a simple curve and a compound curve by Rankine's deflection angle method.
4.Marking of residential building by centre line method for load bearing wall.
5.Marking of small commercial complex by centre line method for columns.
6.To set out compound curve with angular methods with using theodolite only.
7.Use of Total station in highway alignment.
8.Measurement and data logging of distances, horizontal angles and vertical angles using Total station.
9.Use of GIS software for land Water Resources Engineering Water Resources Engineering.
10.Office work-Design and plotting using AutoCAD.

Text Books:

1. Punmia B C., "Surveying", Vol. 1 & 2, Laxmi Publications Pvt. Ltd., New Delhi. 2009 5T
2. P Kanetkar & S P Kulkarni., "Surveying", Vol. 1 & 2, Tata McGraw Hill Publishing Co. Ltd, New Delhi. 2009.

Reference Books:

1. S K Roy, "Fundamentals of Surveying", Prentice Hall of India, New Delhi. 2009
2. S K Duggal, "Surveying", Vol. 1, Tata McGraw Hill Publishing Co. Ltd., New Delhi. 2008 3.M. Chandra, "Plane Surveying"– New age international (P) Ltd.

BTCE15F4800	Engineering Earth Science Lab	L	T	P	C	Hrs/Wk
Duration :16 Wks		**1**	**0**	**1**	**2**	**3**

Prerequisites:

Engineering Earth Science

Course Objectives:

To make the students capable to identify and study properties of rock and minerals . They also should be able to use modern tools line microscope

Course Outcomes:

1. Student should acquire knowledge about engg. properties of rocks and their minerals.
2. Student should be able to identify rocks and minerals
3. Student should be able to use modern tools live microscope to explore samples.
4. Student should be able to interpret map

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F4 800	CO1	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**2**	**2**	**3**	**3**
	CO2	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**2**	**2**	**3**	**3**
	CO3	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**2**	**2**	**2**	**2**
	CO4	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**2**	**2**	**2**	**2**

Exp. No.	**Name of the Experiment**	**No. of classes**
1.	Identification of Minerals as mentioned in theory, their properties, uses and manufacturing of construction materials	2
3.	Identification of rocks as mentioned in theory, their engineering properties and uses in construction and decorative purposes	2
4.	Dip and Strike problems: Determination of dip and strike direction in Civil Engineering projects (Railway lines, tunnels, dams, reservoirs) - graphical method	2
5.	Bore hole problems: Determination of subsurface behavior of rocks, their attitude related to foundation, tunnels, reservoirs and mining(Triangular & Square Method)	2
6.	Calculation of bifurcation ratio, drainage density and drainage frequency of a river basin	2
7.	Interpretation of geological maps related to Civil Engineering projects	2
8.	Viva Voce	--
	Total	12

References:

11) Principles of Engineering Geology and Geotechnics by Dimitri P Krynine and William R Judd, CBS Publishers and Distributors, New Delhi.
12) Earthquake Tips - Learning Earthquake Design and Construction by C V R Murthy Published by National Information Centre of Earthquake Engineering, Indian Institute of Technology, Kanpur.
13) Bureau of Indian Standards, IS: 1893, IS: 4326, IS: 13827, IS: 13828, IS: 13920, IS: 13925, IS: 15662-2006.

V SEMESTER

BTCE15F5100	Design of RCC Structural Elements	L	T	P	C	Hrs/Wk
Duration :16 Wks		2	1	0	3	4

Prerequisites:

Concrete Technology and Alternative Building Materials basic Structural Analysis

Course Objectives:

1. To learn about the concepts and principles of limit state design
2. To compute the ultimate flexural strength, shear strength and torsional strength of reinforced concrete beams.
3. To design reinforced concrete one-way , two-way slabs and Stairs
4. To design reinforced concrete columns and footings.

Course Outcomes:

1. Explain about the concepts and principles of limit state design
2. Compute the ultimate flexural strength, shear strength and torsional strength of reinforced concrete beams
3. Design reinforced concrete, one-way , two-way slabs and Stairs
4. Design reinforced concrete columns and footings

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F5 100	CO1	3	2		3		2	2					2	3	1		
	CO2	3	3	3	2	3	2	2	2	1	2	1	2	3	3	3	3
	CO3	3	3	3	2	3	2	2	2	1	2	1	2	3	3	3	3
	CO4	3	3	3	2	3	2	2	2	1	2	1	2	3	3	3	3

UNIT 1:GENERAL PRINCIPLES OF REINFORCED CONCRETE:
Introduction, Materials for Reinforced Concrete, Design Loads, Limit States, Philosophy of limit state design, Partial safety factors, Characteristic and design loads, Characteristic and design strengths, Codal Provisions.

ULTIMATE STRENGTH OF R.C. SECTION: General aspects of Ultimate strength, Stress block parameters for limit state of collapse, Ultimate flexural strength of singly reinforced rectangular sections, Ultimate flexural strength of doubly reinforced rectangular sections, Ultimate flexural strength of flanged sections, Ultimate shear strength of RC sections, Ultimate torsional strength of RC sections, Concepts of development length and anchorage.

UNIT-II:LIMIT STATES OF COLLAPSE AND SERVICEABILITY:
Numerical problems on flexural strength of singly reinforced, doubly reinforced rectangular sections, flanged sections, shear strength and development length.
Codal provisions for flexural design of beams - practical requirements, size of beam, cover to reinforcement-spacing of bars. General aspects of serviceability, Deflection limits in IS: 456–2000, Calculation of short-term and long-term deflections of flexural members, cracking in structural concrete members, Calculation of crack widths.

UNIT-III:DESIGN OF R.C. BEAMS: Codal provisions for critical sections for moment and shears. Anchorages of bars, check for development length, Reinforcement requirements, Slenderness limits for beams to ensure lateral stability, Numerical problems on design of simply supported and cantilever beams (rectangular and flanged sections).
DESIGN OF R.C. SLABS: General considerations of design of slabs, Rectangular slabs spanning one direction, Rectangular slabs spanning in two directions with various boundary conditions. Design of simply supported, cantilever and continuous slabs as per IS: 456–2000.

UNIT-IV:DESIGN OF R.C. COLUMNS: Codal provisions, effective length of column, loads on columns, slenderness ratio, minimum eccentricity, design of short axially loaded columns, design of columns subject to combined axial load and uniaxial moment and biaxial moment using SP–16 charts.
DESIGN OF ISOLATED R.C. FOOTINGS: Introduction, Codal provisions, Design of isolated square and rectangular footings for axial load and uniaxial moment by limit state method, Numerical problems.
DESIGN OF STAIR CASES: General considerations, types of stair case, Codal provisions, live loads, effective span, distribution of loading on stairs, Design of stairs with waist slab.

REFERENCE BOOKS:

1. Unnikrishna Pillai and Menon, Reinforced concrete Design TMH Education Private Limited, New Delhi.
2. P.C. Varghese, Limit State Design of Reinforced concrete PHI Learning Private Limited 2008-2009
3. M.L.Gambhir, Fundamentals of Reinforced concrete Design PHI Learning Private Limited 2008-2009.
4. S.N.Shinha, Reinforced concrete Design TMH Education Private Limited, New Delhi.
5. Karve & Shah, Reinforced concrete Design Structures Publishers, Pune.
6. S. S. Bhavikatti, Design of RCC Structural Elements Vol-I, New Age International Publications, New Delhi.
7. IS:456-2000 and SP-16

BTCE15F5200	Used Water Treatment & Solid Waste Management	L	T	P	C	Hrs/Wk
Duration :16 Wks		2	1	0	3	4

Prerequisites:

BTCE14F4400

Course objectives: -

1. Gain an understanding on types of sewerage system, dry weather flow, wet weather flow and design of hydraulic elements of sewers.
2. Understand the various sewer materials, sewer appurtenances and the basic principles of house drainage.
3. Acquire an understanding on the physical, chemical and biological parameters of wastewater and on the self purification of natural streams.
4. To be able to select and design appropriate used water treatment unit processes and understand the objectives of used water reuse and recycle.
5. To learn about solid waste, different methods of collection, treatment, disposal and reuse.
6. Understand the various analytical methods for wastewater analysis.\

Course outcome: -

1. Exposure to the necessity of sanitation, types of sewerage system, dry weather flow and wet weather flow and design of hydraulic elements of sewers.
2. Ability to analyze the various sewer materials, sewer appurtenances and the basic principles of house drainage.
3. Acquire an understanding of the physical, chemical and biological parameters of wastewater and on the self purification of natural streams.
4. Ability to select and design appropriate wastewater treatment unit processes and understand objectives of wastewater reuse and recycle. Acquire knowledge on solid waste management. Exposure to standard laboratory methods of wastewater quality analysis.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3	PS O4
BTC E15	CO1	3	3	2	3	3	-	3	-	-	-	-	3	3	3	3	3
	CO2	3	2	2	3	3	-	3	-	-	-	-	3	3	3	3	3

F5200	**CO3**	**1**	**3**	**2**	**2**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**
	CO4	**1**	**3**	**2**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**

Course Contents:

Unit 1: INTRODUCTION

Necessity for sanitation, types of sewerage systems and their suitability. Dry weather flow-factors affecting dry weather flow, flow variations and their effects on design of sewerage system; computation of design flow, wet weather flow, Hydraulic formulae for velocity, effects of flow variations on velocity, self cleansing and non scouring velocities, Design of hydraulic elements for circular sewers flowing full and flowing partially full.

Sewer Materials and Sewer Appurtenances

Sewer materials, shapes of sewers, laying of sewers, joints and testing of sewers, ventilation and cleaning of sewers, Catch basins, manholes, flushing tanks, oil and grease traps, Drainage traps, Basic principles of house drainage, Typical layout plan showing house drainage connections.

Unit 2: USED WATER CHARACTERIZATION

Sampling-significance, techniques and frequency; Physical, Chemical and Biological characteristics of used water; Aerobic and Anaerobic activity, BOD and COD, their significance & problems; self-purification phenomenon, Oxygen sag curve, Zones of purification, , Effluent Disposal standards for land, surface water & ocean, Numerical Problems on Disposal of Effluents, Streeter Phelps equation.

Preliminary Treatment of Used Water

Flow diagram of municipal waste water treatment plant, Preliminary & Primary treatment-Screening, grit chambers, skimming tanks, primary sedimentation tanks – Design criteria & Design examples.

Unit 3: TREATMENT OF USED WATER-REUSE AND RECYCLE

Trickling filter – theory and operation, types and designs; Activated sludge process- Principle and flow diagram, Modifications of ASP, F/M ratio. Design of ASP; Anaerobic Sludge digestion, Sludge digestion tanks, Design of Sludge drying beds; Low cost waste treatment method; Septic tank, Oxidation Pond and Oxidation ditches – Design

Reuse and recycle of used water- Zero effluent discharge systems - Quality requirements for used water reuse, Examples, Sewage farming, sewage sickness, Recreational Reuse, Uses of Sewage in Pisciculture, Groundwater recharge of Sewage Effluents.

Unit 4: SOLID WASTE MANAGEMENT

Definition of solid waste, scope and importance of solid waste management, functional elements, classification and characteristics, collection and transportation, treatment / processing techniques-component separation, volume reduction, size reduction, chemical reduction, biological processing. Disposal methods – open dumping, ocean disposal, incineration, composting, sanitary landfill, biomedical waste disposal, Recycle and reuse of Solid waste – material and energy recovery operations, plastic waste recycle.

TEXT BOOKS

1. S.K.Garg,Sewage Disposal and Air Pollution Engineering –Khanna Publishers
2. B C Punima and Ashok Jain, Wastewater Engineering –Lakshmi Publishers
3. Peavy, H.S., Rowe, D.R., and Tchobanoglous, G., Environmental Engineering - (1986), Mc Graw Hill Book Co.
4. Integrated Solid Waste Management- Tchobanoglous, Mc.Graw Hill

REFERENCES

1. Manual on Wastewater Treatment –CPHEEO, Ministry of Urban Development, New Delhi
2. E.W.Steel,Mc Ghee, Terence -'Water Supply Engineering and Sewerage; Mc.Graw Hill
3. Fair, Geyer and Okun-'Water and Wastewater Engineering: Water Supply and Wastewater Removal, 3rd Edition, John Wiley and Sons.
4. Metcalf and Eddy: 'Waste Water Treatment, Disposal and Reuse'; Tata McGraw Hill Publications.
5. Solid Waste Management in Developing Countries; Bhinde and Sunderashan

BTCE15F5300	**Transportation Engineering-I**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**2**	**1**	**0**	**3**	**4**

Prerequisites:

NONE

Course Objectives:

1. To educate students about the importance of transportation, various modes of transportation with emphasis on road transportation.
2. To make students familiar with the components of railway tracks along with the basic geometric features.
3. To give students an overview of the planning and working of airports, along with the geometric features of runways and taxiways.
4. To make students appreciate the effects of natural phenomena on the components of harbours and ports and the basic aspects of tunneling.

Course Outcomes:

1. Compare the various modes of transportation; explain the principles of transportation planning and the need for integration of the various modes of transportation, with emphasis on highway geometrics and road traffic.
2. Describe the characteristics of rail transportation and the requirements of the components, simple track junctions; compute the geometric features of railway tracks and the permissible speeds.

3. Associate the aircraft characteristics to the functioning of the various components of airports; illustrate the utility of the guiding and control aids; compute the geometric features of runways and taxiways.
4. Enumerate the different types of harbours and their components; illustrate the effects of wind, waves and tides on water front structures and the protection measures; outline the methods of tunneling, tunnel lining, drainage and ventilation

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO1**	**P02**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
BTCE 15F5 300	CO1	**3**	**3**				**2**	**3**	**3**	**3**	**3**		**1**	**3**	**3**	**2**	**3**
	CO2	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**3**	**2**	**2**			**3**	**2**	**3**	**3**
	CO3	**3**	**3**	**3**	**3**		**2**	**3**	**3**	**3**	**3**	**1**	**2**	**3**	**3**	**2**	**2**
	CO4	**3**			**3**	**3**	**3**	**3**	**2**	**2**	**3**		**2**	**3**	**3**		**1**

UNIT – 1

Importance of transportation, comparison of various modes of transportation, importance and scope of highway engineering, highway planning and alignment, importance of highway geometric design and scope of traffic engineering, principles of urban transportation, mass transit facilities, integration of different modes of transportation – numerical examples.

UNIT – 2

Components of railway track, gauges, typical cross sections, coning of wheels and tilting of rails, hauling capacity of locomotives and train loads on railways, types of rails, rail length, rail joints, creep of rails, sleepers, ballast, rail fixtures, gradients and grade compensation, speed of trains on curves, points and crossings, design calculations of turnouts - numerical examples.

UNIT – 3

Layout of an airport and components, typical airport layouts, planning of terminal area, aircraft parking system, aircraft characteristics affecting planning and design of airports, site selection, orientation of runway, basic runway length and corrected runway length, taxiways and exit taxiways, airport markings and lighting, air traffic control, ILS - numerical examples.

UNIT – 4

Classification of harbours, layout of harbours, component parts, effects of natural phenomena on harbour structures, breakwaters, tunnels and open-cuts, – advantages and disadvantages, setting out of tunnel, shapes of tunnels, tunneling in soft soils (needle beam and shield methods only), tunneling in rocks, tunnel lining, drainage of tunnels, tunnel ventilation.

REFERENCE BOOKS:

1. Khanna S.K and Justo C.E.G, "Highway Engineering", Nemchand and Bros, Roorkee.
2. Saxena S C and Arora S P, "A Text Book of Railway Engineering", Dhanpat Rai Publications Pvt. Ltd. New Delhi.
3. Khanna S K, Arora M G and Jain S S, "Airport Planning and Design", Nemchand and Bros. Roorkee.
4. Srinivasan R, "Harbour Dock and Tunnel Engineering", Charotar Publishing House, Anand.
5. Kadiyali L.R, "Traffic Engineering and Transportation Planning", Khanna Publishers, Delhi.
6. Satish, Chandra and Agarwal M M, "Railway Engineering", Oxford University Press, New Delhi.
7. Horonjeff, "Planning and Design of Airports", McGraw Hill Publications, New Delhi. William W. Hay, "An Introduction to Transportation Engineering", Toppan Company Ltd., Tokyo.

BTCE15F5400	**Hydrology & Irrigation Engineering**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**2**	**1**	**0**	**3**	**4**

Prerequisites:

Fluid mechanics

Course Objectives:

1. To impart the knowledge of hydrology that deals with the occurrence, distribution and movement of water on the earth.

2. To educate the students about the Precipitation and related losses of water, concepts of Runoff & Hydrograph for applications like Flood etc.

3. To impart knowledge of various irrigation techniques and water requirements of crops along with assessment of irrigation water.

4. To learn the canal irrigation distribution system along with design of canal.

Course Outcomes:

1. Outline the important process involved in the water cycle & identify methods for determining Precipitation & Components of Water Losses.
2. Classify the runoff components and predict the surface runoff based on hydrograph theory.
3. Summarize various irrigation techniques &estimate water requirements of the crops.

4. Classify the distribution system for canal irrigation. And describe the design procedure of canal systems.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F5 400	CO1	**3**		**2**		**2**	**2**	**3**					**1**	**3**	**2**	**1**	**1**
	CO2	**2**	**3**	**1**	**2**		**2**		**2**	**1**		**1**		**2**	**3**	**3**	**2**
	CO3	**1**	**1**	**3**	**2**	**3**	**3**	**3**			**1**	**2**	**2**	**3**	**2**	**2**	**1**
	CO4	**3**	**2**	**2**	**1**		**2**		**1**		**2**	**3**		**2**	**3**	**3**	**2**

Course Contents:

UNIT 1

INTRODUCTION & WATER LOSSES: Introduction, Water budget equation, Precipitation: introduction, forms of precipitation, types of precipitation, measurement of precipitation (Simon's gauge & Syphon gauge only), selection of rain gauge station. Adequacy of rain gauges, methods of computing average rainfall, interpolation of missing data, adjustment of missing data by double mass curve method. Hyetograph and mass curve of rainfall. Evaporation: Definition, factors affecting, measurement (Class A pan). Estimation using empirical methods (Meyer's and Rohwer's equation), evaporation control. Evapo-transpiration: Definition, factors affecting, measurement, estimation (Blaney criddle method) Infiltration: Definition, factors affecting, measurement (double ring infiltrometer), infiltration indices, Horton's equation of infiltration.

UNIT 2

RUNOFF & HYDROGRAPHS: Definition, concept of catchment, water budget equation, componenets, factors affecting, rainfall runoff relationship using simple regression analysis. Definition, components of hydrographs, unit hydrograph and its derivation from simple storm hydrograph, base flow separation, Prepositions of unit hydrograph-problems.

UNIT 3

INTRODUCTION TO IRRIGATION ENGINEERING:

Introduction, need for irrigation, advantages and disadvantages of irrigation, environmental impacts of irrigation, Systems of irrigation: Gravity irrigation, lift irrigation, well irrigation, tube well irrigation, infiltration galleries, sewage irrigation, supplemental irrigation. Soil-water-plant relationship, soil moisture. Irrigation relationship, frequency of irrigation. Water requirement of crops: Introduction, definitions, crop seasons of India, water requirement of a crop, duty, delta, base period. Consumptive use. Irrigation efficiencies. Assessment of irrigation water with numerical examples.

UNIT 4

CANALS: Definition, Types of canals, Silt theory, Alignment of canals, Design of canals by Kenedy's and Lacey's methods- Problems

TEXT BOOKS:

1. Subramanya.K Engineering Hydrology – Tata Mcgraw Hill NewDelhi-2008 (Ed)
2. Madan Mohan Das, Mim Mohan Das Hydrology- -PHI learning private Ltd. New Delhi-2009 (Ed)
3. Jayarami Reddy, A Text Book Of Hydrology- Laksmi Publications, New Delhi-2007 (Ed)
5. P.N.Modi Irrigation, water Resources and water power Engineering-standard book house, New Delhi.
6. Madan Mohan Das & Mimi Das Irrigation and Water Power Engineering- Saikia; PHILearning pvy. Ltd. New Delhi 2009 (Ed).

REFERENCE BOOKS:

1. Ghanshyam Das- Hydrology & Soil Conservation Engineering- PHI Learning Private Ltd., New Delhi-2009 (Ed)
2. Patra K.C.Narosa Hydrology & Water Resources Engineering- Book Distributors Pvt. Ltd. New Delhi-2008 (Ed)
3. R.K.Sharma & Sharma, Hydrology & Water Resources Engineering- Oxford and Ibh, New Delhi
4. S. K.garg-Irrigation Engineering and Hydraulic structures- Khanna Publication, New Delhi.

BTCE15F5500	**Geotechnical Engineering-I**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**2**	**1**	**0**	**3**	**4**

Prerequisites:

Basic knowledge of Engineering Mechanics, Strength of Materials and Fluid Mechanics

Course Objectives:

1. To create an ability to apply knowledge of geotechnical engineering.
2. To conduct experiments, as well as to analyse and interpret data related to the geotechnical engineering.
3. To accentuate the understanding of the basic principles.
4. To identify the type and characteristics of soil.

Course Outcomes:

1. Understand basic concepts of soil and they will be knowing the classification of soil.
2. Analysis of water soil interaction and seepage activities in soil.
3. Characterisation of compaction and consolidation of soil in field and Laboratory.
4. Understands the strength characteristic of soil in construction.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F5 500	CO1	3	3	1	3	2	2	1			2			3	3	3	2
	CO2	3	2	1	3		2	1			2			3	3	3	2
	CO3	3	2	3	3		2	1			2			3	3	3	1
	CO4	3	2	3	3		2	1			2			3	3	3	2

Course Contents:

UNIT I - INTRODUCTION

Formation of soil – types of soil – clay mineralogy and soil stucture: Soil-Water system, Electrical diffuse double layer, adsorbed water, base-exchange capacity, Common clay minerals in soil and their structures- **INDEX PROPERTIES**-Three phase system of soil and their relationships –Grain size analysis – Stoke's law and hydrometer analysis – Consistency of soils –Determination of consistency indices – Classification of coarse grained and fine grained soil as per BIS

08 hours

UNIT II - PERMEABILITY AND SEEPAGE

Permeability –Definition – Assumption - one dimensional flow through soil – Darcy's law – Limitations - Discharge velocity and seepage velocity – factors affecting the permeability – permeability determination - lab and field methods – permeability in stratified soil deposits – Introduction of flow net and its properties - application of flow net.

08 hours

UNIT III - COMPACTION AND CONSOLIDATION

Compaction – field and lab methods – Proctor's test – factors affecting the compaction – effect of compaction in soil properties – **Consolidation** – Terzaghi's theory of one dimensional consolidation

- partial differential equation (no analytical solution) – Lab method - coefficient of consolidation – Determination - √t and log t methods.

8 hours

UNIT IV – EFFECTIVE STRESS AND SHEAR STRENGTH

Introduction – stresses in soil – concept of effective and neutral stresses – Introduction. Shear strength – shear strength of cohesive and cohesion less soils – Mohr coulomb's theory –Direct shear, Triaxial, unconfined shear strength – Lab and field vane shear test - factors affecting the shear strength.

08 hours

TEXT BOOKS

1. Murthy V.N.S. **Principles of Soil Mechanics and Foundation Engineering**-, 4th Edition, UBS Publishers and Distributors,New Delhi(1996).
2. Punmia .B.C, ***"Soil Mechanics and Foundations"***, Laxmi Publications Pvt. Ltd., 2005.
3. Gopal Ranjan and Rao .A.S.R**, *"Basic and Applied Soil Mechanics"*,** New age international(p) Ltd.,2007.
4. Braja, M. Das **Geotechnical Engineering**;, Fifth Edition, Thomson Business Information India (P) Ltd., India(2002)

REFERENCES BOOKS:

1. Bowles J.E. **Foundation Analysis and Design**- 5th Edition, McGraw Hill Pub. Co. New York. (1996),
2. Alam Singh and Chowdhary G.R. **Soil Engineering in Theory and Practice**, CBS Publishers and Distributors Ltd., New Delhi. (1994)
4. Donold P Coduto **Geotechnical Engineering**- Phi Learning Private Limited, New Delhi
5. Shashi K. Gulathi & Manoj Datta. **Geotechnical Engineering**, Tata Mc Graw Hill(2009).
7. Narasimha Rao A. V. & Venkatrahmaiah C.**Numerical Problems, Examples and objective questions in Geotechnical Engineering**, Universities Press,Hyderabad (2000).
8. **BIS Codes of Practice**: IS 2720(Part-3/Sec. 1) – 1987; IS 2720 (Part – 2)- 1973; IS 2720 (Part – 4) – 1985; IS 2720 (Part – 5) – 1985; IS 2720 (Part – 6) – 1972; IS 2720 (Part – 7) – 1980; IS 2720 (Part – 8) – 1983; IS 2720 (Part – 17) – 1986; IS 2720 (Part - 10) – 1973; IS 2720 (Part – 13) – 1986; IS2720 (Part 11) – 1971; IS2720 (Part 15) – 1986; IS 2720 (Part 30) – 1987; IS 2720 (Part 14) – 1977; IS 2720 (Part – 14) – 1983; IS 2720 (Part – 28) – 1974; IS 2720 (Part – 29) – 1966, IS 2720 (Part-60) 1965.

BTCE15F5600	**Intermediate Structural Analysis**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**2**	**1**	**0**	**3**	**4**

Prerequisites:

Basic Structural Analysis

Course Objectives:

1. To learn about the basic concepts and principles of vibration of structures.
2. To learn about mathematical modeling of vibratory systems.
3. To analyze the free vibration of SDOF system (undamped and damped)

Course Outcomes:

1. To learn about the advantages and disadvantages of statically indeterminate structures
2. To determine the degree of static and kinematic indeterminacy of skeletal structures
3. To analyze statically indeterminate beams and rigid-jointed plane frames by slope deflection, moment distribution and Kani's methods.
4. To analyze plane trusses and axially rigid plane frames by stiffness and flexibility matrix methods (system approach only)

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO 1**	**P 0 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**P S O 1**	**PS O2**	**PS O3**	**PS O4**
BTCE 15F5 600	**CO1**	**3**	**3**	**1**		**2**	**2**	**1**					**2**	**3**	**3**		**2**
	CO2	**3**	**3**	**1**										**3**	**3**		
	CO3	**3**	**3**	**1**		**3**	**2**						**2**	**3**	**3**		**3**
	CO4	**3**	**3**	**1**		**3**	**2**						**2**	**3**	**3**		**3**

Course Contents:

UNIT1:Introduction: Statically indeterminate structures**,** Advantages and advantages**,** Concept of compatibility, determination of degree of static and kinematic determinacies of plane trusses, rigid frames and grids.

Slope Deflection Method: Assumptions and development of slope-deflection equations, analysis of statically indeterminate beams and rigid-jointed plane frames with and without sidesway. Numerical examples.

UNIT2:Moment Distribution Method: Introduction, Definition of terms Stiffness factor, Distribution factor, Carry-over factor, Analysis of beams and rigid jointed plane frames with and without side sway. Numerical examples.

Kani's Method: Introduction, rotation and displacement contribution factors, Advantages, Analysis of Continuous beams and Analysis of rigid jointed plane frames with and without sideway. Numerical examples.

UNIT3:Flexibility Method: Introduction, system and element approaches, Analysis of plane trusses and axially rigid plane frames by flexibility method (system approach only). Numerical Problems

Stiffness Method: Introduction, system and element approaches, Analysis of plane trusses and axially rigid plane frames by stiffness method (system approach only). Numerical examples,

UNIT4:Basic principles of structural dynamics: Vibrations and causes, periodic and aperiodic motion, harmonic and non-harmonic motion, Basic elements of a vibratory system, Concepts of free and forced Vibration, Viscous damping, Mathematical modeling, Dynamics degrees of freedom, Free vibration of Single Degree of Freedom System with and without damping, Simple Numerical Problems.

REFERENCE BOOKS:

1. Devdas Menon, Advanced Structural Analysis Narosa Book Distributors Pvt.Ltd, (2009).
2. Reddy C.S. Basic Structural Analysis - Second Edition, Tata McGraw Hill Publication Company Ltd.
3. Wang and Chu-Kia, Intermediate Structural Analysis McGraw Hill, New York.
4. Theory of Structures Vol. 2 - Tata McGraw Hill Publication Company Ltd.
5. S.P. Gupta, G.S. Pandit and R.Gupta, Structural Dynamics Mario Paz, & William League, Kluwer Academic Publishers.
6. S. S. Bhavikatti – Structural Analysis-II - Vikas Publishers, New Delhi.
7. D.S. Prakash Rao, Structural Analysis- A Unified Approach,University Press Structural Analysis, 4th SI Edition by Amit Prasanth & Aslam Kassimali, Thomson Learning.

BTCE15F5710	Design of Masonry Structures	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Knowledge of Alternate Building Materials and Concrete Technology

Course Objectives:

1. To learn the history of masonry structures
2. To learn the characteristics, classification and properties of masonry materials
3. To learn the strength and elastic behaviour of masonry under compression
4. To learn the failure theories of masonry under compression.

Course Outcomes:

1. Has learnt the history of masonry structures
2. Has learnt the characteristics, classification and properties of masonry materials
3. Has learnt the strength and elastic behaviour of masonry under compression
4. Has learnt the failure theories of masonry under compression.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F5 710	CO 1					3	2	3	2	2		2	2	3	1	1	3
	CO 2	2				2	2	3	1	1		1	2	3	2	1	3
	CO 3	2		2	1	1	1	3	1	1			2	3	2	1	3
	CO 4	3	1		1	1		3	2	1	1		3	3	2	1	3

Course Contents:

UNIT1: Masonry Units, Materials, Types, Masonry Construction, Strength and Stability:

Brick, stone and block masonry units, strength, modulus of elasticity and water absorption of masonry materials, classification and properties of mortars, selection of mortars, Defects and errors in masonry construction, cracks in masonry, types, reasons for cracking, methods of avoiding cracks. Strength and Stability of concentrically loaded masonry walls, effect of unit strength, mortar strength, joint thickness, rate of absorption, effect of curing, effect of ageing, workmanship, strength formulae and mechanism of failure for masonry subjected to direct compression.

UNIT 2: Permissible stresses, Design considerations:

Permissible compressive stress, stress reduction and shape reduction factors, increase in permissible stresses for eccentric vertical and lateral loads, permissible tensile and shear stresses, Effective height of walls and columns, opening in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action, lintels.

UNIT 3: Load considerations for masonry, Design of masonry walls:

Wall carrying axial load, eccentric load with different eccentricity ratios, walls with openings, freestanding wall, Design of load bearing masonry for building up to 3 storeys using IS: 1905 and SP: 20 procedure.

UNIT 4: Reinforced masonry, Masonry walls in composite action:

Application, flexural and compression elements, shear walls, Composite wall – beam elements, infilled frames.

REFERENCE BOOKS:

1. Hendry, A.W, “**Structural Masonry**” Macmillan Education Ltd, Oxford, 1990.
2. Dayaratnam P, “**Brick and Reinforced Brick Structures**”, Oxford & IBH, 1987.
3. Arnold W. Hendry, B.P Sinha & S.R.Davies,E “**Design of Masonry structures**” & Fn SPON, London.
3. **IS 1905–1987,** “Code of practice for structural use of un-reinforced masonry- (3rd revision) BIS, New Delhi.
4. **SP 20 (S&T) – 1991**, “Hand book on masonry design and construction (1st revision) BIS, New Delhi.

BTCE15F5720	Advanced Surveying	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Surveying

Course Objectives:

1. Have an overview of the advanced surveying techniques and modern surveying equipment.
2. Use the concepts of advanced data capturing methods.
3. Analyse spatial data using appropriate computational and analytical techniques.

Course Outcomes:

1. Acquire knowledge about the modern surveying equipment.
2. Determine the depth of water bodies by sounding.
3. Use modern surveying instruments to obtain geo-spatial data and analyse the same to appropriate engineering problems.
4. Capture geodetic data to process and perform analysis for survey problems with the use of electronic instruments.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BTCE 15F5 720	CO1	3	2	2	1	-	-	-	-	-	-	-	-	3	3	1	2
	CO2	3	3	1	2	1	-	-	-	-	-	-	-	3	3	1	2
	CO3	2	2	-	-	1	1	-	-	-	-	-	-	3	3	1	2
	CO4	2	2	-	1	1	-	-	-	-	-	-	-	3	3	1	2

UNIT - I

THEORY OF ERRORS AND TRIANGULATION ADJUSTMENT: Errors and classification of errors Precision and accuracy, Laws of weights and accidental errors.

PROBABILITY: Probability distribution function and density function- normal distribution. RMS error-measure of precision. Rejection of observations-principles of least squares-Normal equations

UNIT – II

METHOD OF CORRELATES: Triangulation adjustment. Angle adjustment, station adjustment and figure adjustment. ELECTRONIC DISTANCE MEASUREMENT (EDM): Introduction, Electro Magnetic (EM) Waves. Phase comparison and modulations. Instruments – Geodimeter – Tellurimeter – Distomat – Range finders – Radars.

UNIT – III

FIELD ASTRONOMY: Earth celestial sphere. Solar system Position by altitude and azimuth system-spherical triangle and spherical trigonometry. Astronomical triangle. Nepiers rule. TIME: Siderial time, day and year-solar time and day-Greenwich mean time-standard time. Meridian and azimuth-their determination - latitude and its determination.

UNIT – IV

Photogrammetry – Introduction, basic definitions, terrestrial photogrammetry, phototheodolite, horizontal and vertical angles from terrestrial photographs, horizontal position of a point from photographic measurements, elevation of ponts by photographic measurements, determination of focal length. Aerial Photogrammetry- advantages, vertical, tilted and oblique photographs, geometry of vertical photographs, scale of vertical photograph over flat and variable terrain, ground coordinates, computation of length of a line, computation of flying height, relief displacement, overlaps, flight planning, computation of required number of photographs for a given area, ground control in photogrammetry. Basics of stereoscopy, stereoscopes, uses, parallax. Basic elements in photographic interpretation. Introduction to digital photogrammetry.

Reference Books:

1. Punmia B C., “Surveying”, Vol. 2 & 3, Laxmi Publications Pvt. Ltd., New Delhi. 2009.
2. T P Kanetkar & S P Kulkarni., “Surveying”, Vol. 2 & 3, Tata McGraw Hill Publishing Co. Ltd, New Delhi. 2009.
3. S K Duggal, “Surveying”, Vol. 2, Tata McGraw Hill Publishing Co. Ltd., New Delhi. 2008.
4. Mikhail E., J. Bethel, and J.C. McGlone, “Introduction to modern photogrammetry”, Wiley, 2001.
5. Wolf P.R, and B.A. Dewitt, “Elements of photogrammetry: with applications in GIS”, 3rd ed, McGraw-Hill, 2000.

Wolf P.R, and B.A. Dewitt, “Elements of photogrammetry: with applications in GIS”, 3rd ed, McGraw-Hill, 2000.

BTCE15F5730	Remote Sensing and GIS	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

water supply and Sanitation Engineering, Hydraulic machines

Course Objectives:

1. To educate students about GIS and Remote sensing
2. To make students familiar with the recent techniques of remote sensing and GIS
3. To educate students on its application in Traffic and Transportation Engineering
4. To give an overview of importance and application of remote sensing and GIS

Course Outcomes:

1. Explain the basics of Remote Sensing.
2. Explain the various GIS techniques
3. Describe their application in the Transportation engineering.
4. Enumerate the uses in other streams of civil engineering

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F5 730	CO1	3	1	1	2	3				2			3	3	3	3	3
	CO2	3	3	2	3	2				2			3	3	3	3	3
	CO3	3	3	2	1					1			3	3	3	3	3
	CO4	3	3	1	2	3	2	3		2			3	3	3	3	3

UNIT - I

Introduction, Ideal remote sensing system, basic principles of electromagnetic remote sensing, electromagnetic energy, electromagnetic spectrum, interaction with earth's atmosphere, interaction with earth- surface materials, spectral reflectance of earth surface materials. Remote sensing platforms and sensors: Introduction, platforms- IRS, Landsat, SPOT, Cartosat, Ikonos, Envisat etc. Sensors-active and passive, MSS, AVHRR, LISS, TM, PAN, WIFS, microwave sensors, sensor resolutions (spatial, spectral, radiometric and temporal).

UNIT – II

Properties of digital image data, data formats, Basics of digital image processing- radiometric and geometric corrections, image enhancements, image transforms based on arithmetic operations, image filtering. Remote sensing image interpretation, thematic classification (supervised and unsupervised) , maximum likelihood classification, introduction to accuracy assessment of classification. Applications of Remote sensing: applications in land use & land cover analysis, change detection, water resources, urban planning, environmental and geological applications.

UNIT – III

Geographic Information system concepts and spatial models. Introduction, Spatial information, temporal information, conceptual models of spatial information, representation of geographic information. GIS Functionality – Introduction, data acquisition, preliminary data processing, data storage and retrieval, spatial search and analysis, graphics and interaction.

Computer Fundamentals of GIS and Data storage, Fundamentals of computers vector/raster storage character files and binary files, file organization, linked lists, chains, trees. Coordinate systems and map projection : Rectangular polar and spherical coordinates, types of map projections, choosing a map projection.

UNIT – IV

GIS DATA MODELS AND STRUCTURES – Cartographic map model, Geo-relation model, vector/raster methods, non-spatial data base structure viz., hierarchal network, relational structures. DIGITIZING EDITING AND STRUCTURING MAP DATA – Entering the spatial data (digitizing), the non-spatial, associated attributes, linking spatial and non-spatial data, use of digitizers and scanners of different types.

Reference Books:

1. Lillesand T.M., and R.W. Kiefer, "Remote sensing and image interpretation", 4th ed, John Wiley & Sons, 2000.
2. Jensen J.R., "Introductory digital image processing: a remote sensing perspective", 2nd ed Prentice Hall, 1996.
3. Richards J.A., and X. Jia, "Remote sensing digital image analysis: an introduction", 3rd ed Springer, 1999.
4. Mather P.M., "Computer processing of remotely-sensed images: an introduction", Wiley, 1988.
5. Peter A Burrough and Reachael A Mc. Donnel, "Principles of GIS", Oxford publications.
6. George Joseph, "Fundamentals of Remote Sensing", Universities Press, Hyderabad.
7. C.P.Lo. Albert K.W. Yeung, "Concepts and Techniques of Geographic Information Systems" 2nd Edition, PHI Learning, New Delhi – 2009

BTCE15F5740	Ground Water Hydraulics	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Fluid Mechanics

Course Objectives:

1. To learn aboutvarious types of Aquifers,
2. Darcy's Law and related technical terms and related problems,
3. Ground water recharge, runoff and balance, ground water development and management,
4. ground water exploration Techniques. Saline water intrusion.

Course Outcomes:

Students will be able to solve problems related

1. To permeability and transmissibility,
2. How to carry out ground water recharge, measurement of runoff and ground water balance.
3. Construction of different types of wells,
4. modeling in ground water management by different methods, Ground water exploration, saline water intrusion and pretension.

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F5 740	CO1	3	1	1	2	3				2			3	3	3	3	3
	CO2	3	3	2	3	2				2			3	3	3	3	3
	CO3	3	3	2	1					1			3	3	3	3	3
	CO4	3	3	1	2	3	2	3		2			3	3	3	3	3

Course Contents:

UNIT 1: INTRODUCTION: Ground water occurrence, definition of aquifer, aquifuge, aquitard and aqueduct. Types of aquifer & its parameters, Darcy's law, hydraulic conductivity, permeability coefficient, intrinsic permeability, transmissibility, problems.

UNIT 2:GROUND WATER RECHARGE, RUNOFF AND BALANCE: Artificial recharge: spreading method, urban storm runoff, vertical recharge, recharge component estimation, ground water discharge estimation, ground water balance and its components, case study.

UNIT 3:GROUND WATER DEVELOPMENT AND MANAGEMENT: Type of well, method of construction, tube well, dug well, ground water development, water logging, conjunctive use, modeling in ground water management, well hydraulic- thesis method, coofer and Jacob method, case study.

UNIT 4:GROUND WATER EXPLORATION TECHNIQUES: Hydro geologic well logging, geophysical well logging, tracer techniques, problems, seismic method, electrical resistivity method, geologic and hydrologic logging, case study.
Ground water extraction& intrusion, ghyben-Herzberg relation, saline zones & interface, prevention & control of saline water intrusion, zone of diffusion.

TEXT BOOK:

1. K Todd- Wiley & sons Ground water hydrology, New Delhi.
2. H.M. Raghunath- Ground water: Wiley Eastern Limited.
3. Karanath K .R : Ground water Assessment, Development and management, Tata McGraw hill, New Delhi, 1987

REFERENCE BOOK:

1. Bower H, Ground water Hydrology: McGraw hill, New Delhi.
2. Garg satya prakesh Ground water and tube well :– oxford & IBH, New Delhi

BTCE15F5750	**Urban Transport Planning**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration:16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

NONE

Course Objectives:

1. To make students familiar with the basic definitions of urban system components, elements; to give an idea about land use and traffic
2. To educate students about the various surveys and their interpretation
3. To give students an overview of the various models used to know the trip generation and distribution.
4. To make students appreciate the factors affecting modal split, traffic assignment techniques and the economic evaluation

Course Outcomes:

On successful completion of this course, students should be able to:

1. Discuss the interdependence of land use and traffic, difficulties in transport planning and the system approach to urban planning along with the stages involved
2. Describe the procedure and suitability of various types of surveys, transport demand and supply
3. Appreciate the methods of trip generation and distribution, comparison of various models used to generate O-D matrix
4. Enumerate the different factors affecting modal split, traffic assignment techniques, consideration of evaluation and expressing evaluation in economic terms.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F5 750	CO1	3					3		2		2		2	3			1
	CO2	3	3			2		2	2	3	3	1		3	3		1
	CO3	3	3		2	2	3	1		3	1	2		3	3	1	2
	CO4	3	3		2	2	1	2	3		3		2	3			2

UNIT – 1 **[12]**

Introduction to urban system components, concepts and definitions, scope of urban transport planning, elements of urban transportation planning, interdependency of land use and traffic, Urban Transport planning for small and medium sized cities, Difficulties in transport planning-Systems approach to urban planning-Stages- Inventory of Existing Conditions

UNIT – 2 **[12]**

Transport Surveys: Basic Movements-Study Area- Zoning-Surveys- Planning of different types of surveys and interpretation- expansion of data from sample- Transport modeling, Transport demand and supply- Traffic surveys for mass transit system planning- Mass Transit Systems: Capacity, Fleet planning and Scheduling, Traffic surveys for mass transit system planning,

UNIT – 3 **[12]**

Trip Generation and Distribution: Factors governing trip generation and attraction – Application of Regression Analysis- Methods of trip distribution: Growth Models and Synthetic Models-Calibration and Application of gravity model, Problems - Category analysis.

UNIT – 4 **[12]**

Modal Split: Factors affecting modal split, Modal split in transport planning, recent developments in modal split analysis

Traffic Assignment: Principles of traffic assignment; assignment techniques. Problems

Evaluation: Need for evaluation, Identification of corridor; Formulation of plans; Economic evaluation.

REFERENCE BOOKS:

1. Kadiyali, L.R., `Traffic Engineering and Transportation Planning' - Khanna Publication, New Delhi, 2009
2. Jotin Khisty and B. Kent Lall "Transportation Engineering –An Introduction"- PHI, New Delhi, 3rd Indian Edition, 2006.
3. Hutchinson, B.G., `Principles of Urban Transport System Planning' - McGraw Hill Book Co., London, UK, 1982.
4. Institute of Traffic Engineers - An Introduction to Highway Transportation Engineering' New York., 1982
5. Transportation Planning Resource Guide
6. M.J.Bruton; Introduction to Transportation Planning –Hutchinson of London Ltd.

BTCE15F5800	CAD Lab	L	T	P	C	Hrs/Wk
Duration :16 Wks		1	0	1	2	3

Prerequisites:

Building planning Drawing

Course Objective:

1. Preparation of drawings of building components
2. Functional design of buildings (residential, public and industrial)
3. Development of plan, elevation and sectional views, water supply, sanitary and electrical layouts of residential buildings given line diagram.
4. To develop line diagrams for non-residential buildings

Course Outcomes:

1. Able to prepare drawings of building components
2. Able to carry out functional design of buildings (residential, public and industrial)
3. Able to develop plan, elevation and sectional views of residential buildings given line diagram. To prepare water supply, sanitary and electrical layouts.
4. Able to develop line diagrams for non-residential buildings Using drafting software.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
	CO1	**3**	**2**	**2**						**2**			**3**	**3**	**3**	**3**	**3**
	CO2	**3**	**2**	**3**	**2**					**2**			**3**	**3**	**3**	**3**	**3**

BTCE 15F4 300	CO3	**3**	**2**	**3**	**2**					**2**			**3**	**3**	**3**	**3**	**3**
	CO4	**3**	**2**	**3**	**1**					**2**			**3**	**3**	**3**	**3**	**3**

1.AUTOCAD: Basics of AUTOCAD, Drawing Tools- Lines, Circle, Arc, Polyline, Multiline, Rectangle, Ellipse, **Modify Tools**–Erase, copy, Mirror, offset, Array, Move, Rotate, Scale, Stretch, Lengthen, Trim, Extend, Break, Chamfer and Fillet. **Using Text**: Single Line Text, Multiline text, Spelling, Edit Text: Special features, View Tools, Layers, Concept, Dimension tools, Hatching, Customizing toolbars, working with multiple drawings.

2.Use of AUTOCAD in Civil Engineering: Cross Section of Foundation, Staircases, Lintel and Chejja, Slab and Beams, Plan, Elevation, Cross Section of TWO Story Building.

3.Use of EXCEL In Civil Engineering: SFD & BMD for Cantilever, Simply Supported Beams, Design of Singly & doubly reinforced beams, Computation of earth work, design of horizontal curves and design of super elevation.

REFERENCE BOOKS:

1. Shah M.H and Kale C.M, **Building Drawing**, Tata Mc-Graw Hill Publishing co. Ltd., NewDelhi.
2. Gurucharan Singh, **Building Construction,** Standard Publishers &distributors, New Delhi.
3. **National Building Code**, BIS, New Delhi.
4. 4. N.Kumarswamy and A. Kameswara Rao, **Building Planning And Drawing,** Chartor Publishing House Pvt. Ltd.Dr.*Balagopal and T.S.Prabhu*, ***Building Drawing and Detailing*** -*Spades Publishers*, Calicut.

BTCE15F5900	**Geotechnical Engg Lab**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**1**	**0**	**1**	**2**	**3**

Prerequisites:

Geotechnical Engineering

Course Objectives:

1. To gain experience regarding the determination of properties of different types of soils and understand how they behave
2. To provide an opportunity to learn how to measure the shear strength of the soil and its importance
3. To impart knowledge about the foundation engineering.

Course Outcomes:

1. Determine the index properties of the soil
2. Classify the soil and identify the suitability of the soil for different foundations.
3. To implement the properties of soil for the analysis and design of foundations

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F5 900	CO1	3	3	1	1	1	2	1	-	1	2	-	2	3	2	2	2
	CO2	3	2	1	2	1	2	1	-	1	2	-	2	3	2	2	2
	CO3	3	2	2	3	1	2	1	-	1	2	-	2	3	2	2	1

Course Contents:

List of Experiments:

1. Water content determination (Oven drying method), Determination of Specific gravity by Pycnometer and density bottle method.
2. Grain size distribution (Sieve analysis Only)
3. Determination of Liquid (Casagrande method) and Plastic limit.
4. Determination of Shrinkage limit of soil.
5. Determination of moisture-density relationship (Standard Proctor's)
6. Determination of Permeability by Constant and Variable head method.
7. Determination of in-situ density by sand replacement and core cutter method.
8. Unconfined compression test for fine grained soils.
9. Triaxial Compression Test.
10. Direct shear test.
11. Determination of CBR value.
12. Only Demonstration - Determination of Relative density – Sand, Vane shear test. Odometer test(Consolidation)

REFERENCE BOOKS:

1. Alamsingh - Geotechnical manual,
2. Basic and Applied Soil Mechanics- GopalRanjan and Rao A.S.R. (2000), New Age International (P) Ltd., New Delhi
3. Shamsherparekh – Geotechnical Manual.
4. Manual of Soil Laboratory Testing- Head K.H., (1986)- Vol. I, II, III, Princeton Press, London
5. Relevant BIS codes.

BTCE15F6100	Transportation Engg-II	L	T	P	C	Hrs/Wk
Duration :16 Wks		2	1	0	3	4

Prerequisites:

Transportation Engg-1

Course Objectives:

1. To educate students about the importance of materials used in highways, basic laboratory testing of these materials, their requirements and criteria for selection for highway works.
2. To make students familiar with different bituminous mix design procedures commonly adopted, the method of deciding gradation requirements.
3. To make students appreciate the design methodologies adopted for designing flexible and rigid pavements for both new and overlay constructions.
4. To give students an overview of the different drainage measures, failures in pavements and methods of maintenance of pavements

Course Outcomes:

On successful completion of this course, students should be able to:

1. Explain: the requirements and selection criteria of highway materials, basic methods of testing the highway materials and interpretation of results in comparison with standard IRC codes.
2. Describe, analyze and compute: requirements of gradation for bituminous mixes, design aggregate gradation of bituminous mixes, conduct mix design and determine volumetric properties of bituminous mixes as per IRC and AASHTO standards
3. Discuss and compute: design factors of design of pavements, thickness design of new pavements for flexible and rigid pavements, design of overlay for pavement up gradation.
4. Enumerate: requirements of drainage systems and design procedures for drains, types of failures occurring in pavements and method of maintenance of pavements

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F5 300	CO1	**3**	**3**				**2**	**3**	**3**	**3**	**3**		**1**	**3**	**3**	**2**	**3**
	CO2	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**3**	**2**	**2**			**3**	**2**	**3**	**3**
	CO3	**3**	**3**	**3**	**3**		**2**	**3**	**3**	**3**	**3**	**1**	**2**	**3**	**3**	**2**	**2**
	CO4	**3**			**3**	**3**	**3**	**3**	**2**	**2**	**3**		**2**	**3**	**3**		**1**

UNIT – 1

Soil: importance and desirable properties of subgrade soil, HRB method of soil classification, – numerical examples. **Aggregates:** Requirements, properties and tests on road aggregates. **Bitumen and modified bitumen:** Requirements, properties and tests, criterion for selection of different binders. **Emulsions and Cutbacks:** Preparation, characteristics, uses and tests.

UNIT – 2

Bituminous Mixes: Requirements of bituminous mixes, Mechanical properties and tests, dense and open textured mixes, General design of bituminous mixes, design methods using Rothfuch's method only, Bituminous mix design methods – Marshall method and Superpave method, Numerical problems - numerical examples.

UNIT – 3

Design: Design factors, CBR method of flexible pavement design as per IRC 37 guidelines, Design of CC pavement as per IRC 58 guidelines, design of joints, dowel bars and tie bars, Overlay design of pavements as per IRC 81 guidelines, Numerical problems on above- numerical examples.

UNIT – 4

Drainage: design and construction of surface and sub-surface drainage system for highways, drainage materials, design procedures and IRC guidelines for drainage of urban roads, **Failures:**

General causes, different types of failures in flexible and rigid pavements, **Maintenance:** methods of maintenance of different types of pavements, special repairs

REFERENCE BOOKS:

1. S K Khanna, C E G Justo and A Veeraragavan, "Highway Engineering", Revised 10th Edition, Nemchand and Bros, Roorkee
2. L.R.Kadiyali and Lal, "Principles of Highway Engineering", Khanna publishers, New Delhi
3. K P Subramanium "Transportation Engineering", Scitech publications, Chennai
4. R Sreenivas Kumar "Highway Engineering", University Press, Pvt. Ltd. Hyderabad
5. S K Khanna, C E G Justo and A Veeraragavan, "Highway Material and Pavement Testing Laboratory Manual", Revised 5th Edition, Nemchand and Bros, Roorkee
6. Relevant IRC and AASHTO codes

BTCE15F6200	Geotechnical Engg-II	L	T	P	C	Hrs/Wk
Duration :16 Wks		2	1	0	3	4

Prerequisites:

Basic knowledge of Engineering Mechanics, Strength of Materials and Fluid Mechanics and Structural Analysis.

Course Objectives:

1. To create an ability to apply knowledge of geotechnical engineering;
2. To analyze and interpret data related to designing foundations and earth retaining structures using geotechnical principles;
3. To analyse the stresses and bearing capacity of soils.

Course Outcomes:

The students will able to,

1. To examine the subsurface of the earth.
2. To analyse the earth pressure
3. To determine Bearing capacity and stresses in the soils.
4. To design the Various foundations

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
	CO1	3	3	1	3	2	2	1			2			3	3	3	2

BTCE 15F6 200	**CO2**	**3**	**2**	**1**	**3**		**2**	**1**			**2**			**3**	**3**	**3**	**2**
	CO3	**3**	**2**	**3**	**3**		**2**	**1**			**2**			**3**	**3**	**3**	**1**
	CO4	**3**	**2**	**3**	**3**		**2**	**1**			**2**			**3**	**3**	**3**	**2**

Course Contents:

UNIT1:SUBSURFACE EXPLORATION: Importance of exploration program, Methods of exploration: Boring, Seismic refraction method of grophysical exploration, Types of samples - undisturbed, disturbed and representative samples, Samplers, sample disturbance, area ratio, Recovery ratio, clearance, Stabilisation of boreholes - Typical bore log. Number and depth of borings for various civil engineering structures, soil exploration report. **DRAINAGE AND DEWATERING:** Determination of ground water level by Hvorselev’s method, Control of ground water during excavation: Dewatering - Ditches and sumps, well point system, Vacuum method, Electro- Osmosis method.
12 hours
UNIT II:LATERAL EARTH PRESSURE: Active and Passive earth pressures, Earth pressure at rest. Rankine’s and Coulomb’s Earth pressure theories-– Graphical solutions for active earth pressure (cohesionless soil only) – Culmann’s and Rebhann’s methods, Lateral earth pressure in cohesive and cohesionless soils, **STABILITY OF EARTH SLOPES:** Types of slopes, causes and type of failure of slopes. Definition of factor of safety, Stability of infinite slopes, Stability of finite slopes by Methodof slices and Friction Circle method, Taylor’s stability number, Fellineous method,.
12 hours
UNIT III:STRESSES IN SOILS: Boussinesq’s and Westergaard’s theories for concentrated, circular and rectangular loads. Comparison of Boussinesq’s and westergaard’s analysis. Pressure distribution diagrams, Contact pressure, Newmark’s chart. **BEARING CAPACITY AND SHALLOW FOUNDATION** Introduction – Bearing capacity- definition – types of shear failure – Bearing capacity of shallow foundation on homogeneous deposits - Methods: Terzaghi’s , Skempton’s and BIS methods – Effect of water table on bearing capacity – Plate load test – Bearing capacity from in-situ tests - SPT, SCPT and plate load test –Types of foundation – contact pressure distribution below isolated footing –
12 hours
UNIT IV:FOUNDATION SETTLEMENT: Importance and Concept of Settlement Analysis, Immediate, Consolidation and Secondary settlements (no derivations, but, computation using relevant formula for Normally Consolidated soils), Tolerance. BIS specifications for total and differential settlements of footings and rafts.
PROPORTIONING SHALLOW AND PILE FOUNDATIONS Allowable Bearing Pressure, Factors influencing the selection of depth of foundation, Factors influencing Allowable Bearing Pressure, Factors influencing the choice of foundation, Proportioning isolated, combined, strip and mat foundations, Classification of pile foundation, Pile load capacity, Proportioning pile foundation

12 hours
TEXT BOOKS:
1. Alam Singh and Chowdhary G.R. **Soil Engineering in Theory and Practice**, CBS Publishers and Distributors Ltd., New Delhi-1994.

2. Punmia B.C. **Soil Mechanics and Foundation Engg,** 16th Edition Laxmi Publications Co. New Delhi2005.
3. Bowles .J.E**, "*Foundation analysis and design*",** McGraw Hill, 2001.
4. Murthy .V.N.S**, "*Textbook of Soil Mechanics and Foundation Engineering*",** CBS Publishers and Distributors, New Delhi, 2009.

REFERENCES BOOKS:

1. Gopal Ranjan and Rao A.S.R. **Basic and Applied Soil Mechanics**, New Age International (P) Ltd., Newe Delhi, 2000.
2. Venkatrahmaiah C.**Geotechnical Engineering**, 3rd Edition New Age International (P) Ltd., Newe Delhi, 2006.
3. Craig R.F. **Soil Mechanics**, Van Nostrand Reinhold Co. Ltd, 1987.
4. Braja M. Das **Principles of Geotechnical Engineering**- (2002), 5th Edition, Thomson Business Information India (P) Ltd., India.
5. Iqbal H. Khan **Text Book of Geotechnical Engineering**- (2005), 2nd Edition, PHI, India

BTCE15F6300	**Design of Steel Structures**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**2**	**1**	**0**	**3**	**4**

Prerequisites:

Basic Structural Analysis

Course Objectives:

4. To learn about the concepts and principles of limit state design of steel structures
5. To learn about the provisions of I.S.Codes 800, 875
6. To learn about the concepts and principles of plastic analysis
7. To analyze statically indeterminate beams by plastic methods
8. To analyze and design bolted and welded connections
9. To analyze and design tension members
10. To analyze and design compression members (laced and battened) including splices etc.
11. To design column bases and foundation
12. To design laterally supported beams

Course Outcomes:

At the end of the course, the student

1. Has learnt about the concepts and principles of limit state design of steel structures Has learnt about the provisions of I.S.Codes 800, 875
2. Has learnt about the concepts and principles of plastic analysis, Is able to analyze statically indeterminate beams by plastic methods
3. Is able to analyze and design bolted and welded connections, Is able to analyze and design tension members

4. Is able to analyze and design compression members (laced and battened) including splices etc., Is able to design column bases and foundation, Is able to design laterally supported beams

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F6 300	CO1	3	3	1	3	2	2	1			2			3	3	3	2
	CO2	3	2	1	3		2	1			2			3	3	3	2
	CO3	3	2	3	3		2	1			2			3	3	3	1
	CO4	3	2	3	3		2	1			2			3	3	3	2

Course Contents:

UNIT-1

Introduction to Plastic Analysis: Introduction, Plastic theory, Plastic hinge concept, Plastic collapse load, Shape factor, conditions of plastic analysis, upper bound, lower bound and uniqueness theorems, Methods of Plastic analysis, Plastic analysis of statically indeterminate beams including continuous beams.

Introduction: Advantages and Disadvantages of Steel structures, Loads and Load combinations, Design considerations, Limit State Method (LSM) of design, Failure criteria for steel, Codes, Specifications and section classification.

UNIT-2

Bolted Connections: Introduction, Behaviour of Bolted joints, Design strength of ordinary Black Bolts, Design strength of High Strength Friction Grip bolts (HSFG), Pin Connections, Simple Connections, Moment-resistant connections, Beam to Beam connections, Beam and Column splices, Semi rigid connections

Welded connections: Introduction, Welding process, Welding electrodes, Advantages of Welding, Types and Properties of Welds, Types of joints, Weld symbols, Weld specifications, Effective areas of welds, Design of welds, Simple joints, Moment resistant connections, Continuous Beam to Column connections, Continuous Beam to Beam connections, Beam Column splices, Tubular connections

UNIT-3

Design of Tension Members: Introduction, Types of tension members, Design of strands, Slenderness ratio, Behaviour of tension members, Modes of failure, Factors affecting the strength of tension members, Angles under tension, Other sections, Design of tension member, Lug angles, Splices, Gussets.

Design of Compression Members: Introduction, Failure modes, Behaviour of compression members, Elastic buckling of slender compression members, Sections used for compression members, Effective length of compression members, Design of compression members, laced and battened built up columns. Column splices.

UNIT-4

Design of Column Base and Foundation: Design of simple slab base and gusseted base, Design of foundation.

Design of Beams: Introduction, Beam types, Lateral stability of beams, factors affecting lateral stability, Behaviour of simple and built-up beams in bending(without vertical stiffeners), Design strength of laterally supported beams in Bending, Design strength of laterally unsupported beams, Shear strength of steel beams, Maximum deflection, Design of laterally supported beams.

References:

1. N Subramanian, Design of Steel Structures, Oxford,2008
2. Duggal,Limit State Design of Steel Structures, Tata Mcgraw Hill 2010
3. Bhavikatti,Design of Steel Structures , I.K. International Publishing House Pvt. Ltd
4. Pasala Dayaratnam S. Design of Steel Structures, Chand, 1999
5. Bureau of Indian Standards, IS800-2007, IS 875-1987
6. Steel Tables

BTCE15F6400	**Estimation and Project Management**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**2**	**1**	**0**	**3**	**4**

Prerequisites:

A thorough knowledge of the subject Building planning and drawing.

Course Objectives:

To learn study various drawing with estimates, methodsof taking out quantities and preparation of detailed and abstract estimates for different civil engineering works. To learn about specifications and carry out rate analysis, measurement of earth work. Importance and significance of various terms related to contracts. Basics and importance of project management.

Course Outcomes:

Students will learn how to study the

1. various drawings and taking out quantities,
2. Work out the cost and preparation of abstract for the estimated cost for the various civil engineering works, how to write specifications, c
3. Carry out rate analysis, obtain measurement of earth work for roads by various standard methods and preparation of contract document related to a project.
4. Documents preparation for tenders.

5. Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO1**	**P02**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
BTCE 15F6 400	**CO1**	**1**	**2**	**3**		**1**		**2**	**1**	**2**				**3**	**3**	**2**	**3**
	CO2	**1**	**2**	**3**		**1**			**1**	**2**				**3**	**3**	**3**	**2**
	CO3	**3**	**1**	**3**		**1**				**1**				**3**	**3**	**3**	**1**
	CO4	**3**	**1**	**3**		**1**		**1**		**1**				**3**	**3**	**3**	**2**

Course Contents:

UNIT1:ESTIMATION: Study of various drawings with estimates, important terms, units of measurement, abstract Methods of taking out quantities and cost –center line method, long and short wall method or crossing method. Preparation of detailed and abstract estimates for the following Civil Engineering works – Buildings – RCC framed structures with flat, sloped RCC roofs with all Building components

UNIT2:ESTIMATE: Different type of estimates, approximate methods of estimating buildings, cost of materials. Estimation of wooden joineries such as doors, windows & ventilators.
ESTIMATES: Steel truss (Fink and Howe truss), manhole and septic tanks, RCC Culverts.
SPECIFICATIONS: Definition of specifications, objective of writing specifications, essentials in specifications, general and detail specifications of common item of works in buildings.

UNIT3:RATE ANALYSIS: Definition and purpose. Working out quantities and rates for the following standard items of works – earth work in different types of soils, cement concrete of different mixes, bricks and stone masonry, flooring, plastering, RCC works, centering and form work for different RCC items, wood and steel works for doors, windows and ventilators.

MEASUREMENT OF EARTHWORK FOR ROADS: Methods for computation of earthwork – cross sections – mid section formula or average end area or mean sectional area, trapezoidal &prismoidal formula with and without cross slopes.

UNIT4:CONTRACTS: Types of contract – essentials of contract agreement – legal aspects, penal provisions on breach of contract. Definition of the terms –Tender, earnest money deposit, security deposit, tender forms, documents and types. Acceptance of contract documents. Termination of contract, completion certificate, quality control, right of contractor, refund of deposit. Administrative approval – Technical sanction. Nominal muster roll, measurement books – procedure for recording and checking measurements – preparation of bills. Valuation- Definitions of various terms, method of valuation, Freehold & Leasehold properties, Sinking fund, depreciation and method of estimating depreciation, Outgoings.

Project management- Introduction, meaning, nature and characteristics, scope and functional areas, rolls, levels, development of management and modern management approaches.

REFERENCE BOOKS:

1. B. N. Dutta, Estimating & Costing, Chand Publisher
2. P.L. Basin S. Quantity Surveying- Chand : New Delhi.
3. S.C. Rangwala Estimating & Specification Charotar publishing house, Anand.
4. G.S. Birde, Text book of Estimating & Costing- DhanpathRai and sons : New Delhi.
5. D.D. Kohli and R.C. Kohli S A text book on Estimating, Costing and Accounts Chand : New Delhi.
6. B. S. Patil, Contracts and Estimates, University Press, 2006.

BTCE15F6510	**Design of Hydraulic structures**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

Fluid Mechanics and Hydrology & Irrigation Engineering

Course Objectives:

1. The reservoir planning and various reservoir operations.
2. About analysis and design of gravity dam
3. About salient features of earth & rock fill dams, and seepage analysis
4. Types and salient features of spillways and energy dissipation below spillways

Course Outcomes:

1. Analyse the requirements and techniques for reservoir operations
2. Analyse and design high and low gravity dams
3. Identify the suitable methods for seepage control through earth and rock fill dams.
4. Suggest suitable type of spillway and its capacity or a given condition

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F6 510	CO1	3	2	2	-	-	-	-	-	2	-	-	3	3	3	3	3
	CO2	3	2	3	2	-	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	2	3	2	-	-	-	-	2	-	-	3	3	3	3	3
	CO4	3	2	3	1	-	-	-	-	2	-	-	3	3	3	3	3

UNIT 1:RESERVOIR PLANNING: Introduction, classification of reservoir, Storage zones of a reservoir, masscurve, fixing capacity of a reservoir, safe yield, problems, density currents,trap efficiency, reservoir sedimentation, life of a reservoir, economic heightof a dam, problems, environmental effects of reservoir, diversion head works- introduction and component parts. Cross drainage works-introduction and types.

Unit 2:GRAVITY DAMS: Introduction, forces on a gravity dam, stress analysis in gravity dams,problems, combination of forces for design. Elementary and practicalprofiles of a gravity dam, stability analysis (without earthquake forces),problems, galleries in gravity dams.

UNIT 3: EARTH AND ROCKFILL DAMS: Introduction, types of earth dams, construction methods, design criteria forearth dams, causes of failure of earth dams, section of dam, preliminarydesign criteria, problems, control of seepage through earth dams, safetymeasures.Rockfill damsand its components.

UNIT4:SPILLWAYS: Introduction, types and energy dissipation below spillways

TEXT BOOKS:

1. R.K. Sharma, Text book of irrigation Engineering & Hydraulic Structures –Oxford & IBH Publishing Company, New Delhi (2002).

2. G.L. Asawa, Irrigation and Water Resources Engineering –New Age International Publishers, New Delhi (2005).
3. Modi P.N., Irrigation, Water Resources and Water Power Engineering –Standard Book House, New Delhi.
4. C. Sathyanarayana Murthy, Design of Minor Irrigation and Canal Structures –New Age International Publishers, New Delhi.

REFERENCE BOOKS:

1. Garg, S.K., Irrigation Engineering & Hydraulic Structures –Khanna Publishers, New Delhi.
2. Madan Mohan Das & Mimi Das Saikia, Irrigation and Water Power Engineering –PHI Learning Pvt. Ltd., New Delhi (2009).

BTCE15F6520	**Earth & Rock fill Dams**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

Soil mechanics, Hydrology & Irrigation Engineering

Course Objectives:

1. The reservoir planning and various reservoir operations.
2. About analysis and design of gravity dam
3. About salient features of earth & rock fill dams, and seepage analysis
4. Types and salient features of spillways and energy dissipation below spillways

Course Outcomes:

1. Enumarate the types of dams
2. Analyse and design of earth dams with suitable foundations
3. Identify the suitable methods for seepage control through earth and rock fill dams.
4. Suggest suitable ways to construct the embankments

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3	PSO4
BTCE 15F6 520	CO1	3	2	2	-	-	-	-	-	2	-	-	3	3	3	3	3
	CO2	3	2	3	2	-	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	2	3	2	-	-	-	-	2	-	-	3	3	3	3	3
	CO4	3	2	3	1	-	-	-	-	2	-	-	3	3	3	3	3

UNIT I: INTRODUCTION-Types of dams, Homogeneous earth Dams, Zoned Earth dams, Rockfill Dams. Typical Embankment, Dam sections, Site selection and exploration, Influence of topography and subsoil conditions on location and alignment of the dam. Foundation sub surface exploration and studies of embankment construction material.

DESIGN OF EARTH DAMS-Material available for embankment construction, character of foundation, climate, shape and size of the valley, River diversion, probable wave action time available for construction function of reservoir and earthquake activity, location and inclination of earth core & shell materials, embankment side slopes, free board and crest width. Filter Zones, Design provisions Draw down pore pressures. Berms, Upstream and down stream slope protection. Internal drainage systems, Seismic design considerations, ground movements, seiches, problems in loose sand and soft clay.

UNIT II:EARTH DAMS ON PERVIOUS FOUNDATION SOIL-Methods of foundation treatment, preventing under seepage with complete vertical barriers and grouting, Reducing under seepage with partial vertical cutoffs and horizontal upstream impervious blankets, controlling under seepage by regulation of leaks and relief wells.

STABILITY ANALYSIS-Stability of infinite slopes. Zones of planes of weakness in foundation, stability analysis of embankment by Taylor's method, Swedish' method including side forces between slices, simplified method suggested by Sherard et. Al., Morgensterm-price method, wedge method, Zone of planes of weakness in foundation, stability during construction, full reservoir and drawdown, settlement and horizontal movements. Special design problems and details

UNIT III:MEASUREMENTS OF PORE WATER PRESSURE AND MOVEMENTS-Purposes and types of instruments, piezometer, devices for measuring movements, USBR measurements of pore water pressure and embankments compression, compression of rock fill embankment sections, during construction and post construction foundation settlement, foundation spreading, observation and measurement of leakage.

TREATMENT OF ROCK FOUNDATIONS AND ABUTMENTS-Types of rock, foundation object of grouting, evaluation of necessity of grouting, planning grouting details, blanket grouting, drilling equipment, size and direction of holes, washing and pressure testing of holes, grouting equipment, procedures for grouting, pressure and consistency of grout, stopping surface leakage, surface treatment of rock foundation and abutments. Earth compaction against rock foundations and abutments, grouting through completed earth embankments, drainage holes, grouting and drainage galleries.

UNIT IV:EMBANKMENT CONSTRUCTION-Equipments for excavating, hauling spreading, blending, compacting and separating over sized rocks and cobbles, construction procedures and quality control of impervious and semi pervious embankments sections, handing dry and wet materials.

Construction procedures and quality control of pervious embankment sections, construction problems caused by fines, construction procedures of hard and soft rockfill embankments, field test on rockfill embankments, slope treatment and riprap.

References

1. Sherard, J.L., Woodward, R.J., Gizienski, S.F. and Clevenger, W.A. Earth and earth-rock dams, John Wiley & Sons, New York., 1963
2. Sowers, G.P. and Sally, H.L. Earth and rockfill dam engineering, Asia Publishing House, New Delhi., 1970
3. Creager, W.P., Justin, J.D. and Hinds, J. Engineering for dams, John Wiley & Sons, New York., 1945.
4. Earth & Rock fill dams – Principles of design and construction by Christian Kutzner Published Oxford and IBH
5. Design of small dams – united states department of the Interior Bureau of Reclamation Published by Oxford and IBH Publishing Company
6. Earth Manual – CBS Publishers and distributors
7. E.N.Bromhead The stability of slopes published by Blackie Academic and Professional
8. Earth and Rock fill dams by Sherad
9. Bharat Singh Earth and Rock fill dams
10. Winterkorn and Fang Foundation Engineering Hand Book,

BTCE15F6610	**Repair & rehabilitation of structures**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

Concrete Technology & Alternative Building Materials

Course Objectives:

1. To learn about causes of deterioration of structures, the investigation and methods of diagnosis of damaged structures and Quality assurance for concrete properties.
2. To learn about influence on serviceability and durability properties of concrete, cause of corrosion and methods to prevent corrosion. Importance and protective measures on various aspects of maintenance.
3. To learn about Inspection, Assessment procedure for evaluating a damaged structure and materials used for repair of damaged structure
4. To learn about techniques for repair , case studies

Course Outcomes:

1. Identify the causes of deterioration of structures, diagnosis of damaged structures by using various methods and capable of maintaining Quality assurance for concrete properties.
2. Examine influence on serviceability and durability properties of concrete, should give preventive measures of corrosion control by various methods.
3. Asses and evaluate the damaged structure by using suitable materials.
4. Identify techniques for repair with the help of different case studies

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3	PS O4
BTCE 15F6 610	CO1	3	2	3	2		2	1	2		3	2		3	3		3
	CO2	3	2	2	3	3	2	3	1	2	3	1	2	3	3	1	3
	CO3	3	3	3	1	3	1	1		1	2	3	2	3	3	1	3
	CO4	2	3	3	2	3	2	3	2	1	1	1	2	3	3	3	3

Course Contents:

UNIT-1: General:

Introduction, cause of deterioration of concrete structures, diagnostic methods and analysis, preliminary investigations, experimental investigations using NDT, load testing, corrosion mapping, core drilling, partial destruction techniques and other instrumental methods.

Quality assurance for concrete construction, concrete properties- strength, permeability, thermal properties and cracking,

UNIT-2: Influence on Serviceability and Durability:

Effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection.

Maintenance and Repair Strategies:

Definitions, Maintenance, Repair and rehabilitation, Facets of maintenance, Importance of maintenance, Protective measures on various aspects.

UNIT-3: Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration, testing techniques

Materials for repair:
Special concretes and mortars, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro-cement, Fibre reinforced concrete.

UNIT-4: Techniques for repair:
Rust eliminators and polymer coating for rebars during repair, foamed concrete, dry pack technique, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning.

Examples of repair to structures:

Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering, wear, fire, leakage and marine exposure, engineereddemolition techniques for dilapidated structures, Case studies.

REFERENCE BOOKS:

1. Sidney, M. Johnson, Deterioration, Maintenance and Repair of Structures McGraw- Hill, London.
2. Denison Campbell, Allen & Harold Roper, Concrete Structures – Materials, Maintenance and Repair Longman Scientific and Technical, London.
3. R.T.Allen and S.C. Edwards, Repair of Concrete Structures, Blakie and Sons, Hampshire.
4. B.Vidiveli, Rehabilitation of concrete structures Standard Publishers & Distributors, New Delhi.
6. B.L Gupta & Amit Gupta, Maintenance Repair of Civil Structures Standard Publishers & Distributors, New Delhi.
7. P.S Gahlot & Sanjay Sharma, Building Repair and Maintenance Management, CBS Publishers & Distributors Pvt. Ltd., New Delhi.
8. P Davaratnam. N.V Ramana Rao, Maintenance and Durability of concrete structures" Universities Press (India), 1997.
9. M.S.Shetty, Concrete Technology - Theory and Practice, S.Chand and Company, NewDelhi.

BTCE15F6620	Structural Dynamics	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Engineering Mechanics, Structural Analysis - I

Course Objectives:

1. To learn about the basic concepts and principles of vibration and mathematical modeling
2. To analyze free vibration of SDOF systems (undamped and damped)

3. To analyze forced vibration of SDOF systems (undamped and damped) due to harmonic and general loading functions including support excitation

4. To learn about the principles and use of vibration measuring instruments

5. To analyze free and forced vibration of MDOF systems (undamped and damped)

6. To analyze the free vibration of continuous systems such as rods and beams

Course Outcomes:

At the end of the course, the student

1. Understand the principles of Structural Dynamics and damping in structures.
2. Summarize the Solution techniques for dynamics of single degree of freedom systems.
3. Understand the principles of engineering seismology.
4. Understand the concepts of earthquake resistance of reinforced concrete buildings.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3	PSO4
BTCE 15F6 620	CO1	2	3	1										2	3		
	CO2		2	2										3		1	2
	CO3	1	2					1						2		1	
	CO4	1	2	1										2			1

Course Contents:

UNIT – 1:Introduction to structural dynamics: Brief history of vibration, Mathematical modeling, basic definitions, simple harmonic motion. D' Alembert's principle, principle of virtual work.

Free vibration of single degree of freedom system: Undamped and damped systems, viscous and Coulomb damping, logarithmic decrement, Evaluation of damping, response to initial conditions, Numerical problems.

UNIT – 2:Forced vibration of single degree freedom systems: Undamped and damped systems, response to harmonic loading, rotating unbalance, reciprocating unbalance. Duhamel's integral, response due to general system of loading, impulsive loadings, dynamic load factor, response spectrum, response of SDOF subjected to harmonic base excitation, vibration isolation and transmissibility, Principle of vibration measuring instrument, Numerical problems.

UNIT – 3:Free vibration of multi degree of freedom systems: Shear buildings modeled as multi degree of freedom systems, natural frequencies, normal modes, orthogonality property of normal modes, modal matrix, Numerical problems.

Forced vibration of multi degree of freedom systems: modal superposition method, response of MDOF systems to harmonic forced excitation, Numerical problems.

UNIT – 4:Free vibration of continuous systems: Longitudinal vibration of uniform bars, derivation of expression, natural frequencies for various boundary conditions, Transverse vibration of uniform beams, derivation of expression, natural frequencies and mode shapes for various boundary conditions.

REFERENCE BOOKS:

1. Mario Paz, Structural Dynamics CBS publishers, New Delhi.
2. W.T.Thomson, Theory of Vibrations with Applications CRC Press
3. M. Mukhopadhaya, Vibrations, Structural dynamics- Oxford IBH, Delhi.
4. Anil Chopra, Structural Dynamics PHI Publishers, Delhi.
5. Clough & Penzen, Structural Dynamics TMH, Delhi.
6. G K Grover, Mechanical Vibrations Nemchand & Bros, Roorkee, India.
7. John M Biggs, Structural Dynamics McGraw-Hill Book Co.

BTCE15F6630	Earth & Earth Retaining Structures	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Basic knowledge of Engineering Mechanics, Strength of Materials, Fluid Mechanics, Basic geotechnical engineering and Structural Analysis

Course Objectives:

1. Understand the classification of ERS based on load support mechanism,
2. Understand the different types of retaining walls.
3. Understand the various Construction methods of Sheet pile walls.
4. Understanding of the basic principles involved in various techniques of Soil. Nailing.

Course Outcomes:

1. An ability to analyse and design independently common earth retaining structures

2. At the end of this course students are expected to gain an appreciation on the most common retaining wall types available in the industry worldwide.
3. The students will know how to tackle basic retaining wall problems and have the ability to design detaining walls based on Lateral Earth Pressure Theory.
4. The students will also have an appreciation of wall movements and potential impact on the surrounding structures.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 02	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3	PSO4
BTCE 15F6 630	CO1	**3**	**1**	**1**	**2**					**1**				**3**	**3**	**3**	**3**
	CO2	**2**	**2**	**2**	**1**		**1**				**1**		**1**	**3**	**3**	**3**	**3**
	C03	**3**	**3**	**2**	**2**			**1**			**1**	**1**		**3**	**3**	**3**	**3**
	CO4	**3**	**3**	**2**	**2**			**1**			**1**	**1**		**3**	**3**	**3**	**3**

Course Content:

UNIT – 1: Introduction to earth retaining structures, Necessity of ERS, classification of ERS based on load support mechanism, construction concept, system rigidity and service life. ERS selection methods, factors affecting ERS selection, Rankine's and Coulomb's Earth pressure theories for cohesive and cohesionless soils, Influence of movement on earth pressure stresses due to compaction and surcharge loads. **12hrs**

UNIT – 2 : Soil properties and lateral Earth pressure. Earth pressures on walls, various types of back fill and condition of loading. Soil tension effects and rupture zones. Effect of flexibility of structures on lateral pressure. Earth pressures due to earthquakes. Conventional Retaining Wall: Types of retaining walls, Stability (sliding, overturning, bearing capacity & overall) of gravity and cantilever walls, Proportioning of retaining walls, Backfill material and drainage.
12hrs

UNIT – 3: Flexible Walls: Sheet pile walls, Construction methods- Cantilever and Anchored sheet pile wall. Reinforced Soil Walls/Mechanically Stabilised Earth: - Failure mechanisms bond and rupture failures, Analysis methods, Limit equilibrium method- Internal and external stability, Static and seismic analyses. **12hrs**

UNIT – 4: Analysis and design of cantilever and anchored sheet pile walls. Braced Cuts and Soil Nailing: Lateral earth pressure in braced cuts, Design of various components, Stability of braced cuts, base heave and stability, yielding and settlement of ground surrounding excavation, Diaphragm walls – slurry support; Soil Nailing. **12hrs**

REFERENCE BOOKS:

1. Braja M. Das Principles of Foundation Engineering.
2. Bowles, Foundation analysis and design –JE – McGraw Hill.
3. Terzaghi, K and Rolph, B.peck Soil Mechanics in Engineering Practice 2nd Edn.John Wiley &Co.
4. Analysis and Design of Foundations and Retaining Structures, Mearut.
5. Prakash, S – SarithaPrakashan, Winterkorn, H.F. and Fang, H.Y., Foundation Engineering Handbook, Galgotia Book- source, 2000.
6. Rowe, R.K., Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers, 2001.
7. Militisky, J. and Woods, R., Earth and Earth retaining structures, Routledge, 1992.
8. Koerner, R.M., Design with Geosynthetics (Third Edition), Prentice Hall, 1997.
9. Day, R.W., Geotechnical and Foundation Engineering: Design and Construction, McGraw Hill, 1999.
10. Das, B.M., Principles of Geotechnical Engineering (Fourth Edition). The PWS series in Civil Engineering, 1998

BTCE15F6640	**Transportation Economics**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

NONE

Course objectives:

1. To give the students an overview of Economics, its basic terms and concepts, and discuss various types of costs and benefits that economist discuss in transport projects.
2. To educate students the importance of transport economic analysis and edify the basic methods of economic analysis carried for transportation engineering projects.
3. To make the students capable of recognizing a project from different methods of economic analysis by identifying the limitations of each method.
4. To give the students an introduction to transport demand and elasticity concept make to make them capable to forecast demand for transport services

Course outcomes:

1. Elucidate the elements of transport economics: highway transportation costs, rroad user costs and benefits.

2. Explain the economic evaluation of null alternative, methods of analysis when applied to a group of mutually exclusive alternatives, depreciation cost, accounting methods, salvage value estimation, depreciation, taxes.
3. Associate characteristics and limitations of the different methods of economic analysis, ranking of independent projects, sensitivity analysis.
4. Enumerate factors affecting demand and supply, shift in demand and supply, transportation demand model, consumer surplus, marginal cost, average cost

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO1**	**P02**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
BTCE 15F6 640	CO1	**3**	**1**	**1**	**2**					**1**				**3**	**3**	**3**	**3**
	CO2	**2**	**2**	**2**	**1**		**1**				**1**		**1**	**3**	**3**	**3**	**3**
	C03	**3**	**3**	**2**	**2**			**1**			**1**	**1**		**3**	**3**	**3**	**3**
	CO4	**3**	**3**	**2**	**2**			**1**			**1**	**1**		**3**	**3**	**3**	**3**

UNIT – 1

Introduction: Concepts and Principles of Engineering Economics, Identification and Measurements of Highway Benefits, Highway Transportation Costs, Road User Costs and Benefits, Road User Cost Study in India. 12 hrs

UNIT – 2

Methods of Economic Analysis: Methods- BCR-NPV-IRR –Their Basic Characteristics, Illustrative applications on above Methods of Economic Analysis, Comparison of the Methods of Analysis when Applied to a Group of Mutually Exclusive Alternatives, Economic Evaluation of Null Alternative. 12 hrs

UNIT – 3

Depreciation Concepts: Depreciation Cost, accounting Methods, Salvage Value Estimation, Depreciation, Taxes, Problems. Characteristics and Limitations of the Different Methods of

Economic Analysis, Ranking of Independent Projects, Sensitivity Analysis. Case studies and problems. 12 hrs

UNIT – 4

Supply and Demand: Concept-Definition-Factors affecting Demand and Supply- Shift in Demand and Supply- Transportation demand Model- Equilibrium-Sensitivity of Travel Demand- Elasticities-Consumer Surplus- Marginal Cost- Average Cost- Pricing. 12 hrs

REFERENCE BOOKS:

1. Robley Winfrey,`**Economic Analysis for Highways'**, International Textbook Company, Pennsylvania.1990.
2. Kenneth J Button, **"Transportation Economics"**, Edward Elgar publishing
3. Jotin Khisty and Kent Lall '**Introduction to Transportation Engineering'** PHI, New Delhi,2001.
4. Kadiyali.L.R.' **Traffic Engineering and Transport planning'**, Khanna publications.
5. IRC: SP:30-1993, Manual on Economic Evaluation of Highway Projects in India.

Text Books:

1. Das, B.M., Principles of Geotechnical Engineering (Fourth Edition). The PWS series in Civil Engineering, 1998
2. Das, B. M. - Principles of Foundation Engineering
3. Bowles. J. E. - Foundation Analysis & Design
4. Militisky, J. and Woods, R., Earth and Earth retaining structures, Routledge, 1992. Clayton, C.R.I., Militisky, J. and Woods, R.I., Earth pressure and Earth-Retaining structures (Second Edition), Survey University Press, 1993

BTCE15F6650	**Air and noise pollution**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

Environmental Studies, Engineering Chemistry

Course Objectives:

1. To introduce source, classification, characterization and effects of air pollution.
2. To explain the meteorological definitions & air transport equations.
3. To introduce the sampling & pollution control matters and devices.
4. To demonstrate legislations and regulations pertinent to air pollution.

Course Outcomes:

1. Identify the sources of air pollution.
2. Identify the effects of air pollution on humans, vegetation, materials etc.
3. Solve problems on stack height, concentration of pollutants.
4. Identify the effects and control measures of air pollution due to automobiles

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3	PS O4
BTCE 15F6 650	CO1	3	3	2	3	3		3					3	3	3	3	3
	CO2	3	3	2	3	2		3					3	3	3	3	3
	CO3	3	3	2	2	2		2					3	3	3	3	3
	CO4	3	3	2	2	2		2					3	3	3	3	3

Course Contents:

UNIT - I

INTRODUCTION: Definition – Classification and Characterization of Air Pollutants, Concentration of pollutants – Problems. Emission Sources, Behavior and Fate of air Pollutants, Chemical Reactions in the Atmosphere, Photo-chemical Smog, Coal-induced smog, Air Pollution Inventories. **EFFECTS OF AIR POLLUTION:** On Human Health, Animals, Plants and Materials – Major Environmental Air Pollution Episodes – London Smog, Los Angeles Smog & Bhopal Gas Tragedy.

UNIT – II

METEOROLOGY: Introduction – Meteorological Variables, Primary and Secondary Lapse Rate, Inversions, Stability Conditions, Windrose – pollution roses. General Characteristics of Stack Plumes, Meteorological Models. Numerical problems on Gaussian plume model, plume rise, stack height. Factors to be considered in Industrial Plant Location and Planning. Noise pollution – sources, measurement units, effects and control

UNIT – III

SAMPLING, ANALYSIS AND CONTROL: Sampling and Measurement of Gaseous and Particulate matter, Stack Sampling, Analysis of Air Pollutants, Smoke and Smoke Measurement, Air Pollution Control Methods – Particulate, Emission Control, Gravitational Settling Chambers, Cyclone Separators, Fabric Filters, Electrostatic Precipitators, Wet Scrubbers – numerical problems. Selection of a Particulate Collecting Equipment, Control of Gaseous Emissions, Adsorption by Liquids, Adsorption by Solids, Combustion Odours and their control.

UNIT – IV

AIR POLLUTION DUE TO AUTOMOBILES: Air Pollution due to Gasoline Driven and Diesel Driven Engines, Effects, Direct and Indirect Methods of control. **BURNING ENVIRONMENTAL ISSUES:** 1. Acid Rain 2. Global Warming 3. Ozone Depletion in Stratosphere 4. Indoor Air Pollution. **ENVIRONMENTAL LEGISLATION:** Environmental Policy, Environmental Acts, Water, Air and Noise Pollution Standards.

Reference Books:

1. Rao M N. and Rao H V N., "Air Pollution" Tata Mc Graw Hill Publishing Co. Ltd., New Delhi. 2004.
2. Boubel, R W., Donald, L.F., Turner, D.B., and Stern, A.C., "Fundamentals of Air Pollution" – Academic Press, 1994.
3. Crawford, M., "Air Pollution Control Theory" – Tata Mc Graw Hill Publishing Co. Ltd., New Delhi. 1980.
4. Henry C Perkins, "Air Pollution" – Tata Mc Graw Hill Publishing Co. Ltd., New Delhi. 1980.
5. Murali Krishna K V S G., "Air Pollution & Control" Kaushal & Co., 1995.
6. Peavy, H.S., Rowe, D.R., and Tchobanoglous, G., "Environmental Engineering" – Tata Mc Graw Hill Publishing Co. Ltd., New Delhi. 1986.
7. Sincero, A.P and Sincero, G.A., "Environmental Engineering – A Design Approach", Prentice Hall of India. 1999.
8. Wark, K., Warner, C.F. and Davies, W.T., "Air Pollution- Its Origin and Control", Harper & Row Publishers, New York. 1998.
9. Rao C S., "Environmental Pollution Control Engineering", New Age International, New Delhi. 2007.

BTCE15F6700	Extensive Survey Practice	L	T	P	C	Hrs/Wk
Duration :16 Wks		1	0	1	2	3

Prerequisites:

Hydrology & Irrigation ,Design of Hydraulic Structuresand Surveying practice lab

Course Objectives:

1. To apply knowledge of mathematics, science, and engineering to understand the measurement techniques.
2. To train the students under difficult and realistic situation of the surveying project.
3. To acquire a sound practical knowledge and application of theory and in practical to overcome the difficulties that could arise in field during surveying.
4. To impart training in the use of modern surveying instruments and to acquire a comprehensive idea of the project.

Course Outcomes:

1. Experiment the use of surveying instruments and performing various survey works in difficult terrain and to identify sites necessary for conducting various surveys.
2. Appraise the need for accurate and thorough note taking in field work to serve as a legal and produce the required maps and related calculations pertaining to survey work
3. Develop the adaptability in conversant with the camp life, to communicate with the local population, to develop team spirit, community living and self-management.
4. Adopt the working of Total station and Global Positioning System in the view of need for licensed surveyors.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BTCE 15F6 700	**CO1**	1	2	3				2	1					3	3	2	3
	CO2	1	2	3					1					3	3	3	2
	CO3	3	2											3	3	3	1
	CO4	3	2					1						3	3	3	2

Course Contents:

An extensive survey training involving investigation and design of the following projects is to be conducted for 2 weeks (14 days). The student shall submit a project report consisting of designs and drawings. (Drawings should be done using AutoCAD)

1. General instructions, Reconnaissance of the sites and fly leveling to establish bench marks.

2. NEW TANK PROJECT: The work shall consist of

i) Alignment of center line of the proposed bund, Longitudinal and cross sections of the center line.
ii) Capacity surveys.
iii) Details at Waste weir and sluice points.
iv) Canal alignment.

(At least one of the above new tank projects should be done by using TOTAL STATION)

3. WATER SUPPLY AND SANITARY PROJECT: Examination of sources of water supply, Calculation of quantity of water required based on existing and projected population. Preparation of village map

by any suitable method of surveying (like plane tabling), location of sites for ground level and overhead tanks underground drainage system surveys for laying the sewers.

4. HIGHWAY PROJECT: Preliminary and detailed investigations to align a new road (min. 1 to 1.5 km stretch) between two obligatory points. The investigations shall consist of topographic surveying of strip of land for considering alternate routes and for final alignment. Report should justify the selected alignment with details of all geometric designs for traffic and design speed assumed. Drawing shall include key plan initial alignment, final alignment, longitudinal section along final alignment, typical cross sections of road.

5. OLD TANK PROJECT: The work shall consist of

i) Alignment of center line of the existing bund, Longitudinal and cross sections of the centre line.

ii) Capacity surveys to explore the quantity.

Details at existing Waste weir and sluice points.

REFERENCE :

1. Punmia B C, Ashok K Jain, Arun K Jain, Surveying Vol 1, 2,3: Surveying, laxmi Publications (P) Ltd, New Delhi.

2. Duggal S.K., Surveying Vol 1, 2: McGraw Hill Educatiion(India) Pvt.Ltd.

3. P.N.Modi Irrigation, water Resources and water power Engineering- - standard book house, New Delhi.

4. ChallaSatya Murthy, Water Resources Engineering: Principles and Practice- New Age International Publishers, New Delhi (2nd Ed.)

BTCE15F6800	**HHM Lab**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**1**	**0**	**1**	**2**	**3**

Prerequisites:

Applied physics& Fluid mechanics

Course Objectives:

1. To understand the properties of fluid, types of fluid and the Types of flow.
2. To study about the flow measuring devices such as orifice meter, venturimeter.
3. To acquire knowledge about the flow through pipes.
4. To acquire the ability to critically observe/ examine and Measure the discharges through flow measuring devices

Course Outcomes:

1. Analyse various flow problems and fluid characteristics.
2. Apply Bernoulli's equations in flow experiments to determine the coefficient of discharge.
3. Determine the losses of flow through various mediums like pipes.
4. Determine hydraulic coefficients of notches and orifices

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 02	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3	PS O4
BTCE 15F6 800	CO1	**3**	**3**	**2**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**
	CO2	**3**	**3**	**2**	**3**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**
	CO3	**3**	**3**	**2**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**
	CO4	**3**	**3**	**2**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**

Course contents:

Hydraulics & Hydraulics Machinery Lab Experiments:

1.Calibration of V-Notch & Rectangular Notch.

2.Calibration of Broad Crested Weir.

3.Calibration of Venturi Flume.

4.Calibartion of Venturi Meter & Orifice Meter.

5.Determinations of Major & minor losses in pipe flow.

6.Determination of hydraulic coefficients of a vertical orifice.

7.Determination of vane coefficients for Flat , Inclined, semi-circular vanes.

8.Performance characteristics of a Single Stage Centrifugal Pump

9. Performance characteristics of a Pelton Wheel Turbine.

10. Performance characteristics of a Francis Turbine

REFERENCE BOOKS:

1. Fluid Mechanics & Machinery Laboratory Manual Prepared by School of Civil Engineering, REVA University, Bengaluru.

2. R.K.Bansal (2004), Fluid Mechanics & Hydraulic Machines; Laxmi Publication (P) Ltd, New Delhi.
3. Hydraulics and Hydraulic Machines Laboratory Manual –R.V.Raikar, PHI Learning Pvt.Ltd.

SYLLABUS VII SEMESTER

BTCE15F7100	Transportation Engineering-III	L	T	P	C	Hrs/Wk
Duration :16 Wks		2	1	0	3	4

Prerequisites:

Transportation-I, Transportation-II

Course Onjectives:

1. To educate students about the importance of highway planning, alignment, and introduce the concepts of highway geometric design.
2. To make students familiar with design elements: sight distance, horizontal curvature, super elevation, grades, visibility on vertical curves, cross section elements.
3. To educate students about the importance of traffic engineering as applied to road transportation and features of traffic characteristics.
4. To give students an overview of transport economics, quantifying various transport costs and benefits, identify the economic feasibility of transport projects.

Course Outcomes:

On successful completion of this course, students should be able to:

1. Explain: the elements and factors affecting geometric design of highways, skid resistance, camber, road margins; illustrate the importance of sight distance; analyze and compute safe stopping sight distance for various design speeds.
2. Describe, analyze and compute: safe overtaking sight distance, super elevation, extra widening of pavement along horizontal curves, horizontal transition curves and setback distances for various design speeds.
3. Outline the scope of traffic engineering, describe the road user characteristics, conduct various traffic studies and design the traffic control measures to the safe and efficient operation of traffic.
4. Identify and compute: the scope of transport economics, various methods of transport project economic cost analysis for determining the economic viable project.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
	CO1	3	1	1	2					1				3	3	3	3

BTCE 15F7 100	CO2	**2**	**2**	**2**	**1**		**1**				**1**		**1**	**3**	**3**	**3**	**3**
	C03	**3**	**3**	**2**	**2**			**1**			**1**	**1**		**3**	**3**	**3**	**3**
	CO4	**3**	**3**	**2**	**2**			**1**			**1**	**1**		**3**	**3**	**3**	**3**

UNIT – 1

Highway planning, location and alignment- Necessity of highway planning, classification of roads, road patterns, Basic requirements of an ideal alignment and factors controlling, engineering survey for highway location, steps in new alignment, necessity of realignment and steps, drawings and report. **Highway geometric design** – Introduction, highway cross-section elements.

UNIT – 2

Highway geometric design – Sight distances – stopping and overtaking sight distances- overtaking zone requirements, **Design of horizontal alignment** – speed, radius, super elevation, extra widening of pavements, transition curves, **Design of vertical alignmen**t – gradient, grade compensation, summit curves and valley curves, **Intersections** –at grade and grade separated intersections, channelization, Numerical examples.

UNIT – 3

Traffic engineering- introduction - traffic characteristics, **Traffic studies** – spot speed, speed and delay, origin and destination, traffic volume, parking, traffic capacity and level of service. **Traffic flow characteristics**. **Traffic operation -** traffic control devices – traffic signs, markings, traffic signals, design of isolated signals by Webster's method. Numerical examples using software on relevant topics

UNIT – 4

Scope of transportation economics, Transportation demand, Demand, supply and equilibrium, Sensitivity of travel demand, Factors affecting elasticities. **Introduction to highway economics** – cost and benefits, highway economic analysis – annual cost method, present worth method, rate of return method, benefit-cost ratio method, Numerical examples.

Text Books:

1. Khanna. S.K. and Justo. C.E.G., Highway Engineering, Nem Chand and Bros, Roorkee.
2. Kadiyali. L. R., Traffic Engineering and Transport planning, Khanna publishers, New delhi.
3. Patha Chakraborty and Animesh Das, Principles of Transportation Engineering, PHI learning.
4. Papacostas, C.A.,, Fundamentals of Transportation Engineering', Prentice-Hall of India Private Limited, New Delhi.
5. Ian G Heggie, Transportation Engineering Economics, McGraw Hill Book Co.
6. Relevant IRC codes

BTCE15F7210	Design & Drawing of RCC & Steel Structures	L	T	P	C	Hrs/Wk
Duration :16 Wks		1	1	0	2	3

Prerequisites:

Knowledge Design of RCC Structural Elements ,Design of Steel Structures

Course Objectives:

1. The general layout of buildings and detailing of staircase and column footings
2. Design and detail cantilever type retaining walls, circular and rectangular water tanks resting on ground
3. The detailing of steel connections
4. The design and detailing of column splices and column bases

Course Outcomes:

1. Draw the general layout of buildings and detail staircase and column footings
2. Design and detail cantilever type retaining walls, circular and rectangular water tanks resting on ground
3. Design and detailing of steel connections
4. Design and detail column splices, lacing and battens ,column bases

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F7 210	CO1	2	1	1			2	3	1	1	1		2	3	3	2	1
	CO2	3	3	3			2	3	1	1	1		2	3	3	2	1
	CO3	3	3	3	1		2	3	1	1	1		2	3	3	3	1
	CO4	2	3	3	1		2	3	1	1	1		2	3	3	3	1

UNIT-1

Layout Drawing: General layout of building showing position of columns, footings, beams and slabs with standard notations, Detailing of Beam and Slab floor system, continuous beams, Detailing of Staircases: Dog legged and Open well.

Design and Detailing of Column footings: Column and footing (Square and Rectangle), Design and detailing of Rectangular Combined footing slab and beam type.

UNIT-2

Design and detailing of Cantilever type retaining walls.

Design and detailing of Circular and Rectangular water tanks resting on ground (Flexible base and Rigid base) using IS: 3370 (Part IV) only.

UNIT-3

Detailing of steel connections**:** Bolted and welded, beam-beam, Beam-column, seated, stiffened and un-stiffened.

Detailing of column **s**plices, Column-column of same and different sections. Columns, Lacing and battens.

Detailing of column bases**:** Slab base and gusseted base, grillage foundation.

UNIT-4

Design and drawing of roof truss (design forces in the members to be given)

REFERENCE BOOKS:

1. N. Krishna Raju, **Structural Design & Drawing Reinforced Concrete & Steel**- University Press, Delhi
2. Krishnamurthy **Structural Design and Drawing** - (Concrete Structures), CBS publishers, New Delhi. Tata Mc-Graw publishers.
3. B.C. Punmia – **Reinforced Concrete Structures** - Laxmi Publishing Co.
4. S.N.Sinha, **Reinforced Concrete Design –**Mc-GrawHill Education,
5. S.K. Duggal, ***Design* of *steel structures*** - Tata Mcgraw Hill, New *Delhi*
6. N. Subramanian **Design of Steel Structures** - Oxford University, Press.
7. Negi - **Design of Steel Structures** - Tata Mc Graw Hill Publishers.
8. Arya and Ajaman- **Design of Steel Structures** - Nem Chand &Bros. Roorkee.
9. S ***Unnikrishna*** Pillai & Devadas ***Menon Reinforced Concrete Design***-. Tata McGraw-Hill, New *Delhi*
10. IS: 456-2000, IS: 800 – 2007, SP(16)-1980, SP 6 (1) – 1984

BTCE15F7310	Design of precast & pre-stressed concrete structures	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Structural Analysis – I and Design of RCC Elements.

Course Objectives:

1. To understand the working principles of Prestressing.
2. To understand the different losses and deflections in Pre-stressing members.
3. To understand the failure pattern, designs of PSC beam.
4. Able to identify the requirements and applications of materials used in prefabricated structures.

Course Outcomes:

1. Familiar with the concepts, principles and methods of prestressing and able to compute the losses that occur in Prestressed concrete members.
2. To analyse the stresses in prestressed concrete beams at transfer and working condition and to compute the short-term and long-term deflections of Prestressed concrete beams.
3. To compute the ultimate flexural strength and shear strength of PSC beam sections and Design of PSC beams with the provisions of **IS: 1343-2012.**
4. Identify the suitable Pre-fabricated Elements required for Design

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3	PS O4
BTCE 15F7 310	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3
	CO2	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO3	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO4	3	1	2	1	3	1	2	1			3	3	3	3	3	3

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Course Contents:

UNIT – 1

Materials: High strength concrete and steel, Stress-Strain characteristics and properties. Structural steel and bolts, Non-cementitious materials.

Precast Concrete: Definition of Precast concrete, Joints and connections: Basic mechanisms, Compression joints, Shear joints, Tension joints, Pinned-jointed connections, Moment resisting connections.

Basic principles of prestressing: Fundamentals, Load balancing concept, Stress concept, centre of thrust. Pre-tensioning and post-tensioning systems, Tensioning methods and end anchorages.

Analysis of sections for flexure: Stresses in concrete due to prestress and loads, stresses in steel due to loads, Cable profiles. Numerical problems.

UNIT – 2

Loss of prestress: Various losses encountered in pre-tensioning and post-tensioning methods, determination of jacking force. Numerical problems

Limit state of serviceability:

Deflection of prestressed members**,** Short term and long term deflections, deflections at transfer and working load conditions with different cable profiles. Deflection limits as per IS 1343. Effect of creep on deflection, load versus deflection curve, methods of reducing deflections.

Control of cracking.

UNIT – 3

Limit state of collapse: Codal provisions, Ultimate flexural strength of sections. shear resistance of sections, shear reinforcement.

Design of end blocks: Transmission of prestress in pretensioned members, transmission length, Anchorage stress in post-tensioned members. Bearing stress and bursting tensile force-stresses in end blocks-Methods, Codal provisions, Design of end blocks.

UNIT -4

Design of PSC Beams: Design of pre-tensioned and post-tensioned symmetrical and asymmetrical sections by working stress method. Permissible stress, design of prestressing force and eccentricity, limiting zone of pre-stressing force cable profile. Introduction to limit state design. Numerical problems.

REFERENCE BOOKS:

1. T.Y. Lin and Ned H. Burns, Design of prestressed concrete structures John Wiley & Sons, New York.
2. N. Krishna Raju, Prestressed Concrete Tata McGraw Publisher, New Delhi.
3. Pre-stressed Concrete Oxford and IBH Publishing Co., New Delhi.

4. P. Dayarathnam, Fundamentals of prestressed concrete by N.C. Sinha & S.K. Roy, S.Chand and Co. Ltd.
5. IS : 1343 : 1980
6. N. Rajagopalan, Pre-stressed Concrete Alpha Science International Ltd.
7. Kim S. Elliott, Precast Concrete Structures, Butterworth-Heinemann
8. CBRI, Building materials and components, India, 1990

BTCE15F7320	Advanced Design Shallow Foundations	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites;

Basic knowledge of Engineering Mechanics, Strength of Materials and Basic Geotechnical Engineering.

Course Objectives:

1. To understand the different methods of soil exploration methods and dewatering techniques.
2. To understand earth pressures on foundations and retaining structures.
3. To understand to find factor of safety of Earth slope.
4. To understand the different types foundation and their bearing capacity and settlement.

Course Outcomes:

1. Understand Types of shallow foundations.
2. Determine the depth of shallow foundation and its construction.
3. Calculate bearing capacity in field with various experiments.
4. Analyse (bearing capacity and settlement) shallow foundations.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BTCE 15F7 320	CO1	3	3	1	3	2	2	1			2			3	3	3	2
	CO2	3	2	1	3		2	1			2			3	3	3	2
	CO3	3	2	3	3		2	1			2			3	3	3	1
	CO4	3	2	3	3		2	1			2			3	3	3	2

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Course Contents:

UNIT I:

General requirements of Foundations – Types of shallow foundations, Modes of shear failure, allowable bearing pressure, Ultimate Bearing capacity of concentrically loaded foundations, Influence of ground water table, Bearing capacity of footings on layered soils, steps involved in proportioning of footings

UNIT II:

Contact pressure under footings – Contact pressure under rigid rectangular footing, strip foundation, rigid circular footing, Principles of footing design, Design of non – rigid combined footings.

UNIT III:

Bearing capacity from SPT, CPT and Field load tests, Building codes, Safety factors in foundation design, Bearing capacity of foundations on slopes, with uplift or tension forces.

UNIT IV:

Settlements for shallow foundations, Designing footings on equal settlements, Reliability of settlement computations, Structures on fills, Allowable bearing pressure for permissible total settlement, approaches based on N values from SPT, Terzaghi – Peck approach for footings on sand, settlement prediction for foundation on mixed soils

TEXT BOOKS:

1.Alam Singh and Chowdhary G.R. **Soil Engineering in Theory and Practice**, CBS Publishers and Distributors Ltd., New Delhi-1994.

2.Punmia B.C. **Soil Mechanics and Foundation Engg,** 16th Edition Laxmi Publications Co. New Delhi2005.

3.Bowles .J.E**, "*Foundation analysis and design*",** McGraw Hill, 2001.

4.Murthy .V.N.S**, "*Textbook of Soil Mechanics and Foundation Engineering*",** CBS Publishers and Distributors, New Delhi, 2009.

REFERENCES BOOKS:

1.Gopal Ranjan and Rao A.S.R. **Basic and Applied Soil Mechanics**, New Age International (P) Ltd., Newe Delhi, 2000.

2.Venkatrahmaiah C.**Geotechnical Engineering**, 3rd Edition New Age International (P) Ltd., Newe Delhi, 2006.

3.Craig R.F. **Soil Mechanics**, Van Nostrand Reinhold Co. Ltd, 1987.

4.Braja M. Das **Principles of Geotechnical Engineering**- (2002), 5th Edition, Thomson Business Information India (P) Ltd., India.

5.Iqbal H. Khan **Text Book of Geotechnical Engineering**- (2005), 2nd Edition, PHI, India

BTCE15F7410	Theory of Elasticity	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites;

Strength of Materials

Course Learning Objectives:

1. To analyze the stress and strain at a point in a loaded elastic material (2D)
2. To analyze 2D dimension problems of elasticity in rectangular coordinates
3. To analyze 2D dimension problems of elasticity in polar coordinates
4. To analyze non-circular sections (solid and thin- walled) subjected to torsion

Course outcomes:

At the end of the course, the student is

1. To analyze the stress and strain at a point in a loaded elastic material (2D)
2. To analyze 2D dimension problems of elasticity in rectangular coordinates
3. To analyze 2D dimension problems of elasticity in polar coordinates
4. To analyze non-circular sections (solid and thin- walled) subjected to torsion

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 02	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
BTCE 15F7 410	CO 1					3	2	3	2	2		2	2	3	1	1	3
	CO 2	2				2	2	3	1	1		1	2	3	2	1	3
	CO 3	2		2	1	1	1	3	1	1			2	3	2	1	3
	CO 4	3	1		1	1		3	2	1	1		3	3	2	1	3

Course Contents:

UNIT -1

Introduction to mathematical theory of elasticity: Definition of continuum, stress at a point, strain at a point, Stress-strain relationship, Generalized Hooke's law, St. Venant's principle. Concepts of Plane stress and plane strain, Principal stresses and strains, measurement of surface strains, strain rosettes, Mohr's circle of stress and strain (2D).

UNIT- 2

Two-dimensional problems in Cartesian coordinates: Differential equations of equilibrium, boundary conditions, strain-displacement relations, compatibility equations, Airy's stress function, Polynomials, bending of a cantilever beam subjected to end load, Simply supported beam subjected to UDL, effect of shear deformation in beam.

UNIT - 3

Two-dimensional problems in polar coordinates: equilibrium equations, strain-displacement relations, compatibility equation, stress-strain relations, axi-symmetric stress distribution, curved beam, thick cylinders. Effect of circular hole on stress distribution in plates subjected to tension, compression and shear, stress concentration factor.

UNIT - 4

Torsion of non-circular sections: Inverse and Semi-inverse methods, stress function, torsion of circular and elliptical sections, Membrane analogy - Torsion of thin walled open and closed sections.

TEXT BOOKS:

1. Timoshenko. S.P. **Theory of Elasticity - International Students** Editon, and Goodier. J.N. - Edition, McGraw Hill Book Co. Inc., New Delhi.
2. Wang. C.T . **Applied Elasticity**- McGraw Hill Book Co. Inc., New Delhi

REFERENCE BOOKS:

1. Valliappan. C, **Contiuum Mechanics Fundamentals**-: Oxford and IBH Publishing Co. Ltd., New Delhi.
2. Srinath.L.S. **Advanced Mechanics of Solids**-: TatMcGraw Hill Publications Co.Ltd., New Delhi.
3. Venkataraman and Patel **Structural Mechanics with Introduction to Elasticity and Plasticity**-: McGraw Hill Book Inc,New York.
4. Arbind Kumar Singh **Mechanics of Solids** : Prentice Hall of India Pvt. Ltd., New Delhi -2007.
5. Sadhu Singh- **Theory of Elasticity** Khanna publishers, New Delhi.

BTCE15F7420	Open channel hydraulics	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Hydraulic & Hydraulic Machines.

Course Objectives:

1. Understand the different types of Flows.
2. Understand the Critical flow depth measurements.
3. Understand the different Flow Profiles.
4. Understand the concept of Hydraulic Jumps.

Course Outcomes:

1. Design of Open channels for uniform flow, critical flow, and gradually varied flow.
2. Analyse and solve practical problems on Critical Flow.

3. Analyse the problems on flow profiles,
4. Explain about concept of rapidly varied flow, of hydraulic jump and its applications as energy dissipater.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F7 420	CO1	3	3	3	1								3	3	3	3	3
	CO2	3	2	3	2								3	3	3	3	3
	CO3	3	2	3	2								3	3	3	3	3
	CO4	3	2	3	2			1					3	3	3	3	3

Course Contents:

UNIT – 1: INTRODUCTION: Difference between pipe flow and open channel flow, classification of flow, energy equation, momentum equation, kinetic energy and momentum factors.
UNIFORM FLOW: Concepts, uniform flow equations, conveyance and hydraulic exponent for uniform flow, design of channels for uniform flow.
UNIT – 2: CRITICAL FLOW: Concept of specific Energy – Classification of flow. Design of channel, Section Factor, Hydraulic exponent for critical flow critical depth as a flow measurement.
GRADUALLY VARIED FLOW: Concepts, GVF equation, its different forms, Basic assumptions, Dynamic equation, Characteristics of flow profile and classification.
UNIT – 3: Analysis of flows profiles, Method of singular point and transitional depth, Methods of computation, Practical problems.
Gradually Varied Flow Computations: Different methods, direct integration method, Bress's Solution, Chow's solution, direct method, standard step method.
UNIT – 4: Rapidly Varied Flow: Concepts, hydraulic jump in rectangular channels, classification of jumps, characteristics of jump – length location height, application of hydraulic jump stilling basins, shape type-2 and type-4.
Hydraulic jump in rectangular channels, Sloping channels, Jump in non rectangular channels, application of hydraulic jump as energy dissipater.
TEXTBOOKS:
1. Open Channel Hydraulics :Subramanya : Tata McGraw Hill Publishing Co Ltd, New Delhi
2. – Madan Mohan Das, Open Channel Flow Prentice Hall of India Pvt. Ltd., New Delhi 2008 Edition.
3. Rajesh Srivastava, Flow Through Open Channels –Oxford Press, New Delhi 2008 Edition.

REFERENCE BOOKS:

1. Open Channel Hydraulics : French : McGraw Hill Book Company, New Delhi.
2. Modi and Seth : Fluid Mechanics : Standard Book Home, New Delhi.
3. Henderson :Open Channel Hydraulics : Mr. Millan Publishing Co. Ltd., New York.
4. VenTe Chow : Open Channel Hydraulic : McGraw Hill Book Company, New Delhi.

BTCE15F7430	Foundation engineering in difficult ground	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Basic knowledge of Engineering Mechanics, Strength of Materials, Fluid Mechanics and Geotechnical Engineering

Course Objectives:

Ability to analyze the problems associated with designing foundations on difficult ground such as weak and soft soils, expansive and shrinking soils; to understand the design alternatives available to design foundations on difficult soils.

Course Outcomes:

An ability to
1. determining the characteristics of the ground, remedial measures
2. Design alternatives in expansive soil
3. design Stability of slopes in difficult ground
4. Design for highway and air- field pavements

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F7 430	CO1	3	3	3	1								3	3	3	3	3
	CO2	3	2	3	2								3	3	3	3	3
	CO3	3	2	3	2								3	3	3	3	3
	CO4	3	2	3	2			1					3	3	3	3	3

Course Contents:

UNIT I: Introduction: Classification, swelling and shrinkage, sensitivity, settlement and bearing capacity of clays, fissures in clay, glacial deposits, and difficult rocks Site investigation in difficult ground: Objectives, difficulties in determining the characteristics of the ground, remedial measures
12 hours
UNIT II: Design alternatives in expansive soil: Introduction, drilled pier and beam foundation, mat foundation, under-reamed pile foundation, general conditions for under reamed piles, design and construction.Treatment of expansive soils: Introduction, removal and replacement, remolding and compaction, pre-loading, pre-wetting, stabilization-lime, cement, fly ash, application methods, moisture control, electro chemical treatments
12 hours
UNIT III: Foundations and earth movements: Introduction, creep of rock masses, landslides, earthquake-primary and secondary effects, earthquake resistant design Stability of slopes in difficult ground: Introduction, mechanism of stability, strength of distorted clay, factor of safety, analysis, remedial measures.
12 hours
UNIT IV: Design for highway and air- field pavements: Introduction, general principles of pavement design, design features and treatment methods for expansive soil subgrades, air-field procedures.
12 hours
TEXT BOOKS

1. F.G.Bell, Foundation in difficult ground, Butterworths & Co.
2. F.H. Chen, Foundations on expansive soil, Elsevier Science Publishing Company,NY.
3. E.A. Sorochan, Construction of buildings on expansive soils, Oxford & IBH Publications

REFERENCE BOOKS

1. Expansive soils- Problems and Practice in foundation and pavement Engineering- John.D. Nelson and Debora J. Miller, John Wiley & Sons.

BTCE15F7440	Solid & hazardous waste management	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Industrial Waste Management and Environmental Engineering.

Course Objectives:

1. To develop insight into the collection, transfer, and transport of municipal solid waste.
2. Different methods of municipal solid waste disposal are studied.
3. Examine the operation of a resource recovery facility and understanding the different methods of waste to energy facility.
4. To understand the different types of biological and hazardous waste disposal.

Course Outcomes:

1. Explain the different methods of collection, transfer, and transport of municipal solid waste.
2. Explain the Different methods of municipal solid waste disposal.
3. Exposure to different method of waste to energy facility.
4. Evaluate landfill site and to study the sanitary landfill reactions.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 02	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
BTCE 15F7 440	CO1	3	3	2	3	3	-	3	-	-	-	-	3	3	3	3	3
	CO2	3	2	2	3	3	-	3	-	-	-	-	3	3	3	3	3
	CO3	1	3	2	2	3	-	3	-	-	-	-	3	3	3	3	3
	CO4	1	3	2	2	2	-	2	-	-	-	-	3	3	3	3	3

Course Contents:

Unit 1: Introduction

Composition and Handling of Solid Wastes: Sources and Types of solid wastes, Characteristics of solid waste, Waste generation and handling at source, Problems due to improper disposal of solid waste. Scope and importance of solid waste management

Unit 2: Collection, Transportation, Treatment/Processing

Systemsofcollection, collection equipment,garbagechutes,transferstations–bailingand compacting,routeoptimizationtechniquesandproblems.

Componentsseparation,volume reduction, size reduction, chemical reduction, plastic waste-environmental significance and reuse, reuse of materials in other industries.

Unit 3: Disposal Methods

Opendumping, ocean disposal, feedingtohogs,incineration- Process–3T's,factorsaffectingincinerationprocess, incinerators–types,preventionofairpollution,Pyrolysis, energy recovery operations, composting- Aerobic and anaerobic composting, factors affecting composting, Indore and Bangalore processes, mechanical and semi mechanicalcompostingprocesses.Vermi-composting, Sanitary landfill-Differenttypes,trencharea,Rampandpit method,siteselection,basicstepsinvolved,celldesign,preventionofsite pollution,leachate&gascollectionandcontrolmethods,geo-syntheticfabrics insanitarylandfills.

Unit 4: Hazardous Waste

Classification, Generation, Toxicology, Bio-medical wastes, Treatment of HW-physico-chemical processes, stabilization and solidification, thermal methods, secured landfills in disposal of Hazardous waste, Remedial technologies.

REFERENCE BOOKS:

1. GeorgeTchobanoglous, Hilary Theisen, Samuel A Vigil, "Integrated Solid Waste Management: Engineering principles and management issues", M/c Graw hill Education. Indian edition
2. Bhideand Sunderashan Solid Waste Management in developing countries.
3. PavoniJ.L. Handbook on Solid Waste Disposal.
4. Howard S Peavy, Donald R Rowe and George Tchobanoglous, "Environmental Engineering", Tata Mcgraw Hill Publishing Co ltd.,
5. S.K.Garg, Environmental Engineering–Vol. II.
6. Bio medical waste handling rules– 2000.
7. Vesilind.PaWorrell&Reinhart.D;Solid Waste Engineering; Cengage Learning India Private Limited, New Delhi.(2009)

BTCE15F7450	**Road safety and management**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

Transportation Engg-I and Transportation ENgg-II

Course Objectives:

1. To understand the design aspects of road geometrics to address the practical problems in highway engineering.
2. To get the knowledge of selecting appropriate cross sectional elements of roads.
3. To understand the analysis of horizontal alignment& vertical alignment of roads.
4. To understand the design various types of intersections of roads.

Course Outcomes:

1. Select appropriate cross sectional elements of roads.
2. Analyse the horizontal alignment of roads.
3. Analyse the vertical alignment of roads.
4. Design various types of intersections of roads.

Mapping of Course Outcomes with programme Outcomes

Cours e Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4

BTCE 15F7 450	**CO1**	**3**	**3**	**3**	**2**						**1**		**1**	**3**	**2**	**3**	**2**
	CO2	**3**	**3**	**3**	**2**			**2**		**3**	**3**			**3**	**3**	**3**	**2**
	CO3	**3**	**3**	**2**	**2**		**1**			**2**	**1**			**3**	**3**	**3**	**2**
	CO4	**3**	**3**			**2**					**2**	**3**	**2**	**3**	**3**		**1**

UNIT – 1 [Lecture Hours: 12]

Road accidents: Collection and Analysis of Accident Data, Condition and Collision Diagram, Causes and Remedies-influence of roadway and traffic conditions on traffic safety; accident coefficients; Analysis of individual accidents to arrive at real causes; Methods of representing accident rate-Statistical Methods in Traffic Safety Analysis – Regression Methods, Poisson distribution, Chi-Squared Distribution, Statistical Comparisons- Numerical Examples

UNIT – 2 [Lecture Hours: 12]

Road safety issues and various measures for road safety- Engineering, education and enforcement measures for improving road safety-Short term and long term measures-Road safety education and training- Reconstruction and Rehabilitation of Roads, Road Maintenance- Traffic calming techniques and innovative ideas in road safety.

.**UNIT – 3 [Lecture Hours: 12]**

Economic evaluation of improvement measures by "before and after studies" Counter measures at hazardous locations – accident investigation, problem diagnosis, development of counter measures, checklists for counter measures- Operating the road network for safety, highway operation and counter-measures, road safety audit, principles- procedures and practice, code of good practice and checklists.

UNIT – 4 [Lecture Hours: 12]

Traffic management techniques- Local area management-Transportation system management-Low cost measures, area traffic control. Various types of medium and long term traffic management measures and their uses. Evaluation of the effectiveness and benefits of different traffic management measures, management and safety practices during road works. Case studies -Road Safety Improvement Strategies, ITS and Safety

REFERENCE BOOKS:

1. BABKOV, V.F. `Road conditions and Traffic Safety', MIR publications, - 1975.
2. K.W. Ogden, `Safer Roads – A Guide to Road Safety Engg.' Averbury Technical, Ashgate Publishing Ltd., Aldershot, England, 1996.

3. Kadiyali, L.R., `Traffic Engineering and Transport Planning', Khanna Publications.
4. RL, DSIR, `Research on Road Safety', HMSO, London.
5. Papacoastas ‘Introduction to Transportation Engineering’ –Prentice
6. Transportation Engineering – An Introduction, C.Jotin khisty, B. Kent Lall

BTCE15F7510	Design of bridges & water tanks	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Hydrology and Irrigation Engineering, Design of RCC Structural Elements

Course Objectives:

1. To learn about the various types and components of bridges, IRC standards
2. To perform hydraulic design and structural design of substructures and foundations
3. To design RC T beam bridgeand composite bridge **s**uperstructure
4. To learn about the provisions of IS: 3370
5. To design and detail circular and rectangular water tanks by working stress and limit state methods
6. To design and detail circular overhead water tanks including staging

Course Outcomes:

At the end of the course, the student

1. Has learnt about the various types and components of bridges, IRC standards
2. Is able to perform hydraulic design and structural design of substructures and foundations
3. Is able to design RC T beam bridgeand composite bridge **s**uperstructure, Has learnt about the provisions of IS: 3370
4. Is able to design and detail circular and rectangular water tanks by working stress and limit state methods, Is able to design and detail circular overhead water tanks including staging

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F7 510	CO1	1	1	1		1		2	1	2				3	3	2	3
	CO2	1	2	3		1			1	2				3	3	3	2
	CO3	3	3	3	1	1		1		1				3	3	3	1
	CO4	3	2	3	1	1		1		1				3	3	3	2

Course Contents:

UNIT – 1: BRIDGE PRELIMINARIES: Classification of bridges and standard loads, Bridge-definition, components of bridges, various classification, types of bridges, forces to be considered for the design, IRC standards.

HYDRAULIC DESIGN: Methods of finding design discharge, natural, artificial and linear water ways, afflux, economic span.

SUBSTRUCTURES AND FOUNDATIONS: Types of abutments, piers and wing walls, forces to be considered for the design, Types of foundations and forces to be considered for the design, depth of scour.

UNIT – 2: DESIGN OF T-BEAM R C BRIDGE with cross beams by Piegaud's and Courbon's method for class-AA loading, empirical design of substructures and foundations.

DESIGN OF COMPOSITE BRIDGE: Design of composite bridge for EUDL, Shear connectors-design requirements for shear connectors.

UNIT – 3: IS: 3370 Codal Provisions, Design and detailing of Circular and Rectangular water tanks resting on ground (Flexible base and Rigid base) and underground by working stress and limit state methods.

UNIT – 4: Design and detailing of Circular overhead water tanks including staging.

TEXT BOOKS:

1. Johnson Victor, Essentials of Bridge Engineering: Oxford IBH Publications, New Delhi.
2. Design of Bridges: Krishna Raju N, Oxford IBH Publications, New Delhi.
3. Jagadish T. R. & Jayaram M. A., Design of Bridge Structures Prentice Hall of India, New Delhi.
4. N. Krishnaraju, Structural Design & Drawing Reinforced Concrete & Steel- University Press.
5. B.C. Punmia – Reinforced Concrete Structures - Laxmi Publishing Co., New Delhi.
6. S.N.Sinha, Reinforced Concrete Design –McGraw Hill Education, Delhi.

BTCE15F7520	Matrix Methods Of Structural Analysis	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Intermediate Structural Analysis

Course Objective:

1. To determine degrees of static and kinematic indeterminacies of framed structures.
2. To determine element flexibility and stiffness matrices, force and displacement transformation matrices and construct structure flexibility and stiffness matrices.
3. To analyze the plane framed structures by the flexibility matrix and stiffness matrix methods (element approach)
4. To analyze the plane framed structures by the direct stiffness method

Course outcomes:

At the end of the course the student is able

1. To determine degrees of static and kinematic indeterminacies of framed structures.
2. To determine element flexibility and stiffness matrices, force and displacement transformation matrices and construct structure flexibility and stiffness matrices.

3. To analyze the plane framed structures by the flexibility matrix and stiffness matrix methods (element approach)
4. To analyze the plane framed structures by the direct stiffness method

Mapping of Course Outcomes with programme Outcomes

Cours e Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F7 520	**CO1**	**3**	**3**	**1**		**2**	**2**	**1**					**2**	**3**	**3**		**2**
	CO2	**3**	**3**	**1**										**3**	**3**		
	CO3	**3**	**3**	**1**		**3**	**2**						**2**	**3**	**3**		**3**
	CO4	**3**	**3**	**1**		**3**	**2**						**2**	**3**	**3**		**3**

Course Contents:

UNIT – 1:Introduction to flexibility method: Degree of static indeterminacy, Element flexibility matrix, Principle of contragradience, Force Transformation Matrix, Construction of structure flexibility matrix, Determination of the displacement vector, Determination of member forces.

UNIT – 2: Analysis of axially rigid continuous beams, rigid plane frames, trusses by flexibility method using Force Transformation Matrix

UNIT – 3: Introduction to stiffness method: Degree of kinematic indeterminacy, Equivalent joint loads, Displacement Transformation matrix. Member stiffness matrix, Total or System stiffness matrix.

Analysis of axially rigid continuous beams, rigid frames and trusses by stiffness method using Displacement Transformation Matrix**.**

UNIT – 4: Introduction to direct stiffness method: Local and global co-ordinate system, Transformation of variables, Transformation of member displacement matrix, Transformation of member force matrix, Transformation of member stiffness matrix, Transformation of stiffness matrix of the member of a truss, Transformation of stiffness matrix of the member of a rigid frame, Overall stiffness matrix, Boundary conditions, Computation of internal forces.

Analysis of trusses, axially rigid continuous beams and rigid-jointed plane frames by direct stiffness method.

REFERENCE BOOKS:

1. Devdas Menon, Advanced Structural Analysis.
2. W. Weaver J.M. Gere, Matrix Analysis of framed structures CBS Publishers and Distributors, 1986
3. H C Martin, Introduction to Matrix Methods of Structural analysis International text book Company, 1996
4. S Rajshekharan. G Sankara Subramanian, Computational structural Mechanics PHI, 2001
5. G.S Pandit & S P Gupta, Structural Analysis A Matrix Approach Tata Mc Graw-Hill, 1981.
6. C.S Reddy, Basic structural Analysis Tata McGraw-Hill, 1996.
7. L S Negi and R S Jangid, Structural Analysis Tata McGraw-Hill, 1997.
8. M Mukhopadhyay,Matrix, finite elements, Computer and Structural analysis Oxford & IBW, 1984.

BTCE15F7530	**Reinforced earth structures**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

Basic knowledge of Engineering Mechanics, Strength of Materials, and Geotechnical Engineering

Course Objectives

1. To create an understanding of the latest technique such as reinforcing the soil;
2. To analyze the concept of RE so as to ascertain stability of RE structures;
3. To understand the different reinforcing materials that can be used efficiently in soils.

Course Outcomes:

An ability to

1. Understand basics of reinforced earth construction geosynthetics and their functions properties and tests on materials
2. Understand Concept of Reinforced earth retaining wall.
3. Determination of force induced in reinforcement ties
4. Applications to Temporary and Permanent roads

6. Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO 1**	**P 0 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**P S O 1**	**PS O2**	**PS O3**	**PS O4**
	CO1	**3**	**3**	**1**		**2**	**2**	**1**					**2**	**3**	**3**		**2**

BTCE 15F7 530	**CO2**	**3**	**3**	**1**										**3**	**3**		
	CO3	**3**	**3**	**1**		**3**	**2**						**2**	**3**	**3**		**3**
	CO4	**3**	**3**	**1**		**3**	**2**						**2**	**3**	**3**		**3**

UNIT- 1:BASICS OF REINFORCED EARTH CONSTRUCTION: Definition, Historical Background, Components, Mechanism and Concept, Advantages and Disadvantage of reinforced earth Construction, Sandwich technique for clayey soil.**GEOSYNTHETICS AND THEIR FUNCTIONS** Historical developments, Recent developments, manufacturing process woven &non-woven, Raw materials –Classification based on materials type – Metallic and Non-metallic, Natural and Man-made, Geosynthetics – **PROPERTIES AND TESTS ON MATERIALS** Properties – Physical, Chemical, Mechanical, Hydraulic, Endurance and Degradation requirements, Testing & Evaluation of properties **12 hours**

UNIT II: DESIGN OF REINFORCED EARTH RETAINING WALLS Concept of Reinforced earth retaining wall, Internal and external stability, Selection of materials, typical design problems

SOIL NAILING TECHNIQUES

Concept, Advantages & limitations of soil nailing techniques, comparison of soil nailing with reinforced soil, methods of soil nailing, Construction sequence, Components of system, Design aspects and precautions to be taken. **12 hours**

UNIT III: DESIGN OF REINFORCED EARTH FOUNDATIONS AND EMBANKMENTS - Modes of failure of foundation, Determination of force induced in reinforcement ties – Location of failure surface, tension failure and pull out resistance, length of tie and its curtailment, Bearing capacity improvement in soft soils, General guidelines. **Embankments** - Concept of Reinforced Embankments, Internal and external stability, Selection of materials, typical design problems

12 hours

UNIT IV :GEOSYNTHETICS FOR ROADS,SLOPES AND LAND FILLS Roads - Applications to Temporary and Permanent roads, Role of Geosynthetic in enhancing properties of road, control of mud pumping, Enhancing properties of subgrade, Design requirements Slopes – Causes for slope failure, Improvement of slope stability with Geosynthetic, Drainage requirements, Construction technique.Geosynthetics - Filter, Drain and Landfills-introductory concepts **12 hours**

TEXT BOOKS:

1. Koerner. R.M. - Design with geosynthetics- Prince HallPublication, 2005
2. Koerner. R.M. & Wesh, J.P.- Construction and Geotechnical Engineering using synthetic fabrics- Wiley Inter Science, NewYork, 1980.
3. Sivakumar Babu G. L.,An introduction to Soil Reinforcement and Geosynthetics –Universities Press, Hyderabad, 2006
4. Swami Saran,I. K. Reinforced Soil and its Engineering Applications, International Pvt. Ltd, New Delhi, 2006
5. Venkattappa Rao. G., &Suryanarayana Raju., G. V.S.Engineering with Geosynthetics- - Tata Mc Graw Hill publishing Company Limited., New Delhi.

REFERENCE BOOKS:

1. Jones, Earth reinforcement and Soil structure- CJEPButterworths, London, 1996.
2. Ingold, T.S. & Millar, K.S. - Geotextile Hand Book- Thomas, Telford, London.
3. Shigenori Hayshi & Jen Otani -Earth Reinforcement Practices - Hidetoshi Octial, Vol. I, A.A. Balkema, Rotterdam, 1992.
4. Bell F.G. - Ground Engineer's reference Book- Butterworths, London, 1987.
5. T.S. - Thomas, Reinforced Earth- Ingold, Telford, London.

BTCE15F7540	Payment management system	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

NONE

Course Objectives:

1. To educate students about the importance of pavement evaluation, different methods of evaluating pavements, factors affecting deterioration and measures to reduce them, methods of evaluating surface condition
2. To make students familiar with concept of predicting pavement performance and deterioration modelling, different models for pavement modelling, HDM software and its use for pavement management.
3. To make students appreciate the design objectives, constraints, alternate pavement design strategies and economic evaluation, importance of economic analysis, life cycle costing.
4. To give students an overview of techniques and tools for pavement preservation, role of computers in pavement management, expert systems.

Course Outcomes:

On successful completion of this course, students should be able to:

1. Explain: the structural and functional requirements of pavements, methods of evaluation pavements, effects of pavement deterioration and remedial measures, methods of evaluation.
2. Describe: modeling techniques for pavement performance prediction, use of HDM software for pavement management, comparison of different models
3. Discuss: design objectives, constraints, compare various pavement design strategies, economic evaluation of pavements and life cycle costing methods
4. Enumerate: tools and techniques of road asset management, expert systems in managing pavements, role of computers of pavement management.
5. **Mapping of Course Outcomes with programme Outcomes**

UNIT – 1 [Lecture Hours: 12]

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F7 540	**CO1**	**3**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**3**	**3**	**3**	**3**
	CO2	**3**	**3**	**2**	**3**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**3**	**3**	**3**	**3**
	CO3	**3**	**3**	**2**	**1**	**2**	**-**	**2**	**-**	**2**	**-**	**-**	**3**	**3**	**3**	**3**	**3**
	CO4	**3**	**3**	**1**	**2**	**2**	**-**	**2**	**-**	**2**	**-**	**-**	**3**	**3**	**3**	**3**	**3**

Evaluation: Structural and functional requirements of flexible and rigid pavements, various aspects of surface and their importance, causes, factors affecting deterioration and measures to reduce – pavement slipperiness, unevenness, ruts, potholes and cracks. Evaluation of surface condition by MERLIN and 5TH wheel bump integrator methods

UNIT – 2 [Lecture Hours: 12]

Introduction to pavement management system – components, planning and research management, pavement performance prediction – concepts, modeling techniques, structural and functional condition deterioration models, mechanistic and empirical models, HDM and other models, comparison of different deterioration models

UNIT – 3 [Lecture Hours: 12]

Design alternatives and selection – design objectives, constraints, basic structural response models, physical design inputs, alternate pavement design strategies and economic evaluation, reliability concepts in pavement engineering, life cycle costing, and analysis of alternate pavement strategies based on distress and performance

UNIT – 4 [Lecture Hours: 12]

Road asset management – pavement preservation programme, techniques and tools, role of computers in pavement management, applications of expert systems for managing pavements, evaluation and rehabilitation.

REFERENCE BOOKS:

1. Ralph Haas and Ronald W. Hudson, ‘Pavement Management System’, McGraw hill book co. 1978
2. Ralph Haas, Ronald Hudson and Zanieswki, ‘Modern Pavement Management’, Kreiger publications

3. Proceedings of the international conference on managing pavements
4. NCHRP, TRR, FHWA and TRB special reports

BTCE15F7550	Environmental impact assessment	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Knowledge in Water Supply Engineering and Waste Water Treatment, Solid and Hazardous Waste Management, Air and Noise Pollution control, Industrial Waste Water Treatment

Course Objectives:

1. To provides instruction in the theory and methods of environmental impact assessment (EIA).
2. To Gain a critical understanding of the use, strengths, and limitations of EIA, and develop working familiarity with EIA methods and analytic techniques.
3. To use for professional planning for different ways which includes evaluation of proposed public and private development projects, government policies and programs.

Course Outcomes:

1. Strengthen understanding of the impacts related to developing projects on Environment, culture and socio-economic environment.
2. Understanding the methodology for preparation of a systematic EIA report.
3. Learn to discuss adaptive management and monitoring as follow up activities.
4. Through case studies, students get exposed to a variety of different resettlements, scenarios, challenges and solutions.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3	PSO4
BTCE 15F7 550	CO1	3	3	2	3	3	-	-	-	2	-	-	3	3	3	3	3
	CO2	3	3	2	3	2	-	-	-	2	-	-	3	3	3	3	3
	CO3	3	3	2	1	2	-	2	-	2	-	-	3	3	3	3	3
	CO4	3	3	1	2	2	-	2	-	2	-	-	3	3	3	3	3

Unit 1: INTRODUCTION

Environmental Impact Assessment (EIA), Historical development of Environmental Impact Assessment - Environmental Impact Statement (EIS) - Environmental Risk Assessment (ERA) - Legal and Regulatory aspects in India - Types and limitations of EIA - Terms of Reference in EIA- Issues in EIA - national - cross sectoral - social and cultural.

Unit 2: COMPONENTS AND METHODS & QUALITY CONTROL

Components - screening - setting - analysis - prediction of impacts - mitigation. Matrices - Networks - Checklists. Importance assessment techniques - cost benefit analysis - analysis of alternatives - methods for Prediction and assessment of impacts - air - water - soil - noise - biological - cultural - social - economic environments.

Standards and guidelines for evaluation, Public Participation in environmental decision making, Trends in EIA practice and evaluation criteria - capacity building for quality assurance.

Unit 3: DOCUMENTATION AND MONITORING

Expert System in EIA - use of regulations and AQM. Document planning - collection and organization of relevant information - use of visual display materials – team writing - reminder checklists. Environmental monitoring - guidelines - policies - planning of monitoring programmes. Environmental Management Plan, Post project audit.

Unit 4: CASE STUDIES

Case studies of EIA of developmental projects- EIA for Water resource developmental projects, Highway projects: Nuclear-Powerplantprojects,Miningproject(Coal,Ironore),ThermalPowerPlant, InfrastructureConstructionActivities.

Course Outcome:

1. Strengthen understanding of the impacts related to developing projects on Environment, culture and socio-economic environment.
2. Understanding the methodology for preparation of a systematic EIA report.
3. Learn to discuss adaptive management and monitoring as follow up activities.
4. Through case studies, students get exposed to a variety of different resettlements, scenarios, challenges and solutions.

References:

1. Canter, L.W., " Environmental Impact Assessment ", McGraw Hill, New York, 1996.
2. Petts, J., " Handbook of Environmental Impact Assessment Vol. I and II ", Blackwell Science, London, 1999.
3. The World Bank Group., " Environmental Assessment Sourcebook Vol. I, II and III ", The World Bank.
4. Guidelines for EIA of developmental Projects Ministry ofEnvironmentandForests,GOI.

BTCE15F7800	Concrete & Highway Material Lab	L	T	P	C	Hrs/Wk
Duration :16 Wks		1	0	1	2	3

Preequisites:

Construction materials, Concrete technology theory.

Course Objectives:

1. To understand the characteristics and behaviour of civil engineering materials used in buildings and infrastructure.
2. Students will learn standard principles and procedure to design prepare and/or test materials such as concrete mix design including field test methods for fresh concrete.
3. Students will know how to select materials based on their properties and their proper use for a particular facility under prevailing loads and environmental conditions.
4. Students will have exposure to practical applications including writing of a technical report related to each experiment.

Course Outcomes:

1. Demonstrate ability to make selection of materials based on their properties, behaviour and intended use in design and construction.
2. Write formal technical report & convey Engineering message efficiently.
3. Understand ethical issues associated with Engineering experiments and professional practice.
4. Collaborate lab work in groups and divide responsibilities among group members.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BTCE 15F7 800	CO1	1	2	3				2	1	1				3	3	2	3
	CO2	1	2	3					1					3	3	3	2
	CO3	3	2	3										3	3	3	1
	CO4	3	2	-	2			1						3	3	3	2

LIST OF EXPERIMENTS:

1. Tests on cement: Normal Consistency, Setting time, Specific gravity of cement, Soundness by Autoclave method, Air permeability test for fineness
2. Tests on Aggregates:Crushing, abrasion, impact and Shape tests (Flaky, Elongation, Angularity number)
3. Tests on fresh concrete: Workability by Slump, Compaction factor and, VeeBee tests.
4. Tests on Hardened concrete: Compression strength ,Split tensile tests, Test on flexural strength of RCC beams, Permeability
5. California Bearing Ratio Test
6. Aggregate Impact Test, Los Angeles Abrasion Test , Aggregate Crushing Test
7. Aggregate Shape Tests, Aggregate Specific Gravity and Water Absorption Test
8. Bitumen Specific Gravity Test, Penetration Test , Softening point Test
9. Ductility Test, Elastic Recovery Test, Viscosity Test, Flash and Fire Point Test
10. Stripping Test, Rothfutch's Aggregate Proportioning Method
11. Marshall Method of Mix Design

REFERENCES BOOKS:

1."Laboratory Manual on Concrete Technology" Sood, Hemant, Mittal L N and Kulkarni P D, CBS Publishers, New Delhi, 2002.

2. Gambhir M L "Concrete Manual Laboratory testing for quality control" of concrete 4th edition DhanpatRai and Sons Delhi 1992.

3. Mehta P.K, "Properties of Concrete", Tata McGraw Hill Publications, New Delhi.

4. Neville AM, "Properties of Concrete", ELBS Publications, London.

5. Relevant BIS codes.

6. S K Khanna, C E G Justo and A Veeraragavan, "Highway Materials Testing Laboratory Manual ", Nem

Chand Bros, Roorkee

7. L R Kadiyali, "Highway Engineering ", Khanna Publishers, New Delhi

BTCE15F7900	Environmental Engineering Lab	L	T	P	C	Hrs/Wk
Duration :16 Wks		1	0	1	2	3

Prerequisites:

Theoretical Concept of Environmental Engineering

Course Objectives:

1. To estimate different parameters of the water quality
2. To Study and analysis the quality requirements for domestic waters.
3. To make the students as to suggest required type of treatment to purify raw water
4. To identify the ill effects of environmental pollution

Course Outcomes:

1. Analyse various physico-chemical and biological parameters of water quality
2. Assess complete water quality assessment for domestic supplies
3. Recommend the various types of treatment methods required to purify raw water.
4. Implement new environmental techniques to avoid pollutants

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO 1**	**P 02**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
BTCE 15F7 900	CO1	**3**	**3**	**3**	**3**	**3**							**3**	**3**	**3**	**3**	**3**
	Co2	**3**	**3**	**3**	**3**	**3**							**3**	**3**	**3**	**3**	**3**
	Co3	**3**	**3**	**3**	**3**	**3**		**3**					**3**	**3**	**3**	**3**	**3**
	CO4	**3**	**3**	**3**	**3**	**3**		**3**					**3**	**3**	**3**	**3**	**3**

LABORATORY EXPERIMENTS

1. Determination of Alkalinity, Acidity, pH
2. Jar test for optimum dosage of alum
3. Determination of fluoride
4. Determination of chlorides
5. Determination of residual chlorine
6. Determination of percentage of available chlorine in bleaching powder
7. Determination of electrical conductivity and turbidity
8. Determination of DO and Biochemical Oxygen Demand (BOD) of Wastewater
9. Determination of Total solids, suspended solids, dissolved solids, volatile solids, fixed solids and settleable solids.
10. Determination of sulphates
11. Determination of iron by phenanthroline method.
12. MPN determination
13. Determination of nitrates
14. Determination of heavy metals-Lead, Cadmium and Zinc

REFERENCE BOOKS:

1. Manual of Water and Wastewater Analysis – NEERI Publication.

2. Standard Methods for Examination of Water and Wastewater (1995), American Publication – Association, Water Pollution Control Federation, American Water Works Association, Washington DC.
3. IS Standards: 2490-1974, 3360-1974, 3307-1974.
4. Chemistry for Environmental Engineering, Sayer and Mccarthy
5. Environmental Engineering Laboratory Manual- Dr.BKotaiah, N Kumara Swamy

SYLLABUS VIII SEMESTER

BTCE15F8100	**Seminar**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**0**	**0**	**2**	**2**	**4**

BTCE15F8200	**Project Work**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**0**	**1**	**5**	**6**	**5**

Description of the course:

Project with seminar consists of several aspects of civil engineering courses studied by taking up topic of interest related to field of civil engineering. The student with the concepts of differenct courses and carrying out the literature review, will complete the Project work with submission of report and presentation of the project work taken up in civil engineering.

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS / COs**	**PO1**	**P02**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**	**PSO3**	**PSO4**
BTCE15F8100 / BTCE15F8200	**CO**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

BTCE15F8310	Finite Element Analysis	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Theory of Elasticity

Course Learning Objectives:

1. To learn about energy concepts and theorems, Rayleigh - Ritz Method and Galerkin's Method
2. To learn about basic concepts, principles, advantages and disadvantages of FEM
3. To derive element properties
4. To analyze 2D problems of framed structures and continuum
5. To learn about formulation of isoparametric elements
6. To learn about the modules of a standard FEM computer program

Course Outcomes:

At the end of the course, the student

1. Has learnt about energy concepts and theorems, Rayleigh - Ritz Method and Galerkin's Method
2. Has learnt about basic concepts, principles, advantages and disadvantages of FEM
3. Is able to derive element properties, Is able to analyze 2D problems of framed structures and continuum
4. Has learnt about formulation of isoparametric elements, Has learnt about the modules of a standard FEM computer program

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PS O2	PS O3	PS O4
BTCE 15F8 310	3	3											3	3			3
	3	3	1										3	3			3
	3	3	2			1					1		3	3		1	3
	2	2	1	2	3	2	1	2	1	1		2	3	3	3	2	2

Course Contents:

UNIT – 1:Introduction: Basic Concepts, Review of Theory of Elasticity, Matrix displacement formulation, Energy concepts, Principles of minimum potential energy and minimum complementary energy.

Rayleigh - Ritz Method, Galerkin's Method, Simple numerical problems.

UNIT – 2: Displacement models, natural coordinates, construction of shape functions for 2 D truss, beam and rigid frame elements, Lagrangian and Hermitian interpolation, assembly of stiffness matrices and load vectors by direct stiffness method, boundary conditions,
Applications of FEM for the analysis of plane truss, continuous beam and simple plane frame problems.
UNIT – 3: Analysis of 2D Continuum Problems: Plane stress and Plane strain**,** Polynomial displacement functions, Triangular, rectangular and quadrilateral elements, Shape functions, Pascal triangle, convergence requirements of shape functions, Simple numerical problems.
UNIT – 4: Theory of Isoparametric Elements: Isoparametric, subparametric and super-parametric elements, formulation of isoparametric quadrilateral element.
FEM Program: Structure of computer program for FEM analysis, description of different modules, pre and post processing.

REFERENCE BOOKS:

1. C.S. Krishnamoorthy, Finite Element Analysis – Theory and Programming, Tata McGraw Hill Co. Ltd., New Delhi.
2. Chadrupatla, Tirupathi R.Finite Element Analysis for Engineering and Technology- University Press, India.
3. J.F. Abel and Desai. C.S., Introduction to the Finite Element Method Affiliated East West Press Pvt. Ltd., New Delhi.
4. Rajasekharan. S, Finite Element Analysis in Engineering Design- Wheeler Pulishers.
5. Daryl L Logan, A First Course on Finite Element Method –Cengage Learning
6. Zienkeiwicz. O.C., the Finite Element Method Tata McGraw Hill Co. Ltd., New Delhi.
7. S.S. Bhavikatti, Finite Element Analysis New Age International Publishers, New Delhi.
8. R.D.Cook, et al., Concepts and applications of finite element analysis John Wiley & Sons, New York.

BTCE15F8320	Ground Improvement Techniques	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Basic knowledge Basics of Geotechnical Engineering

Course Objectives:

1. To create an ability to apply to analyse and interpret data related to improvement in strength and compressibility characteristics of weak soils;
2. To accentuate the understanding of the basic principles involved in various techniques of ground improvement.
3. To accentuate the understanding of the Stabilization concept of ground improvement.
4. To create an ability to apply the grouting process in different locations.

Course Outcomes:

1. At the end of this course the student is expected to learn various techniques of insitu ground modification.
2. At the end of this course the student is expected to learn various techniques of insitu ground compaction and variation of soil properties in ground.
3. At the end of this course the student is expected to learn various stabilization process and about chemical stabilization.
4. At the end of this course the student is expected to learn various methods of soil reinforcement and about grouting method.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3	PS O4
BTCE 15F8 320	**CO1**	**2**				**2**		**3**				**2**		**3**	**2**	**1**	**2**
	CO2	**2**	**2**	**1**		**2**		**2**						**3**	**2**	**1**	**2**
	CO3	**2**				**3**		**2**						**3**	**3**	**3**	**1**
	CO4	**2**				**3**		**1**						**3**	**3**	**3**	**2**

UNIT I: GROUND IMPROVEMENT: Definition, Objectives of ground improvement, Classification of ground improvement techniques, Factors to be considered in the selection of the best soil improvement technique. Ground modification for Black Cotton soil **DRAINAGE AND DEWATERING:** Determination of ground water level by Hvorselev's method, Control of ground water during excavation: Dewatering - Ditches and sumps, well point system, Vacuum method, Electro- Osmosis method. **DRAINAGE & PRELOADING:** Importance, Vertical drains, Sand drains, Drainage of slopes, Electro kinetic dewatering, Preloading.

12 hours

UNIT II: COMPACTION: Effect of grain size distribution on compaction for various soil types like lateritic soil, coarse-grained soil and micaceous soil. Effect of compaction on engineering behaviour like compressibility, swelling and shrinkage, permeability, relative density, liquefaction potential. Field compaction – static, dynamic, impact and vibratory type. Specification of compaction. Tolerance of compaction. Shallow and deep compaction, Dynamic Compaction, Vibrofloatation.

12 hours

UNIT III: CHEMICAL MODIFICATION-I: Definition, cement stabilization, sandwich technique, admixtures. Hydration – effect of cement stabilization on permeability, Swelling and shrinkage and strength and
deformation characteristics. Criteria for cement stabilization. Stabilization using Fly ash.**CHEMICAL MODIFICATION-II:** Lime stabilization – suitability, process, criteria for lime stabilization. Other

chemicals like chlorides, hydroxides, lignin and hydrofluoric acid. Properties of chemical components, reactions and effects. Bitumen, tar or asphalt in stabilization.

12 hours

UNIT IV: GROUTING: Introduction, Effect of grouting. Chemicals and materials used. Types of grouting. Grouting procedure, Applications of grouting.**MISCELLANEOUS METHODS (ONLY CONCEPTS & USES):** Soil reinforcement, Thermal methods, Ground improvement by confinement – Crib walls, Gabions and Mattresses, Anchors, Rock bolts and soil nailing. Stone Column, Micropiles.

12 hours

TEXT BOOKS:

1. Purushothama Raj P. Ground Improvement Techniques- Laxmi Publications, New Delhi1999.
2. Koerner R.M. Construction and Geotechnical Method in Foundation Engineering - Mc Graw Hill Pub. Co., New York-1985.

REFERENCE BOOKS:

1. Manfred Hausmann Engineering principles of ground modification - Mc Graw Hill Pub. Co., New York-1990.
2. Bell, F.G. Methods of treatment of unstable ground- Butterworths, London 1975.
3. Nelson J.D. and Miller D.J.Expansive soils- John Wiley and Sons 1975.
4. Ingles. C.G. and Metcalf J.B.Soil Stabilization; Principles and Practice- - Butterworths, London 1972.

BTCE15F8330	**Industrial Waste Water Treatment**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

Water supply and Sanitation Engineering, Hydraulic machines

Course Objectives:

1. To explain various tertiary treatment unit operations.
2. To explain combined treatment feasibility.
3. To understand the treatment of selected industrial waste.

Course Outcomes:

1. Assess the effect of industrial waste on stream.
2. Make use of tertiary treatment unit operations.
3. Make a choice of combined treatment of domestic and industrial waste.
4. Propose a treatment plant for few selected industrial processes.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F8 330	**CO1**	**3**	**3**	**2**	**3**	**3**							**3**	**3**	**3**	**3**	**3**
	CO2	**3**	**3**	**2**	**3**	**2**							**3**	**3**	**3**	**3**	**3**
	CO3	**3**	**3**	**2**	**1**	**2**		**2**					**3**	**3**	**3**	**3**	**3**
	CO4	**3**	**3**	**1**	**2**	**2**		**2**					**3**	**3**	**3**	**3**	**3**

Course Contents:

UNIT - I

INTRODUCTION: Difference between Domestic and Industrial Wastewater, Effect on Streams and on Municipal Sewage Treatment Plants. Stream Sampling, Effluent and Stream Standards and Legislation to Control Water Pollution. Stream Quality, Dissolved oxygen Sag Curve in Stream, Streeter– Phelps formulation, Numerical Problems on DO prediction.

UNIT – II

TREATMENT METHODS-I: Volume Reduction, Strength Reduction, Neutralization, Equalization and Proportioning.

TREATMENT METHODS-II: Removal of Inorganic suspended solids, Removal of Organic Solids, Removal of suspended solids and colloids. Treatment and Disposal of Sludge Solids.

UNIT – III

COMBINED TREATMENT: Feasibility of combined Treatment of Industrial Raw Waste with Domestic Waste, Discharge of Raw, Partially Treated and completely treated Wastes to Streams.

TREATMENT OF SELECTED INDUSTRIAL WASTE: Process flow sheet showing origin / sources of waste water, characteristics of waste, alternative treatment methods, disposal, reuse and recovery along with flow sheet. Effect of wastewater disposal on water bodies.

THE INDUSTRIES TO BE COVERED ARE:

1. Cotton Textile Industry
2. Tanning Industry
3. Cane Sugar Industry & Distillery Industry

UNIT – IV

TREATMENT OF SELECTED INDUSTRIAL WASTE-I:

1. Dairy Industry
2. Canning Industry
3. Steel and Cement Industry
4. Paper and Pulp Industry

5. Pharmaceutical Industry
6. Food Processing Industry

Reference Books:

1. Nelsol L. Nemerow, "Industrial Waste Water Treatment", **John Wiley & Sons Inc, 2009.**
2. Rao MN, and Dutta A.K., "Waste Water Treatment", Oxford & IBH Publishing Co. Pvt Ltd. 2008.
3. Metcalf and Eddy, "Waste Water Treatment, Disposal and Reuse", Tata McGraw Hill Publications, 2003.
4. Patwardhan A.D., "Industrial Wastewater Treatment", PHI Learning Private Ltd., New Delhi, 2009

Mahajan S.P., "Pollution Control Processes in industries", Tata McGraw Hill Publications,2004

BTCE15F8340	**Highway Geometric Design**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

Road safety and management

Course Objectives:

1. To understand the design aspects of road geometrics to address the practical problems in highway engineering.
2. To get the knowledge of selecting appropriate cross sectional elements of roads.
3. To understand the analysis of horizontal alignment& vertical alignment of roads.
4. To understand the design various types of intersections of roads.

Course Outcomes:

1. Select appropriate cross sectional elements of roads.
2. Analyse the horizontal alignment of roads.
3. Analyse the vertical alignment of roads.
4. Design various types of intersections of roads.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
	CO1	3	3	3	2						1		1	3	2	3	2

BTCE 15F8 340	**CO2**	**3**	**3**	**3**	**2**			**2**		**3**	**3**			**3**	**3**	**3**	**2**
	CO3	**3**	**3**	**2**	**2**		**1**			**2**	**1**			**3**	**3**	**3**	**2**
	CO4	**3**	**3**			**2**					**2**	**3**	**2**	**3**	**3**		**1**

<u>UNIT – 1</u> [Lecture Hours: 12]

Elements and controls of highway geometric design, pavement surface characteristic, camber, widths of carriageway and formation, road margins, right of way, typical cross sections, sight distance, stopping sight distance - numerical examples.

<u>UNIT – 2</u> [Lecture Hours: 12]

Overtaking sight distance – analysis and derivation, sight distances at uncontrolled intersections, horizontal alignment – superelevation, extra widening of pavements, transition curves and set-back distances on horizontal curves - numerical examples.

<u>UNIT – 3</u> [Lecture Hours: 12]

Vertical alignment - types of gradients, grade compensation along horizontal curves, design of summit curves, design of valley curves, engineering surveys for highway location, drawings and report preparation, design of hill roads, road humps - numerical examples.

<u>UNIT – 4</u> [Lecture Hours: 12]

Intersections at grade – forms, unchannelized, channelized, median openings, rotary intersections, grade separated intersections, ramps, bus and pedestrian facilities, design standards for rural expressways - numerical examples.

REFERENCE BOOKS:

1. Khanna S.K and Justo C.E.G, "Highway Engineering", Nemchand and Bros, Roorkee.
2. Kadiyali L.R, "Highway Engineering", Khanna Publishers, Delhi.
3. Kadiyali L.R, "Traffic Engineering and Transportation Planning", Khanna Publishers, Delhi.
4. AASHTO, "A Policy on Geometric Design of Rural Highways", American Association of State Highway and Transportation Officials, Washington D C.
5. Indian Roads Congress, "Guidelines for Design of Horizontal Curves for Highways and Design Tables", IRC: 38-1988, Indian Roads Congress, New Delhi.
6. Indian Roads Congress, "Recommended Practice for Sight Distance on Rural Highways", IRC: 66-1976, Indian Roads Congress, New Delhi.
7. Indian Roads Congress, "Geometric Design Standards for Rural (Non-Urban) Highways", IRC: 73-1980, Indian Roads Congress, New Delhi.
8. Indian Roads Congress, "Geometric Design Standards for Urban Roads in Plains", IRC: 86-1983, Indian Roads Congress, New Delhi.

BTCE15F8410	**Advanced design of pre-stressed concrete structures**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

Design of Prestressed Concrete Structures

Course Learning Objectives:

1. To analyze the stresses in the end blocks and design reinforcement
2. To compute shear and torsional strengths and design reinforcement
3. To analyze and design composite sections
4. To analyze and design statically indeterminate prestressed concrete structures
5. To analyze and design tension and compression members, slab and grid floors
6. To analyze and design precast elements

Course Outcomes:

At the end of the course, the student is able

1. To analyze the stresses in the end blocks and design reinforcement, To compute shear and torsional strengths and design reinforcement
2. To analyze and design composite sections, To analyze and design statically indeterminate prestressed concrete structures
3. To analyze and design tension and compression members, slab and grid floors
4. To analyze and design precast elements

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BTCE 15F8 410	**CO1**	**3**	**3**	**2**	**2**	**2**	**1**	**1**			**1**	**1**	**3**	**3**	**3**	**3**	**3**
	CO2	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**1**		**1**	**1**	**3**	**3**	**3**	**3**	**3**
	CO3	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**1**		**1**	**1**	**3**	**3**	**3**	**3**	**3**
	CO4	**3**	**1**	**2**	**1**	**3**	**1**	**2**	**1**			**3**	**3**	**3**	**3**	**3**	**3**

UNIT -1

ANCHORAGE ZONE STRESSES IN POST-TENSIONED MEMBERS:

Introduction, stress distribution in end block, investigations on Anchorage Zone stresses, Magnel and Guyon’s Methods, Comparative Analysis, Anchorage zone reinforcement.

SHEAR AND TORSIONAL RESISTANCE: Shear and principal stresses, ultimate shear resistance, design of shear reinforcement, Torsion, Design of reinforcement for torsion.

COMPOSITE SECTIONS: Introduction, Advantages, types, analysis of beams at serviceability limit state, stresses due to differential shrinkage, Ultimate moment of resistance, Design for flexural and shear strength.

UNIT – 2

STATICALLY INDETERMINATE STRUCTURES: Introduction, Advantages of continuous members, effect of prestressing in indeterminate structures, methods of analysis for secondary moments, concordant cable profile, Guyon’s theorem, Ultimate load analysis, Design of continuous beams and portal frames.

UNIT – 3

TENSION MEMBERS: Introduction, Ties, Pressure pipes – fabrication process, analysis, design and specifications. Cylindrical containers - construction techniques, analysis, design and specifications.

COMPRESSION MEMBERS: Introduction, Columns, short columns, long columns, biaxially loaded columns, Design specifications.

UNIT – 4

SLAB AND GRID FLOORS: Types of floor slabs, Design of one way, two way and flat slabs. Distribution of prestressing tendons, Analysis and design of grid floors.

PRECAST ELEMENTS: Introduction, Prestressed concrete poles, manufacturing techniques, shapes and cross sectional properties, design loads, design principles. Railway sleepers-classification and Manufacturing techniques, design loads, analysis and design principles. Prestressed concrete pavements, slab and wall panels.

REFERENCE BOOKS:

1. Lin T.Y. and H. Burns - Design of Prestressed concrete structures - John Wiley & Sons, 1982.
2. N. Krishna Raju - Prestressed Concrete- Tata McGraw Hill, 3rd edition, , New Delhi-1995.
3. P. Dayaratnam, Prestressed Concrete Structures by Oxford & IBH Publishing Co. Pvt. Ltd., 5th Edition, 1991, New Delhi.
4. G.S. Pandit and S.P. Gupta – Prestressed Concrete- CBS Publishers, 1993, New Delhi.
5. N.C. Sinha & S.K. Roy, S.Fundamentals of prestressed concrete Chand and Co. Ltd.
6. by Praveen Nagarajan, Prestressed Concrete Design, Pearson, Delhi.
7. IS: 1343: 1980.

BTCE15F8420	Analysis and design of deep foundation	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Basic knowledge of Engineering Mechanics, Strength of Materials, Structural Analysis, Fluid Mechanics and Geotechnical Engineering

Course Objectives:

1. To analyze and interpret design different types of foundations;
2. To understand the design concepts of deep foundations,
3. To design well foundations and construction techniques of caissons and such other advanced type of foundations that are used in special circumstances

Course Outcomes:

An ability to
1. To analyse the single pile foundation.
2. Understand Dynamic analysis and load testsDynamic analysis.
3. To know efficiency of pile groups
4. Enumarate Constructional aspects of a drilled caissons

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F8 420	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3
	CO2	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO3	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO4	3	1	2	1	3	1	2	1			3	3	3	3	3	3

Course Contents:

UNIT I

Single pile – Static capacity and lateral loads Introduction, Timber, Concrete, Steel piles, Corrosion of steel piles, Soil properties for static pile capacity, Ultimate static pile point capacity, Skin resistance, Static load capacity using Load – transfer, load test data. Tension piles – Piles for resisting uplift. Laterally loaded piles, Buckling of fully and partially embedded piles and poles. **12 hours**

UNIT II

Single pile – Dynamic analysis and load testsDynamic analysis, Pile driving, rational pile formula, other Dynamic formulae and general considerations. Reliability of dynamic pile driving formulae. The wave equation, pile load tests, Pile driving stresses, General comments on pile driving. **12 hours**

UNIT III

Pile foundations - Group. Single pile Vs Pile group, Pile group considerations, efficiency of pile groups, stresses on underlying strata from piles, settlements of pile groups, Pile caps, Batter piles, Negative skin friction, Matrix analysis for pile groups, Pile cap design by Computer. **12 hours**

UNIT IV

Types of Caissons, Bearing capacity, stress distribution and settlement, Design of drilled caissons elements, forces in drilled Caissons, design of elements of Caissons, Constructional aspects of a drilled caissons, Construction of Caissons, problems associated with installation, advantages and disadvantages of Caissons foundation, Comparison of Caisson types. **12 hours**

TEXT BOOKS

1.Joseph.E. Bowles "Foundation analysis and Design" McGraw Hill, International edition

2. S.P. Brahma "Foundation Engineering" Tata McGraw Hill publishing company Ltd, New Delhi.

3. Narayana M. Nayak "Foundation design Manual" Dhanpat Rai Publications

4. Purushotham Raj "Geotechnical Engineering" Tata McGraw Hill publishing company Ltd, New Delhi.

REFERENCE BOOKS

1. Poulos, H. G., and Davis. E. H., "Pile Foundation Analysis and Design", John Wiley and Sons, 1980.
2. Tomlinson. M. J., "Pile Design and Construction Practice", A view Point Publication, 1987.
3. Bell. F. G., "Methods of Treatment of Unstable Ground", Newnes- Butterworths, London, 1975.

BTCE15F8430	**Earthquake Geotechnical Engineering**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

Basic knowledge of Engineering Mechanics, Structural Analysis, Fluid Mechanics and Geotechnical Engineering

Course objectives:

1. To create an understanding basic concepts of elementary earthquakes as applied to seismic design of structures;
2. parameters influencing the seismic design;
3. hazards associated with an earthquake.

Course Outcomes:

An ability to

1. Understand the Development of site specification and code-based design
2. Analyse the effect of earthquake on soils, Evaluation of zone of liquefaction in field
3. Seismic design requirements for foundation, Seismic bearing capacity, Seismic settlement.
4. Maintenance and modifications to improve hazard resistance.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE 15F8 510	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3
	CO2	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO3	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO4	3	1	2	1	3	1	2	1			3	3	3	3	3	3

Course Contents:

UNIT – 1

Earthquake Seismology – Causes of earthquake – seismic waves and magnitudes, Plate tectonics, Earthquake fault sources, Quantification of earthquake, Intensity and magnitudes, Earthquake source models, soils effects and liquefaction, Seismograph, Characteristics of ground motion. Effect of local site conditions on ground motions, Design earthquake, Design spectra, Development of site specification and code-based design. **12hrs**

UNIT – 2

Theory of vibration - Basic Definition - Governing equation for single degree freedom system - Forced vibrations - Rotating mass type excitation - Base excitation - Isolation vibration measuring instruments.Stress conditions on soil element under earthquake loading, **Liquefaction –** definition, Mechanism of liquefaction. Evaluation of zone of liquefaction in field.Evaluation of liquefaction using Standard Penetration Resistance. Factors affecting liquefaction and measures for anti-liquefaction. **12hrs**

UNIT – 3

Seismic Design of Foundations, Retaining Walls & Slopes

Seismic design requirements for foundation, Seismic bearing capacity, Seismic settlement, Design loads. Seismic slope stability analysis - Internal stability and weakening instability, Seismic design of retaining walls: Dynamic response of retaining walls, Seismic displacement of retaining walls, Seismic design consideration. **12hrs**

UNIT – 4

Earthquake Hazard Mitigation

Seismic risk vulnerability and hazard - Percept of risk - risk mapping - scale - hazard assessment - Maintenance and modifications to improve hazard resistance - Different type of foundation and its impact on safety - Ground Improvement Techniques. **12hrs**

Text Books:

1. KrammerS.L., Geotechnical Earthquake Engineering, prentice hall, international series, Pearson Education (Singapore) Pvt. Ltd., 2004.

2. KameswaraRao, Vibration Analysis and Foundation Dynamics, wheeler Publishing, New Delhi, 1998.
3. R. W. Day - Geotechnical Earthquake Engineering Handbook, McGraw-Hill, 2002.

References:

1. KameswaraRao, N.S.V., Dynamics soil tests and applications, Wheeler Publishing - New Delhi, 2000.
2. Kamalesh Kumar - Basic Geotechnical Earthquake Engineering – New Age International Publishers, 1st Edition, 2008.
3. Dowrick - Earthquake Resistant Design, John Wiley & Sons. Chowdhary, I., and Dasgupta, S. P.- Dynamics of Structures and Foundation

BTCE15F8510	**Computer application in Civil Engineering**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

Structural Analysis – II, Design of RCC Structural Elements

Course Objectives:

1. To analyze beams, trusses, rigid frames and grids using commercial software

2. To solve civil engineering problems such as SFD and BMD of statically determinate beams etc. using spreadsheets

3. To learn MATLAB and its applications to simple civil engineering problems

Course Outcomes:

1. Analysis of Plane Trusses and beams by using STADD-Pro or ETABS.
2. Analysis of Plane rigid jointed frames and grid frames by using STADD-Pro or ETABS.
4. Use of spread sheet such as EXCEL for solving the following Civil Engineering problems
5. MAT Lab application to simple civil engineering problems

Mapping of Course Outcomes with programme Outcomes

Cours e Code	**POS/ COs**	**PO 1**	**P 0 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**P S O 1**	**PS O2**	**PS O3**	**PS O4**
BTCE 15F8 510	**CO1**	**3**	**3**	**2**	**2**	**2**	**1**	**1**			**1**	**1**	**3**	**3**	**3**	**3**	**3**
	CO2	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**1**		**1**	**1**	**3**	**3**	**3**	**3**	**3**
	CO3	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**1**		**1**	**1**	**3**	**3**	**3**	**3**	**3**
	CO4	**3**	**1**	**2**	**1**	**3**	**1**	**2**	**1**			**3**	**3**	**3**	**3**	**3**	**3**

Course Contents:

UNIT 1 : STRUCTURAL ANALYSIS

Analysis of Plane Trusses and beams by using STADD-Pro or ETABS or any other commercial software.

UNIT 2: STRUCTURAL ANALYSIS

Analysis of Plane rigid jointed frames and grid frames by using STADD-Pro or ETABS or any other commercial software.

UNIT3: SOLUTION OF CIVIL ENGINEERING PROBLEMS USING SPREAD SHEETS

Use of spread sheet such as EXCEL for solving the following Civil Engineering problems

i) Plotting of graphs such as SFD and BMD of statically determinate beams.

ii) Design of singly reinforced and doubly reinforced rectangular beam sections

iii) Computation of earthwork.

UNIT 4: APPLICATION OF MATLAB TO CIVIL ENGINEERING PROBLEMS

Introduction to MATLAB, application to simple civil engineering problems.

REFERENCE BOOKS:

1. Dr M.N.Shesha Prakash and Dr.G.S.Suresh, Computer Aided Design Laboratory- Lakshmi Publications
2. M.A.Jayaram, D.S.Rajendra Prasad, CAD Laboratory Sapna Publications, Bengaluru.
3. Roberts JT, -AUTOCAD 2002- BPB publications
4. Sham Tickoo, AUTOCAD 2004- A beginner’s Guide, Wiley Dreamtech India Pvt Ltd.,
5. Ramesh Bangia, -Learning Excel 2002- Khanna Book Publishing Co (P) Ltd.,
6. Mathieson SA, Microsoft Excel- Starfire publishers
7. Rudra Pratap, Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers Oxford University Press.

BTCE15F8520	Environmental Geotechnology	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisites:

Basic knowledge of Engineering Mechanics, Strength of Materials, Fluid Mechanics and Environmental Engineering

Course Objectives:

1. To create an ability to understand the sources and types of contaminations that are responsible for surface and subsurface contamination;
2. To analyze and interpret data related to the remediation techniques

Course Outcomes:

1. Need for contaminated site characterization
2. Detection of polluted zone, Monitoring and Effectiveness of designed facilities.
3. Planning of phased operation, leachate collection facility, gas collection facility, stability aspects, environmental monitoring systems.

4. Utilization of solid waste for soil improvement.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	P S O 1	PS O2	PS O3	PS O4
BTCE15F 8520	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3
	CO2	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO3	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO4	3	1	2	1	3	1	2	1			3	3	3	3	3	3

Course Contents:

UNIT – 1 **12Hrs**

Sources and Site Characterization:

Introduction to Geo environmental engineering –Scope of Geo-environmental Engineering, Environmental cycle Various Sources of Contaminations, Classification of waste, Characteristics of different wastes and their management, Liquid waste characterization, Solid waste characterization, Hazardous waste characterization, Need for contaminated site characterization; Environmental Concerns with waste, Waste management strategies. Geotechnical properties of solid waste,Waste generation and disposal on land, Impact on environment.

UNIT – 2 **12Hrs**

Subsurface Contamination:

Sources of ground water contamination, Contaminant transport in sub surface – advection – diffusion – dispersion – governing equations – contaminant transformation – absorption – biodegradation – ion exchange – precipitation ground water pollution – pollution of aquifers by mixing of liquid waste – protecting aquifers, Effect of subsurface contamination, Detection of polluted zone, Monitoring and Effectiveness of designed facilities.

UNIT – 3 **12Hrs**

Land fill planning and design consideration:

Introduction, types of landfills, site selection for landfills, shape and size of landfills, landfill layout, landfill section, landfill capacity Liner and liner system, Cover and cover system, Stability of landfills. Site characterization, Planning of phased operation, leachate collection facility, gas collection facility, stability aspects, environmental monitoring systems, construction schedule, material requirement, equipment requirement, environmental control during operation, landfill closure and post closure plan.

UNIT – 4 **12Hrs**

Remediation Techniques:

Objectives of site remediation, various active and passive methods of remediation NAPL sites, Emerging Remediation Technologies. Rational approach to evaluate and remediate contaminated sites – monitored natural attenuation – exsitu and insitu remediation – solidification, bio – remediation, incineration, soil washing, electro kinetics, soil heating, verification, bio venting – Ground water remediation – pump and treat, air sparging, reactive well. Hazardous waste control and storage system – stabilization/ solidification of wastes mechanism of stabilization – organic and inorganic stabilization – utilization of solid waste for soil improvement.

Text Books:

1. Sharma, H. D. and Reddy, K. R. - Geoenvironmental Engineering, John Wiley & Sons (2004)
2. Rowe, R. K. - Geotechnical &Geoenvironmental Engineering Handbook
3. Rowe, R. K. - Geotechnical &Geoenvironmental Engineering Handbook, Kluwer Academic, 2001
4. Reddi, L. N. and Inyang, H. I. - Geoenvironmental Engineering Principles and Applications, Marcel. Dekker, Inc., New York (2000).

References:

1. LaGrega, M. D., Buckingham, P. L. and Evans, J. C. - Hazardous Waste Management, New York: McGraw-Hill, 2001
2. Phillip B. Bedient, Refai, H. S. & Newell C. J. - Ground Water Contamination – Prentice Hall Publications, 4th Edition, 2008
3. Daniel, B.E., Geotechnical Practice for waste disposal, Chapman and Hall, London, 1993.
4. Westlake, K., (1995), Landfill Waste pollution and Control, Albion Publishing Ltd., England, 1995.

BTCE15F8530	**Traffic Engineering & Management**	**L**	**T**	**P**	**C**	**Hrs/Wk**
Duration :16 Wks		**3**	**1**	**0**	**4**	**5**

Prerequisites:

Traffic Engineering

Course Objectives:

1. To educate students about the importance of traffic engineering as applied to road transportation and features of traffic characteristics.
2. To make students familiar with the various traffic studies conducted and the methods of analyzing and presenting the data.
3. To give students an overview of the requirements of intersections, types of intersections and grade separators.
4. To make students appreciate the necessity of traffic regulations, types of traffic regulations and design of traffic regulations

Course Outcomes:

On successful completion of this course, students should be able to:

1. Outline the scope of traffic engineering, describe the road user characteristics and discuss the characteristics of different classes of vehicles.
2. Explain the necessity and methods of conducting various traffic studies and analyse the data collected to be presented in the form relevant to the purpose.
3. Enumerate: features and requirements of intersections, forms and types of intersections, and outline the features of: grade separators, underpasses, overpasses, interchanges.
4. Associate the traffic regulations to the safe and efficient operation of traffic, to identify the control measures and to design the basic regulatory devices.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PS O2	PS O3	PS O4
BTCE 15F8 530	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3
	CO2	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO3	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO4	3	1	2	1	3	1	2	1			3	3	3	3	3	3

Course Contents:

UNIT – 1

Scope of traffic engineering & study of its elements – Introduction, objectives and scope of traffic engineering,Components of road traffic, road user characteristics –physical and psychological, vehicle characteristics- static and dynamic. **Traffic stream characteristics**- relationship between speed, flow and density – Numerical examples. **12 hrs**

UNIT – 2

Traffic Engineering Studies and Analysis: methods of traffic study, equipment, data collection, analysis and interpretation of - Speed studies, Travel time and Delay studies, Volume studies, Origin – destination studies, Parking studies and Accident Studies. Capacity studies- Introduction, highway capacity, level of service, basic freeway capacity studies. **Sampling in traffic studies** – Numerical examples. **12 hrs**

UNIT – 3

Design and Management of traffic control measures – need, control of traffic movements through time sharing and space sharing concepts,Design of channelizing islands, T, Y, skewed, staggered, round about and other at grade intersections, provision for safe crossing of pedestrians and cyclists – grade separated intersection. **12 hrs**

UNIT – 4

Traffic control devices – traffic signs, markings and islands. Different methods of signal design, signal system and co-ordination. **Traffic Regulation**- Road lighting, Regulations on vehicles, drivers, and traffic. **Traffic engineering impacts on environment** – air and noise pollution, impacts on land development, technological approaches to improving environment.

12 hrs

LIST OF EXPERIMENTS:

1. Calculation of PCU
2. Spot Speed Survey and Analysis
3. Traffic Volume Survey and Analysis
4. Traffic Growth Rate Estimation
5. Signal Design I
6. Signal Design II

Reference Books:

1. Kadiyali. L. R., "Traffic Engineering and Transport planning", Khanna publishers, New Delhi.
2. Khanna S.K and Justo C.E.G, "Highway Engineering", Nemchand and Bros, Roorkee.
3. Papacostas, C.A., "Fundamentals of Transportation Engineering", Prentice-Hall of India Private Limited, New Delhi.
4. William R. Mc Shane and Roger P. Roess,, "Traffic Engineering", Prentice hall, New Jersey, 2000.
5. Matson, Smith and Hurd, "Traffic Engineering", McGraw Hill and Co, New York.

BTCE15F8540	Earthquake Resistant Design of Structures	L	T	P	C	Hrs/Wk
Duration :16 Wks		3	1	0	4	5

Prerequisite:

Structural Dynamics

Course Objectives:

1. To learn about causes, types, magnitude and intensity of earthquakes
2. To learn about seismic design provisions of Code
3. To learn about characterization of earthquake ground motion, structural modeling etc.
4. To learn about seismic evaluation and retrofitting methods
5. To learn about seismic design philosophy, seismic performance and methods of seismic analysis
6. To analyze and design RC and masonry buildings for seismic forces

Course Outcomes:

At the end of the course, the student

1. Has learnt about causes, types, magnitude and intensity of earthquakes
2. Has learnt about seismic design provisions of Code

3. Has learnt about characterization of earthquake ground motion, structural modeling etc.Has learnt about seismic evaluation and retrofitting methods
4. Has learnt about seismic design philosophy, seismic performance and methods of seismic analysis and is able to analyze and design RC and masonry buildings for seismic forces

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
BTCE 15F8 540	CO1	3	3	2	2	2	1	1			1	1	3	3	3	3	3
	CO2	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO3	3	3	2	3	2	1	1	1		1	1	3	3	3	3	3
	CO4	3	1	2	1	3	1	2	1			3	3	3	3	3	3

Course Contents:

UNIT - 1

Engineering Seismology Earthquake ground Motion,Theory of plate tectonics, seismic waves, Magnitude and intensity of earthquakes, local site effects, seismic zoning map of India. Types of Earthquakes.

UNIT - 2

Seismic Design Parameters, earthquake ground motion characteristics, response spectra and design spectrum. Structural modelling, Code based seismic design methods. Response control concepts, seismic evaluation and retrofitting methods. Numerical problems.

UNIT - 3

Effect of Structural Irregularities on seismic performance of RC buildings, Vertical irregularity and plan configuration problems, Seismo resistant building architecture, lateral load resistant systems, building characteristics.

Seismic design philosophy, Determination of design lateral forces - Equivalent lateral force procedure, dynamic analysis procedure. Step by step procedure for seismic analysis of RC buildings (without infill's), Equivalent static lateral force method, response spectrum methods, Numerical problems.

UNIT – 4

Earthquake resistant design of RC buildings - Codal provisions, loads, load combinations and detailing of reinforcement.

Earthquake resistant design of masonry buildings - elastic properties of structural masonry, Codal provisions, Design of two storied masonry building.

REFERENCE BOOKS:

1. Pankaj Agarwal, **Earthquake resistant design of structures** Manish Shrikande - PHI India.
2. S.K. Duggal, **Earthquake Resistant Design of Structures** Oxford University Press, 2007.
3. Anil Chopra, **Earthquake Dynamics of Structures** EERI,
4. S.F. Borg, **Earth Quake Engineering Damage Assessment and Structural design** (John Wiley and Sons. 1983.
5. IS 1893 (Parts 1 to 5), IS 4326-1993, 13920-1993.

Registrar
REVA University
Bengaluru - 560 064

REVA UNIVERSITY
Bengaluru, India

School of Electronics & Communication Engineering

HANDBOOK

M. Tech. VLSI & Embedded Systems (Full-Time)

2017-2019 Batch

Registrar
REVA University
Bengaluru - 560 064

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

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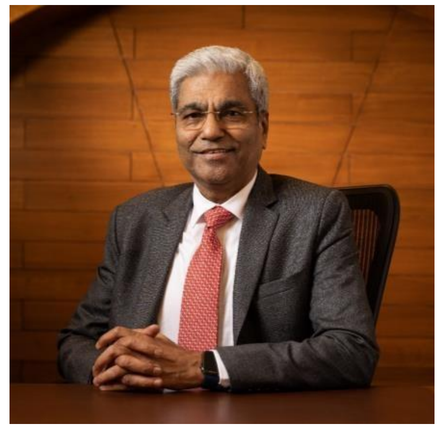
Chancellor's Message



"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. Kulkarni

Vice-Chancellor, REVA University

PREFACE

The M. Tech in VLSI and Embedded System is designed keeping in view the current situation and possible future developments, both at national and international levels. This course is designed to give greater emphasis on VLSI and Embedded System design with a flexibility to explore any of the implementation platform and application field through a number of soft core courses providing knowledge in these specialized areas. This facilitates the students to choose specialized areas of their interest. Adequate attention is given to provide students the basic concepts and requisite skills.

The area of VLSI design has gained enormous popularity over the past few decades due to the rapid advancements in integrated circuit (IC) design and technology. The ability to produce miniaturized circuits with high performance in terms of power and speed is the reason for its popularity. Using ASIC technology, it has been possible to develop high performance multi-core processors. Verification and testing of such complex designs is a critical and challenging task to ensure the quality of the resulting circuits. The advances in EDA software and CAD tools alleviate the effort necessary to carry out the cumbersome design and verification process of ICs.

The program is designed to expose students to various courses having applications in VLSI and Embedded System like Digital VLSI design, ASIC design, SOC design, Low Power VLSI, High Speed VLSI design, VLSI Testing and verification, CMOS RF Circuit design, Low Power Embedded system. They are also exposed to basic concepts of NANO technology, VLSI testing and Verification, fabrication process ,MEMS, Application specific design and embedded platform like ARM, MSP430, low power microcontrollers and FPGA, through outcome based teaching and learning process which emphasizes practical exposure rather than memorization. A variety of activities such as mini projects, seminars, internships, certification programs, etc. in consultation with industries will be carried out. There is also a scope for cultural, social and community service activities for the students to shape their personality suitable for all-round development.

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.

The VLSI and Embedded System students can choose their career in any VLSI and Embedded System development industries. Now a days almost every appliance is coming with some VLSI component. The scope of VLSI and Embedded System is very wide covering almost every home appliances, industry, automotives, and medical appliance manufactures industry automation and control, telecommunication, **Computer and Digital Systems**, defense and space exploration.

I am sure the students choosing M Tech in VLSI and Embedded System in School of Electronics and Communication 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.

Prof. Rajashekhar C. Biradar
Director
School of Electronics and Communication 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 27th February, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

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

The University is presently offering 23 Post Graduate Degree programs, 20 Degree and PG Degree programs in various branches of studies and has 14000+ students studying in various branches of knowledge at graduate and post graduate level and 350 Scholars pursuing research leading to PhD in 21 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 with knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed universities / institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The system also allows students to move forward under the fast track for those who have the capabilities to surpass others. These programs are taught by well experienced qualified faculty supported by the experts from industries, business sectors and such other organizations. REVA University has also initiated many supportive measures such as bridge courses, special coaching, remedial classes, etc., for slow learners so as to give them the needed input and build in them confidence and courage to move forward and accomplish success in their career. The University has also entered into MOUs with many industries, business firms and other institutions seeking their help in imparting quality education through practice, internship and also assisting students' placements.

REVA University recognizing the fact that research, development and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology and other areas of study. The interdisciplinary-multidisciplinary research is given the top most priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano- Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nana Tribology, Fuel Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

The REVA University has also given utmost importance to develop the much required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) department with world class infrastructure, headed by a dynamic experienced Professor & Dean, and supported by well experienced Trainers, Counselors and Placement Officers.

The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognised as a Centre of Skill Development and Training by NSDC (National Skill

Development Corporation) under Pradhan Mantri Kaushal 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 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 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 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 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 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 honoured with many more such honors and recognitions.

ABOUT SCHOOL OF ELECTRONICS AND COMMUNICATION ENGINEERING

The School of Electronics and Communication Engineering headed by a highly experienced Professor and is supported by well qualified faculty members. The school has the state-of-art class rooms and well equipped laboratories. It offers B.Tech and M.Tech and PhD programs in various specialized streams. The curriculum of both graduate and post graduate degree programs have been designed to bridge the gap between industry – academia and hence they are industry application oriented. The B. Tech program aims to prepare human resources to play a leading role in the continuing adventure of modern automated systems and communications. The Master degree programs focus on research and design in the core and IT industries, building and marketing the next generation of product development. This is reflected in various core subjects offered within the program. B. Tech program offers numerous choices of study for the students based on interest in the current state of art technology. Apart from fundamental courses in Electronics and Communication Engineering, the school facilitates to study in four streams such as Circuits and Devices, Communication Engineering, Signal Processing and Programming. Students are at liberty to choose from these streams in higher semesters. However, there is no restriction of cross migration from one stream to another at any level and thus there is a flexibility provided in the course duration.

The faculty members 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 counseling of students for academic performance, additional coaching classes for important subjects for all the semesters, soft skill development classes, scientific and student centered teaching-learning process.

Student's welfare is given utmost priority at School of Electronics and Communication Engineering. Advanced learning methods are adopted to make learning truly interactive. More focus is on discussion and practical applications rather than rote learning. Notes/handouts are given and critical thinking questions are asked to test understanding. Experienced, well qualified and friendly faculty members always strive hard to provide best of education to students.

Vision

The School of Electronics and Communication Engineering is envisioned to be a leading centre of higher learning with academic excellence in the field of electronics and communication engineering blended by research and innovation in tune with changing technological and cultural challenges supported with leadership qualities, ethical and moral values.

Mission

- Establish a unique learning environment to enable the students to face the challenges of the Electronics and Communication Engineering field.
- Promote the establishment of centers of excellence in niche technology areas to nurture the spirit of innovation and creativity among faculty and students.
- Provide ethical and value based education by promoting activities addressing the societal needs.
- Enable students to develop skills to solve complex technological problems of current times and also provide a framework for promoting collaborative and multidisciplinary activities.

ADVISORY BOARD

Sl. No	Name and Affiliation
1	Dr. M.H.Kori, Technology Consultant, Technology Adviser Validus Technologies USA, Retd. Technical Director, Alcatel-Lucent Technologies, Bengaluru
2	Mr. Vinod Chippalakatti, Vice President, CENTUM Electronics, Bengaluru
3	Dr. Madhusudhna Rao, Group Director & Chief Coordinator (LCA AF), ADA, Bengaluru
4	Dr. Shirshu Varma Professor, Department of Computer Science and Engineering IIIT Allahabad
5	Dr. Rathna G. N. Principal Research Scientist, Department of Electrical Engineering IISc., Bengaluru
6	Mr. Goutham Kumar , Head of Electronics,RLE India
7	Dr. Girish Kumar, Professor, Electrical Engineering, IIT Bombay
8	Dr. Muralidhara Kulkarni Department of Electronics & Communication Engineering, NITK, Surathkal
9	Dr. G. S. Javed, Terminus Circuits, Bengaluru
10	Dr. Shivashankar, SECE, VIT Vellore
11	Mr.Aravinda Sharma, Manager, Delphi Systems, Bengaluru
12	Dr. Kashinath, Director, ALS Semiconductors, Bengaluru
13	Mr.LokeshaRai K, Director, Symphony Telecca Services, Bengaluru
14	Sanjeev Kubakaddi, Itie Solutions, Bengaluru

Programme Overview

Electronics and Communication Engineering is an engineering discipline involved design, development, manufacture and deployment of Electronic and Communication systems. It deals with electronic devices, circuits, communication equipment like transmitter, receiver, integrated circuits (IC), analog and digital transmission and reception of data, voice and video, microprocessors, satellite communication, microwave engineering, antennae and wave progression. Signal and Image processing, Communication Technologies, Embedded Systems, VLSI Systems are some of the specialized areas available in electronics for further study.

Very Large Scale Integration (VLSI) system design is the process of creating complex integrated circuits by combining million/billion number of transistors into a single chip. This programme aims to prepare the students to design analog and digital integrated circuits using custom and semicustom design flow.

Worldwide, for the past five decades, the semiconductor industry has distinguished itself by the rapid pace of improvement in its products. The improvement of integration level, cost, speed, power, compactness and functionality of the integrated circuits leads to significant improvement in economic productivity and overall quality of life through proliferation of computers, communication, industrial and consumer electronics.

The improvement and complexity of VLSI system can be achieved by revolution of CMOS transistors, miniaturization of transistors, VLSI design methodology, EDA tool support, fabrication support, new design idea and innovative technology which are active research area in VLSI system design.

The ICs/Micro Processor/Micro-Controller/ chips developed and fabricated using VLSI technology become the heart of embedded systems. Embedded systems have become pervasive across various domains such as automotive, industrial and communication systems leading to tremendous growth in the application and innovation of networked and high performance real time embedded systems.

To sustain the growth rate, the organizations involved in VLSI technology and Embedded Systems development are in need of designers, analysts, developers, manufacturing, testing and marketing engineers as well as managers with a postgraduate degree in VLSI design and Embedded System sector.

The **School of Electronics and Communication Engineering at REVA UNIVERSITY** offers M. Tech., in **VLSI and Embedded Systems**–a postgraduate programme to create motivated, innovative, creative and thinking graduates to fill the roles of Electronic Engineers who can conceptualize, design, analyze and develop VLSI and Embedded systems to meet the modern day requirements.

The number of product and service based semiconductor industry are growing, thus various career opportunities exist in product development companies including mobile and consumer electronics, computing, telecommunications, networking, data processing, automotive, healthcare and industrial applications.

In this context**, The School of Electronics and Communication Engineering at REVA UNIVERSITY would like to add to the growing human resources needs of VLSI and Embedded system sector as engineers through its M. Tech. programme in VLSI and Embedded Systems.**

During the programme the theoretical foundation is built through courses like Digital VLSI design, High speed VLSI design, Low power VLSI Design, Analog and mixed mode design, system on chip design. The practice includes skill development in both Front end & Back end designs, verification and testing. The program also offers strong knowledge and practical skills in developing embedded solutions on varied platforms such as FPGA, Advanced microcontrollers and processors. The students learn to implement real time embedded systems. The designers gain practical knowledge through mini and major projects in both VLSI and Embedded system design domains.

Program Educational Objectives (PEO's)

The programme educational objectives of the Electronics and Communication Engineering of REVA University is to prepare graduates

PEO-1	To have successful professional careers in national and multinational organization and communicate effectively as a member of a team orto lead a team.
PEO-2	To continue to learn and advance their careers throughactivities such asresearch and development, acquiring doctoral degree, participation in national level research programmes, teaching and research at university level etc.,
PEO-3	To be active members ready to serve the society locally and internationally, may takeupentrpreneurship for the growth of economy and to generate employment; and adopt the philosopy of lifelong learning to be aligned with economic and technological development.

Program Outcomes (POs)

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

PO1. **Demonstrate in-depth knowledge** of VLSI and Embeded Systems, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

PO2. **Analyze complex engineering problems critically**, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

PO3. **Think laterally and originally, conceptualize and solve engineering problems, evaluate** a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

PO4. **Extract information pertinent to unfamiliar problems through literature survey and experiments**, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

PO5. **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.

PO6. **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.

PO7**. Demonstrate knowledge and understanding** of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical andfinancial factors.

PO8. **Communicate with the engineering community, and with society at large**, regarding **complex engineering activities** confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

PO9: **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.

PO10. **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.

PO11. **Observe and examine critically the outcomes** of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback (**SELF learning**)

Programme Specific Outcomes (PSO's)

After successful completion of the programme, the graduates shall be ableto

1. Isolate and solve complex problems in the domains of VLSI and Embedded Systems using latest hardware and software tools and technologies, along with analytical and managerial skills to arrive at cost effective and optimum solutions either independently or as ateam.
2. Implant the capacity to apply the concepts of FPGA, ASIC, System On Chip, IoT and cyber physical systems, etc. in the design, development and implementation of application oriented engineering systems
3. Design, Model, Analyze and VLSI and Embedded Systems to solve real life and industry problems.

M.Tech. (VLSI & Embedded Systems Full Time)
Scheme of Instructions
(effective from Academic Year 2017)

Eligibility: B.E./B. Tech. In ECE/TE/EEE/CSE/ISE/ Instrumentation Technology/ Medical Electronics/ Electrical and Electronics Engineering/ M Sc in Electronics with a minimum of 45% (40% in case of candidates belonging to SC and ST) marks in aggregate of any recognized university/institution or any other qualification recognized as equivalent there to.

Sl No	Course Code	Title of the Course	HC/ SC	Credit Pattern			
				L	T	P	Total
1	MT17VS101	Advanced Mathematics	HC	4	1	0	5
2	MT17VS102	CMOS VLSI Design	HC	4	0	1	5
3	MT17VS103	Advanced Embedded System Design	HC	4	0	1	5
4	MT17VS114	Advanced Digital System Design using Verilog	SC1	4	1	0	5
	MT17VS124	Semiconductor Device Modeling & Technology		4	1	0	5
	MT17VS134	Internet of Things- Practical Approach		4	1	0	5
5	MT17VS115	Unix/Linux Shell Scripting and Python Basics	SC2	4	1	0	5
	MT17VS125	SOC Design		4	1	0	
		Total Credits					**25**
1	MT17VS201	Design of Analog CMOS Integrated Circuits	HC	4	0	1	5
2	MT17VS202	Real Time Operating Systems	HC	4	0	1	5
3	MT17VS213	Low Power VLSI Design	SC3	4	1	0	5
	MT17VS223	VLSI for Signal Processing		4	1	0	
4	MT17VS214	High Speed VLSI Design	SC4	4	1	0	5
	MT17VS224	ASIC Design and Verification using SystemVerilog		4	1	0	
5	MT17VS215	MEMS	SC5	4	1	0	5
	MT17VS225	Advanced Computer Architecture		4	0	1	
		Total Credits					**25**

Sl No	Course Code	Title of the Course	HC/SC	Credit Pattern			
				L	T	P	Total
1	MT17VS301	MOOC / Swayam / Edx / Harvard / CM / Internship/Soft skill training	-	0	0	3	3
2	MT17VS302	Mini Project	HC	0	2	8	10
3	MT17VS303	Sports, Yoga, Music, Dance, Theatre	-	0	0	2	2
3	MT17VS313	MSP430	SC6	4	0	1	5
	MT17VS323	FPGA Based Embedded System Design		4	1	0	
	MT17VS333	Synthesis and optimization of Digital Circuits		4	1	0	
	MT17VS343	CMOS RF Circuit Design		4	1	0	
	MT17VS353	Advances in VLSI Design		4	1	0	
4	MT17VS314	Automotive Electronics System	OE	3	1	0	4
		Total Credits					**24**
FOURTH SEMESTER							
1	MT17VS401	Dissertation	HC	0	2	20	22
		Total Credits					**22**
	Total Credits for four Semesters						**96**

Note: HC = Hard Core: SC= Soft Core;
*For all the courses which are not supported by lab component students have to build mini project and it has to be evaluated.

M.Tech. (VLSI & Embedded Systems Full Time)

Detailed Syllabus

(effective from Academic Year 2017)

Semester – I:

Course Code	Course Title	Duration		L	T	P	C
MT17VS101	Advanced Mathematics	14 Weeks	HC	4	1	0	5

Prerequisites:

1. Basic knowledge of matrix mathematics and linear transformations.
2. Linear and parabolic partial differentiation and scalar wave equation in one space dimension.
3. Basics of Laplace transforms, Fourier transforms and Poisson equation by Fourier transform.
4. Simplex algorithm and nonlinear programming.

Course Objectives:

1. To understand the advanced concepts in Matrix theory and calculus
2. To Study the numerical, analytical and logical problem solving using transform methods
3. To learn applications of Poisson and Fourier transform methods.
4. To understand the concept of elliptic equation.
5. To study the various algorithms in linear and nonlinear programming.

Course Outcomes:

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

1. Identify and describe different techniques in solving Engineering problems using Matrix method
2. Describe the Euler equation of first and higher order degree.
3. Apply Laplace transform to one dimensional wave.
4. Analyse properties of harmonic functions.
5. Present the concepts Two Phase and Big M techniques.
6. Explain problem solving using Lagrange’s multiplier method.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
MT17VS101	CO1	3	2	3	4					3			1	1	2
	CO2	3	3	2	1				2					2	1
	CO3	1	3	2	1					1					

	CO4	**2**	**3**	**1**	**2**										
	CO5	**3**	**3**	**2**	**1**				**2**					**2**	**1**
	CO6	**3**	**3**	**2**	**1**				**2**					**2**	**1**

Course Contents:

Unit 1: Matrix Theory, Calculus of Variations **[14]**

QR EL Decomposition – Eigen values using shifted QR algorithm- Singular Value EL Decomposition - Pseudo inverse- Least square approximations

Concept of Functional- Euler's equation – functional dependent on first and higher order derivatives – Functional on several dependent variables – Isoperimetric problems- Variation problems with moving boundaries.

Unit 2:Transform Methods **[14]**

Laplace transform methods for one dimensional wave equation – Displacements in a string – Longitudinal vibration of an elastic bar – Fourier Transform methods for one dimensional heat conduction problems in infinite and semi-infinite rod.

Unit 3:Elliptic Equation **[14]**

Laplace equation – Properties of harmonic functions – Fourier transforms methods for Laplace equations. Solution for Poisson equation by Fourier transforms method.

Unit 4:Linear and Non Linear Programming **[14]**

Simplex Algorithm- Two Phase and Big M techniques – Duality theory- Dual Simplex method. Non Linear Programming –Constrained external problems- Lagrange's multiplier method- Kuhn- Tucker conditions and solutions.Recent trends in the related areas from journals, Conference proceedings Book chapters.

References:

1. Richard Bronson, "**Schaum's Outlines of Theory and Problems of Matrix Operations**", McGraw-Hill, 1988.
2. Venkataraman M. K., "**Higher Engineering Mathematics**", National Publications Co., 1992.
3. Elsgolts, L., "**Differential Equations and Calculus of Variations**", Mir, 1977.
4. Sneddon, I.N., "**Elements of Partial Differential Equations**", Dover Publications, 2006.
5. Sankara Rao, K., "**Introduction to Partial Differential Equations**", Prentice – Hall of India,1995.
6. Taha H A, "**Operations Research - An Introduction**", McMilan Publishing co, 1982.

Course Code	Course Title	Duration		L	T	P	C
MT17VS102	CMOS VLSI Design	14 Weeks	HC	4	0	1	5

Prerequisites:

1. Working principle of MOS transistor theory and MOSFET characteristics.
2. Static characteristics, transient response and propagation delay calculations of MOS inverters.
3. Basic principles of pass transistor circuits and dynamic CMOS characteristics.
4. Basics of volatile memory and non-volatile memory and low power CMOS logic circuits.
5. Knowledge on BiCMOS and BJT theory.
6. Concept of electrostatic discharge (ESD) and basics of latch up prevention and process variations.

Course Objectives:

1. To understand an overview of working principle of MOS transistor and MOS inverters.
2. To be acquainted with all the definitions associated with MOS inverters.
3. To understand dynamic logic circuits.
4. To get understand of semiconductor memory.
5. To study chip input output devices.

Course Outcomes:

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

1. Explain the working principle of MOS transistor and MOS inverters
2. Define all the definitions associated with MOS inverters
3. Analyse dynamic logic circuits
4. Describe the semiconductor memory
5. Explain chip input output devices

Mapping of Course Outcomes with Program Outcomes

Course Code	POs/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	P O 10	P O 11	P O 12	PSO 1	PSO 2	PSO 3
MT17VS102	CO1	3	2		2		1	1			2		3		3	2
	CO2	3	3	3			1			2			2		3	2
	CO3	3	3				2			1			1		3	2
	CO4	3	3			2							1		3	2
	CO5	3	3			2							1		3	2

Course Contents:

Unit 1: MOS Transistor, MOS Inverters **[14]**

The Metal Oxide Semiconductor (MOS) Structure, the MOS System under External Bias, Structure and Operation of MOS Transistor, MOSFET Current-Voltage Characteristics, and MOSFET Scaling and Small-Geometry Effects.

Static Characteristics: Introduction, Resistive-Load Inverter, Inverters with type MOSFET Load, CMOS Inverter.

Unit 2: MOS Inverters (continued) **[14]**

Switching Characteristics and Interconnect Effects: Introduction, Delay-Time Definition, Calculation of Delay Times, and Inverter Design with Delay Constraints, Estimation of Interconnect Parasitics, Calculation of Interconnect Delay, and Switching Power Dissipation of CMOS Inverters.

Dynamic Logic Circuits: Introduction, Basic Principles of Pass Transistor Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High Performance Dynamic CMOS Circuits.

Unit3: Semiconductor Memories **[14]**

Introduction, Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM), Nonvolatile Memory, Flash Memory, Ferroelectric Random Access Memory (FRAM). Low-Power CMOS Logic Circuits: Introduction, Overview of Power Consumption, Low-Power Design Through Voltage Scaling, Estimation and Optimization of Switching Activity, Reduction of Switched Capacitance, Adiabatic Logic Circuits.

BiCMOS Logic Circuits: Introduction, Bipolar Junction Transistor (BJT): Structure and Operation, Dynamic Behavior of BJTs, Static Behavior, Switching Delay in BiCMOS Logic Circuits, BiCMOS Applications.

Unit 4:Chip Input and Output (I/O) Circuits
[14]

Introduction, ESD Protection, Input Circuits, Output Circuits and L (di/dt) Noise, On-Chip Clock Generation and Distribution, Latch-Up and Its Prevention.

Design for Manufacturability : Introduction, Process Variations, Basic Concepts and Definitions, Design of Experiments and Performance Modeling, Parametric Yield Estimation, Parametric Yield Maximization, Worst-Case Analysis, Performance Variability Minimization.

Recent trends in the related areas from journals, Conference proceedings Book chapters.

References:

1. Sung Mo KangandYosufLeblebici, "**CMOS Digital Integrated Circuits: Analysis and Design**", Tata McGraw-Hill, Third Edition, 2003.
2. Neil Weste and K. Eshragian, "**Principles of CMOS VLSI Design: A System Perspective**", Second Edition, Pearson Education (Asia) Pvt. Ltd. 2000.

CMOS VLSI Lab

Course Objectives:

1. To understand the ASIC Design flow
2. To demonstrate VLSI CAD tool- Cadance
3. To desing VLSI Digital Circuits
4. To perform Area, power and timing analysis of the designed digital circuits.

Course Outcomes:

On completion of this course the students will be able to:

1. Design the digital VLSI circuits (a, b , c , d)
2. Perform the Power, area and timing analysis of the designed digital circuits (a, b, c, d)

Lab Experiments

1. Write a VHDL/Verilog code to realize the A Buffer. Simulate & synthesize the same on FPGA kit.
2. Write a VHDL/Verilog code to realize the inverter. Simulate & synthesize the same on FPGA kit.
3. Write a VHDL/Verilog code to realize the Transmission Gate. Simulate & synthesize the same on FPGA kit.
4. Write a VHDL/Verilog code to realize the universal gates Simulate & synthesize the same on FPGA kit..
5. Write Verilog / VHDL Code for the following circuits and their Test Bench for **verification**, observe the waveform and **synthesis** the code with technological library with given Constraints.
    a. RS Flip flop
    b. D Flip flop
    c. JK Flip flop
    d. T Flip flop
    e. Master Slave JK Flip flop
6. Write Verilog / VHDL Code for the Serial & Parallel adderand their Test Bench for **verification**, observe the waveform and **synthesis** the code with technological library with given Constraints.
7. Write a VHDL/Verilog code to realize the kit 4-bit counter [Synchronous and synchronous counter] Simulate & synthesize the same on FPGA kit.
8. Write a VHDL/Verilog code to realize l the kit Successive approximations register [SAR]. Simulate & synthesize the same on FPGA.
9. Mini Project*

Course Code	Course Title	Duration		L	T	P	C
MT17VS103	Advanced Embedded Systems Design	14 Weeks	HC	4	0	1	5

Prerequisites:

1. Concept of Embedded systems and its design optimization.
2. Knowledge on architecture of embedded systems and embedded microcontroller cores.
3. Working principle of interfacing subsystems and external systems and DSP.
4. Concepts of real time programming and RTOS.

Course Objectives:

1. Understand how to design an embedded system.
2. To know how to partition a system to hardware and software parts efficiently.
3. To know Hardware/software Co-design concepts.
4. To Understand the Architecture and Working of ARM Cortex-M3 Processors and Controllers.
5. To study the concepts of Architectural Support for High level languages.
6. To study the concepts of Architectural support for system Development and Operating systems.

Course Outcomes:

On completion of this course the students will be able to:

1. Design embedded system architectures for various applications.
2. Implement, Identify, formulate, and solve engineering problems.
3. Analyze and Compare various Processor and Controller Architectures with ARM
4. To identify different functional blocks in an ARM Microcontroller and their Applications
5. Program ARM Cortex-M3 MCUs by identifying the software development tools

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT17VS103	CO1	3	3	3		2				2	3		3	2	3	2
	CO2	3	3	3		2				2	3		3	2	3	2
	CO3	3	3	3		2				2	3		3	2	3	2
	CO4	3	3	3		2				2	3		3	2	3	2
	CO5	3	3	3		2				2	3		3	2	3	2

Course Contents:

Unit 1:Introduction [14]

Overview of embedded systems, embedded system design challenges, common design metrics and optimizing. Survey of different embedded system design technologies & trade-offs. Embedded microcontroller cores, embedded memories, Examples of embedded systems. Architecture for embedded system.

Unit 2: Introduction to Cortex-M3 Processor [14]

A Brief History, Architecture Versions, Different MCU architectures vs ARM, ARM Processor Families, Cortex-M3 Processor Applic Interrupt/Exception Sequences, Nested Interrupts, Tail-Chaining, Late Arrivals, Interrupt Latency, Exception/Interrupt Handlers, Software Interrupts

Unit 3:Cortex-M3Programming [14]

A Typical Development Flow, Development Tools – C Compilers and Debuggers, Embedded OS Support, Embedded C Programming using Keil MDK-ARM

Cortex Microcontroller Software Interface standard (CMSIS) – Areas of standardization, Organization and using CMSIS, Overview of NxP's LPC1768, Memory map, Understanding different functional blocks and their Applications in LPC 1768 - System Control, Clocking and Power Control, Timers, WDT, RTC, ADC, I2C, SPI

Unit 4:Cortex-M3MicrocontrollersProgramming and Development [14]

Pin Connect block, GPIO Programming, Configuring GPIOs for External Interrupts. Understanding UART and its Applications, Configuration for Serial Communication.

Reference Books:

1. Jack Ganssle, "**The Art of Designing Embedded Systems**", Elsevier, 1999.
2. J.W. Valvano, "**Embedded Microcomputer System: Real Time Interfacing**", Brooks/Cole, 2000.
3. David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
4. Gomaa, "**Software Design Methods for Concurrent and Real-time Systems**", Addison-Wesley, 1993.
5. InstructorReferenceMaterial
6. JosephYiu, "THE DEFINITIE GUIDE TOTHE ARMCORTEX-M3"
7. ManualsandTechnicalDocumentsfromthe ARM Inc, web site.

Advanced Microcontroller Lab

Course Objectives:

1. To Learn C Programming, Debugging and Interfacing Peripherals for a given ARM Cortex-M3Microcontroller.

Course Outcomes:

The students will be able to

1. Program ARM Cortex-M3 MCU Target using Keil uVision IDE
2. Interface and Program hardware peripherals like LED, Push Button Switch, LCD, Keypad
3. Establish serial communication between the MCU target and Desktop PC.

Laboratory Experiments:

1. Interface an External Push Button Switch, LED, with MCU target board, and Write a C Program to Configure and Control the ON-OFF operation of the LED using the switch. (*Configure Switch as an External interrupt source*)
2. Interface a 4x4 Matrix Keypad, LEDs Array, with MCU target board, and Write a C program to display the binary equivalent pattern of the numeric key pressed on the LEDs array.
3. Interface a 16x2 LCD for its 4-bit mode operation, with MCU target board and Write a C Program to display a message on both the lines of the LCD.
4. Write a C Program to Configure the on-chip UART functional block of the MCU target board to output a message on serial terminal of a host machine via its serial/ COM port.

Course Code	Course Title	Duration		L	T	P	C
MT17VS114	Advanced Digital System Design using Verilog	14 Weeks	SC	4	1	0	5

Prerequisites:

Knowledge on Digital system design, Boolean algebraic theorems and number systems, Basics of sequential logic and memory types, Principles of ICs, PLDs and interfacing memory.

Course Objectives:

This course will enable students to:

1. Understand the concepts of Verilog Language.

2. Design the digital systems as an activity in a larger systems design context.
3. Study the design and operation of semiconductor memories frequently used in application specific digital system.
4. Illustrate the different components and functions related to design of Combinational circuits.
5. Illustrate the different components and methodology related to design of Sequential circuits.
6. Provide an Understanding to concepts FSM basics.

Course Outcomes:

After studying this course, students will be able to:

1. Design & Construct the combinational circuits using discrete gates and programmable logic devices.
2. Describe Verilog model for sequential circuits and test patterngeneration.
3. Apply different modeling techniques in the programming of Verilog HDL
4. Explore the different types ofsemiconductor memories and their usage for specific chip design.
5. Understand and analyze the programming of combinational and sequential logic designin Verilog HDL
6. Design and synthesis of different types of processor and I/O controllers that are used in embedded system design.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
MT17VS114	**CO1**	**4**	**4**	**3**	**3**	**2**							**1**	**1**		**2**
	CO2	**1**	**4**	**3**	**3**	**2**							**2**	**1**		**2**
	CO3	**4**	**3**	**4**	**2**	**2**					**1**		**1**	**1**		**2**
	CO4	**1**	**3**	**4**		**2**							**1**	**1**		**2**
	CO5	**4**	**4**	**3**	**3**	**2**							**1**	**1**		**2**
	CO6	**1**	**4**	**3**	**3**	**2**							**2**	**1**		**2**

Unit 1: Introduction to Digital System and Methodology **[14]**

Digital Systems and Embedded Systems, Binary representation and Circuit Elements, Real-World Circuits, Design Methodology.

Gate-level combinational circuit: Introduction, General description, Basic lexical elements and data types, Data types, Program skeleton, Structural description, Test bench.

Overview of FPGA and EDA software: Introduction, Architecture of FPGA, Development flow, HDL for combinational Circuits, Design of Adder, Subtractor, Decoders, Encoders, Multiplexer, code Converter.

Unit 2: Functions tasks and User defined Primitives **[14]**

Introduction, functions, tradeoff between hardware and speed, scope of functions, recursive functions, tasks, task definition, task enabling, user defined primitives, combinational UDPs, More general combinational UDPs, Instantiation of UDP, Combinational UDP and Function, Sequential UDPs, UDP instantiation with delays, vector type instantiation of UDP

Unit 3: Sequential Basics: **[14]**

Storage Elements, Flip-flops and Registers, Shift Registers, Latches, Sequential Data paths and Control, Finite-State Machines, Clocked Synchronous Timing Methodology, Asynchronous Inputs, Verification of Sequential Circuits, Asynchronous Timing Methodologies,

Memories: General Concepts Memory Types, Asynchronous Static RAM Synchronous Static RAM, Multiport Memories, Dynamic RAM, Read - Only Memories.

Unit 4: Queues, PLAS, Compiler directives and FSMS: **[14]**

File based tasks and functions, compiler directives, time related tasks, queues, PLDs, programming PLD in Verilog, Design of finite state machine- Moore machine, Melay machine.

Text Books

1. T.R. Padmanabhan, B. Bala Tripura Sundari , Design through Verilog HDL", Wiley Publication.
2. Pong P Chu, "FPGA Prototyping by Verilog Examples", Wiley, 2006.

References:

1. Peter J. Ashenden, **"**Digital Design: An Embedded Ssytems Approach Using VERILOG", Elesvier, 2010.
2. Frank Vahid, "Digital Design", Wiley, 2006.

Course Code	Course Title	Duration		L	T	P	C
MT17VS124	Semiconductor Device Modeling & Technology	14 Weeks	SC	4	1	0	5

Prerequisites:

1. Basic knowledge of Electronics Devices.

Course Objectives:

1. Understand the basic concepts of semiconductor materials
2. Characterize the concepts of P- N Junction diode
3. Understand the basic characteristics of metal semiconductor junction
4. Study the device modeling

Course Outcomes:

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

1. Analyze the concepts of semiconductor materials and analyze its properties
2. Analyze the characteristics and concepts of P-N Junction Diode
3. Analyze the characteristics and concepts of Metal-Semiconductor Junction

4. Analyze the characteristics and concepts of MOSFET and BJT
5. Apply, Awareness and Understanding of current trends in semiconductor device modeling in Design and Fabrication Unit

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	P O 10	P O 11	P O 12	PSO 1	PSO 2	PSO 3
MT17VS124	CO1	3		2	1									3	1	2
	CO2	2		3	1									2	1	3
	CO3	1		3	2									1	2	3
	CO4	3		1	2									1	3	2
	CO5	3		2	1									3	1	2

Course Contents:

Unit 1:Semiconductor Materials [14]

Intrinsic carrier concentration: Dopant atoms and energy levels, Ionization energy: the extrinsic semiconductor, Position of Fermi-energy level, variation of EF with doping concentration and temperature. Carrier drift: mobility, conductivity and velocity saturation, Carrier Diffusion: diffusion current density, total current density, The Einstein relation, Excess carrier generation and recombination, Characteristics of excess carriers – continuity equation and time-dependent diffusion equation.

Unit 2: PN Junction diode [14]

Basic structure, built-in potential, electric field, space charge width, reverse applied bias space charge width and Electric field, junction capacitance, Ideal current-voltage relationship, minority carrier distribution, Ideal PN-junction currents under forward and reverse bias, Temperature effects, small signal model of PN-junction, Equivalent circuits, recombination current, junction breakdown; SPICE models of p-n diode.

Unit 3: Metal Semiconductor Junction and FET Capacitor [14]

Schottky barrier, I-V and C-V characteristics of M-S junction, thermal emission and tunneling current, Field-Effect Transistors: JFET- current-voltage characteristics, effects in real devices, high-frequency and high-speed issues. MOS structure: Energy band diagrams, work function difference, Depletion layer thickness, Flat band voltage, threshold voltage, charge distribution, MOS Capacitance – voltage characteristics.

Unit 4: Bipolar Transistor and Current trends [14]

Basic Principle of Operation: Simplified transistor current relationship, Modes of operation, amplification with bipolar transistors, Minority carrier distribution, Forward active mode and other modes of operation, Low frequency common base current gain, Non-ideal effects – Base width modulation, breakdown voltage, equivalent circuit models, Eber's – Moll model, Hybrid – pi model, Frequency limitation, large signal switching; SPICE models of BJT.

References:

1.N. Das Gupta, and A. DasGupta, Semiconductor Devices: Modelling and Technology, Prentice Hall of India Private Limited, New Delhi, 2004.
2. B. G. Streetman and S. Banerjee, Solid State Electronic Devices, 5th edition, Prentice Hall of India Private Limited, New Delhi, 2000.
1. Chenming Calvin Hu, Modern Semiconductor Devices for Integrated Circuits, Pearson, 2009.
2. Y. Taur, and T. H. Ning, Fundamentals of Modern VLSI Devices, Cambridge University press, 1998
3. S. M. Sze, **“VLSI Technology**”, 2nd edition, McGraw-Hill, 1998
4. S. K. Dieter, **“Semiconductor Material and Device Characterization,”** by John Wiley and Sons, New York, 1990.
5. G. W. Roberts and A. S. Sedra SPICE 2nd edition, Oxford University Press, 1997
6. Yuan TaurandTak H. Ning, **“Fundamentals of Modern VLSI Devices”,** Cambridge University Press; 2 edition, 2013.

Course Code	Course Title	Duration		L	T	P	C
MT17VS134	Internet of Things- Practical Approach	14 Weeks	SC	4	1	0	5

Prerequisites:

Basics of wireless networks, protocols, sensors

Course Objectives:

1. To introduce the full connected-product experiences by integrating Internet services and physical objects
2. To give an insight into developing prototypes of Internet-connected products using appropriate tools
3. To introduce theBasic Arduino programming. Extended Arduino libraries. Arduino-based Internet communication
4. To provide insght intoXML and JSON, HTTP APIs for accessing popular Internet services

Course Outcomes

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

1. Understand full connected-product experiences by integrating Internet services and physical objects
2. Analyzing, designing, and developing prototypes of Internet-connected products using appropriate tools .

3. Identifying, classifying and describing different kinds of Internet-connected product concepts Describe different network protocols
4. Analyzing the challenges and applying adequate patterns for user-interaction with connected-objects

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COs	PO1	P02	PO3	PO4	PO5	PO6	P 7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	CO1	1				2	3							3	1	2
	CO2	2	1			2	3							2	1	3
	CO3	1				2	3							3	2	1
	CO4	1				2	3									

Course Contents:

Unit 1:Introduction to the Internet of Things **[14]**

Origins. Early concepts and products. Examples of current products and value propositions. Architectures and design patterns. Analysis of a full connected-object experience. State of the Art, challenges and future directions.

Unit 2: Prototyping Connected Objects **[14]**

Open-source prototyping platforms. Basic Arduino programming. Extended Arduino libraries. Arduino-based Internet communication. Practical activities

Unit 3: Integrating Internet Services **[14]**

XML and JSON. HTTP APIs for accessing popular Internet services (Facebook, Twitter, and others). Practical activities

Unit 4: Project Development and Competition **[14]**

Development of a project including: value proposition, physical connected object prototyping, programming the behaviour, accessing Internet services and designing the user experience. Case studies

Reference books:

1. Smart Things: Ubiquitous Computing User Experience Design. Mike Kuniavsky. Morgan Kaufmann Publishers. 2010
2. Meta Products: Building the Internet of Things. Sara Cordoba, WimerHazenberg, Menno Huisman. BIS Publishers. 2011.
3. Getting Started with Arduino (Make: Projects). Massimo Banzi. O'Reilly Media. 2008
4. Emotional Design: Why We Love (or Hate) Everyday Things. Donald A. Norman. Basic Books, 2004.
5. Physical Computing: Sensing and Controlling the Physical World with Computers. Tom Igoe, Dan O'Sullivan. Premier Press. 2004.

Course Code	Course Title	Duration		L	T	P	C
MT17VS115	Unix/Linux Shell Scripting and Python Basics	14 Weeks	SC	4	1	0	5

Prerequisites:

1. Basic knowledge of Unix OS.

Course Objectives:

1. Understand the and write the shell scripts
2. Understand the concept of process in Unix
3. Study the basic concepts of python scripting language

Course Outcomes:

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

1. Design scripting code for a given application
2. Apply various conditional statements, loops and command line arguments to develop the script code
3. Develop the python scripting code

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
MT17VS115	**CO1**		**2**	**1**		**3**								**3**	**1**	**2**
	CO2	**2**	**1**		**2**	**3**								**2**	**1**	**3**
	CO3	**1**		**2**		**3**								**3**	**2**	**1**

Course Contents:

Unit 1: Shell Basics, Writing first script **[14]**

Types of shells, Shell functionality, Environment, Writing script & executing basic script, Debugging script, Making interactive scripts, Variables (default variables), Mathematical expressions,

Conditional Statements and Loops: If-else-elif, Test command, Logical operators- AND,OR,NOT, ase –esac, Loops, While, For, Until, Break & continue.

Unit 2:Command line arguments **[14]**

Positional parameters, Set & shift, IFS, Break & continue, Processing file line by line Functions, What is regular expression, Grep, cut, sort commands, Grep patterns.

Unit 3: SED& AWK, Processes **[14]**

Concept of process in Unix, Background processes, Scheduling processes -At, batch &Cron

Unit 4: Python Basic **[14]**

Latest developments in the semiconductor device modeling and introduction to device simulation tools & technologies, e.g., Silvaco-CMOS Process and Smart SPICE. Exposure to equipment and process used in Semiconductor Fab. Unit, Test and Measure Equipments.

References:

1. Brian W. Kernighan & Rob Pike, The Unix Programming Environment, Prentice Hall of India Private Limited, New Delhi, 2004.
2. Carl Albing, JP Vossen, and Cameron Newham,BashCookbook,O'Reilly 2007.
3. Tim Hall and J-P Stacey,Python 3 for Absolute Beginners, Apress, 2009.

Course Code	Course Title	Duration		L	T	P	C
MT17VS125	SOC Design	14 Weeks	SC	4	1	0	5

Prerequisites:

1. Basics of SoC design and system architecture.
2. Concepts of interconnect architecture and bus architecture of Soc.
3. Principles of memory design and cache architecture.
4. Basic knowledge of ASIC design flow and FPGA design flow.

Course Objectives:

1. Provide a comprehensive introduction to the ASIC and SoC technology.
2. Provide theoretical and practical aspects of ASIC and SoC design.
3. Introduce ASIC design, ASIC library design and Programmable ASIC.
4. Give an overview to SoC design, its challenges and Design flow.
5. To understand the memory design concepts in processors.
6. To understand ASIC design flow using semi/full /standard cells.

Course Outcomes:

On completion of this course the students will be able to:

1. Select the appropriate processors for a given application keeping area, power and speed as constraints and to Deepen CMOS VLSI design knowledge
2. Design full custom/ semicustom/ standard cells for ASIC
3. Implement network on chip technologies
4. Analyze memories using reconfigurable architectures for rapid prototyping
5. Analyze system on chip and board based systems.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	P 7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	CO1		**2**	**1**		**3**								**3**	**1**	**2**
	CO2	**2**	**1**		**2**	**3**								**1**	**3**	**2**
	CO3	**1**		**2**		**3**								**2**	**3**	**1**
	CO4		**2**	**1**		**3**								**3**	**1**	**2**
	CO5	**2**	**1**		**2**	**3**								**1**	**3**	**2**

Course Contents:

Unit-1: System Approach and Chip Basics **[14]**

System Architecture, Components of the System, Hardware and Software. An approach for SoC Design, System On Chip Design Process: A canonical SoC Design, SoC Design flow - waterfall vs spiral, Top-down vs Bottom up, System Architecture and Complexity. Chip Basics. Cycle Time, Die Area and Cost, Ideal and Practical Scaling, Power, Area–Time–Power Trade-Offs in Processor Design, Reliability, Configurability.

Unit-2: Processors and Interconnects **[14]**

Processor Selection for SoC, Basic Concepts in Processor Architecture, Instruction Handling, and Buffers, Minimizing Pipeline Delays, Branches. Vector, Very Long Instruction Word (VLIW), and Superscalar with case studies. Interconnect architectures for SoC. Bus architecture. Network on Chip topologies. Routing, Switching and Flow Control in NoCs.

Unit-3: Memory Design **[14]**

System-on-Chip and Board-Based Systems – Scratchpads and Cache Memory, Basic Notions, Cache Organization, Cache Data, Write Policies, Strategies for Line Replacement at Miss Time, Other Types of Cache, Split I- and D-Caches and the Effect of Code Density, Multilevel Caches, Virtual-to-Real Translation, SoC (On-Die) Memory Systems, Board-based (Off-Die) Memory Systems, Simple DRAM and the Memory Array, Models of Simple Processor–Memory Interaction.

Unit-4: ASIC Design **[14]**

Full/Semi Custom with ASIC, Standard Cell based ASIC, Gate array based ASIC, Programmable logic device, FPGA design flow, ASIC cell libraries. ASIC Library Design, Logical effort and library cell design. Low-Level Design Entry, Schematic Entry, Hierarchical design, the cell library, connections, vectored instances and buses, Edit in place attributes, Net list, screener, back annotation.

Text Books:

1. Micheal J Flynn and Wayne Luk,"**Computer System Design: System-on-Chip**," Wiley, First Edition, 2011.
2. Sudeep Pasricha and NikilDutt,"**On-Chip Communication Architectures: System on Chip**

Interconnect", Morgan Kaufmann, 2008.
3. Michael Keating, Pierre Bricaud, "**Reuse Methodology manual for System on chip designs**", Kluwer academic Publishers, 2nd edition-2008.
4. M.J.S .Smith, "**Application Specific Integrated Circuits**", Pearson Education, 2003.

References:

1. Rao R. Tummala, MadhavanSwaminathan, "**Introduction to system on package sop-Miniaturization of the Entire System**", McGraw-Hill-2008.
2. James K. Peckol, "**Embedded Systems: A Contemporary Design Tool**", WILEY Student Edition, 2007.
3. Ahmed Amine Jeraya, Wayne Wolf, "**Multiprocessor System On chip**", Morgan Kauffmann, 2005.

Semester – II:

Course Code	Course Title	Duration		L	T	P	C
MT17VS201	Design of Analog CMOS Integrated Circuits	14 Weeks	HC	4	0	1	5

Prerequisites:

1. Basics of MOS devices and its characteristics.
2. Concepts of single stage amplifiers and frequency response of amplifiers.
3. Knowledge on differential amplifiers, Operational amplifiers and current mirrors.
4. Basic knowledge on DAC and ADC architectures and phase locked loops.

Course Objectives:

1. To understand the basics and operation of MOS devices.
2. To analyse and understand analog CMOS integrated circuits.
3. To analyse and design single stage MOS amplifier circuits.
4. To understand the basic operation of differential amplifier and op-amps.

Course Outcomes:

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

1. Design single stage, differential and current mirror
2. Analyse the stability, feedback in amplifiers, op-amps
3. Design oscillators and PLL.
4. Design ADCs and DACs

Mapping of Course Outcomes with Program Outcomes

Course Code	POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
MT17VS 201	CO1	3	2	3	1								2	1	3
	CO2	3	3	2	1								1	2	3
	CO3	2	2	3	2								3	1	
	CO4	2	1	2	1								2	3	

Course Contents:

Unit 1: Basic MOS Device Physics **[14]**

General considerations, MOS I/V Characteristics, second order effects, MOS device models. Single stage Amplifier: CS stage with resistance load, divide connected load, current source load, triode load, CS stage with source degeneration, source follower, common-gate stage, cascade stage, choice of device models.

Unit 2: Differential Amplifiers & Current Mirrors **[14]**

Basic difference pair, common mode response, Differential pair with MOS loads, Gilbert cell. Basic current mirrors, Cascade mirrors, active current mirrors.

Operational Amplifiers: One Stage OP-Amp, Two Stage OP-Amp, Gain boosting, Common Mode Feedback, Slew rate, Power Supply Rejection, Noise in Op Amps.

Unit 3: Oscillators and Phase Locked Loops **[14]**
Ring Oscillators, LC Oscillators, VCO, Mathematical Model of VCO. Simple PLL, Charge pump PLL, Non-ideal effects in PLL, Delay locked loops and applications. Band gap References and Switched capacitor Circuits: General Considerations, Supply Independent biasing, PTAT Current Generation, Constant Gm Biasing, Sampling Switches, and Switched Capacitor Amplifiers.

Unit 4: Data Converter Architectures **[14]**
DAC & ADC Specifications, Resistor String DAC, R-2R Ladder Network, Current Steering DAC, Charge Scaling DAC, Cyclic DAC, Pipeline DAC, Flash ADC, Pipeline ADC, Integrating ADC, Successive Approximation ADC.

References:

1. BehzadRazavi, **"Design of Analog CMOS Integrated Circuits**", TMH, 2007.
2. Philip Allen and Douglas Holberg, **"CMOS Analog Circuit Design",** Oxford University, Press, 2011.
3. R. Jacaob Baker, Harry W Li and David E Boyce, **"CMOS Circuit Design, Layout, Stimulation",**CMOS Circuit PHI Edn, 2005.

Design of Analog CMOS Integrated Circuits Lab

Course Objectives:
1. Learn the CAD tool and the flow of the Full Custom IC design cycle.
2. Design the various analog CMOS VLSI circuits.
3. Perform DRC, LVS and Parasitic Extraction of the various designs.

Course Outcomes:
1. Demonstrate the VLSI Cad tool to design CMOS VLSI analog circuits
2. Design, implement and analyse various Analog mixed mode circuits
3. Perform DRC, LVS for the designed circuits.
4. Carry out the mini project on the design of a CMOS subsystem.

Lab Experiments

1. Design of inverter with given specifications, and perform the following
    1. Draw the schematic and perform
        a. DC analysis
        b. Transient Analysis
    2 Draw the Layout and perform DRC and ERC
    3. Extract RC and Back annotate the same and verify the design
2. Design the following circuits with given specifications*, completing the design flow mentioned below:
   a.Draw the schematic and verify the following
   i) DC Analysis
   ii) AC Analysis
   iii) Transient Analysis
   b.Draw the Layout and verify the DRC, ERC, LVS
   d.Extract RC and back annotate the same and verify the Design.

   i) A Single Stage differential amplifier
   ii) Common source amplifier
   iii) Design an opamp with given specification.

Course Code	Course Title	Duration		L	T	P	C
MT17VS202	Real Time Operating Systems	14 Weeks	HC	4	0	1	5

Prerequisites:

1. Concepts of Operating systems.
2. Basics of task management and task scheduling.
3. Knowledge on RTOS and memory management.
4. Basic knowledge on performance metrics and RTOS tools.

Course Objectives:

1. To acquire knowledge about concepts related to OS such as Scheduling techniques,threads, inter-thread communications, memorymanagement.
2. To acquire knowledge about different types of scheduling algorithms
3. To study about Free RTOS
4. To understand the various functions of RTOS

Course Outcomes:

On completion of this course the students will be able to:

1. Describe the fundamental concepts of RTOS

2. Develop programs for real time services, firmware and RTOS.
3. Develop programs formulate threaded applications on FreeRTOS

Mapping of Course Outcomes with Program Outcomes

Course Code	POs/ COs	PO1	PO 2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MT17VS202	CO1	3	2	3	1								2	1	3
	CO2	3	3	2	1								1	2	3
	CO3	2	2	3	2								3	1	

Course Contents:

Unit 1: Real time systems and Resources [14]

Real-Time Systems and Resources: Brief history of Real Time Systems, A brief history of Embedded Systems Requirements of Embedded System,Challenges in Embedded System. System Resources, Resource Analysis, Real-Time Service Utility.

Processing with Real Time Scheduling: Scheduler Classes, Preemptive Fixed Priority Scheduling Policies with timing diagrams, Rate Monotonic least upperbound,Necessary and Sufficient feasibility, Deadline –Monotonic Policy, Dynamic priority policies,Worst case execution time, Dead lock and live lock.

Unit 2: Real Time Operating Systems [14]

Operating System basics,The Kernel and its subsystems, Kernel Space and User Space, Kernel Architecture, Types of operating system, Task, process and Threads, Multi-Processing and Multitasking, Types of multitasking, Task Scheduling, Task states, Non-Preemptive scheduling, Preemptive Scheduling,Round Robin Scheduling,IdleTask,Task Communication, Task Synchronization,Thread Safe Reentrant Functions.

Unit 3: Embedded Firmware Design, development and Free RTOS [14]

Embedded Firmware Design Approaches, Super-loop based approach, Embedded Operating System based approach, Programming in Embedded C, Integrated development environment (IDE), Overview of IDEs for Embedded System Development.

Introduction to Free RTOS, multitasking on an LPC17xx Cortex-M3 Microcontroller, LPC17xx Port of Free RTOS, Resources Used by Free RTOS, Task Management, Task Functions, Task Priorities, Idle task and task hook function, Creation and Deletion of tasks.

Unit 4: Embedded System design with Free RTOS **[14]**

Queue Management, Characteristics of Queue, Working with Large Data, Interrupt Management, Queues within an Interrupt Service Routine, Critical Sections and Suspending the Scheduler, Resource Management, Memory Management.

References:

1. ARM Instructor Reference Material
2. SamSiewert,**"Real-Time Embedded SystemsAnd Components".**
3. Shibu K.V.**,"Introduction to Embedded System".**
4. "Using the Free RTOS Real-time Kernel" From Free RTOS.
5. Manuals and Technical Documents from the ARMInc, web site.

Real Time Operating System Lab

Course Objectives:

1. To Perform Multithreaded Programming in RTOS Platform.
2. To Acquire the Knowledge on working of Interrupts and Writing ISRs.

Course Outcomes:

The students will be able to

1. Program in C on FreeRTOS win32 and ARM Cortex-M3 Port.
2. Demonstrate Task Management.
3. Demonstrate Inter-Task Communication.

Laboratory Experiments:

1. Write a C Program to perform the task Management in FreeRTOS, using win32 port on Visual
   Studio IDE:
   a. Create Two Tasks and Pass the "*Task-Name*" as an argument to thetask function. b. Demonstrate the use of idle task hook function.
   c. Update the task priority dynamically.

2. Write a C Program to create a task in FreeRTOS, using win32 port on Visual Studio IDE; that periodically generates a software interrupt for every 1sec.

3. Write a C Program to Demonstrate Inter-Task Communication using Queues inFreeRTOS, use
 ARM Cortex-M3 Port (LPC1768 MCU Kit)
    a. Task-1 creates data (stores in a structure) and sends it to the queue
    b. Task-2 reads the message packet from the queue and reacts accordingly.

4. Write a C Program to Demonstrate Task Synchronization and Resource Sharing among multiple tasks in FreeRTOS, use ARM Cortex-M3 Port (LPC1768 MCU Kit)
    a. Assume multiple tasks trying to write data to a serial port.
    b. Use Mutex semaphore to gain exclusive access to serial port.

Course Code	Course Title	Duration		L	T	P	C
MT17VS213	Low Power VLSI Design	14 Weeks	SC	4	1	0	5

Prerequisites:
Concepts of low power VLSI design and scaling technologies involved, Knowledge on simulation programming with integrated circuits and probabilistic power analysis, Basics of design parameters of low power circuits and low power architecture, Knowledge on clock distribution and architectural level methodologies.

Course Objectives:
This course will enable students to:
1. understand different sources of power dissipation in CMOS & MIS structure.
2. explore the different types of low power adders and multipliers.
3. focus on synthesis of different level low power transforms.
4. Analyze the various energy recovery techniques used in low power design.

Course Outcomes:
Course Outcomes:
On completion of this course the student will be able to:
1. Analyse different source of power dissipation and the factors involved.
2. Understand the different techniques involved in low power adders and multipliers.
3. Understandings of the impact of various low powers transform
4. Identify and analyse the different techniques involved in low power design

Mapping of Course Outcomes with Program Outcomes:

Cour Se Code	POs/ COs	P O	PO 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	P O	P O	P O	PS O1	PS O2	PS O3
MT17 VS213		**1**									**10**	**11**	**12**			
	CO1	**3**	**3**							**3**	**3**	**2**				
	CO2	**3**	**2**	**3**						**3**	**3**	**3**		**3**		**3**
	CO3	**3**	**3**							**3**	**2**	**3**				
	CO4	**3**	**3**							**2**	**1**	**3**		**3**		

Course Contents:

Unit 1: Introduction **[14]**

Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches, Device & Technology Impact on Low Power: Dynamic dissipation in CMOS, Impact of technology Scaling, Technology.

Unit 2: Power estimation, Simulation Power analysis **[14]**

SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation.

Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy.

Unit 3: Synthesis for low power and Low power Clock distribution **[14]**

Logic level: Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic.

Low power Architecture & Systems: Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation,

Clock distribution: Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network.

Unit 4: Algorithm and Architectural Level Power Analysis and Optimization **[14]**

Algorithm & Architectural Level Methodologies: Introduction, design flow, Algorithmic level analysis & optimization, Architectural level estimation & synthesis.

Software design for Low power: Introduction, sources of software power dissipation, software power estimation, software power optimization- minimizing the memory access costs.

Text Books:

1. Kaushik Roy, Sharat Prasad, "**Low-Power CMOS VLSI Circuit Design**" Wiley, 2000.
2. Gary K. Yeap, "**Practical Low Power Digital VLSI Design**", KAP, 2002.
3. Rabaey, Pedram, "**Low Power Design Methodologies**" Kluwer Academic, 1997.

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Course Code	Course Title	Duration		L	T	P	C
MT17VS223	VLSI for Signal Processing	14 Weeks	SC	4	1	0	5

Prerequisites:

1. Concepts of DSP systems and its architecture.
2. Basic knowledge on FIR digital filters.
3. Concepts of retiming and systolic architecture.
4. Knowledge of recursive and adaptive filters.
5. Basics on algorithms used in fast convolution method.

Course Objectives:

1. To understand the basic concepts of DSP algorithms.
2. To analyze the various pipelining and parallel processing techniques.
3. To analyze the retiming and unfolding algorithms for various DSP applications.

Course Outcomes:

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

1. Apply DSP algorithms on to the IC technology
2. Analyze the concept of pipelining and other processing for DSP applications

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COs	PO 1	P02	PO 3	PO4	PO5	PO6	P7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	CO1	1		2			3							3	1	2
	CO2	1	3				3							2	1	3
	CO3	1		2			3							3	2	1

Course Contents:

Unit 1: Introduction to DSP systems **[14]**

Typical DSP Algorithms, DSP Application Demands and Scaled CMOS Technologies, Representations of DSP Algorithms.

Iteration Bounds:Data flow graph Representations, loop bound and Iteration bound, Algorithms for Computing Iteration Bound, Iteration Bound of multi rate data flow graphs.

Pipelining and parallel processing, pipelining of FIR Digital Filters, parallel processing, Pipelining and parallel processing for low power.

Unit 2: Retiming **[14]**

Definition and Properties, Solving Systems of Inequalities, Retiming Techniques, Unfolding an Algorithm for Unfolding, Properties of Unfolding, and Critical path, Unfolding and Retiming, Application of Unfolding.

Systolic architecture design: systolic array design Methodology, FIR systolic array, Selection of Scheduling Vector, Matrix-Matrix Multiplication and 2D systolic Array Design, Systolic Design for space representation containing Delays**.**

Unit 3: Fast convolution **[14]**

Cook-Toom Algorithm, Winograd Algorithm, Iterated convolution, cyclic Convolution Design of fast convolution Algorithmby Inspection.

Unit 4: Pipelined and Parallel recursive and adaptive filter **[14]**

Pipeline Interleaving in Digital Filter, first order IIR digital Filter, Higher order IIR digital Filter, parallel processing for IIR filter, Combined pipelining and parallel processing for IIR Filter, Low power IIR Filter Design Using

Pipe lining and parallel processing, pipelined Adaptive digital filter.

References:

1. KeshabK.Parthi, "**VLSI Digital Signal Processing systems, Design and Implementation**", Wiley, Inter Science, 1999.
2. Mohammed Isamail and Terri Fiez, "**Analog VLSI Signal and Information Processing**", Mc Graw-Hill, 1994.
3. S.Y. Kung, H.J. White House, T. Kailath, "**VLSI and Modern Signal Processing**", Prentice Hall, 1985.
4. Jose E. France, YannisTsividis, "**Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing**", Prentice Hall, 1994.

Course Code	Course Title	Duration		L	T	P	C
MT17VS214	High Speed VLSI Design	14 Weeks	SC	4	1	0	5

Prerequisites:

1. Knowledge on high speed digital design and its issues.
2. Concept of noise and power supply network.
3. Principles of synchronization and timing convention.
4. Basic knowledge on clocked and no clocked logics and latching strategies.

Course Objectives:

1. Introduce the concept of high speed digital circuits.
2. Understand the power distribution and noise sources in VLSI circuits.
3. Understand the importance of timing analysis in high speed VLSI circuits.
4. Introduce the concept of latch and clock driven logic circuits for high speed VLSI circuits.

Course Outcomes:

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

1. Identify and analyse the sources of noise in VLSI circuits.
2. Describe the Signalling modes for transmission lines in VLSI circuits
3. Perform the timing analysis for VLSI Circuits
4. Design the clocked and non-clocked logic circuit
5. Design various latch based digital circuits.

Mapping of Course Outcomes with Program Outcomes:

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT17 VS214	CO1	3	3							3	3	2				
	CO2	3	2	3						3	3	3		3		3
	CO3	3	3							3	2	3				
	CO4	3	3							2	1	3		3		
	CO5	3	3							2	1	3		3		

Course Contents:

Unit 1: Introductionto High Speed Digital Design [14]

Frequency, time and distance issues in digital VLSI design. Capacitance and inductance effects, high speed properties of logic gates, speed and power.Modeling of wires, geometry and electrical properties of wires, Electrical models of wires, transmission lines, lossless LC transmission lines, lossy RLC transmission lines and special transmission lines.

Unit 2:Power distribution and Noise [14]

Power supply network, local power regulation, IR drops, area bonding. On-chip bypass capacitors and symbiotic bypass capacitors. Power supply isolation. Noise sources in digital systems, power supply noise, crosstalk and inter symbol interference.

Signaling convention and circuits: Signaling modes for transmission lines, signaling over lumped transmission media, signaling over RC interconnect, driving lossy LC lines, simultaneous bi-directional signaling terminations, transmitter and receiver circuits.

Unit 3: Timing Convention and Synchronization [14]

Timing fundamentals, timing properties of clocked storage elements, signals and events, open loop timing, level sensitive clocking, pipeline timing, closed loop timing, clock distribution, synchronization failure and meta-stability, clock distribution, clock skew and methods to reduce clock skew, controlling crosstalk in clock lines, delay adjustments, clock oscillators and clock jitter - PLL and DLL based clock aligners.

Unit 4: Clocked& Non-Clocked Logics **[14]**

Single-Rail Domino Logic, Dual-Rail Domino Structures, Latched Domino Structures, Clocked Pass GateLogic, Static CMOS, DCVS Logic, Non-Clocked Pass Gate Families.

Latching Strategies:Basic Latch Design, and Latching single-ended logic and Differential Logic, Race Free Latches for Pre-charged Logic Asynchronous Latch Techniques.

References:

1. William S. Dally & John W. Poulton, "**Digital Systems Engineering**", *Cambridge University Press*, 1998.
2. Kerry Bernstein &ET. Al., "**High Speed CMOS Design Styles**", Kluwer, 1999.
3. Howard Johnson & Martin Graham, "**High Speed Digital Design**" A Handbook of Black Magic, *Prentice Hall PTR*, 1993.
4. Masakazu Shoji, "**High Speed Digital Circuits**", *Addison Wesley Publishing Company*, 1996.
5. Jan M, Rabaey, et al, "**Digital Integrated Circuits**", A Design Perspective, *Pearson*, 2003.

Course Code	Course Title	Duration		L	T	P	C
MT17VS224	ASIC Design and Verification using System Verilog	14 Weeks	SC	4	1	0	5

Prerequisites:

1. Fundaments knowledge of Digital System Design with Verilog HDL
2. Data Structures & Algorithm in C++

Course Objectives:

1. To study the basic concepts of system verilog.
2. Study the different kinds of data types
3. Differentiate between HDL and HVL
4. Study the basic concepts of OOPs

Course Outcomes:

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

1. Model a scenario for Verification of a DUT in System Verilog
2. Analyze the usefulness of a driver, monitor, checker, test cases in a verification environment

3. Understand different kinds of datatypes and can distinguish difference between an HDL and HVL
4. Design test bench to verify the functionality of a design
5. Understand the concept of randomization and its importance in verification coverage in a bigger design
6. Able to design a VIP for an IP as a project

Mapping of Course Outcomes with Program Outcomes:

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
MT17VS224	CO1	3	2	2	3	3	3		3	2	2	1	3	3	3
	CO2	3	2	2	3	3	3		3	2	2	1	3	3	3
	CO3	3	3	2	3	3	3		3	2	2	1	3	3	3
	CO4	3	2	2	2	2	3		3	2	2	1	2	2	2
	CO5	3	2	2	3	3	3		3	2	2	1	3	3	3
	CO6	3	2	2	3	3	3		3	2	2	1	3	3	3

Course Contents:

Unit 1: Verification Guidelines and Data Types [14]

Introduction, The Verification Process, The Verification Plan, The Verification Methodology, Manual, Basic Testbench Functionality, Directed Testing, Methodology Basics, Constrained-Random Stimulus, Functional Coverage, Testbench Components, Layered Testbench, Building a Layered Testbench, Simulation Environment Phases, Maximum Code Reuse, Testbench Performance. Introduction to data types, Built-in Data Types, Fixed-Size Arrays, Dynamic Arrays, Queues, Associative Arrays, Linked Lists, Array Methods, Choosing a Storage Type, Creating New Types with typedef, Creating User-Defined Structures, Enumerated Types, Constants, Strings, Expression Width, Net Types.

Unit 2: Procedural Statements and Routines [14]

Introduction, Procedural Statements, Tasks, Functions, and Void Functions, Task and Function Overview, Routine Arguments, Returning from a Routine, Local Data Storage, Time Values.

Unit 3: Basic OOPs [14]

Introduction, Think of Nouns, not Verbs, Your First Class, Where to Define a Class, OOP Terminology, Creating New Objects, Object Deallocation, Using Objects, Static Variables vs. Global Variables, Class Routines, Defining Routines Outside of the Class, Scoping Rules, Using One Class Inside Another, Understanding Dynamic Objects, Copying Objects, Public vs. Private Straying Off Course, Building a Testbench.

Unit 4:Connecting the Testbench and Design [14]

Introduction, Separating the Testbench and Design, The Interface Construct, Stimulus Timing,

Interface Driving and Sampling, Connecting It All Together, Top-Level Scope, Program – Module Interactions, SystemVerilog Assertions, The Four-Port ATM Router.
Current Trends in Testing and Verification: Advanced verification methodologies, e.g., UVM and OVM at basic levels. Cadence-IUS / Mentor-QuestaSim EDA Development Environment.

References:

1. SystemVerilog for Verification: A Guide to Learning the Testbench Language Features, Chris Spear, Publisher:Springer-Verlag New York, Inc. Secaucus, NJ, USA, 2006
2. Donald Thomas, **“Logic Design and Verification Using SystemVerilog**”, CreateSpace Independent Publishing Platform, 2014.
3. Language Reference Manual for SystemVerilog.

Course Code	Course Title	Duration		L	T	P	C
MT17VS215	MEMS	14 Weeks	SC	4	1	0	5

Prerequisites

Engineering Physics, Upper Division standing in Engineering, Chemistry or Chemical Engineering and Material Science, VLSI Technology, Elements of Mechanical Engineering.

Course Objectives:

This course will enable students to:

1. Introduce the basic three pillars of MEMS design, fabrication and materials.
2. To introduce different materials used for MEMS.
3. To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices
4. Highlight the various electrical and mechanical concepts with regards to MEMS arena.
5. Demonstrate the various fabrication and micro machining techniques.
6. Recognize the basic operation principles Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography, Plasma properties.
7. Understand Etch mechanism, reactive Plasma Etching techniques and Equipment.
8. To introduce various sensors and actuators.

Course Outcomes:

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

1. Differentiate between micro systems, MEMS and NEMS
2. Assess the various electro-mechanical properties of materials used for MEMS design
3. Describe the various steps involved in the MEMS fabrication
4. Analyze the chemical and physical vapor processes; heteroepitaxy and defects; substrates and substrate engineering

5. Convey knowledge of advanced concepts of lithography and etching
6. Explore electrostatic, thermal, piezoelectric and magnetic actuators at micro scale

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P 7	PO8	PO9	P O 10	P O 11	P O 12	PSO 1	PSO 2	PSO 3
	CO 1	1		2		3		3					4	1		2
	CO 2	1			2	3		4		3				1		2
	CO 3	1	1	2		3	4	2						1		2
	CO 4	1		3			2					3	4	1		2
MT17VS215	CO5	1		3			2					3	4	1		2
	CO6	1		3			2					3	4	1		2

Course Contents:

Unit 1: Introduction to MEMS **[14]**

Overview of MEMS and Microsystems: What are MEMS, Why Miniaturization, Why microfabrication, Microsystems versus MEMS, Smart Materials, Structures and Systems, Integrated Microsystems, Typical MEMS and Microsystem Products, The Multidisciplinary nature of Microsystem design and manufacture, Applications of smart Materials and Micro Systems, Applications of Aerospace, Biomedical and Automotive industry.

Materials for MEMS: Silicon compatible material System-Silicon, Czochralski Crystal Growing, Silicon oxide and Nitride, Thin metal Films, Polymers, Other material and substrates.

Unit 2: Microsystems Fabrication Process: **[14]**

Epitaxy: Introduction, Vapor-Phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Epitaxial Evaluation.

Lithography: Introduction, Optical Lithography, Electron Lithography, X-ray Lithography, Ion Lithography. Photolithography, Ion-implantation, diffusion, oxidation, CVD, PVD, etching and materials used for MEMS, Some MEMS fabrication processes: surface micro-machining, bulk micromachining, LIGA process.

Unit 3: Microsystems Design and Packaging **[14]**

Assembly, Packaging, and Testing (APT) of Microsystems, Microsystem Packaging, overview of Mechanical Packaging of Microelectronics, interfaces in Microsystem Packaging, Essential Packaging Technologies, Three Dimensional Packaging, Assembly of Microsystems, Selection of Packaging Materials.

Unit 4: Micro Sensors, Actuators, Systems and Smart Materials **[14]**

Case studies – silicon capacitive accelerometer, piezo-resistive pressure sensor, blood analyzer, conduct metric gas sensor, silicon micro-mirror arrays, piezo-electric based inkjet print head, electrostatic comb-drive and magnetic micro relay, portable clinical analyzer, active noise control in a helicopter cabin.

VLSI Process Integration: Introduction, Fundamental Considerations for IC Processing, NMOS IC technology, CMOS IC Technology, MOS Memory IC Technology, Bipolar IC Technology, IC Fabrication.

Text Books:

1. G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre, "**Micro and Smart Systems**", *Wiley India, 2010.*
2. Chang Liu, "**Foundation of MEMS**" *Pearson Education International, 2006.*
3. Tai Ran Hsu, "**MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering**, *Wiley, 2008*.

Reference Books:

1. S. M. Sze, **"VLSI Technology",** *McGraw-Hill, Second Edition.*
2. Nadim Maluf, Kirt Williams "**An Introduction to Microelectromechanical Systems Engineering"** Second addition.

Course Code	Course Title	Duration		L	T	P	C
MT17VS225	Advanced Computer Architecture	14 Weeks	SC	4	1	0	5

Prerequisites:

1. Concepts of computer design, pipelining and instruction level parallelism.
2. Knowledge on design of memory hierarchy and real faults in a system.
3. Basic knowledge on very long instruction word and EPIC.
4. Concepts of multiprocessors and interprocessor communication.
5. Concepts of computer arithmetic.

Course Objectives:

1. Introduce the fundamentals of computer design.
2. Understand the quantitative principles of computer design and their performance.
3. Understanding the concepts of instruction level parallelism.
4. Introduce the fundamentals of advanced memoryhierarchy.
5. Introduce the basics of VLIW processors.
6. Understand the concepts of multiprocessors and inter process communication.
7. Study of computer arithmetic blocks.

Course Outcomes:

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

1. Analyse the importance of power and performance for given computer architecture.
2. Identifying the pitfalls and fallacies for the performance in the computer architecture.
3. Describe the instruction level parallelism and its importance with respect to performance and power dissipation in computer architecture
4. Calculate the performance of I/O devices
5. Designing the efficient hardware and software for the VLIW processors.
6. Designing the efficient arithmetic components for computer architecture.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO1	P 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
MT17VS 225	**CO1**	**3**		**1**				**3**					**3**	**3**	**2**	**2**
	CO2	**2**		**2**				**3**					**3**	**3**	**2**	**1**
	CO3	**2**		**2**				**3**					**3**	**3**	**2**	**2**
	CO4			**3**				**3**					**3**			**2**
	CO5	**2**		**2**				**3**					**3**	**3**	**2**	**2**
	CO6	**2**		**2**				**3**					**3**	**3**	**2**	**2**

Course Contents:

Unit 1: Introduction and Review of Fundamentals of Computer Design [14]

Introduction; Classes computers, Defining computer architecture, Trends in Technology, Trends in power in Integrated Circuits, Trends in cost, Dependability, Measuring, reporting and summarizing Performance, Quantitative Principles of computer design, Performance and Price-Performance; Fallacies and pitfalls; Case studies.

Some topics in Pipelining, Instruction –Level Parallelism, Its Exploitation and Limits on ILP:Introduction to pipelining, ILP; Crosscutting issues, fallacies, and pitfalls with respect to pipelining, Basic concepts and challenges of ILP, Case study of Pentium 4, Fallacies and pitfalls.

Introduction to limits in ILP, Performance and efficiency in advanced multiple-issue processors.

Unit 2: Memory Hierarchy Design, Storage Systems [14]

Review of basic concepts, Cross cutting issues in the design of memory hierarchies, Case study of AMD Opteron memory hierarchy, Fallacies and pitfalls in the design of memory hierarchies, Introduction to Storage Systems, Advanced topics in disk storage.

Definition and examples of real faults and failures: I/O performance, reliability measures, and benchmarks; Queuing theory; Crosscutting Issues, Designing and evaluating an I/O system – The Internet archive cluster; Case study of NetAA FAS6000 filer; Fallacies and pitfalls.

Unit 3: Hardware and Software for VLIW and EPIC Introduction [14]

Exploiting Instruction-Level Parallelism Statically, Detecting and Enhancing Loop-Level Parallelism, Scheduling and Structuring Code for Parallelism, Hardware Support for Exposing Parallelism: Predicated Instructions, Hardware Support for Compiler Speculation, The Intel IA-64

Architecture and Itanium Processor, Concluding Remarks.

Unit 4:Large-Scale Multiprocessors and Scientific Applications Introduction, Interprocessor Communication [14]

The Critical Performance Issue, Characteristics of Scientific Applications, Synchronization: Scaling Up, Performance of Scientific Applications on Shared-Memory Multiprocessors, Performance Measurement of Parallel Processors with Scientific Applications, Implementing Cache Coherence, the Custom Cluster Approach: Blue Gene/L, Concluding Remarks. Computer Arithmetic:Introduction, Basic Techniques of Integer Arithmetic, Floating Point, Floating-Point Multiplication, Floating-Point Addition, Division and Remainder, More on Floating-Point Arithmetic, Speeding Up Integer Addition, Speeding Up Integer Multiplication and Division, Fallacies and Pitfalls.

References:

1. Hennessey and Patterson, "**Computer Architecture A Quantitative Approach**", 4th Edition, Elsevier, 2007.
2. Kai Hwang, "**Advanced Computer Architecture - Parallelism, Scalability, Programmability**", 2nd Edition, 1992.

Semester – III:

Course Code	Course Title	Duration		L	T	P	C
MT17VS313	MSP430	14 Weeks	SC	4	0	1	5

Prerequisites:

1. Knowledge on basics of MSP430 architecture.
2. Concepts of Interrupts and Interfacing techniques in MSP430.
3. Basic knowledge of I^2C and serial communication.
4. Practical knowledge on MSP430 programming.

Course Objectives:

1. Study the introduction to the TI MSP430 family of microcontrollers, their architecture, peripheral features and programming.
2. Understand and Provide theoretical and practical aspects of low-power system development using the MSP430.
3. Know the peripheral features of the MSP430, which include timers, digital and analog IO and serial communication modules.
4. Understand and Present case studies of application of the MSP430 so that the student can handle embedded system design projects independently.
5. Know the applications of the MSP430 in embedded systems

Course Outcomes:

On completion of this course the students will be able to:

1. Design, develop, and evaluate software or a software/hardware system, component, or process to meet desired needs within realistic constraints.
2. Demonstrate and function on multi-disciplinary teams working in mechatronics and low power embedded systems.
3. Design, identify, formulate, and solve engineering problems
4. Analyse the need for, and an ability to engage in life-long learning and continuing professional development
5. Analyse a problem, and identify and define the computing requirements appropriate to its solution.
6. Design and develop principles in the construction of software systems of varying complexity.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO1	P 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
MT17VS 313	CO1	3	1	1	1			3					3	3	2	2
	CO2	2	1	2	1			3					3	3	2	1
	CO3	2	1	2				3					3	3	2	2
	CO4			3				3					3			2

	CO5	**2**	**1**	**2**				**3**					**3**	**3**	**2**	**2**
	CO6	**2**	**1**	**2**				**3**					**3**	**3**	**2**	**2**

Course Contents:

Unit 1:MSP430 Architecture and Programming **[14]**

Architecture of the MSP430, addressing modes, instruction set, development environment, MSP430 programming in C and assembly language.

Unit 2: Interrupts and Digital IO in the MSP430 **[14]**

Interrupts, interrupt service routines, low-power modes of operation, parallel ports, digital inputs, and outputs, driving heavier loads, liquid crystal displays, driving an LCD from an MSP430x4xx.

Unit 3: Timers and Analog IO in the MSP430 **[14]**

Watchdog timer, basic timer1, timer A, measurement in the capture mode, pulse-width modulation, modes of timer A and timer_B, comparator A, basic operation of the ADC10 and ADC12, the SD16_a sigma–delta ADC.

Unit 4:Communication Peripherals the MSP430 **[14]**

SPI and I²C features in MSP430, asynchronous serial communication, case studies of the applications of the MSP430 in embedded systems.

References:

1. John Davies, "**MSP430 Microcontroller Basics**", Newnes (Elsevier Science), 2008.
2. C P Ravikumar, "**MSP430 Microcontroller in Embedded System Project**," Elite Publishing House Pvt. Ltd., December 2011.
3. **MSP430 Teaching CD-ROM**, Texas Instruments, 2008.
4. Sample Programs for MSP430 downloadable from *www.msp430.com.*

Course Code	Course Title	Duration		L	T	P	C
MT17VS323	FPGA Based Embedded System Design	14 Weeks	SC	4	1	0	5

Prerequisites:

Concepts of digital system design and behavior modelling of a system, Basics of Verilog and VHDL, Knowledge of sequential and combinational circuits.

Course Objectives:

This course will enable students to:

1. Know FPGA architecture, interconnect and technologies.
2. Analyze the FPGA architecture and design implementation methodologies.
3. Explore the configuration, implementation and testing of embedded system on FPGA.

Course Outcomes:

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

1. Design the reconfigurable digital systems.
2. Demonstrate and Debug the embedded systems before the actual product is developed.
3. Design finite state machines for various applications.
4. Implement, Design and develop embedded system using FPGA and EDA tools.

Mapping of Course Outcomes with Programme Outcomes

Course Code	**POS/ COs**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
	CO1	**3**	**3**	**3**		**2**				**2**	**3**		**3**	**2**	**3**	**2**
	CO2	**3**	**3**	**3**		**2**				**2**	**3**		**3**	**2**	**3**	**2**
	CO3	**3**	**3**	**3**		**2**				**2**	**3**		**3**	**2**	**3**	**2**
	CO4	**3**	**3**	**3**		**2**				**2**	**3**		**3**	**2**	**3**	**2**

Course Contents:

Unit 1: Introduction **[14]**

Embedded System Overview, Hypothetical Robot Control System, Digital Design Platforms, Use of Pre-designed HDL Codes, Simulating Digital Logic Using Verilog

Unit 2: FPGA and CPLD **[14]**

Architecture of a FPGA, FPGA Interconnect Technology, Logic Cell, FPGA Memory, Clock Distribution and Scaling, Standards, Multipliers, Floor Plan and Routing, Timing Model for a FPGA, FPGA Power Usage

Unit 3: FPGA-based Embedded Processor **[14]**

Hardware–Software Task Partitioning, FPGA Fabric Immersed Processors, Soft Processors, Hard Processors, Tool Flow for Hardware–Software Co-design, Interfacing Memory to the Processor, Interfacing Processor with Peripherals, Types of On-chip Interfaces, Wishbone Interface, Avalon Switch Matrix, OPB Bus Interface, Design Re-use Using On-chip Bus Interface, Creating a Customized Microcontroller, Robot Axis Position Control

Unit 4: FPGA-based Signal Interfacing and Conditioning **[14]**

Serial Data Communication, Physical Layer for Serial Communication, RS-232-based Point-to-Point Communication, RS-485-based Multi-point Communication, Serial Peripheral Interface (SPI), Signal Conditioning with FPGAs, Prototyping Using FPGAs, Test Environment for the Robot Controller

Text Books:

1. Rahul Dubey, "**Introduction to Embedded System Design Using Field Programmable Gate Arrays**", Springer, 2008
2. Peter Ashenden, "**Digital Design using VHDL**", Elsevier, 2007.

3. Peter Ashenden, “**Digital Design using Verilog**”, Elsevier, 2007.

Reference Books:

1. M.J.S. Smith, “**Application Specific Integrated Circuits**”, Pearson, 2000.
2. W.Wolf, “**FPGA based system design**”, Pearson, 2004.
3. Clive Maxfield, “**The Design Warriors’s Guide to FPGAs**”, Elsevier, 2004.

Course Code	Course Title	Duration		L	T	P	C
MT17VS333	Synthesis and Optimization of Digital Circuits	14 Weeks	SC	4	1	0	5

Prerequisites:

Basics of microelectronics, semiconductor technologies.

1. Concepts of system modelling and different optimizations of combinational logic circuit.
2. Knowledge on transformations, synthesis and delay calculation for combinationalcircuit.
3. Basics of scheduling algorithm.

Course Objectives:

1. To understand different methods used for the simplification of Boolean functions.
2. To understand and implement combinational, synchronous, and asynchronous sequential circuits.
3. To be acquainted with the MOS devices, system level design.
4. To outline the formal procedures for the analysis and design of combinational circuits and sequential circuits using computer aided synthesis.
5. To provide hands on experience to the concepts taught in class.

Course Outcomes:

On completion of this course the students will be able to:

1. Design combinational and sequential circuits
2. Differentiate between Mealy and Moore model state machines, and draw a block diagram of each.
3. Describe the operation of basic logic gates (NOT, NAND, NOR) constructed using N- and P-channel MOSFETs and draw their circuit diagrams.
4. Define logic gate fan-in and describe the basis for its practical limit.
5. Calculate the DC noise immunity margin of a logic circuit and describe the consequence of an insufficient margin.
6. Design and demonstrate some basic projects based on sequential design.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT17VS333	**CO1**	**3**	**3**	**3**		**2**				**2**	**3**		**3**	**2**	**3**	**2**
	CO2	**3**	**3**			**2**				**2**	**3**		**3**	**2**	**3**	**2**
	CO3	**3**	**3**	**3**		**2**				**2**	**3**		**3**	**2**	**3**	**2**
	CO4	**3**	**3**	**3**		**2**				**2**	**3**		**3**	**2**	**3**	**2**
	CO5	**3**	**3**	**3**		**2**				**2**	**3**		**3**	**2**	**3**	**2**
	CO6	**3**	**3**	**3**		**2**				**2**	**3**		**3**	**2**	**3**	**2**

Course Contents

Unit 1: Introduction **[14]**

Microelectronics, semiconductor technologies and circuit taxonomy, Microelectronic design styles, computer aided synthesis and optimization.

Graphs: Notation, undirected graphs, directed graphs, combinatorial optimization, Algorithms, tractable and intractable problems, algorithms for linear and integer programs, graph optimization problems and algorithms, Boolean algebra and Applications.

Unit 2: Hardware Modeling **[14]**

Hardware Modeling Languages, distinctive features, structural hardware language, Behavioral hardware language, HDLs used in synthesis, abstract models, structures logic networks, state diagrams, data flow and sequencing graphs, compilation and optimization techniques.

Two Level Combinational Logic Optimization: Logic optimization, principles, operation on two level logic covers, algorithms for logic minimization, symbolic minimization and encoding property, minimization of Boolean relations.

Unit 3: Multiple Level Combinational Optimizations **[14]**

Models and transformations for combinational networks, algebraic model, Synthesis of testable network, algorithm for delay evaluation and optimization, rule based system for logic optimization.

Sequential Circuit Optimization: Sequential circuit optimization using state based models, sequential circuit optimization using network models.

Unit 4: Schedule Algorithms **[14]**

A model for scheduling problems, Scheduling with resource and without resource constraints, Scheduling algorithms for extended sequencing models, Scheduling Pipe lined circuits.

Cell Library Binding: Problem formulation and analysis, algorithms for library binding, specific problems and algorithms for library binding (lookup table F.P.G.As and Antifuse based F.P.G.As), rule based library binding.

References:

1. Giovanni De Micheli, "**Synthesis and Optimization of Digital Circuits**", Tata McGraw-Hill, 2003.
2. ZviKohavi, "**Switching and Finite Automata Theory**", Tata McGraw Hill, thirdedition,

2000.
3. Alan B.Marcovitz, “**Intro. To Logic Design**”, TMH, second edition, 2002.
4. Srinivas Devadas, Abhijit Ghosh, and Kurt Keutzer, “**Logic Synthesis**”, McGraw-Hill, USA, 1994.
5. Neil H.E. Weste and David money harris, “C**MOS VLSI Design: A circuits and system Perspective**”,fourth edition, Pearson Education (Asia) Pvt. Ltd., 2000.
6. Kevin Skahill, “**VHDL for Programmable Logic**”, Pearson Education (Asia) Pvt. Ltd., 2000.

Course Code	Course Title	Duration		L	T	P	C
MT17VS343	CMOS RF Circuit Design	14 Weeks	SC	4	1	0	5

Prerequisites:
1. Concepts of RF design and wireless technology.
2. Basic knowledge on RF modulation techniques.
3. Knowledge on behaviour and characteristics of BJT and MOSFET.

Course Objectives:
1. Understanding of the design and analysis of radio frequency integrated circuits and systems (RFICs) for communication.
2. Integrated Electronic Circuit Design which covers transistor-level design.

Course Outcomes:
On completion of this course the student will be able to:
1. Describe and understand the general challenges in the design of CMOS RF circuits.
2. Design matching circuits using passive RLC components.
3. Use various techniques to design high-frequency amplifiers.
4. Design and analyze oscillators.
5. Understand fundamentals of phase noise in oscillators.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
MT17VS343	**CO1**	**3**	**3**	**3**	**3**								**2**	**3**	**3**
	CO2	**3**	**2**	**2**	**3**								**2**	**3**	**3**
	CO3	**4**	**2**	**3**	**2**	**4**							**2**	**3**	**3**
	CO4	**3**	**3**	**3**	**3**	**2**		**2**					**3**	**3**	**3**
	CO5	**3**	**3**	**3**	**3**	**2**		**2**					**3**	**3**	**3**

Course Contents:

Unit 1: Introduction to RF Design and Wireless Technology **[14]**

Design and Applications, Complexity and Choice of Technology**.**
Basic concepts in RF design:Nonlinearly and Time Variance, Intersymbol interference, random processes and noise. Sensitivity and dynamic range, conversion of gains and distortion**.**

Unit 2: RF Modulation [14]

Analog and digital modulation of RF circuits, Comparison of various techniques for power efficiency, Coherent and non-coherent detection, Mobile RF communication and basics of Multiple Access techniques. Receiver and Transmitter architectures, direct conversion and two-step transmitters.

Unit 3: BJT and MOSFET Behavior at RF Frequencies [14]

BJT and MOSFET behavior at RF frequencies, modeling of the transistors and SPICE model, Noise performance and limitations of devices, integrated parasitic elements at high frequencies and their monolithic implementation.

Unit 4: RF Circuits Design [14]

Overview of RF Filter design, Active RF components & modeling, Matching and Biasing Networks. Basic blocks in RF systems and their VLSI implementation, Low noise Amplifier design in various technologies, Design of Mixers at GHz frequency range,various mixers- working and implementation. Oscillators- Basic topologies VCO and definition of phase noise, Noise power and trade off. Resonator VCO designs, Quadrature and single sideband generators. Radio frequency Synthesizers- PLLS, Various RF synthesizer architectures
And frequency dividers, Power Amplifier design, Liberalization techniques, Design issues in integrated RF filters.

References:

1. B. Razavi, “**RF Microelectronics**” PHI 1998.
2. R. Jacob Baker, H.W. Li, D.E. Boyce “**CMOS Circuit Design, layout and Simulation**”, PHI 1998.
3. Thomas H. Lee “**Design of CMOS RF Integrated Circuits**” Cambridge University press 1998.
4. Y.P. Tsividis, “**Mixed Analog and Digital Devices and Technology**”, TMH 1996.

Course Code	Course Title	Duration		L	T	P	C
MT17VS314	Advances in VLSI Design	14 Weeks	SC	4	1	0	5

Prerequisites:

1. Concepts of MOS and CMOS circuits.
2. Knowledge on BICMOS, steering logic and buffers.
3. Differences between MOS and CMOS.
4. Concepts of various design methods in CMOS.

Course Objectives:

1. To understand the basics and operation of static, comparison between CMOS and BiCMOS.
2. To understand short channel effects.
3. To understand the challenges to CMOS.
4. To understand the super buffers, layouts and technology mapping.

Course Outcomes

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

1. Learn advanced technologies in the fields of VLSI design with the fundamental concepts.
2. Apply advanced technical knowledge in multiple contexts.
3. Understand and design advanced VLSI based system and analyse and interpret results.
4. Use the techniques, skills, modern Electronic Design

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	P O 10	P O 1 1	P O 1 2	PSO 1	PSO 2	PSO 3
MT17VS314	CO1	1		2			3							3	1	2
	CO2		1	2			3							2	1	3
	CO3				2	1	3							3	2	1
	CO4		2	1	3											

Course Contents:

Unit 1: Review of MOS Circuits **[14]**

MOS and CMOS static plots, switches, comparison between CMOS and BI - CMOS.

Short Channel Effects and Challenges to CMOS: Short channel effects, scaling theory, processing challenges to further CMOS Miniaturization.

Unit 2: Beyond CMOS **[14]**

Evolutionary advances beyond CMOS, carbon Nanotubes, conventional vs. tactile computing, computing, molecular and biological computing - molecular Diode and diode- diode logic. Defect tolerant computing.

Super Buffers, Bi-CMOS and Steering Logic: Introduction, RC delay lines, super buffers- An NMOS super buffer, tri state super buffer and pad drivers, CMOS super buffers, Dynamic ratio less inverters, large capacitive loads, pass logic, designing of transistor logic, General functional blocks - NMOS and CMOS functional blocks.

Unit 3: Special Circuit Layouts and Technology Mapping **[14]**

Introduction, Talley circuits, NAND-NAND, NOR- NOR, and AOI Logic, NMOS, CMOS Multiplexers, Barrel shifter, Wire routing and module layout.

Unit 4: System Design **[14]**

CMOS design methods, structured design methods, Strategies encompassing hierarchy, regularity, modularity & locality, CMOS Chip design Options, programmable logic, Programmable inter connect, programmable structure, Gate arrays standard cell approach,
Full custom design.

References:

1. Kevin F Brennan "**Introduction to Semi-Conductor Device**", Cambridge publications, 2006.
2. Eugene D Fabricius "**Introduction to VLSI Design**", McGraw-Hill International publications, 1990.
3. D.APucknell. "**Basic VLSI Design**", PHI Publication, 2005.
4. Wayne Wolf, "**Modern VLSI Design**" Pearson Education, Second Edition, 2002.

Course Code	Course Title	Duration		L	T	P	C
MT17VS314	AUTOMOTIVE ELECTRONICS SYSTEM	14 Weeks	OE	3	1	0	4

Course Objectives:

1. Understand the functions of electronic systems in modern automobiles, modern electronics technology to improve the performance, safety, comfort and related issues
2. Study the principles of automotive sensors and interfacing techniques, design, model and simulate interfacing systems with sensors
3. Know the principles and functionalities of various Automotive Communication Protocols (ACPs), Design ACP based In-Vehicle Networks(IVNs), selection of ACPs for various application in Automotive
4. Know the industry standard practices for ECU design for automotive, modeling and analysis of application software for ECU design and development, design of ECUs for automobiles, design of HIL and fault diagnostics

Course Outcomes:

1. Implement and Interface sensors and for various automotive applications
2. Design and diagnose the faults in the systems Implement automotive fault diagnostics and faults
3. Analyze on and off board diagnostics, diagnostics protocol.

Mapping of Course Outcomes with Program Outcomes4.

Course Code	POs / COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MT17VS314	CO1	2	1					2				3	1		2
	CO2	1	2	1		3			3				1		2
	CO3	1		1			2				3		1		2

Course Contents:

Unit 1: Automotive Industry and Modern Automotive Systems [14]

Vehicle classifications and specifications, need for electronics in automobiles, Automotive Fundamentals Overview – Four Stroke Cycle, Engine Control, Spark and Compression Ignition Engines, Ignition systems, Spark plug, Spark pulse generation, Ignition Timing. Transmission Control - Automotive transmissions, Drive Train, Brakes, Steering System - Steering Control, Starting System- Battery, Air/Fuel Systems, Fuel Handling, Air Intake System, Lighting.

Unit 2: Introduction to Automotive Sensors and Instrumentation [14]

Sensors and actuators, Air/ Fuel Management Sensors – Oxygen (O2/EGO) Sensors, Throttle Position Sensor (TPS), Engine Crankshaft Angular Position (CKP) Sensor, Magnetic Reluctance Position Sensor, Engine Speed Sensor, Ignition Timing Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Manifold Absolute Pressure (MAP) Sensor - Strain gauge and Capacitor capsule, Engine Coolant Temperature (ECT) Sensor, Intake Air Temperature (IAT) Sensor, Knock Sensor, Airflow rate sensor, Throttle angle sensor Sensors in Engine control, adaptive cruise control, braking control, traction control, steering, stability, Lighting, wipers, climate control, Sensors for occupant safety, Sensor and actuator interfacing techniques and electronic displays. Actuators – Fuel Metering Actuator, Fuel Injector, Ignition Actuator

Unit 3: Control Systems [14]

Exhaust After-Treatment Systems – AIR, Catalytic Converter, Exhaust Gas Recirculation (EGR), Evaporative Emission Systems Electronic Engine Control – Engine parameters, variables, Engine Performance terms, Electronic Fuel Control System, Electronic Ignition control, Idle sped control, EGR Control Communication – Serial Data, Communication Systems, Power windows, Remote keyless entry systems, GPS,Automotive Communication Protocols Protection, Body and Chassis Electrical Systems, Remote Keyless Entry, Vehicle Motion Control – Cruise Control, Chassis, , Power Brakes, antilock braking systems, Electronic stability and other technologies, Traction Control, Electronic Stability Control, Electronically controlled suspension Fundamentals of electronically controlled steering system, Power Steering,

Unit 4: Safety and Convenience [14]

Electronics for Passenger Safety and Convenience – SIR, Air bag and seat belt pretension systems, Tire pressure monitoring systems, Automotive Instrumentation – Sampling, Measurement & Signal Conversion of various parameters Integrated Body – Climate Control Systems, Electronic HVAC Systems, Lighting, Entertainment Systems Automotive Diagnostics – Timing Light, Engine

Analyzer, Process of Automotive Fault Diagnostics, Fault Codes, On-board diagnostics, Off-board diagnostics, Expert Systems. Future Automotive Electronic Systems – Alternative Fuel Engines, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Radio navigation, Advance Driver Information System, AFS.

Reference Books:

1. Denton. Burlington "**Automotive Electrical and Electronic Systems**", MA 01803, Elsevier Butterworth-Heinemann, 2004.
2. Ronald K. Jurgen. "**Automotive Electronics Handbook**", 2nd Edition, McGraw-Hill, 2007
3. Christian Kohler, "**Enhancing Embedded Systems Simulation**" Vieweg+TeubnerVerlag/ Springer, 2011.
4. Gabriela Nicolescu and Pieter J. Mosterman, "**Model-Based Design for Embedded Systems**", CRC Press, 2010
5. Gilbert Held, "**Inter- and Intra-Vehicle Communications**", CRC Press, 2007.
6. William B. Ribbens, "**Understanding Automotive Electronics**", 5th Edition, Newnes, 2006
7. Bosch, "**Automotive Electrics & Electronics**", Robert Bosch GmbH, 3rd Edition, 1999.

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 Electronics and Communication 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 Electronics and Communication 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), Xilinx, NS-2, Cadence, ANSYS, Advanced C C++ 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.

SCHOOL OF APPLIED SCIENCES

M Sc. in Mathematics Program

HAND BOOK
2017-19

Rukmini Knowledge Park,

Kattigenahalli, Yelahanka, Bangalore-560064

Phone No: +91-080-66226622, Fax: 080-28478539

Rukmini Educational
Charitable Trust

www.reva.edu.in

Chancellor’s Message

“Education is the most powerful weapon which you can use to change the world.”

- Nelson Mandela.

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

It is deemed virtuous to serve seekers of knowledge 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 ahuge 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

Director's Message

The M.Sc. Mathematics programme aims to build strong foundations in core areas of higher mathematics in both the pure and applied areas. It is meant for students who would typically take up careers involving mathematical research or mathematical skills – in academia or in industry. The training imparted to the students helps them master the art of problem solving, developing logical reasoning and computational capabilities which are essential traits in all walks of life. Additionally, the knowledge of mathematical modelling and computational training which the students acquire during the programme makes them highly sought after. In keeping with the demands of industry and academia, the syllabus is updated regularly, with inputs taken from various stakeholders including students, alumni, and parents at different stages of the preparation of the syllabus. The curriculum is carefully designed to meet the NET and GATE examination syllabus and industry trends. Curriculum has good mix of foundation courses, hardcore courses, soft-core courses, practical's, and projects along with open electives, soft skill and skill development courses. The curriculum caters to and has relevance to local regional, national and global developmental needs. Maximum number of courses are integrated with crosscutting issues with relevant to professional ethics, Gender, Human values, Environment and sustainability.

Since the beginning of REVA University, the Mathematics Department is involved in implementing best practices in various dimensions such as academics, research, outreach activities, student development programs, student centric learning, student competitions, skill enhancement activities, motivation for competitive exams, mini projects, major projects, multidisciplinary projects, industry visits, technical talks by industry and academicians, certification programs, etc. Individual students are taken care by a strong mentoring system wherein faculty members are not only allotted as mentors to students, but also they will act as local guardians and they will have constant follow up with mentees in regard to academic and personal issues till students complete the degree.

This handbook provides an outline of regulations for master's degree, scheme of instruction, and detailed syllabus. I am sure the students choosing MSc Mathematics at 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 a pleasant stay at REVA and grand success in their career.

Dr. Beena G

Director
School of Applied Sciences

PREFACE

Higher education across the globe is opening doors of its academic disciplines to the real-world experiences. The disciplinary legitimacy is under critical review. Trans-border mobility and practice learning are being fore-grounded as guiding principles. Interactive learning, bridging disciplines and facilitating learners to gain different competencies through judicious management of time is viewed as one of the greatest and fascinating priorities and challenges today.

The M.Sc. Mathematics 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 Abstract Algebra, Linear Algebra, Real and Complex Analysis, Topology, Functional Analysis, Number theory, computational techniques, R-tools, and Python 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 experience of practical exposure in working environment.

The L: T: P structure of teaching and learning under Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) would certainly help our students learn and build competencies needed in this knowledge based society.

This handy document containing a brief information about M.Sc. Mathematics, 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.

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 No. 80 dated 27th February, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

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

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, 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 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 faculty, 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 in presence of dignitaries, faculty members and students gathering and the first "REVA Life Time Achievement Award" for the year 2015 has been awarded to Shri. Kiran Kumar, Chairman ISRO on the occasion of Founder's Day Celebration, 6th January, 2016 and the second “REVA Life Time Achievement Award” for the year 2016 has been awarded to Shri. Shekhar Gupta, Renowned Journalist on the occasion of Founder’s Day Celebration, 6th January, 2017.

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 ShubhaVidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also 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.

Vision

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

Mission

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

Objectives

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

ABOUT THE SCHOOL OF APPLIED SCIENCES

The School of Applied Sciences offers graduate and post graduate programs in Biotechnology, Biochemistry, Chemistry, Physics and Mathematics which are incredibly fascinating. It aims to attract talented youth and train them to acquire knowledge and skills useful to industrial sectors, research laboratories, and educational institutions. The School presently offers M.Sc. degree programs in Bio-Chemistry, Bio-Technology, Chemistry, Physics, Mathematics and B Sc with various combinations viz, Physics Chemistry and Mathematics, Mathematics , Physics and Statistics, Mathematics Statistics and Computer Science, and Biology Mathematics & Computer Science and also Post Graduate Diploma in Clinical Research Management. The School also facilitates research leading to PhD in Biotechnology, Biochemistry, Physics, Chemistry, Mathematics, and related areas of study.

The School of Applied Sciences is shouldered by well qualified, experienced, and highly committed faculty. The state-of-the-art infrastructure digital classrooms, well equipped laboratories, conference rooms and the serene academic atmosphere at REVA University will enhance the transfer as well as creation of knowledge. The school provides an interactive, collaborative peer tutoring environment that encourages students to break down complex problems and develop strategies for finding solutions across a variety of situations and disciplines. The school aims to develop a learning community of critical thinkers who serves as models of innovative problems solving in the university environment to enrich their academic and professional careers.

Vision

To nurture intellect, creativity, character, and professionalism among students and impart contemporary knowledge in various branches of Chemical, Biological, Physical and Mathematical Sciences that are socially relevant and transform them to become global citizens.

Mission

To achieve excellence in studies and research through pedagogy and support interface between industry and academia.

About the Department of Mathematics

The school of Physical Sciences headed by a highly experienced professor and is supported by a highly experienced and well qualified faculty. 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 will develop a learning community of critical thinkers who serves as models of innovative problems solving in the university environment to enrich their professional careers. M.Sc., in Mathematics is designed to meet the present-day demand for specific mathematical and computational skills and training requirements of science, engineering, and technology graduates. The courses are tailored to prepare students in teaching and research as well as in community activities and development. The courses provide opportunity for the students to know about the applications of mathematics in several fields of practical interest including those of designing & writing codes and computer algorithms for dealing with various systems. The areas of study that covers analysis, algebra, topology, complex analysis, differential equations, mechanics, discrete mathematics, Statistics, programming language, design & analysis of algorithms, theory of computation, and numerical techniques. Besides, greater emphasis is laid on methods of Mathematics, fluid mechanics, mathematical modeling and simulation, graph theory, fuzzy logic, cryptography, operations research, and mathematics of multimedia.

The minor project work that the students must undertake compulsorily is integrated with industry experience. This will not only enhance acquaintance to applications of mathematics, computation and their models to real world problems but improve students' knowledge and self-confidence. The school also has research program leading to doctoral degree. The curriculum of both graduate and post-graduate degree programs have been designed to bridge the gap between academia-research. The program focus on research to offer professional services at National and International levels

Advisory Board

Proceedings of the meeting of the Board of Studies in Mathematics held on 1st June, 2017 at 10.30 am in the Department of Mathematics, Conference Hall, Admin Block, REVA University, Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru-560064.

REVA UNIVERSITY
Bengaluru, India

Board of Studies in Mathematics

Date of the Meeting: 01.06.2017 **Time: 10.30 AM**

Sl. No.	Name of Members	Designation	Signature
1	Dr. Hanumagowda B N Professor, School of Basic Sciences – Mathematics, RU	Chairperson	
2	**Prof. A.S.Vasudeva Murthy,** Associate Professor, TIFR-CIM, Yelahanka Bangalore, Email ID: ma28@vsnl.net	Member	
3	**Dr. Joseph Varghese,** Associate Professor, Department of Mathematics Christ University, Bangalore 560029, Email: frjoseph@christuniversity.in	Member	
4	**Mr. Sandeepa M. S.** Data Scientist, Assistant Manager DXC Technologies, Electronic City, Bangalore	Member	M.S.
5	**Dr. Vishu Kumar** Professor, School of Basic Sciences, REVA University, Bangalore	Member	
6	**Dr. Harish Babu G A** Professor, School of Basic Sciences, REVA University, Bangalore	Member	
7	**Dr. Murugesan R** Professor, School of Basic Sciences, REVA University, Bangalore	Member	
8	**Dr. Nagamaruthi Kumari** Associate Professor, School of Basic Sciences, REVA University,	Invitee	
9	**Dr.Raju B. T.** Associate Professor, School of Basic Sciences, REVA University,	Invitee	
10	**Dr. Uday Kumar K.N.** Associate Professor, School of Basic Sciences, REVA University,	Invitee	
11	**Ms. Brinda Halambi** Asst. Professor, School of Mathematics, REVA University, Bangalore	Invitee	

Proceedings

At the outset, Prof. Hanumagowda, the Chairperson of the BoS in Department Of Mathematics welcomed all the members present, explained the purpose of the meeting and the agenda in brief. Then the agenda was taken up for discussion, when Dr.R.Murugesan has given the Power Point Presentation.

Agenda 1: Preparation of Course Curriculum.

The Chairperson explained briefly about the establishment of REVA University and the course being introduced under REVA University. He also explained the features of CBCS/CAGP of education the University is committed to follow since its inception itself. He requested all the members to corporate and to draft the curriculum as per the REVA University Regulations for CBCS-CAGP for PG programs.

The BoS members discussed the agenda in detail and drafted the course curriculum including the scheme of instruction, eligibility criterion, etc. The Board also drafted detailed syllabus.

Resolution: The Board unanimously resolved to adopt CBCS-CAGP of education for M.sc in Mathematics program from the Academic Year 2017-19 and recommend the University to adopt detailed curriculum drafted, which is provided in Annexure 2.

M.Sc., (Mathematics) Program

Program Overview

The mathematical sciences are a group of areas of study that includes, in addition to mathematics, those academic disciplines that are primarily mathematical in nature but may not be universally considered subfields of mathematics proper. Statistics, for example, is mathematical in its methods but grew out of scientific observations which merged with inverse probability and grew through applications in the social sciences.

Mathematical sciences work is becoming an increasingly integral and essential component of a growing array of areas of investigation in biology, medicine, social sciences, business, advanced design, climate, finance, advanced materials, and much more. This work involves the integration of mathematics, statistics, and computation in the broadest sense, and the interplay of these areas with areas of potential application; the mathematical sciences are best conceived of as including all these components. These activities are crucial to economic growth, national competitiveness, and national security.

Thus, mathematics 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 mathematics has played a major role in the development of country and Manjul Bhargava is a Canadian-American mathematician of Indian origins has won Field Medal which is equivalent to Nobel Prize in mathematics.

In this context, Universities across the country offer Mathematics as a subject at undergraduate and Mathematics as a programme at postgraduate level.

M. Sc. (Mathematics) 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 analysis, algebra, topology, complex analysis, differential equations, discrete mathematics, mechanics and numerical analysis. Besides, greater emphasis is laid on methods of mathematics, fluid mechanics, mathematical modeling, graph theory, fuzzy logic, cryptography, operation research and mathematics of multimedia.

Program Educational Objectives (PEOs)

The program educational objectives of the Mathematics of REVA University are to prepare the graduates to

PEO-1	Serve as a tutor in mathematics and perform with effective communication and ethics.
PEO-2	Carryout research in the areas of pure and applied mathematics and publish work as individual or in a team.
PEO-3	Provide consultancy in the advanced areas of mathematics with lifelong learning attitude.

Program Outcomes (POs):

PO-1	**Science knowledge**: Demonstrate the skills in the areas of mathematics and applied areas.
PO-2	**Problem analysis**: Apply mathematical skills to formulate, solve and interpret complex problems through mathematical models.
PO-3	**Conduct investigations of complex problems**: Comprehend, analyze, model, and solve complex problems based on structured and relevant reasoning.
PO-4	**Modern tool usage:** Use latest computer techniques as a tool to carry out scientific investigations and develop new variants of the acquired methods and problems related to environment and society.
PO-5	**Ethics:** Exhibit professional and ethical responsibility.
PO-6	**Individual and teamwork**: Encourage collaborative learning through group activities and hands-on learning.
PO-7	**Communication**: Communicate mathematical ideas with clarity and coherence, both written and verbally.
PO-8	**Life-long learning**: Recognize the need to expertise in the areas of mathematics by self-up gradation through lifelong learning.

Program Specific Outcomes (PSO)

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

PSO-1	Demonstrate the knowledge of Mathematical Analysis, Algebra, Statistics, Optimization and Computational Mathematics.
PSO-2	Analyse and solve problems in Mathematical Analysis, Algebra, Statistics, Optimization and Computational Mathematics.
PSO-3	Use tools and techniques for addressing the problems of Industry, Organizations, and environment in Mathematical Analysis, Algebra, Statistics, Optimization and Computational Mathematics.

REVA University Regulations for CBCS (CHOICE BASED CREDIT SYSTEM) AND CAGP (CONTINUOUS ASSESSMENT AND GRADING PATTERN) OF EDUCATION AND ITS ADVANTAGES

CBCS is a proven, advanced mode of learning in higher education. It facilitates students to have freedom in making their own choices for acquiring a Degree / Master's Degree program. It is more focused towards the student's choice in providing a wide range of Units available in a single campus across various disciplines offered by experts in the subjects. It leads to quality education with active teacher-student participation.

Studying under CBCS has following advantages:

- Students may undergo training in cross-disciplinary and multi-disciplinary subjects and acquire more focused and preferred knowledge.
- Students may get more skills from other subject(s) which are required for the career path in addition to their regular subject knowledge.
- Students may get many opportunities to use the laboratories and gain practical exposure to the much-needed Units available in other departments/schools for want of scientific inputs.
- Courses are conducted by subject experts identified based on their experiences. Courses taught by such experts may provide in-depth information and clear understanding of the Units.
- Students may get an opportunity to study courses with other students of different programs and exchange their views and knowledge in a common class room.
- CBCS provides a cross-cultural learning environment.
- Students may benefit much from selecting the right options to successfully face the public service examinations like UPSC, KPSC, IES wherein the knowledge of additional subjects become mandatory for general or optional papers.
- Students are exposed to the culture of universal brotherhood during their campus life.
- Students can practice various methods of learning a subject.

Summary of REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Post Graduate Degree Program

CBCS is a proven, advanced mode of learning in higher education. It facilitates students to have freedom in making their own choices for acquiring a Degree / Master Degree program. It is more focused towards the student's choice in providing a wide range of modules available in a single campus across various disciplines offered by experts in the subjects. It leads to quality education with active teacher-student participation.

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- Students are exposed to the culture of universal brotherhood during their campus life.
- Students can practice various methods of learning a subject.

BRIEF OUTLINE OF REVA UNIVERSITY REGULATIONS FOR CHOICE BASED CREDIT SYSTEM (CBCS) AND CONTINUOUS ASSESSMENT GRADING PATTERN (CAGP) FOR M.Sc. PROGRAM IN MATHEMATICS, 2017

Course:

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

(i) L= Lecture (ii) T= Tutorial (iii) P= Practice, where:

L stands for Lecture session consisting of classroom instruction.

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

P stands for Practice session and it consists of Hands on Experience / Laboratory Experiments / Field Studies / Case Studies that equip students to acquire the much-required skill component.

In terms of credits, every one-hour session of L amounts to 1 credit per Semester and a minimum of two hour session of T or P amounts to 1 credit per Semester, over a period of one Semester of 16 weeks for teaching-learning process. The total duration of a semester is 20 weeks inclusive of semester-end examination.

A course shall have either or all the three components. That means a course may have only lecture component, or only practical component or combination of any two or all the three components.

The total credits earned by a student at the end of the semester upon successfully completing the course are L + T + P. The credit pattern of the course is indicated as L: T: P.

If a course is of 4 credits then the different credit distribution patterns in L: T: P format could be:

4 : 0 : 0, 1 : 2 : 1, 1 : 1 : 2, 1 : 0 : 3, 1 : 3 : 0,

2 : 1 : 1, 2 : 2 : 0, 2 : 0 : 2, 3 : 1 : 0, 3 : 0 : 1,

0 : 2 : 2, 0 : 4 : 0, 0 : 0 : 4, 0 : 1 : 3, 0 : 3 : 1,

The concerned BoS will choose the convenient Credit Pattern for every course based on the requirement. However, generally, a course shall be of FOUR Credits and occasionally may be of TWO Credits.

Different Courses of Study are labeled and defined as follows:

Core Course:

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

(i) 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.

(ii) 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.

(iii) 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.

Open Elective Course:

An elective course chosen generally from other discipline / subject, with an intention to seek exposure is called an Open Elective Course.

Project Work:

Project work is a special course involving application of knowledge in solving / analyzing /exploring a real-life situation / difficult problem. A project works up to FOUR credits is called Minor Project work. A project work of EIGHT or TWELVE credits is called Major Project work. A Minor Project work may be a hard core or a Soft Core as decided by the BoS / School Council concerned. But the Major Project shall be Hard Core.

Eligibility for Admission:

The eligibility criteria for admission to Master Program of 2years (4 Semesters) are given below:

Sl. No.	Program	Duration	Eligibility
1	Master of Science (Mathematics)	2 Years	Passed Bachelor's Degree of 3 years with Mathematics 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.

Duration of the program and Medium of Instruction:

A Master's degree program is of 4 semesters - 2 years duration of 96 credits. A candidate can avail a maximum of 8 semesters - 4 years as per double duration norm, in one stretch to complete Master's degree, including blank semesters, if any. Whenever a candidate opts for blank semesters, he/she has to study the prevailing courses offered by the School/Department when he/she resumes his/her studies.

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

A candidate can enroll for a maximum of 24 credits per Semester including:

(i) Dropped Courses of corresponding semester(s) of previous year(s), if any:

(ii) Additional Courses from the corresponding Semester of immediate succeeding year.

However, a candidate may not successfully earn a maximum of 24 credits per semester.

Generally, a full-time candidate may register for 20 credits per semester.

Eligibility for Declaration of Ranks / Medals:

Only such candidates who register for a minimum of 16 credits per semester from I semester to IV semester and complete successfully 96 credits in 4 successive semesters shall be considered for declaration of Ranks, Medals, Prizes and are eligible to apply for Student Fellowship, Scholarship, Free ships, and such other rewards / advantages which could be applicable for all full-time students and for hostel facilities.

Continuous Assessment, Earning of Credits, and Award of Grades.

The assessment / evaluation of the candidate is based on continuous assessment. The structure for evaluation is as follows:

For assessment and evaluation, a semester is divided into 4 discrete components identified as IA1, IA2, and IA3 and Final

The performance of a candidate in a course will be assessed for a maximum of 100 marks as explained below. Scheme of Assessment & Evaluation

1. The Scheme of Assessment and Evaluation will have two parts, namely;
   i. Internal Assessment (IA); and
   ii. Semester End Examination (SEE)

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

3. The 50 marks of Internal Assessment (IA) shall comprise of:

Internal Test	= 30 marks
Assignments	= 10 marks
Seminars	= 10 marks

4. There shall be **three internal tests** conducted as per the schedule given below. T**he students must attend all the three tests compulsorily.**

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

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

- For the **1st test** the syllabus shall be **First Unit and 1st half of Second Unit** of the Course;
- For the **2nd test** it shall be **Second half of Second Unit and Third Unit** of the Course;
- For the **3rd test** the syllabus will be **Fourth Unit** of the Course.

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

7. There shall be two Assignments and two Seminars each carrying 5 marks. Hence two assignments carry 10 marks (5+5 marks) and two seminars carry 10 marks (5+5 marks) as stated at Sl.No.3 above.

8. The Semester End Examination for 50 marks shall be held during 19th and 20th week of the beginning of the semester and **the syllabus for the semester end examination shall be entire 4 units**.

9. The **duration of the internal test shall be 90 minutes and for semester end examination the duration shall be 3 hours.**

10. The question papers for internal test shall be set by the internal faculty who have taught the course. If more than one faculty teaches the course all the faculty together shall devise the question paper(s). However, a Committee of senior faculty shall scrutinize these question papers to bring in the uniformity in the question paper pattern and as well to maintain the quality of the question papers.

11. The test shall be common for all the students and the evaluation of the answer scripts shall be done by the internal faculty who have taught the course.

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

13. There shall be double evaluation, viz, first valuation by the internal faculty who have taught the subject and second evaluation shall be the external examiner.

14. The average of the two evaluations (internal examiner & external examiner) shall be the marks to be considered for declaration of results.

Summary of Continuous 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	Second Part of 6th Week	First Unit and 1st half of Second Unit	15	Consolidation of First Unit and 1st half of Second Unit
Submission of Assignments	8th Week	First Unit and Second Unit	5	Instructional process and Continuous Assessment
Seminars	9th Week	First Unit and Second Unit	5	Instructional process and Continuous Assessment
Second Internal Test	2nd Part of 13th Week	2nd half of Second Unit and Third Unit	15	Consolidation of 2nd half of Second Unit and Third Unit
Allocation of Topic for 2nd Assignment / Seminars	11th Week	Third Unit and Fourth Unit		Instructional process and Continuous Assessment
Submission of Assignments	13th Week	Third Unit and Fourth Unit	5	Instructional process and Continuous Assessment
Seminars	14th Week	Third Unit and Fourth Unit	5	Instructional process and Continuous Assessment
Third Internal Test	2nd Part of 16th Week	Fourth Unit	15	Consolidation of entire Fourth Unit
Semester End Practical Examination	17th & 18th Week	Entire syllabus	50	Conduct of Semester - end Practical Exams
Preparation for Semester–End Exam	17th & 18th Week	Entire Syllabus		Revision and preparation for semester–end exam
Semester End Theory Examination	19th and 20th Week	Entire Syllabus	50	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.

14. Assessment of Performance in Practical's

14.1. The performance in the practice tasks / experiments shall be assessed based on:

a) Knowledge of relevant processes;

b) Skills and operations involved;

c) Results / products including calculation and reporting

14.2. The 50 marks meant for continuous assessment of the performance in carrying out practicals shall further be allocated as under:

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

14.3. The 50 marks meant for Semester End (C3) Examination, shall be allocated as under:

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

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

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

Right from the initial stage of defining the problem, the candidate must submit the progress reports periodically and, 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 must submit final report of the project / dissertation for final evaluation. The components of evaluation are as follows:

i	Periodic Progress and Progress Reports (25%)
ii	Results of Work and Draft Report (25%)
iii	Final Evaluation and Viva-Voce (50%). Evaluation of the report is for 30% and the Viva-Voce examination is for 20%.

16.0 Requirements to Pass a Course

16.1 A candidate's performance from IA and SEE will be in terms of scores, and the sum of IA and SEE scores will be for a maximum of 100 marks (IA = 50 + SEE = 50) and must secure a minimum of 40% to declare pass in the course. However, a candidate must secure a minimum of 25% (12.5 marks) in Semester End Examination (SEE) which is compulsory

16.2. **Eligibility to Appear for Semester - end Examination and Provision to Drop the Course.**

Only those students who fulfill 75% of attendance requirement are eligible to appear for Semester end examination in that course.

16.3. In case a candidate opts to drop the course he / she must re-register for the dropped course only in subsequent semesters whenever it is offered if it is Hard Core Course. He / she may choose alternative course if it is Soft Core Course or Open Elective course or Skill Development Course. **The details of any dropped course will not appear in the Grade Card.**

16.4. **Provision to Withdraw Course:**

A candidate can withdraw any course within ten days from the date of notification of final results. Whenever a candidate withdraws a course, he/she has to register for the same course in case it is hard core course, the same course or an alternate course if it is soft core/open elective. **A DROPPED course is automatically considered as a course withdrawn.**

17. Re-Registration and Re-Admission:

17.1 **Re-Registration and Re-Admission:** A candidate's class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University and is considered as dropped the semester and is not allowed to appear for end semester end examination (SEE shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

In case a candidate fails in more than 2 courses in odd and even semesters together in a given academic year, he / she may either drop all the courses and repeat the semester or reappear (SEE-semester end examination) to such of those courses where in the candidate has failed during subsequent semester / year within a stipulated period.

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

17.3 **Requirements to Pass the Semester and Provision to Carry Forward the Failed Subjects / Courses:**

17.4 Provision to Carry Forward the Failed Subjects / Courses:

A student who has failed in 2 courses in 1st and 2nd semesters together shall move to 3rd semester. And he / she shall appear for semester end examination of failed courses of the said semesters concurrently with 3rd semester end examinations (SEE) and 4th semester end examinations (SEE) of second year of study.

18. Attendance Requirement:

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

18.2 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.

18.3 Any student with less than 75% of attendance in a course in aggregate during a semester shall not be permitted to appear to the end semester (SEE) examination.

18.4 Faculty offering the courses will place the above details in the School / Department meeting during the last Wk. of the semester, before the commencement of SEE, and subsequently a notification pertaining to the above will be brought out by the Head of the School before the commencement of SEE examination. A copy of this notification shall also be sent to the office of the Registrar & Registrar (Evaluation).

18.5 **Absence during mid semester examination**

In case a student has been absent from a mid-semester examination due to the illness or other contingencies he / she may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Head of the School, for make-up examination. The Head of the School may consider such request depending on the merit of the case and after consultation with course instructor and class teacher, and permit such student to appear for make-up mid semester examination.

18.6 **Absence during end semester examination:**

In case a student is absent for end semester examination on medical grounds or such other exigencies, the student can submit request for make-up examination, with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Director of the School. The Director of the School may consider such request depending on the merit of the case and after consultation with class teacher, course instructor and permit such student to appear for make-up mid semester examination

19. **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).This statement will not contain the list of DROPPED courses.

19.1 **Challenge Valuation:**

A student who desires to apply for challenge valuation shall obtain a Xerox copy of the answer script by paying the prescribed fee within 10 days after the announcement of the results. He / She can challenge the Grade awarded to him/her by surrendering the Grade Card and by submitting an application along with the prescribed fee to the Registrar (Evaluation) within 15 days after the announcement of the results. This challenge valuation is only for Semester End Examination (SEE) component.**The answer scripts for which challenge valuation is sought for shall be sent to another external examiner. The marks awarded will be the higher of the marks obtained in the challenge valuation and in maiden valuation.**

19.2 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 Registrar (Evaluation).

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

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

O - Outstanding; A-Excellent; B-Very Good; C-Good; D-Fair; E-Satisfactory; F - Fail;

Here, P is the percentage of marks (P=[(IA1+IA2)+M] 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.

19.4 **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 i^{th} course and Gi is the grade point scored by the student in the i^{th} course.

Illustration for Computation of SGPA and CGPA

Illustration No. 1

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade)
Course 1	**4**	**A**	**9**	**4X9=36**
Course 2	**4**	**B**	**8**	**4X8=32**
Course 3	**4**	**C**	**7**	**4X7=28**
Course 4	**4**	**O**	**10**	**4X10=40**
Course 5	**4**	**D**	**6**	**4X6=24**
Course 6	**4**	**O**	**10**	**4X10=40**
	24			**200**

Thus, **SGPA = 200 ÷ 24 = 8.33**

Illustration No. 2

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade point)
Course 1	**5**	**A**	**9**	**5X9=45**
Course 2	**5**	**C**	**7**	**5X7=35**
Course 3	**5**	**A**	**9**	**5X9=45**
Course 4	**5**	**B**	**8**	**5X8=40**
Course 5	**4**	**O**	**10**	**4X10=40**
	24			**205**

Thus, **SGPA = 205 ÷ 24 = 8.54**

19.5 Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (96) for two-year post graduate degree in Computer Science & Engineering 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 i^{th} 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	24	8.33	24 x 8.33 = 199.92
2	24	8.54	24 x 8.54 =204.96
3	24	9.35	24x9.35=224.4
4	24	9.50	24x9.50=228.0
Cumulative	96		857.28

Thus, **CGPA** = 24x8.33+24x8.54+24x9.35+24x9.50 = 8.93

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 8.93 x 10=89.30

19.6 Classification of Results

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

CGPA	Numerical Index	FGP
		Qualitative Index
> 4 CGPA < 5	**5**	SECOND CLASS
5 > = CGPA < 6	6	
6 >= CGPA < 7	7	FIRST CLASS
7 >= CGPA < 8	8	
8 >= CGPA < 9	9	DISTINCTION
9 >= CGPA 10	10	

Overall percentage=10*CGPA

20.0. Provision for Appeal

If a candidate is not satisfied with the evaluation of IA1, IA2 and IA3 components, he/she can approach the grievance cell with the written submission together with all facts, the assignments, test papers etc, which were evaluated. He/she can do so before the commencement of semester-end examination. The grievance cell is empowered to revise the marks if the case is genuine and is also empowered to levy penalty as prescribed by the university on the candidate if his/her submission is found to be baseless and unduly motivated. This cell may recommend taking disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the grievance cell is final.

21. Grievance Cell

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

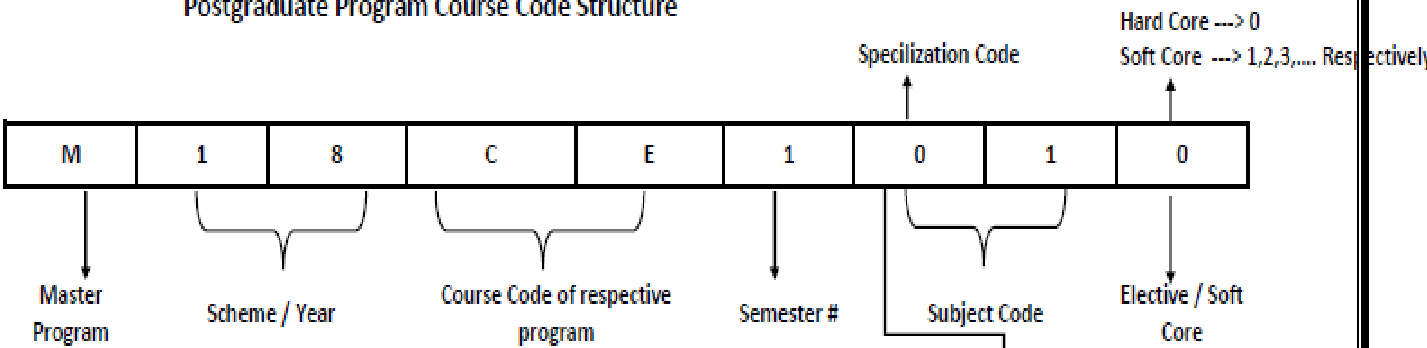
The Registrar (Evaluation) - Ex-Officio Chairman / Convener

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.

22.0. About any specific case of ambiguity and unsolved problem, the decision of the Vice-Chancellor shall be final.

Postgraduate Program Course Code Structure



M.Tech (CSE)	CP
M.Tech (DEC)	DE
M.Tech (VLSI)	VL
M.Tech (MD)	MD
M.Tech (DCN)	DC
M.Tech (APE)	AP
M.Tech (CASE)	SE
M.Tech (TEM)	TE
M.Tech PT (CSE)	CP
M.Tech PT (VLSI)	VL
MBA	MB
M.Com	MC
MCA	MA
MS (CS)	MS
M.Sc (PH)	PH
M.Sc (CH)	CH
M.Sc (MT)	MT
M.Sc (BC)	BC
M.Sc (BT)	BT
MPA	PA
LLM	LM
MA (EN)	EN
MA (JR)	JM

M.Sc (Chemistry)-Sem III - Specialization course Code Example

Specilization Code		Course Code
Inorganic Chemistry	1	M18CH3110
Organic chemistry	2	M18CH3210
Physical Chemistry	3	M18CH3310

Mapping of PEOS with Respect to POs

	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8
PEO1	√	√	√	√	√	√	√	√
PEO2	√	√	√	√	√	√	√	√
PEO3	√	√	√	√	√	√	√	√

Attainment of CO (Course Outcome)

CO Attainment	Value
0.4 - 0.6	1
0.6 – 0.75	2
> 0.75	3

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3
MS17MT101	CO1	3	2	2		3		1	3	3	3	3
	CO2	3	3	2		2		1	2	3	3	3
	CO3	3	3	2		3		1	1	3	3	3
	CO4	3	3	2		2		1	2	3	3	3
MS17MT102	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3

	CO1	3	3	1		2	2	1	1	3	3	3
	CO2	3	2	1		2	1	2	1	3	3	3
	CO3	3	2	1		2	2	2	1	3	3	3
	CO4	3	2	1		2	2	2	1	3	3	3
MS17MT103	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	3	1	2	2	3	2	3	3	3	3
	CO2	3	2	1	1	1	2	2	3	3	3	3
	CO3	3	2	1		2	2	1	3	3	3	3
	CO4	3	2	1	1	2	2	1	3	3	3	3
MS17MT104	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	2	1	1		1	2	3	3	3
	CO2	3	2	2	1	1		1	2	3	3	3
	CO3	3	2	2	1	1		1	2	3	3	3
	CO4	3	2	2	1			1	3	3	3	3
MS17MT105	POS/ COS	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	3	1		2	1	2	2	3	3	3
	CO2	3	2	1		1		3	3	3	3	3
	CO3	3	2	1		1		3	3	3	3	3
	CO4	3	2	1		1		2	2	3	3	3
MS17MT115	POS/ Cos	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	3	1	2	2	2	3	3	3	3	3
	CO2	3	2	1	2	2	2	3	3	3	3	3

	CO3	3	2	1	1	2	1	3	3	3	3	3
	CO4	3	2	1		1		2	2	3	3	3
MS17MT126	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	1	1			1		3	3	3
	CO2	3	2	1	1			1		3	3	3
	CO3	3	2	1	1		1		1	3	3	3
	CO4	3	2	2		1		1	2	3	3	3
MS17MT201	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	1	2	1			2	3	3	3
	CO2	3	2	1	2	1		1	1	3	3	3
	CO3	3	2	1	1			1	2	3	3	3
	CO4	3	2	1	2	1		1	3	3	3	3
MS17MT202	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	1		1		1	1	3	3	3
	CO2	3	2	2	1			1	2	3	3	3
	CO3	3	1	2	1	1		1	1	3	3	3
	CO4	3	2	1	1			1	1	3	3	3
MS17MT203	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	2	1	1		1	2	3	3	3
	CO2	3	2	2	1	1		1	2	3	3	3
	CO3	3	2	2	1	1		1	2	3	3	3
	CO4	3	2	2	1			1	3	3	3	3

MS17MT204	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	2		1	1	1	2	3	3	3
	CO2	3	2	1		1		1	2	3	3	3
	CO3	3	1	2	1	1		1	2	3	3	3
	CO4	3	2	2	1				2	3	3	3
MS17MT215	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	3	1		1		1	2	3	3	3
	CO2	3	2	1		1		2	2	3	3	3
	CO3	3	2	1		1		2	1	3	3	3
	CO4	3	2	1		2		2	3	3	3	3
MS17MT225	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	1		1		1		3	3	3
	CO2	3	2	2		2		1		3	3	3
	CO3	3	2	2		1		1		3	3	3
	CO4	3	2	2		1		1		3	3	3
MS17MT216	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	1		1			3	3	3	3
	CO2	3	2	1		1			3	3	3	3
	CO3	3	2	2		1			3	3	3	3
	CO4	3	2	1		1			3	3	3	3
MS17MT226	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3

	CO1	3	2	1		1			3	3	3	3
	CO2	3	2	1		1			3	3	3	3
	CO3	3	2	2		1			3	3	3	3
	CO4	3	2	1		1			3	3	3	3
MS17MT301	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	1	1	2		1		3	3	3
	CO2	3	2	2	1	2		1		3	3	3
	CO3	3	2	1		1		1		3	3	3
	CO4	3	1	2		1		1		3	3	3
MS17MT302	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	3	2	2		3	2	3	3	3
	CO2	3	2	3	2	1		2	1	3	3	3
	CO3	3	2	3	2	2		3		3	3	3
	CO4	3	2	3	2	1		2	1	3	3	3
MS17MT303	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	2	2			1	1	3	3	3
	CO2	3	1	1	2	2		1	2	3	3	3
	CO3	3	2	1	2	1		2	2	3	3	3
	CO4	3	2	1	2	1		1	2	3	3	3
	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	3	2	2		2	2	3	3	3
	CO2	3	2	3	2	1		2	2	3	3	3

MS17MT314	CO3	3	3	2	2	1		2	1	3	3	3
	CO4	3	3	2	2	1		1	2	3	3	3
MS17MT324	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	2	2			1	1	3	3	3
	CO2	3	1	1	2	2		1	2	3	3	3
	CO3	3	2	1	2	1		2	2	3	3	3
	CO4	3	2	1	2	1		1	2	3	3	3
MS17MT305	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	1		1		2	2	3	3	3
	CO2	3	2	1	1	1		2	2	3	3	3
	CO3	3	2	1	2	1		1	2	3	3	3
	CO4	3	2	1	2	1		2	1	3	3	3
MS17MT411	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	2	1			1	1	3	3	3
	CO2	3	2	1	1	1			1	3	3	3
	CO3	3	2	2		2		1	1	3	3	3
	CO4	3	1	1	2			1	1	3	3	3
M20MT421	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	1	2	1	2		2	2	3	3	3
	CO2	3	1	2	2	1		1	2	3	3	3
	CO3	3	2	2	1	1		2	2	3	3	3
	CO4	3	2	2	1	1		2	2	3	3	3

M20MT402	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	2	2	1	1		1	3	3	3
	CO2	3	1	2	1	2	1		1	3	3	3
	CO3	3	2	2	1	2		1	1	3	3	3
	CO4	3	1	2	1	1		2	1	3	3	3
M20MT403	POS/ COs	PO 1	P02	PO 3	PO 4	PO 5	PO 6	P7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	1	2	2	1		1	1	3	3	3
	CO2	3	2	1	2	2		2	2	3	3	3
	CO3	3	2	2	2	2		1	2	3	3	3
	CO4	3	2	1	2	2		1	2	3	3	3
M20MT414	POs/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	2	1	2		1	2	3	3	3
	CO2	3	2	2	1	1		1	2	3	3	3
	CO3	3	2	1	2	1		1	2	3	3	3
	CO4	3	2	2	1	2		2	2	3	3	3
M20MT424	POS/ COS	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	2	1	1	1	1	1	3	3	3
	CO2	3	2	1			1			3	3	3
	CO3	3	2	2	1	2		2	1	3	3	3
	CO4	3	2	2	2	1	1	1	2	3	3	3
M20MT405	POs/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3

	CO1	3	2	2	1	1	1	1	1	3	3	3
	CO2	3	2	2	1	2		1	1	3	3	3
	CO3	3	2	2	1	1	1	1	1	3	3	3
	CO4	3	2	1	2	1	1	1	1	3	3	3
M20MT416	POS/ COS	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3
	CO1	3	2	2	1	1	1	1	1	3	3	3
	CO2	3	2	1			1			3	3	3
	CO3	3	2	2	1	2		2	1	3	3	3
	CO4	3	2	2	2	1	1	1	2	3	3	3

Mapping of PEO'S with Respect to PO's

	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8
PEO1	√	√	√	√	√	√	√	√
PEO2	√	√	√	√	√	√	√	√
PEO3	√	√	√	√	√	√	√	√

M Sc., in Mathematics

Eligibility: Passed Bachelor’s Degree of 3 years with Mathematics 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.

Scheme of Instruction

Course Code	Course Title	Course Type	Credits L	Credits T	Credits P	Credits Total	Contact Hours
Semester I							
MS17MT101	Algebra	HC	3	1	0	4	5
MS17MT102	Real Analysis	HC	3	1	0	4	5
MS17MT103	Statistical Methods - I	HC	3	1	0	4	5
MS17MT104	Discrete Mathematics	HC	3	1	0	4	5
MS17MT115	Ordinary and Partial Differential Equations	SC	3	1	0	4	5
MS17MT125	Number Theory	SC	3	1	0		
MS17MT106	R – Programming with Statistical Methods (Practical)	HC	0	0	2	2	3
	Total Credits of I Semester		**18**	**06**	**02**	**22**	**28**
Semester II							
MS17MT201	Linear Algebra	HC	3	1	0	4	5
MS17MT202	Complex Analysis	HC	3	1	0	4	5
MS17MT203	Graph Theory	HC	3	1	0	4	5
MS17MT204	Statistical Methods - II	HC	3	1	0	4	5
MS17MT215	Finite Element Method	SC	3	1	0	4	5
MS17MT225	Fluid Mechanics	SC	3	1	0		
MS17MT216	Python Programming and SPSS	SC	2	0	2	4	5
MS17MT226	SAS	SC	2	0	2		
	Total Credits of II Semester		**22**	**06**	**04**	**24**	**30**
Semester III							
MS17MT301	Topology	HC	3	1	0	4	5
MS17MT302	Magneto hydrodynamics	HC	3	1	0	4	5
MS17MT303	Functional Analysis	HC	3	1	0	4	5
MS17MT314	Computational Fluid Dynamics	SC	3	1	0	4	5
MS17MT324	Statistical Methods-III	SC	3	1	0		
MS17MT305	Mini Project work	HC	0	0	2	2	3
MS17MT3__	Open elective	OE	3	1	0	4	5
	Total Credits of III Semester		**18**	**06**	**02**	**22**	**28**
Semester IV							
MS17MT411	Calculus of Variation and Integral Equation	SC	3	1	0	4	5
MS17MT421	Measure Theory.	SC	3	1	0		
MS17MT402	Numerical Analysis	HC	3	1	0	4	5
MS17MT403	Operations Research	HC	3	1	0	4	5
MS17MT414	Mathematical Methods	SC	3	1	0	4	5
MS17MT424	Differential Geometry	SC	3	1	0		
MS17MT405	Project Work	HC	0	0	8	8	
MS17MT416	Fuzzy set & Fuzzy Logic	SC	3	1	0	4	5
MS17MT426	Advanced Graph Theory						
	Total Credits of IV Semester		**21**	**07**	**08**	**28**	**25**
	Total Credits of I to IV Semester					**96**	**111**

Total credits: 96 (HC = 64; SC = 28; OE=04)

Open Electives: 1. Optimization Techniques - (**MS17MT307**) 2. Cryptography - (**MS17MT308**)

DETAILED SYLLABUS- I SEMESTER

Sub Code: **MS17MT101**	**ALGEBRA**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. Students will gain an understanding of the Cayley's theorem, Sylow's theorem and finite abelian group.
2. Students will study the ring and field over polynomials
3. Student will read and analyse Galois theory
4. Student will read and analyse the linear transformation, unitary and normal transformation.

Course Out comes:

Students can

1. Analyze the concept of various groups and theorems.
2. Analyze the concept of polynomial rings, polynomial rings over rational field, commutative ring and construct with straightedge and compass.
3. Analyze Galois Theory, Galois group over the rational and finite fields.
4. Apply the concept of linear transformation, canonical forms and real quadratics forms.

Unit I: **13 hrs**

Automorphisms, Cayley's theorem, Cauchy's theorem, permutation groups, symmetric groups, alternating groups, simple groups, conjugate elements and class equations of finite groups, Sylow's theorems, direct products, finite abelian groups, solvable groups

UNIT-II: **13 hrs**

Polynomial rings, polynomials rings over the rational field, polynomial rings over commutative rings, extension fields, roots of polynomials, construction with straightedge and compass, more about roots

UNIT-III: **13 hrs**

Galois Theory: The elements of Galois theory, solvability by radicals, Galois group over the rationals, finite fields

UNIT-IV: **13 hrs**

Algebra of linear transformations, characteristic roots, canonical forms - triangular, nilpotent and Jordan forms, Hermitian, unitary and normal transformations, real quadratic forms.

Reference Books:

1. M. Artin, Algebra, Prentice Hall of India, 1994.
2. I.N. Herstein, Abstract Algebra
3. D.S. Dummit and R. M. Foote, Abstract Algebra, 2nd Edition, John Wiley, 2002.
4. J.A. Gallian, Contemporary Abstract Algebra, 4th Edition, Narosa, 1999.
5. N. Jacobson, Basic Algebra I, 2nd Edition, Hindustan Publishing Co., 1984, W.H. Freeman, 1985.

Sub Code:**MS17MT102**	**REAL ANALYSIS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:
1. Students will gain an understanding of the Metric space, compact set and connected set.
2. Students will study the limit and continuous function
3. Student will read and analyse the Reimann - Stieltjes integrals
4. Student will read and analyse the sequence and series of functions

Course out comes: After this course the students shall be able to

1. Analyse the concept of Metric space, compact set and connected set
2. Analyse the concepts of continuity, compactness of continuity and monotone function
3. Apply the Riemann-Stieltjes integrals for various differentiation and integration problems
4. Apply the concept of Uniform convergence and continuity in differentiation, integration and polynomial

UNIT-I: Metric space **13 hrs**

Introduction, metric spaces-compact sets, Bolzano Weierstrass theorem, Heine - Borel theorem, perfect sets, connected sets.

Unit –II: Limit and Continuity **13 hrs**

Limits of functions- Continuous functions- Continuity and compactness Continuity and connectedness-Discontinuities – Monotone function and functions of bounded variation.

UNIT-III: Riemann-Stieltjes integral **13 hrs**

Riemann-Stieltjes integral; definition and existence of the integral, linear properties, change of variables, integral as a limit of sum. Integration and differentiation, integration of vector valued functions, Rectifiable curves.

UNIT-IV: Sequences and series of functions **13 hrs**

Sequences and series of functions: Uniform convergence- Uniform convergence and continuity-Uniform convergence and integration- Uniform convergence and differentiation- Approximation of a continuous function by a sequence of polynomials.

Reference Books

1. Walter Rudin, Principles of Mathematical Analysis, 3rd Edition. McGraw Hill Company, New York, 1976.
2. Bartle, R.G/Donald R.Sherbert. Introduction to Real Analysis, John Wiley and Sons Inc., 4th edition 2017.
3. Malik,S.C. and Savita Arora. Mathematical Anslysis, Wiley Eastern Limited.New Delhi, 1991.
4. Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.
5. A.L.Gupta and N.R.Gupta, Principles of Real Analysis, Pearson Education, (Indian print) 2003.

6. Tom M. Apostol :Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1997.

Sub Code: **MS17MT103**	**STATISTICAL METHODS - I**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objective:

1. Analyse the data numerically and graphically.
2. Apply the measures of location and measure of dispersion for grouped and ungrouped datas
3. Analyse the classical optimization techniques and numerical methods of optimization.
4. Apply the concepts of probability models to the real-world problems

Course Outcomes: At the end of the course, the student

1. Distinguish between qualitative and quantitative data and various scales of measurements.
2. Produce graphical representations of data
3. Compute the different measures of central tendency and dispersion and its various measures
4. Form the optimization problem and apply various optimization technique to solve real world problems.
5. Apply various methods of non-linear programming to compute engineering problems.

UNIT I: **13 hrs**

Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio. Presentation: tabular and graphical, including histogram and ogives, consistency and independence of data with special reference to attributes.

UNIT II: **13 hrs**

Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments, absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections.

Unit III: **13 hrs**

Introduction: Introduction to optimization, engineering applications of optimization, Formulation of structural optimization problems as programming problems. Optimization Techniques: Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimization solutions by penalty function techniques, Lagrange multipliers techniques and feasibility techniques.

Unit IV: **13 hrs**

Non-linear programming: Non-linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic and cubic methods, Unconstrained optimization methods, direct search methods, random search methods, descent methods. Constrained optimization techniques such as direct methods, the complex methods, cutting plane method, exterior penalty function methods for structural engineering problems.

Reference Books:

1.Dudewicz E.J and Mishra S.N (1988): Modern Mathematical Statistics, Wiley, International Students Edition.
2.Rohatgi V.K. (1984): An Introduction to probability theory and mathematical statistics.
3.Rao C.R (1973): Linear Statistical Inference and its Applications, 2/e, Wiley Eastern.
4.Pitman J. (1993): Probability, Narosa Publishing House.
5.S.C. Gupta and V.K. Kapoor: Fundamentals of Mathematical Statistics. Sulthan and Chand Company.
6.Mukhopadhyay, P(2002), Mathematical Statistics, Books and Allied (p) Ltd., Kolkata.

Sub Code: **MS17MT104**	**DISCRETE MATHEMATICS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. Recall basic Techniques in Counting
2. Demonstrate basic logic
3. Interpret the combinatorial ideas in practical problems
4. Develop the basics in Coding theory.

Course Out comes:

1. Distinguish the Tautologies and Controdictions
2. Analize the ideas of permutations and combinations.
3. Develop the ideas of Groups and Rings in Coding Theory
4. Apply the ideas of Posets and Lattices in Boolean Algebra

Unit-I: **13 hrs**

Sets: Definition of sets, subsets, standard set operations; union, intersection, relative complement, symmetric difference, complement, Cartesian products, power sets; algebraic laws; cardinality of finite sets. Propositional logic, first order logic, Basic logical operation, Tautologies, contradictions, Logical equivalences, Predicates, Universal and existential quantifiers

Unit-II: **13hrs**

Permutations and Combinations, Multinomial theorem, Circular Permutations, Solutions in Non-negative Integers, Set Partitions, Catalan Numbers, Advanced Counting Principles, Pigeonhole Principle , Principle of Inclusion and Exclusion

Unit-III: **13 hrs**

Definitions, Examples, and Elementary Properties: Groups, Homomorphisms, Isomorphisms, and Cyclic Groups,Rings Coding Theory: Elements of Coding Theory, The Hamming Metric, The Parity Check, and Generator Matrices

Unit-IV: **13 hrs**

Attices And Boolean Algebra: Partial ordering – Posets – Lattices as posets – Properties of lattices - Lattices as algebraic systems – Sub lattices – Some special lattices – Fundamentals of Boolean algebra.

Reference books:

1. Discrete Mathematics and Its Applications, By Kenneth H Rosen, McGraw Hill, Sept.2002.
2. “Graph Theory with Applications to Engineering and Computer Science” Prentice Hall, Englewood Cliffs, 1974
3. Combinatorics: Theory and Applications, By V. Krishnamurthy, East-West Press Pt. Ltd., New Delhi, 1986.

4.Discrete Mathematical Structures with Applications to Computer Science, By J. Tremble, Manohar, McGraw Hill Pub, 1975.

Sub Code: **MS17MT115**	**ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. Identify essential characteristics of ordinary differential equations.
2. To develop strong background on finding solutions to linear second order differential equations with constant and variable coefficients.
3. Partial differential equations allow deterministic mathematical formulations of phenomena in physics and engineering as well as biological processes
4. This course is to present the main results in the context of partial differential equations that allow learning about these models and to study numerical methods for the approximation of their solution.

Course Out comes:

1. Compute the Wronskian using variation of parameter method
2. Solve different types of differential equations using power series method
3. Solve first order and second order partial differential equations by reducing in to canonical form
4. Solve the PDE by variable separable method.

Unit-1: **13 hrs**

Linear differential equations of nth order, fundamental sets of solutions, Wronskian - Abel's identity, theorems on linear dependence of solutions. The n^{th} order non-homogeneous linear equations - Variation of parameter method, zeros of solutions - comparison and separation theorems. Eigen value problems - Sturm-Liouville problems - Orthogonality of eigen functions, Green's function method. Fundamental existence and uniqueness theorem-Picards method.

Unit-2: **13 hrs**

Power series solution of linear differential equations - ordinary and singular points of differential equations, Classification into regular and irregular singular points; Series solution about an ordinary point and a regular singular point - Frobenius method- Hermite, Laguerre, Chebyshev and Gauss Hypergeometric equations and their general solutions. Generating function, Recurrence relations, Rodrigue's formula Orthogonality properties.

Unit 3: **13 hrs**

First Order Partial Differential Equations- Cauchy problem, the method of characteristics for Semi linear, quasi linear and Non-linear equations. Classification of second-order linear partial differential equations into hyperbolic, parabolic and elliptic PDEs, Reduction to canonical forms.

Unit 4: **13 hrs**

Homogeneous and non-homogeneous PDE with constant coefficients, second order PDE with variable coefficients, Heat equation, Wave equation: Solution by the method of separation of variables. Laplace equation: Solution by the method of separation of variables.

REFERENCE BOOKS

1. G.F. Simmons: Differential Equations, TMH Edition, New Delhi, 1974.
2. M.S.P. Eastham: Theory of ordinary differential equations, Van Nostrand, London, 1970.
3. S.L. Ross: Differential equations (3rd edition), John Wiley & Sons, New York, 1984.
4. I. N. Sneddon, Elements of PDE's, McGraw Hill Book company Inc., 2006.

5. L Debnath, Nonlinear PDE's for Scientists and Engineers, Birkhauser, Boston, 2007.
6. F. John, Partial differential equations, Springer, 1971.

Sub Code: **MS17MT125**	**NUMBER THEORY**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives: This course is concerned with the basics of analytical number theory.

1. Topics such as divisibility, congruence's, quadratic residues and functions of number theory are covered in this course.
2. Some of the applications of the said concepts are also included.

Course Outcome: The students can
1. Define and interpret the concepts of divisibility, congruence, greatest common divisor, prime, and prime-factorization,
2. Solve linear Diophantine equations and congruences of various types, and use the theory of congruences in applications.
3. Prove and apply properties of multiplicative functions such as the Euler phi-function and of quadratic residues.
4. Apply the Law of Quadratic Reciprocity and other methods to classify numbers as primitive roots, quadratic residues, and quadratic non-residues,

Unit I: **13 hrs**

Number theory - Congruences, residue classes, theorems of Fermat, Euler and Wilson, linear congruences, elementary arithmetical functions, primitive roots, quadratic residues and the law of quadratic reciprocity.

Unit II: **13 hrs**

Prime numbers, The Fundamental theorem of Arithmetic, The series of Reciprocals of primes, The Euclidean Algorithm. Fermat and Mersenne numbers. Farey series, Farey dissection of the continuum, Irrational Numbers-Irrationality of mth root of N, e and π, Diophantine equations.

Unit III: **13 hrs**

Arithmetical Functions – The Mobius function, The Euler' function and Sigma function, The Dirichlet product of Arithmetical functions, Multiplicative functions. Averages of Arithmetical functions – Euler summation formula, Some elementary asymptotic formulas, The average orders of d(n), σ(n), φ(n), μ(n). Approximation Irrational numbers, Hurwitz's Theorem, Representation of a number by two or four squares.

Unit IV: **13 hrs**

Continued fractions - Finite continued fractions, Convergent of a continued fraction, Continued fractions with positive quotients. Simple continued fractions, The representation of an irreducible rational fraction by a simple continued fraction. The continued fraction algorithm and Euclid's algorithm. The difference between the fraction and its convergents, Infinite simple continued fractions, the representation of an irrational number by an infinite continued fraction, Equivalent numbers and periodic continued fractions.

Reference Books:
1. D. M. Burton, Elementary number theory, McGraw Hill.
2. Hardy, G.H. and Wright, E.M., An Introduction to the Theory of Numbers (6th ed, Oxford University Press, (2008).
3. Niven, H. S. Zuckerman and H. L. Montgomery, An Introduction To The Theory Of Numbers, 5 th Edition, Wiley Student Editions
4. Apostol, T.M., Introduction to Analytic number theory, UTM, Springer, (1976).

Sub Code: **MS17MT106**	**R-PROGRAMMING**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Outcome: The students can

1. Develop a R-script with available data types and operators.
2. Apply decision and repetition structures in R-script.
3. Develop simple programs in R for mathematical problems.
4.Calculate the regression coefficients using R
5.Illustrate graphical visualizations of data in R
6.Demonstrate the probability distributions using R

Introduction to R-Programming

Prerequisite: Students should have a basic understanding of Computer Programming terminologies. A basic understanding of any of the programming languages will help you in understanding the R programming concepts and move fast on the learning track.

Fundamentals in R: basic syntax : R command prompt , script file ,comments, data types : lists ,matrices , arrays, factors ,data frames , variables: variable assignment ,data type of a variable, finding variables ,deleting variables, operators: types of operators ,arithmetic operators , relational operators, logical operators , assignment operators, miscellaneous operators , decision making : if statement ,if...else statement ,the if...else if...else statement ,switch statement, Loops, Functions, R-graphical representation of Data, R-measure of central tendency, R-regression ,R-distributions (Binomial and Normal).

R List of Experiments:

1. Write an R script to demonstrate use of variables.

2. Write an R script to demonstrate use of vector and matrix data types.

3. Write an R script to demonstrate use of Data frames.

4. Write an R script to demonstrate use of Lists.

5. Write an R script to demonstrate use of conditional statements if, if-else.

6. Write an R script to demonstrate use of arithmetic, logical operators.

7. Write an R script to demonstrate use of loops.

8. Write an R script to demonstrate use of functions.

9. Write an R script to demonstrate use of visualizations in R - basic plot, ggplot

10.Write an R script to demonstrate use of 3d visualization in R-scatterplot3d

11. Write an R script to demonstrate use of probability library - prob to find probability of coin toss.

12. Write an R script to demonstrate use of set operations .

13. Write an R script to demonstrate use of conditional probability.

14. Write an R script to demonstrate use of covariance on a data set.

15. Write an R script to demonstrate use of correlation on a data set.

16. Write an R script to demonstrate use of linear regression.

17. Write an R script to demonstrate use of multiple regression

18. Write an R script to demonstrate use of logistic regression

19. Write an R script to demonstrate use of normal distribution

20. Write an R script to demonstrate use of binomial distribution

Books for References:

1. The R Book by Michael R Crawley, John Wiley & Sons Ltd.

2. The Art of R-Programming by Norman Matloff.

3. R cook book by Paul teetor, Oreilly Ltd.

4. Introduction to Probability and Statistics Using R,G. Jay Kerns, First Edition.

II SEMESTER

Sub Code: **MS17MT201**	**LINEAR ALGEBRA**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives: This course will:

1. Recall basic concepts of matrices and matrix algebra
2. Present methods of solving systems of linear equations
3. Demonstrate basic concepts of vector spaces
4. Interpret the concepts of linear transformations by using the matrices
5. Develop methods of computing and using eigen values and eigenvectors..

Course Outcomes: Students in this course will:

1. Solve the system of Linear Equations by using Matrix Algebra
2. Derive the Norms and Inner Product Spaces
3. Summarize the vector space properties.
4. Analyze different forms of the Linear Transformations

Unit I: **13 hrs**

Vector Spaces, Subspaces, Linear Combinations and Systems of Linear Equations, Linear Dependence and Linear Independence, Bases and Dimension, Maximal Linearly Independent Subsets; Linear Transformations, Null Spaces, and Ranges, The Matrix Representation of a Linear Transformation, Composition of Linear Transformations, and Matrix Multiplication, Invertibility and Isomorphisms, The Change of Coordinate Matrix, The Dual Space; Elementary Matrix Operations and Elementary Matrices, The Rank of a Matrix and Matrix Inverses, Systems of Linear Equations.

Unit II: **13 hrs**

Properties of Determinants, Cofactor Expansions, Elementary Operations and Cramer's Rule; Eigenvalues and Eigenvectors, Diagonalizability, Invariant Subspaces and the Cayley-Hamilton Theorem; Inner Products and Norms, The Gram-Schmidt Orthogonalizing Process and Orthogonal Complements.

Unit III: **13 hrs**

The Adjoint of a Linear Operator, Normal and Self-Adjoint Operators, Unitary and Orthogonal Operators and Their Matrices, Orthogonal Projections and the Spectral Theorem; Bilinear and Quadratic Forms.

Unit IV: **13 hrs**

The Diagonal form, The Triangular form; The Jordan Canonical Form; The Minimal Polynomial; The Rational Canonical Form.

Books for Reference:

1. S. Friedberg, A. Insel, and L. Spence - Linear Algebra, Fourth Edition, PHI, 2009.
2. Jimmie Gilbert and Linda Gilbert – Linear Algebra and Matrix Theory, Academic Press, An imprint of Elsevier.
3. I. N. Herstein – Topics in Algebra, Vikas Publishing House, New Delhi.
4. Hoffman and Kunze – Linear Algebra, Prentice-Hall of India, 1978, 2nd Ed.,
5. P. R. Halmos – Finite Dimensional Vector Space, D. Van Nostrand, 1958.
6. S. Kumeresan – Linear Algebra, A Geometric approach, Prentice Hall India, 2000.

Sub Code: **MS17MT202**	**COMPLEX ANALYSIS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Objectives :

1. Students will study the analytic function and Cauchy;s theorem for triangular, rectangular, circular regions also Liouliies theorem.
2. Students will study Power series
3. Student will read and analyse the singularities.
4. Student will read and analyse the Residues theorem, and Contour integrals.

Course Outcomes:

Upon completion of this course the student will be able to:

1. Analyze the limit and continuity for function of complex variable
2. Evaluate Complex Contour integrals by applying the Cauchy's integral theorem in its various versions.
3. Analyze sequences and series of analytic functions and types of convergence.
4. Evaluate complex integrals using residues theorem.

Unit I: **13 hrs**

Analytic functions, Harmonic conjugates, Elementary functions, Mobius Transformation, Conformal mappings, Cauchy's Theorem and Integral formula, Morera's Theorem, Cauchy's Theorem for triangle, rectangle, Cauchy's Theorem in a disk, Zeros of Analytic function. The index of a closed curve, counting of zeros. Principles of analytic Continuation. Liouville's Theorem, Fundaments theorem of algebra**.**

Unit II: **13 hrs**

Series, Uniform convergence, Power series, Radius of convergences, Power series representation of Analytic function, Relation between Power series and Analytic function, Taylor's series, Laurent's series. Rational Functions

Unit III: **13 hrs**

Singularities, Poles, Classification of Singularities, Characterization of removable Singularities, poles. Behavior of an Analytic functions at an essential singular point. Entire and Meromorphic functions.

Unit IV: **13 hrs**

The Residue Theorem, Evaluation of Definite integrals, Argument principle, Rouche's Theorem, Schwartz lemma, Open mapping and Maximum modulus theorem and applications, Convex functions, Hadmard's Three circle theorem**.**

Reference Books

1. S. Ponnaswamy : Functions of Complex variable, Narosa Publications-1997
2. J. B. Conway : Functions of one complex variable, Narosa, 1987.
3. L.V. Ahlfors : Complex Analysis, McGraw Hill, 1986.
4. R. Nevanlinna :Analystic functions, Springer, 1970.
5. E. Hille : Analytic Teory, Vol. I, Ginn, 1959.

Sub Code: **MS17MT203**	**GRAPH THEORY**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. This course is aimed to Demonstrate variety of problems in Graph Theory.
2. In this course students will Interpret Theorems in real life scenario
3. This course is aimed to interpret various techniques to find shortest distance in a network
4. This course will demonstrate the graphs algorithms.

Course Outcomes: After the course the student

1. Apply the concept of connectivity to solve utility problems, mapping problems.
2. Apply the concept of planarity to solve 2D circuit problem (minimizing the number of intersection of wires).
3. Apply the concept of colorability to solve Sudoku problem, mobile frequency assignment problem.
4. Apply the concept of matching to estimate the bond lengths.
5. Apply the concept of matching to solve TSP.
6. Apply the concept of domination to solve routing problem, locating

Unit – 1: **Introduction to graph theory** 13 Hrs

Definition and introductory concept, Graphs as Models, Isomorphism, Decomposition and special graphs, Connected graphs, Bipartite Graphs, Eulerian Graphs, Hamilton Graphs, Directed Graphs, Vertex Degrees, Graphic Sequences, Orientation and Tournaments.

Unit – 2: **Trees and Planar Graphs** 13 Hrs

Properties of Trees, Distance in Trees and Graphs, Enumeration of Trees, Spanning Trees in Graphs, Decomposition and Graceful Labelins, Minimum Spanning Tree, Shortest Paths, Minimal Spanning tree algorithm, Planar graphs, Dual of the Planar Graphs, Euler's Formula, Kuratowskis's Theorem. Thickness and crossing Number.

Unit – 3: **Connectivity and Paths** 13 Hrs

Connectivity, Edge Connectivity, Block, 2-Connected Graphs, Connectivity in Digraphs, K – Connected and k – edge connected Graphs, Menger's Theorem, Maximum Network Flow, Integral Flows.

Unit – 4 : **Coloring of Graphs** 13 Hrs

Definition and Examples of Graph coloring, Chromatic number, Chromatic Polynomial of a Graphs, Four Color Problem, Five Color Theorem, Brookes Theorem, Graph with Large Chromatic Number, Turan's Theorem, Color Critical Graphs.

REFERENCE BOOKS

1. F. Harary: Graph Theory, Addison -Wesley,1969
2. G.Chartrand and Ping Zhang: Introduction to Graph Theory. McGrawHill, International edition (2005)
3. J.A.Bondy and V.S.R.Murthy: Graph Theory with Applications, Macmillan, London, (2004).
4. D.B.West, Introduction to Graph Theory,Pearson Education Asia, 2nd Edition, 2002.
5. Charatrand and L. Lesnaik-Foster: Graph and Digraphs, CRC Press (Third Edition), 2010.
6. T.W. Haynes, S.T. Hedetneime and P. J. Slater: Fundamental of domination in graphs, Marcel Dekker. Inc. New York.1998.
7. J. Gross and J. Yellen: Graph Theory and its application, CRC Press LLC, Boca Raton, Florida, 2000.
8. N. Deo: Graph Theory: Prentice Hall of India Pvt. Ltd. New Delhi – 1990

Sub Code: **MS17MT204**	**STATISTICAL METHODS- II**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1.Explore random variable, various distributions, and statistical independence.

2. Understand the probability mass and density functions of various random variables and their distributions.

3.Explore applications of continuous and discrete distributions.

4. Carry out statistical hypothesis tests for population mean and proportions.

5.Understand correlation and regression models and their coefficients.

Course Outcomes:

By completing this course the student shall be able to:

1. Analyze the concepts of random variable techniques to generate data from various distributions.

2. Analyze the concepts of functions of random variables and their distribution using Jacobian transformation

3.Apply selected probability distributions for different kinds of problems

4. Analyse the data using appropriate statistical distributions (t, f and χ^2)

5. Analyze the concepts of applying modelling of correlation and regression for multiple and partial correlations

UNIT – I: 13 hrs

Probability as a set function, continuity axiom of probability, Borel - Cantelli lemma, random variable, distribution function and its properties, discrete and continuous distribution functions, convolutions of random variables, vector of random variables and statistical independence. Notion of mathematical expectation, conditional expectation, moment inequalities – Markov, Chebyshev, Kolmogorov, Holder, minkowski. Characteristic function – Inversion theorem.

UNIT – II: 13 hrs

Brief review of basic distribution theory, joint, marginal and conditional p.m. functions and p.d. functions. Rectangular, normal, exponential, gamma, beta, Cauchy, Laplace, and Weibull distributions. Functions of random variables and their distributions using Jacobian of transformations.

UNIT – III: 13 hrs

Discrete distributions & Continuous distributions: Definitions, moment generating functions, probability generating functions, characteristic functions, means, variances, reproductive properties (if exist) and interrelations of multinomial, compound binomial, Compound Poisson (for Discrete) and interrelations of Weibull, Laplace, lognormal, logistic (for Continuous).
Distributions: Central Chi Square, t and F distributions and its properties, applications, relation between t and F, F and $\chi 2$; Fisher's Z-distribution, fisher's Z - transformation.

UNIT-IV: 13 hrs

Statistical Hypothesis: Null and Alternative, simple and composite, Type I and Type II errors. Test function. Power of the test and level of significance. Parameters and estimates.
Analysis of Variance: Meaning and assumptions, fixed, random and mixed models. Principles – One way and two way classification models with and without interaction effect.
Correlations and Regression modelling, Multiple and partial correlation coefficients, multiple linear regression, inter relationship among partial and multiple correlation and regression coefficients. Null distributions of simple, partial, and multiple correlation coefficients.

References Books:

1.Anderson, T.W (1983), An introduction to Multivariate Statistical Analysis, Wiley, 2nd Edition.
2.Rao, C.R (1973), Linear Statistical Inference and its applications, 2nd edition, Wiley
3.Srivastava. M.S and Khatri, C.G (1979), An introduction to Multivariate Statistics, North Holland
4.Morrison,F(1985): Multivariate Statistical Methods, Mc Graw Hill Book Company.
5.Johnson A.R and Wishern, D.W (1996), Applied Multivariate Statistical Analysis, Prentice Hall of India
6.Sharma, S (1996), Applied Multivariate Techniques, Wiley.
7.Krishisagar, A.M (1972), Multivariate Analysis, Marcel Dekker
8.K.C. Bhuyan(2005): Multivariate Analysis and its Applications, Central

Sub Code: **MS17MT215**	**FINITE ELEMENT METHOD**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:
1. Illustrate about different finite element methods in one, two and three dimensions.
2. Analyse variety of finite elements as per the requirements of solutions of differential equations.

Course Outcomes: Upon completion of this course, the student will be able to:
1.Apply finite element method to solve Differential equations.
2. Apply finite element method to solve heat transfer problems.
3. Apply finite element method to solve two and three dimensional problems.
4. Apply finite element method to solve Laplace &Poisson equations of specific applications

Unit I: **13hrs**

Weighted Residual Approximations: Point collocation, Galerkin and Least Squares method. Use of trial functions to the solution of differential equations.

Unit II: **13hrs**

Finite Elements: One dimensional and two-dimensional basis functions, Lagrange and serendipity family elements for quadrilaterals and triangular shapes. Isoparametric coordinate transformation. Area coordinates standard 2- squares and unit triangles in natural coordinates.

Unit III: **13hrs**

Finite Element Procedures: Finite Element Formulations for the solutions of ordinary and partial differential equations: Calculation of element matrices, assembly, and solution of linear equations.

Unit IV: **13hrs**

Finite Element solution of one dimensional ordinary differential equations, Laplace and Poisson equations over rectangular and nonrectangular and curved domains. Applications to some problems in linear elasticity: Torsion of shafts of a square, elliptic and triangular cross sections.

REFERENCE BOOKS:
1. O.C. Zienkiewiez and K. Morgan : Finite Elements and approximation, John Wieley, 1983
2. P.E. Lewis and J.P. Ward : The Finite element method- Principles and applications, Addison Weley, 1991
3. L.J. Segerlind : Applied finite element analysis (2nd Edition), John Wiley, 1984
4. OC Zienkiewicz, RL Taylor: The FEM. Vol.1 Basic formulation and Linear problems, 4Ed, NY, MGH, 1989.
5. J.N. Reddy: An introduction to finite element method, New York, Mc.Graw Hill, 1984.
6. D.W. Pepper, J.C. Heinrich : The finite element method, Basic concepts and applications, Hemisphere, Publishing Corporation, Washington, 1992.
7. S.S. Rao : The finite element method in Engineering, 2nd Edition, Oxford, Pergamon Press, 1989.
8. D. V. Hutton, fundamental of Finite Element Analysis, (2004).
9. EG Thomson, Introduction to FEM, Theory Programming and applications, Wiley Student Ed, (2005).

Sub Code: **MS17MT225**	**FLUID MECHANICS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

This course aims at studying the fundamentals of fluid mechanics such as tensors, kinematics of fluid, incompressible flow, and boundary layer flows.

1. This course aims at study of fluid flows such as viscous flow, inviscid flow, incompressible flow, and boundary layer flows.

Course outcomes:

1. Apply the concepts of tensors in continuum hypothesis, material and spatial coordinates
2. Analyze the laws of conservations
3. Analyze the dimensional and non-dimensional parameters
4. Analyze the different types of fluid flow problems.

Unit I: 13hrs

Coordinate transformations - Cartesian tensors - Basic Properties - Transpose - Symmetric and Skew tensors - Isotropic tensors- Deviatoric Tensors - Gradient, Divergence and Curl in Tensor Calculus - Integral Theorems. Continuum Hypothesis- Configuration of a continuum – Mass and density – Description of motion – Material and spatial coordinates - Translation – Rotation - Deformation of a surface element- Deformation of a volume element - Isochoric deformation – Examples - Stretch and Rotation- Decomposition of a deformation- Deformation gradient - Strain tensors - Infinitesimal strain - Compatibility relations - Principal strains.

Unit II: 13hrs

Material and Local time derivatives. - Strain-rate tensor- Transport formulas – Stream lines - Path lines - Vorticity and Circulation - Examples. Stress components and Stress tensor - Normal and shear stresses - Principal stresses. Fundamental basic physical laws- Law of conservation of mass - Principle of linear and momentum - Balance of energy - Examples. Equations of fluid mechanics – Viscous and non-viscous fluids –Stress tensor for a viscous fluid – Navier-Stokes equation - simple consequences and simple applications.

Unit III: 13hrs

Motion of inviscid fluids:- Recapitulation of equation of motion and standard results - Vortex motion- Helmholtz vorticity equation - Permanence of vorticity and circulation - Kelvin's minimum energy theorem – Impulsive motion - Dimensional analysis - Nondimensional numbers. Two dimensional flows of inviscid fluids:- Meaning of two-dimensional flow - Stream function – Complex potential - Line sources and sinks - Line doublets and vortices - Images - Milne-Thomson circle theorem and applications - Blasius theorem and applications.

Unit IV: 13hrs

Motion of Viscous fluids:- Stress tensor – Navier-Stokes equation - Energy equation - Simple exact solutions of Navier-Stokes equation: (i) Plane Poiseuille and Hagen- Poiseuille flows (ii) Generalized plane Couette flow (iii) Steady flow between two rotating concentric circular cylinders (iv) Stokes's first and second problems. Diffusion of vorticity - Energy dissipation due to viscosity.

Reference Books:

1. D.S. Chandrasekharaiah and L. Debnath: Continuum Mechanics, Academic Press, 1994.
2. A.J.M. Spencer: Continuum Mechanics, Longman, 1980.
3. S. W. Yuan : Foundations of Fluid Mechanics, Prentice Hall, 1976.
4. P. Chadwick : Continuum Mechanics, Allen and Unwin, 1976.
5. L.E. Malvern : Introduction to the Mechanics of a Continuous Media, Prentice Hall,1969.
6. Y.C. Fung, A First course in Continuum Mechanics, Prentice Hall (2nd edition), 1977.
7. Pijush K. Kundu, Ira M. Cohen and David R. Dowling, Fluid Mechanics, Fifth Edition , 2010.
8. C.S.Yih : Fluid Mechanics, McGraw-Hill, 1969.

Sub Code: **MS17MT216**	**PYTHON PROGRAMMING and SPSS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objective:

1. To introduce students to the features of R.
2. To enable the students to write simple scripts using control structures and conditons.
3. To enable the students to create graphical representations
4. To enable students to perform regression analysis

Course Outcomes:

After learning the course, the student will be able:

1.Explain the basic constructs in Python

2. Apply control structures in Python

3. Develop programs with lists , tuples lists, strings, sets and dictionaries.

4.Apply elementary techniques in Python programming

5.Apply decision and repetition structures in program design.

6. Build programs with simple algorithms

UNIT-I : 13 hrs

Introduction to Python The basic elements of python, Branching Programs, Control Structures, Strings and Input, Iteration , Functions, Scoping and Abstraction Functions and scoping, Specifications, Recursion, Global variables, Modules, Files, System Functions and Parameters

UNIT-II : **13 hrs**

Structured Types, Mutability and Higher-Order Functions Strings, Tuples, Lists and Dictionaries, Lists and Mutability, Functions as Objects, Testing, Debugging, Exceptions and Assertions Types of testing – Black-box and Glass-box, Debugging, Handling Exceptions

UNIT-III : 13 hrs

Classes and Object-Oriented Programming Abstract Data Types and Classes, Inheritance, Encapsulation and Information Hiding

UNIT-IV : **13 hrs**

Simple Algorithms and Data structures Search Algorithms, Sorting Algorithms, Hash Tables

Reference Books:

1. John V Guttag. "Introduction to Computation and Programming Using Python", Prentice Hall of India
2. R. Nageswara Rao, "Core Python Programming", dreamtech
3. Wesley J. Chun. "Core Python Programming - Second Edition", Prentice Hall
4. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in Pyhon", Wiley
5. Kenneth A. Lambert, "Fundamentals of Python – First Programs", CENGAGE Publication
6. Luke Sneeringer, "Professional Python", Wrox "Hacking Secret Ciphers with Python", Al Sweigart, URLhttps://inventwithpython.com/hacking/chapter

III SEMESTER

Sub Code: **MS17MT301**	**TOPOLOGY**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objective:

1. To explore the foundations of mathematics (logic and set theory) at a level and depth appropriate for someone aspiring to study higher-level mathematics and/or to become a professional mathematician.
2. To present an introduction to the field of topology, with emphasis on those aspects of the subject that are basic to higher mathematics.
3. To introduce the student to what it means to do mathematics, as opposed to learning about mathematics or to learning to do computational exercises.

Course Outcomes: After the completion of the course, students will

1. Explain the Basic of Topology
2. Identify different types of Topologies
3. Analyze the Connectedness and compactness
4. Prove different Axioms and Theorems by Urysohn's concepts and Tychonoff's results

UNIT-I: Topological Spaces **13 hrs**

Basic Concepts , The Metric Topology, Interior Points, Limit Points, Boundary Points, Closure of a Set , Hausdorff Topological Spaces, Continuous Functions .

UNIT-II: Product and Quotient Spaces **13hrs**

Product Space, Connected Spaces , Connected Subsets of the Real Line, Some Properties of Connected Spaces, Connected Components

UNIT-III: Connected Topological Spaces **13 hrs**

Compact Spaces and Related Results, Local Compactness , One Point Compactification of a Topological Space (X,J) , Tychonoff Theorem for Product Spaces

UNIT-IV: Countability and Separation Axioms **13 hrs**

First and Second Countable Topological Spaces , Properties of First Countable Topological Spaces , Regular and Normal Topological Spaces , Urysohn Lemma, Tietze Extension Theorem, Baire Category Theorem, Urysohn Metrization Theorem

Reference Books

1. J.R. Munkres,*Topology*, Second Edition, Prentice Hall of India, 2007.
2. Simmons,G.F. *Introduction to topology and modern analysis*, Tata McGraw Hill, 1963.
3. Dugundji,J. *Topology*, Prentice Hall of India, 1966.
4. Willard, *General topology*, Addison-Wesley, 1970.
5. Crump, W. Baker, *Introduction to topology*, Krieger Publishing Company, 1997.
6. Topology Without Tears by “SIDNEY A MORRIS’,VERSION OF Feb 23, 2018

Sub Code: **MS17MT302**	**MAGNETO HYDRODYNAMICS**	C	L	T	P		CH
Duration: 14 Weeks		4	3	1	0		5

Course Objectives:

1. This course helps the students to understand the basic concepts of heat transfer, types of convection shear and thermal instability of linear and non-linear problems, dimensional analysis.
2. The flow problems are analyses using finite element method.

Course Outcomes:

1. Understand both flow physics and mathematical properties of governing Navier-Stokes equations and define proper boundary conditions for solution.
2. An introduction to the theory and practice of the finite element method. Experience with writing a simple finite element solver for an ordinary differential equation.
3. Understanding of physics of compressible and incompressible fluid flows.
4. Ability to solve the fluid flow equations using Finite element method.

Unit I: **13hrs**

Review of partial differential equations, numerical analysis, fluid mechanics. Finite Difference Methods: Derivation of finite difference methods, finite difference method to parabolic, hyperbolic and elliptic equations, finite difference method to nonlinear equations, coordinate transformation for arbitrary geometry.

Unit II: **13hrs**

Central schemes with combined space-time discretization-Lax-Friedrichs, Lax-Wendroff, MacCormack methods, Artificial compressibility method, pressure correction method – Lubrication model, Convection dominated flows – Euler equation – Quasilinearization of Euler equation, Compatibility relations, nonlinear Burger equation.

Unit III: **13hrs**

Finite Volume Methods: General introduction, Node-centered-control volume, Cell-centered-control volume and average volume, Cell-Centred scheme, Cell-Vertex scheme, Structured and

Unstructured FVMs, Second and Fourth order approximations to the convection and diffusion equations (One and Two-dimensional examples).

Unit IV: **13hrs**

Finite Element Methods: Introduction to finite element methods, one-and two-dimensional bases functions – Lagrange and Hermite polynomials elements, triangular and rectangular elements, Finite element method for one-dimensional problem: model boundary value problems, discretization of the domain, derivation of elemental equations and their connectivity, composition of boundary conditions and solutions of the algebraic equations. Finite element method for two-dimensional problems: model equations, discretization, interpolation functions, evaluation of element matrices and vectors and their assemblage.

REFERENCE BOOKS

1. T. J. Chung: 'Computational Fluid Dynamics', Cambridge Univ. Press, 2003.
2. J Blazek, ' Computational Fluid Dynamics', Elsevier, 2001.
3. Harvard Lomax, Thomas H. Pulliam, David W Zingg, 'Fundamentals of Computational Fluid Dynamics', NASA Report, 2006.
4. C.A J. Fletcher: 'Computational techniques for Fluid Dynamics', Vol. I & II, Springer Verlag 1991.

Sub Code: **MS17MT303**	**FUNCTIONAL ANALYSIS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. To understand the concepts of linear transformation, isomorphism, normed linear space and Banach space.
2. To familiarize about open mapping theorem, closed graph theorem and uniform boundedness theorem.
3. To understand the concepts of Hilbert spaces, Schwarz inequality, conjugate space, finite dimensional spectral theory.

Course Outcomes:

1. Analyze the concepts of linear transformation, isomorphism, normed linear space and Banach space.
2. Analyze the concept of open mapping theorem, closed graph theorem and uniform boundedness theorem.
3. Analyze the concepts of Hilbert spaces, Schwarz inequality, parallelogram law, Bessel inequality.
4. Analyze the concept of conjugate space, finite dimensional spectral theory.

Unit-I: **13 hrs**

Normed linear spaces, Banach spaces, continuous linear transformations, isometric isomorphisms, functionals and the Hahn-Banach theorem, the natural embedding of a normed linear space in its second dual

Unit-II: **13 hrs**

The open mapping theorem and the closed graph theorem, the uniform boundedness theorem, the conjugate of an operator 12 hrs

Unit-III: **13 hrs**

Inner products, Hilbert spaces, Schwarz inequality, parallelogram law, orthogonal complements, orthonormal sets, Bessel's inequality, complete orthonormal sets 12 hrs

Unit-IV: **13 hrs**

The conjugate space, the adjoint of an operator, self-adjoint, normal and unitary operators, projections, finite dimensional spectral theory. 12 hrs

ReferenceBooks :

1. G.F. Simmons, Introduction to topology and modern Analysis, Reprint, Tata McGraw-Hill, 2004
2. K. Yoshida, Functional analysis, 6th ed., Springer, 1996.
3. E. Kreyszig, Introductory functional analysis with applications, 1st ed., John Wiley, 1978.
4. B.V. Limaye, Functional analysis, 2nd ed., New Age International, 1996.
5. W. Rudin, Functional analysis, 2nd ed., McGraw Hill, 2010.
6. S. Karen, Beginning functional analysis, Reprint, Springer, 2002.

Sub Code: **MS17MT314**	**COMPUTATIONAL FLUID DYNAMICS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objective:

1. Explains the basic concepts of heat transfer, types of convection, thermal instability of linear and non-linear problems, dimensional analysis.
2. Flow problems are analysed using finite element method.

Course Outcome:

1. Apply the concepts of Finite Difference method to solve various types of Partial Differential Equations.
2. Analyze the concepts of physics of compressible and incompressible fluid flows.
3. Apply finite volume method to solve the fluid flow equations.
4. Apply finite element method to solve one- dimensional and two-dimensional problems

Unit I: **13hrs**

Review of partial differential equations, numerical analysis, fluid mechanics. Finite Difference Methods: Derivation of finite difference methods, finite difference method to parabolic, hyperbolic and elliptic equations, finite difference method to nonlinear equations, coordinate transformation for arbitrary geometry.

Unit II: **13hrs**

Central schemes with combined space-time discretization-Lax-Friedrichs, Lax-Wendroff, MacCormack methods, Artificial compressibility method, pressure correction method – Lubrication model, Convection dominated flows – Euler equation – Quasilinearization of Euler equation, Compatibility relations, nonlinear Burger equation.

Unit III: **13hrs**

Finite Volume Methods: General introduction, Node-centered-control volume, Cell-centered-control volume and average volume, Cell-Centred scheme, Cell-Vertex scheme, Structured and

Unstructured FVMs, Second and Fourth order approximations to the convection and diffusion equations (One and Two-dimensional examples).

Unit IV: **13hrs**

Finite Element Methods: Introduction to finite element methods, one-and two-dimensional bases functions – Lagrange and Hermite polynomials elements, triangular and rectangular elements, Finite element method for one-dimensional problem: model boundary value problems, discretization of the domain, derivation of elemental equations and their connectivity, composition of boundary conditions and solutions of the algebraic equations. Finite element method for two-dimensional problems: model equations, discretization, interpolation functions, evaluation of element matrices and vectors and their assemblage.

REFERENCE BOOKS

1. T. J. Chung: 'Computational Fluid Dynamics', Cambridge Univ. Press, 2003.
2. J Blazek, ' Computational Fluid Dynamics', Elsevier, 2001.
3. Harvard Lomax, Thomas H. Pulliam, David W Zingg, 'Fundamentals of Computational Fluid Dynamics', NASA Report, 2006.
4. C.A J. Fletcher: 'Computational techniques for Fluid Dynamics', Vol. I & II, Springer Verlag 1991.

Sub Code: **MS17MT324**	**Statistical Methods – III**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1) Distinguish between observational studies and controlled experiments.
2) Determine basic sampling schemes (simple random sampling, stratified sampling, census versus sample), their strengths and weaknesses.
3) Analyze sources of potential bias in study designs and strategies for reducing those biases. Issues include sampling and non-sampling bias, confounding lurking variables spuriousness and statistical control.
4) Interpret numerical statistics and graphical summaries of data.
5) Analyze how a study could be changed to allow conclusions about causation.

Course Outcomes:

By completing this course the student will learn to perform the following:

1. Analyse the basic concepts and application of sampling theory

2. Analyse different types of sampling methods.

3. Apply sampling theory to the area of demography

4.Apply time-series analysis concept to solve statistical problems.

UNIT – I: **13 hrs**

Basic concepts of sampling: Population, Sample, Sampling unit, Sampling frame, Complete enumeration survey, Sample Survey, Random number tables, Sampling errors, Non-sampling errors and sources, Important aspects at the planning stage of sample surveys, Role of Central Statistical Organization (CSO) and National Sample Survey Organization (NSSO).Simple random sampling with and without replacements, Estimation of population -mean, total and proportion in SRS without replacement and variances of these estimates. Determination of sample size in sampling from attribute data and variable data.

UNIT – II: **13 hrs**

Stratified random sampling, estimation of population – mean, total, proportion and variances of these estimates, Allocation problems in stratified sampling, Gain in precision due to stratification. Determination of sample size in proportional and Neyman allocations. Systematic sampling, Variance of the estimated mean, concept of circular systematic sampling. Cluster sampling with equal cluster sizes, Variance of estimated mean, Optimum cluster size for fixed cost.

UNIT- III: **13 hrs**

Demography: Source of Demographic data, measurement of mortality: CMR, ASDR, IMR, and MMR. Fecundity and fertility. Measurement of fertility: CBR, ASFR, GFR and TFR. Production rates: NPR, GRR. Life tables: components of life table, force of mortality and expectation of life, construction of life table, uses of a life table, population projection using logistic curve.

UNIT-IV: **13 hrs**

Time Series Analysis: Components of time series, addictive and multiplicative models. Measurement of trend by moving averages and by least squares. Construction of seasonal indices by simple averages and ratio to moving averages.
Index Numbers: Introduction, price and quality IN. Construction of IN: simple and weighted methods. Tests for consistency of IN, CPI, problems involved in the construction of general and CPI numbers. Uses and Limitations.

Recommended Books:

1.Anderson, T.W (1983), An introduction to Multivariate Statistical Analysis, Wiley, 2nd Edition.
2.Rao, C.R (1973), Linear Statistical Inference and its applications, 2nd edition, Wiley
3.Srivastava. M.S and Khatri, C.G (1979), An introduction to Multivariate Statistics, North Holland
4.Morrison,F(1985): Multivariate Statistical Methods, Mc Graw Hill Book Company.
5.Johnson A.R and Wishern, D.W (1996), Applied Multivariate Statistical Analysis, Prentice Hall of India
6.Sharma, S (1996), Applied Multivariate Techniques, Wiley.
7.Krishisagar, A.M (1972), Multivariate Analysis, Marcel Dekker
8.K.C. Bhuyan(2005): Multivariate Analysis and its Applications, Central

IV Semester

Sub Code: **MS17MT411**	**CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. To understand the concept of integral equations.
2. To understand and solve the applications related problems such as classical mechanics and differential equations.

Course Outcomes:

1. Apply the Euler's equation to solve geodesics and Brachistochrone problem with boundary conditions.
2. Analyse different types of advanced variational problems.
3. Analyze the concepts of linear integral equations with applications.
4. Apply different methods of solution of linear integral equations

Unit-I **13hrs**

Euler equations and variationalnotations: Maxima and minima, method of Lagrange multipliers, the simplestcase, Euler equation, extremals, stationary function, geodesics,Brachistochrone problem, natural boundary conditions and transitionconditions, variational notation, the more general case.

Unit-II **13hrs**

Advanced variational problems: Constraints and Lagrange multipliers, variable end points, Sturm-Liouville problems, Hamilton's principle, Lagrange's equation, theRayleigh-Ritz method.

Unit-III **13hrs**

Linear integral equations: Definitions, integral equation, Fredholm and Volterra equations,kernel of the integral equation, integral equations of different kinds,relations between differential and integral equations, symmetrickernels, the Green's function.

Unit-IV **13hrs**

Methods for solutions of linearintegral equations: Fredholm equations with separable kernels, homogeneous integralequations, characteristic values and characteristic functions ofintegral equations, Hilbert-Schmidt theory, iterative methods forsolving integral equations of the second kind, the Neumann series.

Reference Books:

1. F.B. Hildebrand, Methods of Applied Mathematics, New York:Dover, 1992.
2. B. Dacorogna, Introduction to the Calculus of Variations,London: Imperial College Press, 2004.
3. F. Wan, Introduction to the Calculus of Variations and ItsApplications, New York: Chapman/Hall, 1995.
4. J. Jost and X. Li-Jost, Calculus of Variations, Cambridge:Cambridge University Press, 1998.
5. R.P. Kanwal, Linear Integral Equations: Theory andTechniques, New York: Birkhäuser, 2013.
6. C. Corduneanu, Integral Equations and Applications,Cambridge: Cambridge University Press, 2008.
7. A.J.Jerry, Introduction to Integral Equations with Applications,2nd ed., New York, John Wiley & Sons, 1999.

Sub Code: **MS17MT421**	**MEASURE THEORY**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. Students will gain an understanding of the Lebesgue measure in limit, sets, and functions.
2. Students will study the Lebesgue integration on measurable functions and measurable non negative functions.
3. Students will study the Lebesgue integration on monotone functions, differentiation of monotone functions, and absolutely continuous functions.

4. Student will read and analyse the Linear space on inequalities, approximation, separations, and convex functions.

Course Outcomes:

1. Analyze the concept of Lebesgue measurable theory for sets and functions.

2. Apply the concept of Lebesgue Integration for Riemann Integrals, the general Lebesgue integral and convergence.

3. Apply the concept of Lebesgue integration for monotone function, differentiation of monotone function and integral derivatives.

4. Analyze the concept of linear space in different theorem, sequential convergence, compactness, and minimization of convex functional.

Unit-I: **13hrs**

Lebesgue Measure: Lebesgue Outer Measure, The s-Algebra of Lebesgue measurable Sets, Outer and Inner Approximation of Lebesgue Measurable Sets,Countable Additivity, Continuity and the Borel-Cantelli Lemma, Nonmeasurable Sets, The Cantor Set and the Canton-Lebesgue Function,

Unit-II: **13hrs**

Sums, Products and Compositions of Lebesgue Measurable Functions, Sequential Pointwise Limits and Simple Approximation, Littlewood's three principles, Egoroff's Theorem and Lusin's Theorem.

Unit III: **13hrs**

The Lebesgue Integration

The Riemann Integral; The Lebesgue Integral of a Bounded Measurable Function over a Set of Finite Measure, The Lebesgue Integral of a Measurable Nonnegative Function; The General Lebesgue Integral; Countable Additivity and Continuity ofIntegration, Uniform Integrability, Uniform Integrability and Tightness, Convergence in measure, Characterizations of Riemann and Lebesgue Integrability.

Unit IV: **13hrs**

Differentiation and Lebesgue Integration: Continuity of Monotone Functions, Differentiation of Monotone Functions, Functions of Bounded Variation, Absolutely Continuous Functions, Integrating Derivatives.

Reference Books:

1. Springer, 2014. M.E. Munroe, "Introduction to measure and integration" Addison Wesley, 1959.
2. G. de Barra, "Measure theory and integration", New Age, 1981.
3. P.K. Jain and V.P. Gupta, "Lebesgue measure and integration", New Age, 1986.
4. F. Morgan, "Geometric measure theory – A beginner's guide", Academic Press, 1988.
5. F. Burk, "Lebesgue measure and integration: An introduction", Wiley, 1997.
6. D.H. Fremlin, "Measure theory", Torres Fremlin, 2000.

Sub Code: **MS17MT402**	**NUMERICAL ANALYSIS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. The course will also develop an understanding of the elements of error analysis for numerical methods and certain proofs.
2. The course will further develop problem solving skills.

3. Derive appropriate numerical methods to solve a linear system of equations.

Course Outcomes:

1. Solve the non-linear equations in one variable using different numerical techniques
2. Analyze the different types of interpolation methods
3. Analyze the different types of errors and stability methods.
4. Solve partial differential equations using various numerical methods

Unit-I: **13hrs**

Numerical Solutions of Nonlinearsystem of Equations: Fixed points for functions of several variables, Newton's Method,Quasi-Newton methods, Homotopy and Continuation Methods.

Unit-II **13hrs**

Initial value problems for OrdinaryDifferential Equations: Solution by Runge-Kutta Fehlberg method, Runge-Kutta- Gillmethod. Solutions of higher order differential equations and systemof differential equations by Runge-Kutta methods.

Unit-III **13hrs**

Boundary value problems for OrdinaryDifferential Equations: Linear Shooting method, Shooting method for nonlinear Problems,Finite –difference methods for non-linear problems, Rayleigh-Ritz method.

Unit-IV **13hrs**

Modern methods for linear andnon-linear differential equations: Homotopy Perturbation method and Differential Transformsmethods.

Reference Books:

1. Richard L. Burden and J. Douglas Faires, Numerical Analysis,Fourth Edition, P.W.S. Kent Publishing Company, 2007.
2. S. J. Liao, Beyond Perturbations, 2. CRC Press, 2003.
3. R.L. Burden and J. Douglas Faires, Numerical Analysis, FourthEdition, P.W.S. Kent Publishing Company, 2007.
4. S.C. Chopra and P.C. Raymond, Numerical methods forengineers, Tata McGraw-Hill, 2000.
5. C.F. Gerald and P.O. Wheatley, Applied numerical methods,Pearson Education, 2002.
6. L. C. Andrews, and R. L. Philips, Mathematical Techniques forEngineers and Scientists, Prentice Hall of India, 2006.

Sub Code: **MS17MT403**	**Operations Research**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. To appropriately formulate sequencing problem for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Sequencing problems.
2. To appropriately formulate Integer Programming models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these IP problems.

3. To appropriately formulate Queuing models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Queuing problems.
4. To interpret and apply the results of an operations research model.
5. To communicate the results of an operations research project through a written report and an oral presentation.

Course Outcomes:

A student must demonstrate the ability to:
1. To apply the concepts of linear programming technique to solve system of linear equations.
2. Analyze different types of Integer programming problems (IPP)
3. Apply the concepts of LPP and IPP to solve game theory problems.
4. Analyze the concepts of probabilistic distribution queuing theory

.Unit I: **13 hrs**

Linear Programming: Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, simplex algorithms, revised simpler methods, duality in linear programming.

Unit II: **13 hrs**

INTER PROGRAMMING PROBLEMS: Introduction, Importance of IPP, Applications of IPP, Methods of IPP – Cutting Method. Mixed Integer Programming Problems, Branch and Bound Methods.

Unit III: **13 hrs**

Game Theory: The formulation of two persons, zero sum games, solving simple games- a prototype Example, games with mixed strategies, graphical solution procedure, and dominance rule, odd's method.

Sequencing Problems: Introduction, Definition, n-Jobs through 2-Machines, n-Jobs through 3-Machines, n-Jobs through k-Machines, 2-Jobs through k-Machines.

Unit IV: **13 hrs**

Queueing Theory : Essential Features of Queueing System - Operating Characteristic of Queueing System - Probabilistic Distribution in Queueing Systems - Classification of Queueing Models - Solution of Queueing Models - Probability Distribution of Arrivals and Departures.

Reference Books

1. J. K. Sharma, *Operations Research* Theory and Applications, Third Edition (2007), Macmillan India Ltd.
2. F.S. Hillier and J.Lieberman -,*Introduction to Operations Research* (8th Edition), Tata McGraw Hill Publishing Company, New Delhi, 2006.
3. Beightler. C, D.Phillips, B. Wilde, *Foundations of Optimization* (2nd Edition) Prentice Hall Pvt Ltd., New York, 1979
4. Bazaraa, M.S; J.J.Jarvis, H.D.Sharall, *Linear Programming and Network flow,* John Wiley and sons, New York 1990.
5. Gross, D and C.M.Harris, *Fundamentals of Queueing Theory*, (3rd Edition), Wiley and Sons, New York, 1998.
6. Hamdy A. Taha ,*Operations Research* (sixth edition), Prentice - Hall of India Private Limited, New Delhi.

Sub Code: **MS17MT414**	**MATHEMATICAL METHODS**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. The course will also develop an understanding of the elements of error analysis for numerical methods and certain proofs.
2. The course will further develop problem solving skills.
3. Derive appropriate numerical methods to solve a linear system of equations.

Course Outcomes:

1. Apply various transforms to solve typical mathematical problems.
2. Apply the integral equations to solve IVP, BVP and eigen value problems.
3. Solve problems related with asymptotic expansions.
4. Adapt regular, singular perturbation and irregular singular perturbation methods to solve differential equations.

Unit I: **13 hrs**

Integral Transforms**:** General definition of Integral transforms, Kernels, etc. Development of Fourier integral, Fourier transforms – inversion, Illustration on the use of integral transforms, Laplace, Fourier, Hankel and Mellin transforms to solve ODEs and PDEs - typical examples. Discrete orthogonality and Discrete Fourier transform. Wavelets with examples, wavelet transforms.

Unit II: **13 hrs**

Integral Equations: Definition, Volterra and Fredholm integral equations. Solution by separable kernel, Neumann's series resolvent kernel and transform methods, Convergence for Fredholm and Volterra types. Reduction of IVPs BVPs and eigenvalue problems to integral equations. Hilbert Schmidt theorem, Raleigh Ritz and Galerkin methods.

Unit III: **13 hrs**

Asymptotic expansions : Asymptotic expansion of functions, power series as asymptotic series, Asymptotic forms for large and small variables. Uniqueness properties and Operations. Asymptotic expansions of integrals; Method of integration by parts (include examples where the method fails), Laplaces method and Watson's lemma, method of stationary phase and steepest descent.

Unit IV: **13 hrs**

Regular and singular perturbation methods: Parameter and co-ordinate perturbations. Regular perturbation solution of first and second order differential equations involving constant and variable coefficients. Include Duffings equation, Vanderpol oscillator, small Reynolds number flow. Singular perturbation problems, Matched asymptotic expansions, simple examples. Linear equation with variable coefficients and nonlinear BVP's. Problems involving Boundary layers. Poincare – Lindstedt method periodic solution. WKB method, turning points, zeroth order Bessel function for large arguments, solution about irregular singular points.

REFERENCE BOOKS

1. I.N. Sneddon – The use of Integral Transforms, Tata Mc Graw Hill, New Delhi, 1974.
2. R.P. Kanwal: Linear integral equations theory and techniques, Academic Press, New York, 1971.
3. C.M. Bender and S.A. Orszag – Advanced mathematical methods for scientists and engineers, Mc Graw Hill, New York, 1978.
4. H.T. Davis – Introduction to nonlinear differential and integral equations, Dover Publications, 1962.
5. A.H. Nayfeh – Perturbation Methods, John Wiley & sons New York, 1973
6. Don Hong, J. Wang and R. Gardner. Real analysis with introduction to wavelets and applications, Academic Press Elsevier (2006)

Sub Code: **MS17T424**	**DIFFERENTIAL GEOMETRY**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objective:

1.To understand the basic concepts of geometry of curves and surfaces in Euclidean space.
2. To familiarize with the quantities of some geometric interest.
3. To familiarize with calculus on surfaces.

4. To understand the concept of curvatures and special curves in a surface

Course Outcomes:

1) Discuss the basic concepts of geometry of curves and surfaces in Euclidean space.
2) Discuss properties and geometric interpretation of some quantities.
3) Explain calculus on surfaces.
4) Apply computational techniques for the curvatures and special curves in a surface.

Unit I: **13hrs**

Calculus on Euclidean Space: Euclidean space. Natural coordinate functions. Differentiable functions. Tangent vectors and tangent spaces. Vector fields. Directional derivatives and their properties. Curves in E3. Velocity and speed of a curve. Reparametrization of a curve. 1-forms and Differential forms. Wedge product of forms. Mappings of Euclidean spaces. Derivative map.

Unit II: **13hrs**

Frame Fields**:**Arc length parametrization of curves. Vector field along a curve. Tangent vector field, Normal vector field and Binormal vector field. Curvature and torsion of a curve. The Frenet formulas Frenet approximation of unit speed curve and Geometrical interpretation. Properties of plane curves and spherical curves. Arbitrary speed curves. Cylindrical helix Covariant derivatives and covariant differentials. Cylindrical and spherical frame fields. Connection forms. Attitude matrix. Structural equations. Isometries of E3 **-** Translation, Rotation and Orthogonal transformation. The derivative map of an isometry.

Unit III: **13hrs**

Calculus on a Surface: Coordinate patch. Monge patch. Surface in E3. Special surfaces- sphere, cylinder and surface of revolution. Parameter curves, velocity vectors of parameter curves, Patch computation. Parametrization of surfaces- cylinder, surface of revolution and torus. Tangent vectors, vector fields and curves on a surface in E3. Directional derivative of a function on a surface of E3. Differential forms and exterior derivative of forms on surface of E3. Pull back functions on surfaces of E3.

Unit IV: **13hrs**

Shape Operators: Definition of shape operator. Shape operators of sphere, plane, cylinder and saddle surface. Normal curvature, Normal section. Principal curvature and principal direction. Umbilic points of a surface in E3. Euler's formula for normal curvature of a surface in E3. Gaussian curvature, Mean curvature and Computational techniques for these curvatures. Minimal surfaces. Special curves in a surface of E3 **-** Principal curve, geodesic curve and asymptotic curves. Special surface **-** Surface of revolution.

REFERENCE BOOKS:

1. Barrett O' Neil : Elementary Differential Geometry. Academic Press, New York and London, 1966
2. T.J.Willmore : An introduction to Differential Geometry. Clarendon Press, Oxford 1959.
3. D.J.Struik : Lectures on Classical Differential Geometry, Addison Wesley, Reading, Massachusetts, 1961.
4. Nirmala Prakassh: Differential Geometry- an integrated approach. Tata McGraw-Hill, New Delhi, 1981.

Sub Code: **MS17MT416**	**FUZZY SET AND FUZZY LOGIC**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objectives:

1. Students will study the fuzzy sets, basic operation on fuzzy sets, inverse and image fuzzy operations.
2. Students will study fuzzy relation and fuzzy graph
3. Student will read and analyse the fuzzy sets and fuzzy logic on possibility theory and probability theory.

Course Out comes:

At the end of the course, students should:

1. Analyze the concept of fuzzy set and fuzzy logic using fuzzy operations.
2. Apply the fuzzy operations on functions, relations and fuzzy graph.
3. Analyze possibility theory, fuzzy measure and possibility theory verses probability theory.
4. Apply the operation of fuzzy sets on fuzzy reasoning, fuzzy system and pattern recognition.

Unit - I: 13 hrs

Fuzzy sets - Basic definition a -level sets. Convex fuzzy sets. Basic operations Fuzzy sets. Type of Fuzzy sets. Cartesian products. Algebraic products. Bounded sum and difference t-norms and t-conorms. The extension Principle- The Zadeh's extension principle image and inverse image of Fuzzy arithmetic.

Unit - II: 13 hrs

Fuzzy Relation and Fuzzy Graphs-Fuzzy equivalence equations. Fuzzy graphs, Similarity relation.

Unit - III: 13 hrs

Possibility theory-Fuzzy measures, Evidence theory necessity measure, Possibility theory versus probability theory.

Unit-IV: 13 hrs

Constructing Fuzzy sets and operations on Fuzzy sets. Approximate reasoning. Fuzzy System. Pattern Recognition

Reference Books:

1. Fuzzy set theory and its application allied publisher rd New Delhi - 1991 - U. Z. Zimmermann
2. Fuzzy set and fuzzy logic prentice Hall of Indi New Delhi 1995- G J Klir& Bo Yuan
3. Fuzzy logic in Engineering applications by Timothy J Ross Introduction to Fuzzy Sets, Fuzzy Logic, and Fuzzy Control Systems by Guanrong Chen, Trung Tat Pham

Sub Code: **MS17MT426**	**Advanced Graph theory**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Outcomes

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

1. a. Analyze the concept of matching to estimate the bond lengths.
   b. Analyze the concept of matching to solve TSP.
2. a. Connect the concept of connectivity to solve utility problems, mapping problems.
   b. Connect the concept of planarity to solve 2D circuit problem (minimizing the number of intersection of wires).
3. Connect the concept of domination to solve routing problem, locating radar station problem.
4. Analyze and connect the concept of colorability to solve Sudoku problem, mobile frequency assignment problem.

Module – 1 Matchings and Factors **15 Hrs**

Matching, Maximum Matchings, Hall's Matching Condition, Hall's Theorem, Min – Max Theorem, Independent Sets and Covers, Maximum Bipartite Matching, Weighted Bipartite Matching, Tutte's 1- Factor Theorem, Partition – Degree Sequence, Havel's and Hakimi Algorithms and graphical related problems.

Module – 2 Advanced Digraph theory **14 Hrs**

Acyclic Digraph, Multipartite Digraphs, Transitive Digraphs, Line Digraphs, Series-Parellel Digraphs, Quasi-Transitive Digraphs, Path-Mergeable Digraphs, Locally Semicomplete Digraphs, Planar Digraphs.

Module – 3 Domination in Graphs **13 Hrs**

Domination in Graphs, Bounds in terms of order, Bounds in terms of size, Bounds interms of Degree, Diameter and Girth, Bounds in terms of Independence and Covering, Domatic Number.

Module – 4 Chromatic Graph Theory **10 Hrs**

T – Colorings, L(2,1)-Colorings, Radio Colorings, Hamiltonian Colorings, Domination and Colorings(aplications).

Text Books and Reference

1. D. B West, Introduction to Graph Theory, New Delhi, Prentice – Hall of India, 2011.
2. T.W. Haynes, S.T. Hedetniemi and P.J. Slater, Fundamentals in Domination in Graphs, New York: Dekker, Inc., 1998
3. J.. Bang – Jensen and G. Gutin, Digraphs. London: Springer,2009.
4. G. Charrtand and P. Zhang, Chromatic Graph Theory, New York: CRC Press, 2009

Sub Code: **MS17MT307**	**Optimization Techniques**	C	L	T	P	CH
Duration: 14 Weeks		4	0	0	0	4

Course Objectives:
1. To learn engineering applications and formulation of optimization problems.
2. To learn various optimization techniques.
3. To learn the geometry and standard form of linear programming problems.
4. To learn various methods of non-linear programming to compute structural engineering problems.
5. To learn geometric and dynamic programming
6. To formulate and obtain the solution of structural optimization problems by different techniques.

Course Outcomes: At the end of the course, the student
1. Has learnt engineering applications and formulation of optimization problems
2. Has learnt various optimization techniques
3. Has learnt the geometry and standard form of linear programming problems
4. Has learnt various methods of non-linear programming to compute structural engineering problems.
5. Has learnt geometric and dynamic programming
6. Is able to formulate and obtain the solution of structural optimization problems by different techniques.

Course Contents:

Unit 1

Introduction: Introduction to optimization, engineering applications of optimization, Formulation of structural optimization problems as programming problems.

Optimization Techniques: Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimization solutions by penalty function techniques, Lagrange multipliers techniques and feasibility techniques.

Unit 2

Linear Programming: Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, simplex algorithms, revised simpler methods, duality in linear programming.

Unit 3

Non-linear programming: Non-linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic and cubic methods, Unconstrained optimization methods, direct search methods, random search methods, descent methods.

Constrained optimization techniques such as direct methods, the complex methods, cutting plane method, exterior penalty function methods for structural engineering problems.

Unit 4

Game Theory:

The formulation of two persons, zero sum games, solving simple games- a prototype Example, games with mixed strategies, graphical solution procedure, and dominance rule, odd's method.

Sequencing Problems:

Introduction, Definition, n-Jobs through 2-Machines, n-Jobs through 3-Machines, n-Jobs through k-Machines, 2-Jobs through k-Machines.

Structural Optimization and Geometric programming: Geometric programming, conversion of NLP as a sequence of LP/ geometric programming

Reference Books:

1. S.S Rao, **"Optimization – Theory and Practice"** – Wiley Eastern Ltd.
2. Uri Krisch, **"Optimum Structural Design"** – McGraw Hill.
3. Richard Bronson, **"Operation Research"** – Schaum's Outline Series.
4. Bhavikatti S S, **"Structural Optimization using sequential linear Programming"** – Vikas Publishing House.

Sub Code: **MS17MT308**	**CRYPTOGRAPHY**	C	L	T	P	CH
Duration: 14 Weeks		4	3	1	0	5

Course Objective:

To know the methods of conventional encryption.

1. To understand the concepts of public key encryption and number theory
2. To understand authentication and Hash functions.
3. To know the network security tools and applications.
4. To understand the system level security used.

Course Outcomes:

1. Understand the principles and practices of cryptographic techniques.
2. Understand the theory of fundamental cryptography, encryption, and decryption algorithms,
3. Understand a variety of generic security threats and vulnerabilities, and identify and analyse particular security problems for a given application.
4. Build simple cryptosystems by applying encryption algorithms,
5. Comprehend secure identity management (authentication), message authentication, and digital signature techniques.

Unit-I **13hrs**

INTRODUCTION

OSI Security Architecture - Classical Encryption techniques – Cipher Principles – Data Encryption Standard – Block Cipher Design Principles and Modes of Operation - Evaluation criteria for AES – AES Cipher – Triple DES – Placement of Encryption Function – Traffic Confidentiality

Unit-II **13hrs**

PUBLIC KEY CRYPTOGRAPHY

Key Management - Diffie-Hellman key Exchange – Elliptic Curve Architecture and Cryptography - Introduction to Number Theory – Confidentiality using Symmetric Encryption – Public Key Cryptography and RSA.

Unit-III **13hrs**

AUTHENTICATION AND HASH FUNCTION

Authentication requirements – Authentication functions – Message Authentication Codes – Hash Functions – Security of Hash Functions and MACs – MD5 message Digest algorithm - Secure Hash Algorithm – RIPEMD – HMAC Digital Signatures – Authentication Protocols – Digital Signature Standard

Unit-IV **13hrs**

SYSTEM LEVEL SECURITY

Intrusion detection – password management – Viruses and related Threats – Virus Counter measures – Firewall Design Principles – Trusted Systems.

Reference Books:

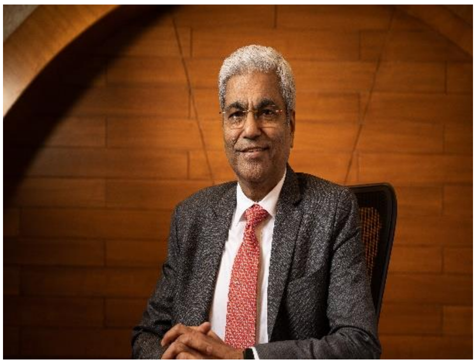
1. William Stallings, "Cryptography And Network Security – Principles and Practices", Pearson Education, 2011
2. Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill, 2003.
3. Bruce Schneier, "Applied Cryptography", John Wiley & Sons Inc, 2001.
4. Charles B. Pfleeger, Shari Lawrence Pfleeger, "Security in Computing", Third Edition, Pearson Education, 2003.

Registrar
REVA University
Bengaluru - 560 064

REVA
UNIVERSITY
Bengaluru, India

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 our future generation to be ethically, morally and intellectually elite. They practice the art of teaching with a student-centred 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

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 Centres” in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise.

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

Welcome to the portals of REVA University!

Dr. S. Y. Kulkarni,

Vice-Chancellor, REVA University

Director Message

At REVA, we aim to prepare you for life, be it in the case when you choose to enter the workforce in Science or pursue higher studies at the graduate level. REVA is poised to make its mark not only on the national level but as an internationally acclaimed university. We are striving to achieve this goal in years to come. Biotechnology assimilates in itself a number of disciplines. Biotechnology as a subject has grown rapidly and as far as employment is concerned it has become one of the fast-growing sectors. Maximum number of courses are integrated with cross cutting issues, relevance to professional ethics, gender, human values, environment and sustainability. The curriculum caters to and has relevance to local, national, regional and global developmental needs.

Employment record shows that biotechnology has a great scope in future. Biotechnologists can find careers with pharmaceutical companies, chemical, agricultural and allied companies. They can be employed in the areas of planning, production and management of bio-processing industries. There is a large scale employment in research laboratories run by the government as well as the corporate sectors. Further, there is great demand for biotechnology experts in numerous industries and sectors after the completion of MSc Biotechnology course, some of which are • Agriculture • Animal Husbandry • Environment Conservation • Genetic Engineering • Health Care • Medicine • Industrial Research and Development

I am sure the students choosing MSc Biotechnology at 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 a pleasant stay at REVA and grand success in their career.

Dr. Beena G
Director, School of Chemical and Biological Sciences

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 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 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.

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

The REVA University has also given utmost importance to develop the much required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and

Placement (CDC) department with world class infrastructure, headed by a dynamic experienced Professor & Dean, and supported by well experienced Trainers, Counselors and Placement Officers.

The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been 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, EMC2 , VMware, SAP, Apollo etc, to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreign universities also facilitates students to study some of the programs partly in REVA University and partly in foreign university, viz, M.S in Computer Science one year in REVA University and the next year in the University of Alabama, Huntsville, USA.

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

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat Ratna Prof. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr. Balaram, Former Director IISc., and noted Scientist, Dr. V S

Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of Defence Dr. Sathish Reddy, Scientific Advisor, Ministry of Defence, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

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 in presence of dignitaries, faculty members and students gathering and the first "REVA Life Time Achievement Award" for the year 2015 has been awarded to Shri. Kiran Kumar, Chairman ISRO on the occasion of Founder's Day Celebration, 6th January, 2016 and the second "REVA Life Time Achievement Award" for the year 2016 has been awarded to Shri. Shekhar Gupta, Renowned Journalist on the occasion of Founder's Day Celebration, 6th January, 2017.

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 11 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.

Vision

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

Mission

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

Objectives

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

ABOUT THE SCHOOL OF CHEMCIAL & BIOLOGICAL SCIENCES
Department of Biotechnology

The School of Chemical and Biological Sciences has been recently started and offers graduate and post graduate programs which are incredibly fascinating and practice oriented. 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. in BioChemistry, M.Sc. in Bio-Technology. The School also facilitates research leading to PhD in Chemical and Biological disciplines.

Vision

To Impart contemporary knowledge in various socially relevant disciplines to students and transforming them to become global citizens by nurturing intellect, creativity, character and professionalism.

Mission

To achieve excellence through pedagogy, support interface between industry and academy through research in order to help students achieve creative and professional outlook to make them global citizens.

Objectives:

- This program aims to provide the required skills and knowledge necessary to pursue a successful career in Biotechnology.
- The program is suitable for applicants who have a primary degree in Biological Sciences and wish to take up a career in manufacturing, quality assurance, product development and research, as well as in the broader sectors of sales & marketing.
- Impart need based, practical education and global competence in contemporary life sciences and engineering knowledge in accordance with the vision of REVA University.
- Create leaders in the field of Life Sciences and professional Engineers by encouraging scientific thinking, novel ideas and creativity among students.
- The program provides hands- on training and practical skills in the field of Plant & Agricultural biotechnology, Molecular genetics, Bioinformatics, Biochemical techniques & Enzymology, Medical biotechnology, Genetic Engineering and Molecular biology, with aligning to current

demand in the field of research & industry.

- Foster growth, innovation, research and to promote entrepreneurship.

VALUES

• Excellence in all our academic and research endeavours

• Dedication and service to our stakeholders

• Leadership through innovation

• Accountability and transparency

• Creating conducive academic environment with service motto

• Integrity and intellectual honesty

• Ethical and moral behaviour

• Freedom of thought and expression

• Adaptability to the change

• Team-work

“The constant questioning of our values and achievements is a challenge without which neither science nor society can remain healthy.’

― Aage Niels Bohr

BOS MEMBERS

Name and Position	
Prof.Dr. Padma Thiagarajan Professor (Higher Academic Grade) School of BioSciences and Technology (SBST) Vellore Institute of Technology Vellore, Tamil Nadu	
Dr.NellaiahHariharan Head, R & D and Training, Bangalore Biotech Labs. Pvt. Ltd. (BiOZEEN) Bengaluru, Karnataka	
Mr.KumarShankaran Founder, Leucine Rich Bio Private Limited Bengaluru, Karnataka	

Program Overview

M. Sc. (Biotechnology) at REVA UNIVERSITY has been designed to meet the human resources needs of existing and futuristic biotech industries, biotech research organizations 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 biotech industries, research organization and academic institutions. The programme also provides sufficient skills and training on entrepreneurship development in Biotechnology. The programme deals with courses on cell biology, micro biology, genetic engineering, biochemistry; medical, animal and environmental biotechnology, biochemical techniques and processes, entrepreneurship and many other related courses.

Program Educational Objectives (PEOs)

PEO-1	Become a professional B iotechnologist with strong ethics & communication skills.
PEO-2	Pursue research in reputed institutes at national & international level.
PEO-3	Establish consultancy services and to work as entrepreneur with an ability to develop new products/processes with an attitude of lifelong learning.

Program Outcomes (POs)

1. Science knowledge: Demonstrate of the knowledge in various domains of life sciences including healthcare considering public health and safety, and the cultural, societal, and environmental concerns.

2. **Problem analysis**: Identify, formulate and analyze problems related to the various domains of Biotechnology such as Environmental Biotechnology, Agricultural Biotechnology, Genetic Engineering and Nano Biotechnology.

3. **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.

4. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern technology for product/process development which in turn benefit the society.

5. Environment and sustainability: Understand and implement environmental friendly approaches in Biotechnology to support sustainable development.

6. **Ethics:** Apply ethical principles and commit to professional ethics, responsibilities and norms in Life Sciences.

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

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

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

10. **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 (PSO)

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

1. Describe, Design, Analyse and Test biotechnology products

2. Apply appropriate processes and control parameters in the production of biotechnology products
3. Use higher order critical, analytical skills to solve a new problem

Brief Summary of REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for MSc BT Program.

1.0 Teaching and Learning Process

The teaching and learning process under CBCS-CAGP of education in each course of study will have three components, namely-

(i) L= Lecture (ii) T= Tutorial (iii) P= Practice, where:

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

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

P stands for **Practice** session and it consists of Hands on Experience / Laboratory Experiments / Field Studies / Case Studies that equip students to acquire the much required skill component.

2.0 Course of Study and Duration:

The study of MSc BT program is grouped under various courses. Each of these course carries credits which are based on the number of hours of teaching and learning. In the teaching-learning process every **one hour session of L amounts to 1 credit per Semester.** In case of **T or P** minimum of **two hour session amounts to 1 credit or a three hour session amounts to 2 credits per semester of 16 weeks. The total duration of a semester is 20 weeks inclusive of semester-end examination.**

A course shall have either or all the three components. That means a course may have only lecture component, or only practical component or combination of any two or all the three components.

2.1. Various course of study are labeled and defined as: (i) Core Course (CC), (ii) Hard Core Course (HC), (iii) Soft Core Course (SC), (iv) Foundation Course (FC) and (v) Open Elective Course (OE).

(i) **Core Course (CC):** A course which should compulsorily be studied by a candidate as a core-requirement is termed as a Core course.

(ii) **Foundation Course (FC):**

The foundation Course is a core course which should be completed successfully as a part of graduate degree program irrespective of the branch of study.

(iii) **Hard Core Course (HC):**

The **Hard Core Course** is a Core Course in the main branch of study and related branch(es) of study, if any that the candidates have to complete compulsorily.

(iv) **Soft Core Course (SC):**

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

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

An elective course chosen generally from other discipline / subject, with an intention to seek exposure is called an O**pen Elective Course.**

2.2. Project Work:

Project work is a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem.

2.3. Minor Project:

A project work up to **FOUR to SIX** credits is called **Minor Project** work. A Minor Project work may be a hard core or a Soft Core as decided by the BoS / concerned.

2.4. Major Project / Dissertation:

A project work of **EIGHT, TEN, TWELVE or SIXTEEN** credits is called **Major Project** work. The Major Project / Dissertation shall be Hard Core.

3.0. Minimum Credits to be Earned:

3.1. A candidate has to earn 96 credits for successful completion of MSc Biotechnology degree with a distribution of credits for different courses as prescribed by the university.

3.2. A candidate can enrol for a maximum of 32 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.

3.3. Only such full time candidates who register for a minimum prescribed number of credits in each semester from I semester to VI semester and complete successfully 96 credits in 4 successive semesters shall be considered for declaration of Ranks, Medals, Prizes and are eligible to apply for Student Fellowship, Scholarship, Free-ship, and such other rewards / advantages which could be applicable for all full time students and for hostel facilities.

4.0. Add on Proficiency Diploma and Add on Proficiency Certification:

4.1. Add on Proficiency Diploma:

In excess to the minimum of 96 credits prescribed for M Sc in Biotechnology a candidate can opt to complete a minimum of 18 extra credits to acquire **add on proficiency diploma** in a particular discipline / subject in his / her subject of study or in other subjects / discipline along with the masters' degree.

4.2. **Add on Proficiency Certification:**

To acquire **add on proficiency certification** a candidate can opt to **earn a minimum of 4 extra credits** either in the field of Biotechnology or in different discipline(s) / subject(s) in addition to a minimum of 96 prescribed credits for the Masters degree program.

5. Scheme of Assessment & Evaluation for P G Degree Programs of TWO YEARS duration

5.1. The Scheme of Assessment and Evaluation will have two components, 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 PG programs shall carry 50 marks each (i.e., 50 marks internal assessment; 50 marks semester end examination).

5.3. The 50 marks of Internal Assessment (IA) shall comprise of:

Internal Test (2)	= 30 marks
Assignments (2)	= 10 marks
Seminars (2)	= 10 marks

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

- 1st test for 15 marks at the end of 5th week of the beginning of the Semester;
- 2nd test for 15 marks at the end of the 10th week of the beginning of the Semester; and
- 3rd test for 15 marks at the end of the 15th 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 of Second Unit of the Course;
- For the 2nd test it shall be 2nd half of Second Unit and Third 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 and two Seminars each carrying 5 marks each. Hence two assignments carry 10 marks (5+5 marks) and two seminars carry 10 marks (5+5 marks) as stated at Sl.No. 5.3 above.

5.8. The Semester End Examination (SEE) for 50 marks shall be held during 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. There shall be double evaluation, viz, first valuation by the internal teachers who have taught the subject and second evaluation shall be the external examiner.

5.11. The average of the two evaluations (internal examiner & external examiner) shall be the marks to be considered for declaration of results. However the difference between the marks awarded by the external and internal examiners shall not be more than 20%. In such cases where there is a difference of more than 20%, there shall be third valuation by the external examiner who has not valued the script, in which case the average of the marks awarded by the third valuer and nearest marks of the marks awarded by the first two examiners (internal and external) shall be considered for declaration of results.

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

Summary of Continuous 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	Second Part of 6th Week	First Unit and 1st half of Second Unit	15	Consolidation of First Unit and 1st half of Second Unit
Submission of Assignments	8th Week	First Unit and Second Unit	5	Instructional process and Continuous Assessment
Seminars	9th Week	First Unit and Second Unit	5	Instructional process and Continuous Assessment
Second Internal Test	2nd Part of 13th Week	2nd half of Second Unit and Third Unit	15	Consolidation of 2nd half of Second Unit and Third Unit
Allocation of Topic for 2nd Assignment / Seminars	11th Week	Third Unit and Fourth Unit		Instructional process and Continuous Assessment
Submission of Assignments	13th Week	Third Unit and Fourth Unit	5	Instructional process and Continuous Assessment
Seminars	14th Week	Third Unit and Fourth Unit	5	Instructional process and Continuous Assessment
Third Internal Test	2nd Part of 16th Week	Fourth Unit	15	Consolidation of entire Fourth Unit
Semester End Practical Examination	17th & 18th Week	Entire syllabus	50	Conduct of Semester - end Practical Exams
Preparation for Semester–End Exam	17th & 18th Week	Entire Syllabus		Revision and preparation for semester–end exam
Semester End Theory Examination	19th and 20th Week	Entire Syllabus	50	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 50 marks meant for continuous assessment of the performance in carrying out practical shall further be allocated as under:

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

6.3. The 50 marks meant for Semester End Practical Examination, shall be allocated as under:

I	Conduction of semester end practical examination	30 marks
Ii	Write up about the experiment / practical conducted	10 marks
iii	Viva Voce	10 marks
	Total	**50 marks**

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:

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:

i	Periodic Progress and Progress Reports (25%)

ii	Results of Work and Draft Report (25%)
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, he/she can approach the grievance cell with the written submission together with all facts, the assignments, test papers etc, which were evaluated. He/she can do so before the commencement of semester-end examination. The grievance cell is empowered to revise the marks if the case is genuine and is also empowered to levy penalty as prescribed by the university on the candidate if his/her submission is found to be baseless and unduly motivated. This cell may recommend taking disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the grievance cell is final.

Grievance Cell:

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 fulfil 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 = 50 + SEE = 50) and have to secure a minimum of 40% to declare pass in the course. However, a candidate has to secure a minimum of 30% (15 marks) in Semester End Examination (SEE) which is compulsory.

10.2. **Provision to carry forward the failed subjects / courses:**

The student who has failed in 4 courses in odd and even semesters together shall move to next semester of immediate succeeding year of study. And he / she shall appear for SEE of failed courses of previous semesters concurrently with odd and even end SEE of current year of study. However, he / she shall have to clear all courses of both odd and even semesters of preceding year to register for next succeeding semester.

11.0. Re-Registration and Re-Admission:

11.1. In case a candidate fails in more than 4 courses in odd and even semesters together in a given academic year has to seek re-admission to those semesters during subsequent year within a stipulated period.

11.2. 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 not allowed to appear for end semester examination (SEE) and he / she shall have to seek re-admission to that semester during subsequent year within a stipulated period.

11.3. In such case a candidate drops all the courses in semester due to personal reasons he / she re-admission to such dropped semester.

12.0. Attendance Requirement:

a) All students must attend every lecture, tutorial and practical classes.
b) 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 attended.
c) Any student with less than 75% of attendance in a course in aggregate during a semester shall not be permitted to appear to the SEE.
d) Teachers offering the courses will place the above details in the School / Department meeting during the last week of the semester, before the commencement of SEE, and subsequently a notification pertaining to the above will be brought out by the Head of the School before the commencement of SEE. A copy of this notification shall also be sent to the office of the Registrar & Registrar (Evaluation).

12.1. 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.

12.2. Absence during end semester examination:

In case a student is absent for end semester examination on medical grounds or such other exigencies, the student can submit request for make-up examination, with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Director of the School. The Director of the School may consider such request depending on the merit of the case and after consultation with class teacher, course instructor and permit such student to appear for make-up mid semester examination

13.0. Provisional Grade Card: The tentative / provisional grade card shall 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).

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.

13.1. Final Grade Card: Upon successful completion of MSc in Biotechnology Degree a Final Grade card consisting of Grades of all courses successfully completed by the candidate will be issued by the Registrar (Evaluation).

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 P	Grade G	Grade Point (GP=V x G)	Letter Grade
90-100	10	v*10	O
80-89	9	v*9	A
70-79	8	v*8	B
60-69	7	v*7	C
50-59	6	v*6	D
40-49	5	v*5	E
0-39	0	v*0	F

O - Outstanding; A+-Excellent; 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.

13.3. Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (96) for MSc BT degree is calculated taking into account all the courses undergone by a student over all 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.

13.4. Computation of SGPA and CGPA

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

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

SGPA (Si) = ∑(Ci x Gi) / ∑Ci

Where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

Illustration for Computation of SGPA and CGPA
Illustration No. 1

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade)
Course 1	**4**	**A**	**9**	**4X9=36**
Course 2	**4**	**B**	**8**	**4X8=32**
Course 3	**3**	**C**	**7**	**3X7=21**
Course 4	**3**	**O**	**10**	**3X10=30**
Course 5	**3**	**E**	**5**	**3X5=15**
Course 6	**3**	**D**	**6**	**3X6=18**
Course 7	**2**	**O**	**10**	**2X10=20**
Course 8	**2**	**B**	**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**	**B**	**8**	**4X8=32**
Course 2	**4**	**C**	**7**	**4X7=28**
Course 3	**3**	**A**	**9**	**3X9=27**
Course 4	**3**	**C**	**7**	**3X7=21**
Course 5	**3**	**D**	**6**	**3X6=18**
Course 6	**3**	**E**	**5**	**3X5=15**

Course 7	**2**	**C**	**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
	25			199

Thus**, SGPA = 199 ÷ 25 = 8.29**

13.5. Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (96) for MSc BT degree 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	24	6.83	24 x 6.83 = 163.92
2	24	7.29	24 x 7.29 = 174.96
3	24	8.29	24 x 8.29 = 198.96
4	24	8.55	24 x 8.55 = 205.20
Cumulative	96		743.04

Thus, **CGPA** = $\frac{24x6.83+24x7.29+24x8.29+24x8.55}{96}$ = 7.74

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 7.67 x 10 = 76.7

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	Numerical Index	FGP
		Qualitative Index
> 4 CGPA < 5	**5**	SECOND CLASS
5 > = CGPA < 6	6	
6 >= CGPA < 7	7	FIRST CLASS
7 >= CGPA < 8	8	
8 >= CGPA < 9	9	DISTINCTION
9 >= CGPA 10	10	

Overall Percentage=10*CGPA

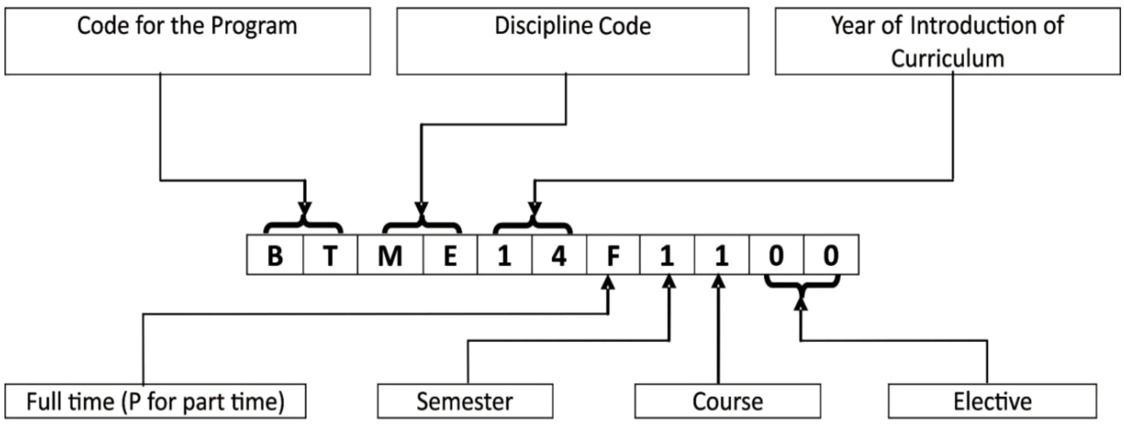
15. Challenge Valuation

A student who desires to apply for challenge valuation shall obtain a photo copy of the answer script by paying the prescribed fee within 10 days after the announcement of the results. He / She can challenge the grade awarded to him/her by surrendering the grade card and by submitting an application along with the prescribed fee to the Registrar (Evaluation) within 07days after the announcement of the results. This challenge valuation is only for SEE.

The answer scripts for which challenge valuation 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.

Course Numbering Scheme



List of Codes for Programs and Disciplines / Branch of Study

Program Code	Title of the Program	Discipline Code	Name of the Discipline / Branch of Study
BA	Bachelor of Arts	AE	Advanced Embedded Systems
BB	BBM (Bachelor of Business Management)	AI	Advanced Information Technology
BC	B.Com (Bachelor of Commerce)	AP	Advanced Power Electronics
BR	B. Arch (Bachelor of Architecture)	CA	Computer Aided Structural Engineering
BS	B Sc, BS (Bachelor of Science)	CE	Civil Engineering
BT	B.Tech (Bachelor of Technology)	CH	Chemistry
BP	Bachelor of Computer Applications	CO	Commerce
BL	LLB (Bachelor of Law)	CS	Computer Science and Engineering / Computer Science
MA	Master of Arts	DE	Data Engineering and Cloud Computing
MB	MBA (Master of Business Administration)	EC	Electronics and Communication Engineering
MC	M.Com (Master of Commerce)	EN	English
MS	M.Sc / MS (Master of Science)	MD	Machine Design and Dynamics
MT	M Tech (Master of Technology)	ME	Mechanical Engineering
MC	Master of Computer Applications	EE	Electrical & Electronics Engineering

M Sc in BIOTECHNOLOGY (2018-19 batch)

Eligibility: Bachelors Degree of three years with Biotechnology or any Life Science subject as one of the cognate / major / optional subjects with 45% (40% in case of candidates belonging to SC/ST) of marks in aggregate from any recognized University / Institution or any other qualification recognized as equivalent thereto.

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F1100	CO 1	2	3	2					3		3	3	3	
	CO 2	2	3	2	2				3		3	3	3	3
	CO 3	3	3						2		3	3	3	
	CO 4	2	3	2					2		3	3	3	
Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F1200	CO1	2	2	3	2		1	1		1	1	2	1	1
	CO2	1	3	3	1		1		1	3	1	3	1	1
	CO3		2	3	1			1	1	1	2	2	1	1
	CO4	1	1	3				1	1	2	1	2	1	
Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F1300	CO 1	3									2	3	2	
	CO 2	3	2									3	3	`1
	CO 3			3	3		3	2	2	2	1	3	3	
	CO 4			2	3		2				1	3	3	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F1400	CO1	3	3	2	1				1	2	2	2	2	1
	CO2	2	3	3	2	1	1	1	1	2	2	1	1	1
	CO3	2	3	3	2	1	1	1	1	2	2	1	1	1
	CO4	2	2	3	3	1	1	1	1	2	2	2	1	1
Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F1500	CO 1	2	3	3	2						2	3	3	3
	CO 2	2	3	2	3			2	3		3	3	3	3
	CO 3	3	2	2		2	3	3	2		3	3	3	
	CO 4	3	3	2			2				3	3	2	
	CO 5	3	3	3	3		2	3			3	3	1	2
	CO 6	3	2	2			3	3	3		3	3	2	2
Course Code	**POS /**	PO1	PO2	PO3	PO	PO5	PO6	PO7	PO8	PO9	PO10	PS0	PS0	PS03

	COS				4							1	2	
MSBT16 F1600	CO 1	3	3	1	3							3	3	
	CO 2	1	3	2	3		2	1	2	1	1	3	3	1
	CO3	2	3	3	2	1			1	1	1	3	3	
	CO4	3	3	2	2			1	1	1		2	3	2
	CO5	3	3	2	2	2		2	2	3	1	3	2	
	CO6	3	2	3	2	1	2		3	2	1	2	3	
Course Code	**POS / COS**	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PS0 1	PS02	PS0 3
MSBT16 F1710	CO1	3	3	2	2				1	1	2	3	2	2
	CO2	2	2	3	3					1	2	2	2	2
	CO3	2	3	2	2	2	1		2	2	3	3	3	3
	CO4	3	3	3	2	2	1	2	2	2	3	3	2	2
Course Code	**POS / COS**	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PS0 1	PS02	PS0 3
MSBT16 F1720	CO1	1			3							2		
	CO2	1	3		3	2		3	3	3	3	3	2	2
	CO3		3	3	3	2						3	2	2
	CO4				3	2		3	3	3	3	3	2	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS0 1	PS0 2	PS03
MSBT16 F2100	CO1	2	2	3					3		3	3	3	
	CO2	2	2	2			2	2	3		3	3	3	2
	CO3	2		3					3		3	3	3	
	CO4	2		2	3			2	3		3	3	3	3
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS0 1	PS0 2	PS03
MSBT16 F2200	CO1	2	3	2	3		3				3	3	3	
	CO2	2	3	3	3			3			3	3	3	3
	CO3	2	2	3			3				3	3	3	3
	CO4	2	3	2	3		3	3			3	3	3	3
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS0 1	PS0 2	PS03
MSBT16 F2300	CO1	2	2	2	1	1			1	2		2	1	3
	CO2	2	2	3	1	1	2	1	1	2	1	2	1	2
	CO3	2	1			1				1	1	2	2	
	CO4	1		2	1	1		1	1	2	1	2	1	1
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS0 1	PS0 2	PS03
MSBT16 F2400	CO 1	2	3	3			3		3		3	3	3	
	CO 2	2	2	3	3				3		3	3	3	
	CO 3	2	3	3	3		3		3		3	3	3	3
	CO 4	2	2	3	3	2	3	3	3		3	3	3	3

Course Code	**POS /**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS0 1	PS0 2	PS03
MSBT16 F2500	CO1	3	2	2	3	1				3	2	3	2	
	CO2	1	2	3	3		1		3	2	1	3	3	1
	CO3	2	3	2	1				1	3	3	3	3	
	CO4	3	3	3	2	1	1		2	3	1	3	3	
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS0 1	PS0 2	PS03
MSBT16 F2600	CO1	2	3	3					2		3	2		2
	CO2	2	3	3	3				2		3	3	2	2
	CO3	2	3	3		2			2		3	3	2	2
	CO4	2	3	3					2		3	3	2	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS0 1	PS0 2	PS03
MSBT16F2710	CO1	2	3	3					2		3	3	1	2
	CO2	2	3	3	3				2		3	2	2	2
	CO3	2	3	3		2			2		3	3	2	2
	CO4	2	3	3					2		3	3	2	2
Course Code	**POS / COS**	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PS0 1	PS02	PS0 3
MSBT16F27 20	CO1	3	3	3			3				3	3	3	3
	CO2	3	3	3	3		3	3			3	3	3	3
	CO3	3	3	3	3		3				3	3	2	
	CO4	3	3	3	3		3	3	3		3	3	3	3
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS0 1	PS0 2	PS03
MSBT16 F3100	CO1	2	3	2	3	3	3	3				1	2	2
	CO2	2	3	3	3				2	2	1		3	2
	CO3	3			3	3		2		2			2	3
	CO4	3	3	3	3							3	3	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS0 1	PS0 2	PS03
MSBT16 F3200	CO1	3					2				1	3	3	
	CO2	2	3	3	2			1	2		1	3	3	2
	CO3	3	2	3	3	1	3	2	1	2	1	3	2	
	CO4	3	3	3	1	2	2		3	2	1	3	3	1
Course Code	**POS / COS**	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PS0 1	PS02	PS0 3
MSBT16 F3300	CO1	2	3	2	3	3			2	2			3	2
	CO2	2	3	3	3	3	3				1		2	3
	CO3	3	3	3	3	3							2	3

	CO4	3	3	3	3			2	2	1			3	3
Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F3420	CO1	3	2	2	3	1				3	2	3	2	
	CO2	1	2	3	3		1		3	2	1	3	3	1
	CO3	2	3	2	1				1	3	3	3	3	
	CO4	3	3	3	2	1	1		2	3	1	3	3	
Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F3510	CO1	2	2		3						3	3	2	2
	CO2		3	3							3	3	2	2
	CO3			3	3		2			3		3	2	2
	CO4			3	3			3		3	3	3	2	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F3520	CO1	2	2	3	2		1	1		1	1	2	1	1
	CO2	1	3	3	1		1		1	3	1	3	1	1
	CO3		2	3	1			1	1	1	2	2	1	1
	CO4	1	1	3				1	1	2	1	2	1	
Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F3600	CO1	2	2	2	1	2	1	3	2	3	3	3		1
	CO2	2	2	3	1	2		2	2	3	3	2	1	2
	CO3	2	2	3	3	2		1	2	3	2	1	1	
	CO4		1	2	3	2	1	2	3	3	1	2		1
Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F3700	CO1	2	3	3	3							3	2	2
	CO2	2	2	3	3	3	3					2	3	2
	CO3	2	2	3	3	3	3		3	3	3	3	3	3
	CO4	3	3	3	3	3	3	3	3	3	3	3	3	3
Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16	CO1	2	2	2	2	2	1	2	3	3	3	3	1	

F4100	CO 2	1	1	3	2	2	1	3	3	3	3	3	1	1
	CO 3	2	2	1	2	2		1	2	3	3	1	1	
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS0 1	PS0 2	PS03
MSBT16 F4200	CO1	2	2	2	1	2	1	2	2	3	3	2		1
	CO2	1	2	2	2	2		2	3	3	3	3	1	2
	CO3	1	2	1		1		1	1		1	1		
	CO4	1				2		1	1	1	1	1		1
Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F4310	CO1	2	2	2	1	2	1	3	2	3	3	3		1
	CO2	2	2	3	1	2		2	2	3	3	2	1	2
	CO3	2	2	3	3	2		1	2	3	2	1	1	
	CO4		1	2	3	2	1	2	3	3	1	2		1
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS0 1	PS0 2	PS03
MSBT16 F4320	CO 1	1	2	1	1	1			3		3	2	1	2
	CO 2	2	3	2	3	2			3		3	3	2	2
	CO 3	2	3	3	3	2			3		3	3	2	2
	CO 4	2	3	3	3	2			3		3	3	2	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS0 1	PS0 2	PS03
MSBT16 F4400	CO 1	2	3	3	3							3	2	2
	CO 2	2	2	3	3	3	3					2	3	2
	CO 3	2	2	3	3	3	3		3	3	3	3	3	3
	CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3

	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10
PEO1	√	√	√	√	√	√	√	√	√	√
PEO2	√	√	√	√	√	√	√	√	√	√
PEO3	√	√	√	√	√	√	√	√	√	√

M. Sc. (Biotechnology) Program

Scheme of Instruction (effective from Academic Year 2017-2019)

Scheme of Instructions **Duration: 4 Semesters (2 years)**

	FIRST SEMESTER - BT16F 1		HC/SC/ OE	L	T	P	Credits
1	MSBT16 F1100	Cell Biology	HC	3	1	0	4
2	MSBT16 F1200	Molecular Genetics and Developmental Biology	HC	3	1	0	4
3	MSBT16 F1300	Microbiology	HC	3	1	0	4
4	MSBT16 F1400	Biochemistry	HC	3	1	0	4
5	MSBT16 F1500	Cell biology and molecular genetics (Practical)	HC	0	0	2	2
6	MSBT16 F1600	Microbiology and Biochemistry (Practical)	HC	0	0	2	2
7	MSBT16 F1710	Bioinformatics	SC	3	1	0	4
	MSBT16 F1720	Food Science & Technology					
Total Credits				**15**	**5**	**4**	**24**

SECOND SEMESTER - BT16F 2			HC/SC/ OE	L	T	P	Credit s
1	**MSBT16F2100**	Molecular Biology	HC	3	1	0	4
	MSBT16F2200	Immunology and Medical Biotechnology	HC	3	1	0	4
	MSBT16F2300	Bioprocess Engineering	HC	3	1	0	4
	MSBT16F2400	Biochemical Techniques and enzymology	HC	3	1	0	4
	MSBT16F2500	Molecular Biology and Immunology and Medical biotechnology lab	HC	0	0	2	2
	MSBT16F2600	Biochemical Techniques and enzymology& Bioprocess Engineering lab	HC	0	0	2	2
	MSBT16F7100	Entrepreneurship& business plan presentation	SC	3	1	0	4
	MSBT16F7200	Forensic Biology					
Total credits				15	5	4	24

Third SEMESTER - BT16F 3			HC/SC/ OE	L	T	P	Credit s
1	MSBT16 F3100	Plant& agricultural Biotechnology	HC	3	1	0	4
2	MSBT16 F3200	Genetic Engineering	HC	3	1	0	4
3	MSBT16 F3300	Plant agricultural biotechnology & Genetic engineering lab	HC	0	0	2	2
4	MSBT16 F3410	Animal Biotechnology	SC	3	1	0	4
5	MSBT16 F3420	Toxicology					
6	MSBT16 F3510	Clinical data Science					
7	MSBT16 F3520	Biostatistics and Research Methodology	SC	3	1	0	4
8	MSBT16 F3600	Organic Farming	OE	4	0	0	4
9	MSBT16 F3700	Minor project	HC	0	0	4	4
Total credits				16	4	6	26

Fourth SEMESTER - BT16F 4			HC/SC/ OE	L	T	P	Credit s
1	MSBTS16 F4100	Environmental Biotechnology	HC	3	1	0	4
2	MSBT16 F4200	Environmental Biotechnology Lab	HC	0	0	2	2
3	MSBT16 F4310	Genomics & Proteomics	SC	3	1	0	4
4	MSBT16 F4320	Nano biotechnology					
5	MSBT16 F4400	Major project	HC	0	0	12	12
Total credits				6	2	14	22
Total credits for all four semesters				52	16	28	96

Semester-wise Summary of Credit Distribution

Semesters	L	T	P	No. of Credits
First Semester	15	5	4	24
Second Semester	15	5	4	24
Third Semester	16	4	6	26
Fourth Semester	6	2	14	22
Total Credits				**96**

HC=Hard Core; SC=Soft Core; OE=Open Elective; MC=Mandatory Course

M.Sc. (Biotechnology) Program

Detailed Syllabus

(Effective from Academic Year 2021-23)

SEMESTER – I

CELL BIOLOGY

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBTF1100	**CELL BIOLOGY**	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

1. Microscopy is the prerequisite and basic knowledge of cell biology is essential.

2. Basic knowledge of genes and inheritance of traits.

Course Objectives:

The overall objectives of the course are:

1. To understand the concept of prokaryotic and eukaryotic cells, internal organelles and cytoskeletal protein organization and its functions.

2. To equip students with the understanding of the structure and organization of chromosomes and the impact of the genetic variation among the individuals.
3. To understand the cell signalling and cell cycle events in the normal cells and events that can lead to conversion of a normal cell to cancer state.
4. To eexplain the concept of population genetics and its application in studying the evolution of the species and to discuss the involvement of genes in growth and development of the organisms.

Course Outcomes:

After completing the course, the student should be able to

1. To illustrate the structure and function of the eukaryotic cell, various organelles, and concept of existence of cytoskeletal protein with their wide applications.

2. To outline the inheritance pattern at the molecular level and correlate the significance of variation at the genetic level.

3. To explore the molecules involved in cell signaling and cell cycle, and the molecules which malfunction in cancer cells.

4. Employ the concept of population genetics and understand the evolution of species and Illustrate the developmental genetics of the organisms.

Mapping of Course Outcomes with Program Outcomes

Course Code	**POS/ COs**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBTF1100	CO1	2	3	2					3		3	3	3	
	CO2	2	3	2	2				3		3	3	3	3
	CO3	3	3						2		3	3	3	
	CO4	2	3	2					2		3	3	3	

Course Content: **Total Hours: 52 hrs**

Unit-I **13 hrs**

Plasma Membrane and Membrane Transport - Plasma membrane- structure and functions, membrane models. Transport across membrane- passive diffusion, osmosis, active transport, Ion Channels, A B C transporters, Na^{+} and K^{+} pump, Ca^{2+} ATPase pump, co-transport, symport, antiport, endocytosis and exocytosis. Membrane vesicular traffic. Quorum sensing.

Unit 2 **13 hrs**

Cytoskeleton - Nature of cytoskeleton, Actin filaments, actin-binding proteins- Molecular basis of muscle contraction, Intermediate filaments, Microtubules, MAPs, Structure and functions of cilia and flagella.

Unit 3 **13 hrs**

Cell Signaling - Extracellular matrix (collagen, proteoglycans, fibronectin, lamins). Cell-cell interactions, Cell adhesion-integrins, selectins, cadherins. Cell Junction- Tight and gap junctions, Desmosomes, plasmodesmata. General principles of cell signaling, signaling via G-protein coupled receptors, kinase receptors, role of secondary messengers. Mechanism of nerve transmission- Resting and action potential, electrical and chemical transmission, Neurotransmitters and their receptors.

Unit 4 **13 hrs**

Cell Cycle - Molecular events of cell division and cell cycle, regulation of cell cycle events- Cyclins, Cyclin dependent kinases, inhibitors. Apoptosis, Necrosis. Cell Cycle: Stages regulation (Checkpoints) and deregulation in cancer. Chemical carcinogens, radiation in carcinogenesis, oncogenes and tumour suppressor genes, metastatic cascade.

References:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter (2014). 6th Edition. Molecular Biology of the Cell, Garland Science publisher.
2. **Geoffrey M. Cooper** and **Robert E. Hausman (**2016). The Cell: A molecular approach.7th edition. Publisher: Sinauer Associates, USA.
3. Gerald Karp (2013). Cell and Molecular Biology: Concepts and Experiments.7th edition. John Wiley and Sons Inc. NY.
4. Harvey Lodish, Arnold Berk, Chris A Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Matthew P Scott (2012). 7th edition. Molecular Cell Biology, Macmillan Publishers
5. Kanugo, M.S. (2002) Genes and aging.2nd edition. Cambridge University Press.
6. Matthews, C.A. (2003). Cellular physiology of nerve and muscle. 4th edition. Wiley-Blackwell publishers.

Molecular genetics & Developmental Biology

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBTF1200	Molecular Genetics & developmental biology	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

1. Microscopy is the prerequisite and basic knowledge of cell biology is essential.

2. Basic knowledge of genes and inheritance of traits.

Course Objectives:

The overall objectives of the course are:

1. To understand the concept of prokaryotic and eukaryotic cells, internal organelles and cytoskeletal protein organization and its functions.

5. To equip students with the understanding of the structure and organization of chromosomes and the impact of the genetic variation among the individuals.
6. To understand the cell signalling and cell cycle events in the normal cells and events that can lead to conversion of a normal cell to cancer state.
7. To eexplain the concept of population genetics and its application in studying the evolution of the species and to discuss the involvement of genes in growth and development of the organisms.

Course Outcomes:

After completing the course, the student should be able to

1. To illustrate the structure and function of the eukaryotic cell, various organelles, and concept of existence of cytoskeletal protein with their wide applications.

2. To outline the inheritance pattern at the molecular level and correlate the significance of variation at the genetic level.

3. To explore the molecules involved in cell signaling and cell cycle, and the molecules which malfunction in cancer cells.

4. Employ the concept of population genetics and understand the evolution of species and Illustrate the developmental genetics of the organisms.

Mapping of Course Outcomes with Program Outcomes

Course Code	**POS/ COs**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBTF1200	CO1	2	3	2					3		3	3	3	
	CO2	2	3	2	2				3		3	3	3	3
	CO3	3	3						2		3	3	3	
	CO4	2	3	2					2		3	3	3	

Course Content: **Total Hours: 52 hrs**

Unit-1 **13hrs**

Chromosomes and Mendelian inheritance – concepts and theories of Mendelian genetics, Chromosomes and heredity. Gene concept, genetic code. Chromosome theory of inheritance. Extra-chromosomal inheritance. Structure and organization of eukaryotic chromosomes: Supercoiled loops, domains and scaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Nucleosomes- Organization of DNA in the nucleosome. Human chromosomal aberrations, karyotype analysis- normal and abnormal karyotype.

Unit-II 13hrs

Population Genetics - Gene pools, allele frequencies, Hardy Weinberg equation, non random breeding, genetic drift, gene flow, natural selection, speciation. Biological species concept, Mechanisms of reproductive isolation, modes of speciation. Protein and DNA sequence polymorphism. Molecular evolution – nucleotide and amino acids variation, molecular clock, neutral theory of evolution, genome evolution (Primate Evolution). Molecular basis of evolution in *Homo sapiens*.

Unit III **14 hrs**

Eukaryotic Recombination – Linkage and crossing over, Mechanism of recombination and types. Holliday, model. Synaptonemal complex and role of RecA in recombination. Enzymes involved in homologous and site specific recombination. Topological manipulation of DNA. Retrotransposons and their significance; Transposable Genetic Elements: Transposons – Transposable elements in prokaryotes and eukaryotes – IS elements, Composite transposons, Tn3 elements, Ac and Ds elements, P elements, Retrotransposons and their significance. Transposable elements in human and their genetic and evolutionary significance.

Unit IV **14 hrs**

Principles of development - Developmental Genetics, gametogenesis, fertilization, cleavage, gastrulation, cell fate, differentiation, morphogenesis, and organ formation. Growth, Aging. Organogenesis- Organization of various Tissues and their Development, endocrinology, metamorphosis and regeneration. The genetics of development in plants (*Arabidopsis*- floral morphogenesis and homeotic gene expression). The genetics of development of animals (*Drosophila)*.

References:

1. David Freifelder. (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
2. Gardner/Simmons/Snustad. (2006). Principles of Genetics. 8th edition, John Wiley and sons.
3. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th edition, Pearson Education.
4. Streips and Yasbin. (2001). Modern microbial Genetics, 4th edition , Niley Ltd.
5. John Ringo (2004). Fundamental Genetics. 2nd edition, Cambridge University Press.
6. Winter,P.C., Hickey,G.I. and Fletcher, H.L.(2002)Genetics, 4th edition,Viva Books
7. *ewin, Benjamin; Krebs, Jocelyn E.; Goldstein, Elliott S.; Kilpatrick, Stephen T. (2014), Genes XI, Jones and Bartlett Learning*
8. Brown, T.A., Chapman and Hall (2011) Genetics a Molecular Approach, 2nd edition, Garland science. Gilbert. (2013) Developmental biology. 10th edition.

Course Code	Course Title	Duration Weeks	CourseType	L	T	P	C	Hrs./ wk
MSBT16F1300	**MICROBIOLOGY**	16	SC	3	1	0	4	4

Prerequisites/Pre reading for the course:

Basis of Biology & knowledge of microscopy.

Course Objectives:

The overall objectives of the course are:

1. Understand the recent developmental aspects microbiology
2. Illustrate creative and modern technology involved in microbiology
3. Understand the beneficial and deleterious roles of microbiology in society

Course Outcomes:

After completing the course, the student should be able to

1. Understand the basics of classification about microbial cells and various sterilization techniques
2. Develop professional skills in the techniques involved in Virology
3. Acquire the knowledge about industrial aspect of application of microbial cells

4. Analyse and solve the medical microbiology related issues

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0103	CO1	3									2	3	2	
	CO2	3	2									3	3	1
	CO3			3	3		3	2	2	2	1	3	3	
	CO4			2	3		2				1	3	3	2

Course Content

Unit-1 13hrs

Microbiology Introduction-Principles and classification of microbes-Binomial nomenclature Whittaker's five kingdom classification–sterilization and disinfection-Physical and chemical methods of sterilization, stains and staining methods. Microbiological media, and isolation and enumeration of microorganisms, methods of obtaining pure cultures and identification of microbes. Microbial growth, factors influencing microbial growth, and nutritional types in microorganisms. Eukaryotic microbes - General characteristics, reproduction and importance. Sterilization and disinfection- Physical and chemical methods of sterilization.

Unit II 10 hrs

Virology-General characteristics, structure and classification of Viruses. Viruses that affect humans, animals and plants. Isolation, cultivation and identification of Viruses. Viroids and prions-general properties and diseases caused by viroids and prions.

Unit III 15 hrs

Food and Industrial Microbiology-Role of microbes in food production, Microbiology of fermented foods, dairy products and alcoholic beverages. Food spoilage and Preservation techniques. Microbes as source of food. Applications of Microbes in industrial production of antibiotics (penicillin and streptomycin), amino acids (Glutamic Acid) and organic Acids (citric acid and Lactic acid).

Unit-IV 12hrs

Medical microbiology-Pathogenesis, Laboratory diagnosis, Prevention and control of important microbial diseases and Pathogenic bacteria (*E.coli, Mycobacterium leprae, Mycobacterium tuberculosis, Salmonella typhi, Staphylococcus aureus, Vibrio cholerae*). Pathogenic fungi

(*Candida sp, Aspergillus, Cryptococcus*). Viral Diseases (HIV, Rabies virus, Hepatitis A virus and Polio Virus) and pathogenic Protozoa (*Plasmodium, Trypanosoma*)

References:

1. M J Pelczar Jr, ECS Chan, NR Krieg (2007) Microbiology 5th Edition Pub: Tata Mcgraw-Hill Publishing Co Ltd.
2. General Microbiology by Stanier Pub; Ingraham and Wheeler (1998), 5th edition. McMillan Publisher
3. Atlas R.M. (2000) Microbiology: Fundamentals and applications 4th Edition, Singapore : Pearson Education Asia
4. Brock T.D. and Madigan M.T (2014) Biology of Microorganisms, 14th Edn. Prentice Hall, Englewood Cliffs N.J.
5. Prescott L.M, Harley T.P and Klein D.A. (2012), 9th edition, Microbiology, WMC. Brown publishers

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16 F1400	**BIOCHEMISTRY**	HC	3	1	0	4	4

Prerequisites/Pre reading for the course:

Microscopy is the prerequisite and strong knowledge of molecular biology is essential.

Course Objectives:

The overall objectives of the course are:

1. Explore the different aspects in the field of biochemistry.
2. Understand the recent developmental aspects of biochemical pathways in living organisms
3. Illustrate creative and modern technology involved in cell activities
4. Identify various intermediates involved in the biochemical pathways
5. Understand the deficiencies caused due to alterations in the biomolecules for addressing the human diseases.

Course Outcomes:

After completing the course, the student should be able to

1. Understand the basics about classification, structure, functions of Biomolecules and vitamins
2. To analyse and interpret the role of biomolecules and vitamins in human health
3. Understand and develop a biochemical pathway that helps to support systems biology
4. Illustrate the concept of bioenergetics and energy functions in systems biology

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F1400	CO1	3	3	2	1				1	2	2	2	2	1
	CO2	2	3	3	2	1	1	1	1	2	2	1	1	1
	CO3	2	3	3	2	1	1	1	1	2	2	1	1	1
	CO4	2	2	3	3	1	1	1	1	2	2	2	1	1

Course Content: **Total Hours: 52 hrs**

Unit I **13 hrs**

Carbohydrates- Structure, properties, function and classification, Glycoproteins, proteoglycans and peptidoglycans, Blood group antigens; Glycolysis; Tricarboxylic acid cycle; Glyoxylate cycle, Pentose phosphate pathway; Cori cycle; Gluconeogenesis, glycogenesis and glycogenolysis.

Unit II **13hrs**

Lipids and Vitamins- Structure, properties and classification; Steroids and bile acids; Prostaglandins - prostacyclins, leukotrienes and thromboxanes;Beta-oxidation and synthesis of fatty acids; Ketone bodies; Cholesterol metabolism. Substances derived from cholesterol; Steroid hormones.

Vitamins- Classification, functions and coenzymes.

Unit III **13hrs**

Amino acids, Proteins and Nucleic acids- Structure, properties and classification Amino acids- Decarboxylation, Transamination, oxidative deamination of amino acids, transport of ammonia and urea cycle. Biosynthesis of non-essential amino acids, Proteins – Conformation, Denaturation, Renaturation; Ramachandran’s Plot.

Nucleic acids: DNA Polymorphism.Types of RNA including tRNA; Purine and Pyrimidine metabolism.

Unit IV **13 hrs**

Bioenergetics and Electron Transport Chain- Laws of thermodynamics; concept of free energy, standard free energy change and its measurement; Enthalpy and entropy. Energy-rich bonds - ATP and interconversions of nucleotide phosphates. Phosphate potential. High-energy compounds. Components of Electron Transport Chain; Theories of oxidative phosphorylation.

Reference Books:

1. Lehninger and D L Nelson (2012) Principles of Biochemistry, 6th edition. Macmillan Publications
2. Jeremy M Berg, John L Toymoczko and LubertStryer (2015) Biochemistry 8th Edition Macmillan Publications
3. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, (2012) Physical Biology of the Cell, 2nd edition, Garland Publishers.
4. Voet, D. and Voet, J.G. (2009) Biochemistry. 3rd edition. John Wiley and sons.
5. Reginald H.Garrett and Charles M. Grisham (2013) Biochemistry, 6th edition, Mary Finch publisher

6. Elliot, Biochemistry and Molecular Biology (2009)4th edition, Oxford University Press.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16 F1500	**CELL BIOLOGY & MOLECULAR GENETICS (PRACTICAL)**	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Fundamentals of molecular biology, biochemical techniques, plant morphology, anatomy and microbiology is a prerequisite for this course.

Course Objectives:

The overall objectives of the course are:

1. To illustrate different cell organelles, different staining techniques and its enzyme activity.
2. To provide information about various stages of mitosis & meiosis.
3. To study the usage of microscope and the calibration to analyze the size of cells.
4.Facilitate students to understand the concept of polyploidy induction.
5. Impart knowledge on the development process of chick embryo.
6. Estimate the dimensions of the cells and enable students to analyse the chromosomes and characterize different models

Course Outcomes:

After completing the course, the student should be able to

1. To develop deeper understanding of cell & its function at cellular levels.
2. To understand & comprehend the various techniques used for the isolation of cells & cell organelles.
3. Analyze the role of chemicals in induction of mutations.
4. Distinguish the stages of embryo development and role of genes.
5. Analyze and observe the cells and compare chromosomes in organisms.
6. Exploit the knowledge of karyotyping in medical cytogenetics.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F1500	CO1	2	3	3	2						2	3	3	3
	CO2	2	3	2	3			2	3		3	3	3	3
	CO3	3	2	2		2	3	3	2		3	3	3	
	CO4	3	3	2			2				3	3	2	
	CO5	3	3	3	3		2	3			3	3	1	2
	CO6	3	2	2			3	3	3		3	3	2	2

Course Content:

1. Microscopic measurements: Stage micrometry of onion and yeast cells
2. Study of mitosis in onion
3. Study of meiosis in grasshopper testis/onion flower buds
4. Isolation of chloroplast by sucrose density gradient and determination of its purity
5. Isolation of nucleus and mitochondria and determination of its purity
6. Determination of the rate of active transport of glucose across the intestinal membrane
7. Study of phylogenetic tree: construction and analysis
8. Induction of polyploidy in onion root tip
9. Problems on Sex linked inheritance and population genetics
10. Induction of mutation in *Drosophila melanogaster*
11. Dissection of polytene chromosome from *Drosophila melanogaster*
12. Karyotyping in animal/plant.

Reference Books:

1. John Davey and J. Michael Lord (2003).3rd edition. Essential Cell Biology- A Practical approach. Publisher Oxford University press
2. J.E. Celis.(2006). 3rd edition. Cell Biology: A Laboratory Hand Book, USA: Elsevier Academic Press
3. Gerald Karp (2013). Cell and Molecular Biology: Concepts and Experiments.7th edition. John Wiley and Sons Inc. NY.
4. Redei, George P. (1999) 3rd edition. Genetics Manual Current: Theory, Concepts, Terms World Scientific Publishers
5. Anthony JF Griffiths, Jeffrey H Miller, David T Suzuki, Richard C Lewontin, and William M Gelbart.(2000) 7th edition. An Introduction to Genetic Analysis. Publisher: New York W.H. Freeman.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16 F1600	**MICROBIOLOGY & BIOCHEMISTRY (PRACTICAL)**	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Microscopy is the prerequisite and basic knowledge pertaining to analytical technique is essential.

Course Objectives:

The overall objectives of the course are:

1. Explore the practical aspects in the culturing and their importance.
2. Develop strong & knowledgeable techniques for research in microbiology area.
3. Inculcate the analytical skills in estimating carbohydrates, proteins, fats and phosphate.
4. Develop confidence in conducting the experiments independently.

Course Outcomes:

After completing the course, the student should be able to

1. Apply the knowledge of culturing and preserving the microbes in the laboratory conditions.
2. Develop professional practical skills in microbiology.
3. Acquire the knowledge of biochemistry in the areas of research.
4. Acquire enhanced skills and confidence levels to meet the industrial requirements

Mapping of Course Outcomes with program Outcomes

Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F1600	CO1	3	3	1	3							3	3	
	CO2	1	3	2	3		2	1	2	1	1	3	3	1
	CO3	2	3	3	2	1			1	1	1	3	3	
	CO4	3	3	2	2			1	1	1		2	3	2
	CO5	3	3	2	2	2		2	2	3	1	3	2	
	CO6	3	2	3	2	1	2		3	2	1	2	3	

Course Content:

1. Isolation of air microflora by plate exposure method. Colony characteristics and counting of colonies (serial dilution method), pure culture techniques
2. Staining techniques: Simple, differential, endospore and capsule; bacterial motility by hanging drop technique, negative staining
3. Biochemical tests (a) Indole (b) Methyl red (c) Voges-Proskauer (d) Citrate utilization (e) Triple sugar iron agar (f) Starch hydrolysis (g) Gelatin hydrolysis (h) Catalase (i) Oxidase
4. Bacterial growth curve by turbidometry
5. Testing of quality of water (Coliform test)
6. Counting of microbes using haemocytometer
7. Estimation of reducing sugar by o-Toluidine method
8. Estimation of total carbohydrates in biological samples by Anthrone method
9. Estimation of protein in biological samples by Folin-Ciocalteau method
10. Estimation of Inorganic phosphate by Fiske Subbarow method
11. Estimation of Lactose by DNS method
12. Estimation of saponification, Iodine and Acid numbers of fats from the prepared biological sample

Reference Books:

1) Katoch, Rajan(2011). Analytical techniques in Biochemistry and molecular Biology. Springer
2) Martin Holtzhauer.(2007)Basic Methods for the Biochemical Lab, Springer,.
3) Keith Wilson and John Walker(2010). 7th edition. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press
4) Samuel Singer (2001). Experiments in Applied Microbiology. Academic Press.
5) Collins, C.H., Tatrica M. Lyne and Grange, J.M. (2004).8th edition. Microbiological methods. Hodder Arnold publishers.
6) Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, and Gary Sayler(1998). Techniques in Microbial Ecology. Oxford University Press. NY.
7) Alexander N. Glazer, Hiroshi Nikaido (2007).2nd edition. Microbial Biotechnology, Freeman
8) K. R. Aneja (2003). 4th edition. Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International publisher

9) James G. Cappuccino and Natalie Sherman (2013). 10th edition. Microbiology: A Laboratory Manual. Publisher: Pearson India

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16 F1710	**BIOINFORMATICS**	HC	3	1	0	4	4

Prerequisites for the course

1. Basic knowledge of biology and computer science is required

Course Objectives:

The overall objectives of the course are to:

1. Introduce the basic concepts of bioinformatics.
2. Demonstrate applications of bioinformatics and biological databases in problem solving Pertaining to research.
3. Familiarize with the various aspects of internet applications.
4. Apply the knowledge of biological database for problem solving in the field of research.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F1710	CO1	3	3	2	2				1	1	2	3	2	2
	CO2	2	2	3	3					1	2	2	2	2
	CO3	2	3	2	2	2	1		2	2	3	3	3	3
	CO4	3	3	3	2	2	1	2	2	2	3	3	2	2

Course Outcomes:

After completing the course, the student should be able to

1. Apply the knowledge and basic principles of concepts of biological data
2. Comprehend the role of various softwares and tools in computational drug discovery
3. Acquire problem-solving skills using bioinformatics algorithms to solve biological data structures
4. Understand the various concepts & methods involved in statistical analysis.

Course Content: **Total Hours: 52 hrs**

Unit I **13 hrs**

Biological Data Retrieval and Analysis - Introduction and Scope of bioinformatics. Biological information resources. Genome sequence acquisition and analysis; Data acquisition, Biological Databases; Structure and annotation. Data mining and data characteristics. Sequence alignment and Database searches Pair wise and multiple sequence alignment. Methods of local and global alignment, Dynamic programming, Scoring matrix.

Unit II **13 hrs**

Introduction to NCBI, NCBI data bases, Searching PubMed, BLAST, BLASTn, BLASTp, PSI-BLAST, Searching sequence databases for sequence similarity; Multiple sequence alignment, Phylogenetic Analysis; Primer designing.

Unit III **13 hrs**

Genomic data science- Introduction to genome sequencing, platforms, file types, data structures, applications; Sequencing data analysis – Quality analysis, Genome annotation and alignment, differential expression, pathway analysis, functional analysis.

Unit IV **13 hrs**

Bioinformatics in Drug discovery - Conceptual model of protein structure, Structural types and conceptual models, Globular proteins, secondary structure, tertiary structure, integral membrane proteins and domains. Protein structure analysis, Molecular docking.

Bioinformatics in the Pharmaceutical Industry- QSAR method; ADMET Predictions. Parameters in drug discovery identification of drug target molecules, drug design and its approaches. Molecular Docking studies.

Reference Books:

1. Attwood, T. and P.S. David.(2006). Introduction to Bioinformatics. Pearson Education Ltd., New York
2. Baxevanis, AD., and Ouellette, BFF. (2006). 3rd Edition. Bioinformatics A Practical Guide to Analysis of Genes and Proteins., John Wiley and Sons, New York
3. Attwood TK. and Higgs, PG. (2005). Bioinformatics and molecular evolution. Blackwell Publishers, London.
4. Lesk, AM. (2002). Introduction to Bioinformatics. Oxford University Press

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16 F1720	Food Science & Technology	SC	3	1	0	4	4

Prerequisites/Pre reading for the course:

Basic knowledge about the chemistry of biomolecules and properties is must.

Course Objectives:

The overall objectives of the course are:

1. To provide knowledge related to nutritional aspects in food science.

2. Impart knowledge on production process from raw materials to finished product in food Processing industries, and food packaging materials.

Course Outcomes:

After completing the course, the student should be able to:

1. Understand and concise the major food constituents and their nutritional makeup & importance of water in food chemistry.
2. Know the importance of microorganisms in food, food borne diseases and analytical methods for estimating microbial toxins.
3. Acquire knowledge in various food processing techniques and their advantages in food industry, and understand the food processing approaches.
4. Understand the significance of food additives with their permissible limits and the importance of packing system in food industries.

Mapping of Course Outcomes with program Outcomes

Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F1720	CO1	1			3							2		
	CO2	1	3		3	2		3	3	3	3	3	2	2
	CO3		3	3	3	2						3	2	2
	CO4				3	2		3	3	3	3	3	2	2

Course Content: **Total Hours: 26 hrs**

Unit I **6 Hrs**

Food Chemistry: Major constituents of food – carbohydrates, proteins and fats, and its importance, minor constituents of food- vitamins, minerals, antioxidants and enzymes and their importance, significance of water in food.

Unit II **7 Hrs**

Food Microbiology: Importance of microorganisms in food science. Food spoilage-features, dynamics and significance, food borne diseases - Bacterial, viral and parasitic. Analytical methods for microbial metabolite and toxins determination.

Unit III **6 Hrs**

Food processing and preservation: Processing and preservation of food by heat, low temperature, drying and non-thermal methods. UHT and HTST processing. Processed foods-types and features.

Unit IV **7 Hrs**

Food additives and food packaging: Food additives: definition, types and functions, permissible limits and safety aspects. Food packaging: Definitions, objectives and functions of packaging and packaging materials. Biodegradable plastics.

Reference Books:

1. Pelczar, M.I and Reid, R.D. (2007) Microbiology McGraw Hill Book Company, New York, 5th Edition.
2. Prescott LM Harley JP and Klein DA (2006). Microbiology (7th edition) McGraw Hill, Newyork.
3. Adams, M.R. and M.G. Moss (2009): Food Microbiology, 1st Edition, New Age International (P) Ltd.
4. Doyle, P., Bonehat, L.R. and Mantville, T.J (2010): Food Microbiology, Fundamentals and Frontiers, ASM Press, Washington DC.
5. Desrosier NW & James N. (2007). Technology of food preservation. AVI. Publishers
6. Fellows, P.J. (2005). Food processing technology: Principle and Practice. 2nd Ed. CRC Publishers
7. Jelen, P. (2005). Introduction to Food Processing. Prentice Hall
8.Ahmed, S. (Ed.). (2018). Bio-based Materials for Food Packaging: Green and Sustainable Advanced Packaging Materials. Springer.
9. Ebnesajjad, S. (Ed.). (2012). Plastic films in food packaging: materials, technology and applications. William Andrew.

SECOND SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F2100	**MOLECULAR BIOLOGY**	HC	3	1	0	4	4

Prerequisites/Pre reading for the course:

Basics knowledge about genetic material and characteristics of protein is essential

Course Objectives:

The overall objectives of the course are:

1. Acquire the knowledge of chromatin structure and gene expression
2. Explore the mechanism of post transcriptional events and translation
3. Apply the basic knowledge of molecular biology in Genomics and Proteomics
4. Understand the structure and functions of DNA, RNA and Protein

Course Outcomes:

After completing the course, the student should be able to

1. Explore the genetic information flow in the eukaryotic cell; including nucleic acid structures, the definition of a gene, the organization of the genome, the replication, the formation of RNA (transcription), the processing of pre mRNA and the protein synthesis (translation)
2. Explain the principles and concept of transcription, translation and gene regulation in prokaryotic and eukaryotic cells

3. Describe the consequences of different types of mutations and DNA- repair system
4. Illustrate the mechanisms of transposable elements, the concepts of applications of omics including next generation sequencing

Mapping of Course Outcomes with program Outcomes

Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16F2100	CO1	2	2	3					3		3	3	3	
	CO2	2	2	2			2	2	3		3	3	3	2
	CO3	2		3					3		3	3	3	
	CO4	2		2	3			2	3		3	3	3	3

Course Content: **Total Hours: 52 hrs**

Unit I **13 hrs**

DNA Topology- Central dogma, DNA structure, Super coiled forms of DNA, Super helical density, energetics of super coiled DNA (Topological domains of DNA and role of super coiling in gene expression and DNA replication) DNA-Protein Interactions - General features, Interaction of Helix-turn Helix motif, B-sheet, Different forms of DNA (A, B and Z DNA).

Unit II **13 hrs**

DNA Replication- DNA binding motifs and types, Characteristics and functions of Prokaryotic and Eukaryotic DNA polymerases, Mechanism of prokaryotic and Eukaryotic DNA replication and its Fidelity, Telomerase and Telomere synthesis. Replication of viral DNA, Inhibitors of DNA replication.

Unit III **13 hrs**

Transcription and Translation - RNA polymerases, features of prokaryotic and eukaryotic promoters, assembly of transcription initiation complex in prokaryotes and eukaryotes and its regulation; synthesis and post transcriptional modification of prokaryotic and eukaryotic transcripts. Genetic Code, Structure and role of t-RNA in protein synthesis, ribosome assembly and structure, Wobble hypothesis, prokaryotic and eukaryotic translation.

Unit IV **13 hrs**

Protein modifications and targeting - Posttranslational modifications of proteins (protein folding, processing by proteolytic cleavage and chemical modification), Ubiquitination, Proteosome and Protein degradation. Regulation of gene expression in prokaryotes - Operon concept, positive and negative regulation. Examples of lac-, ara and trp- Operon regulation; global regulatory responses; Regulation of gene expression in eukaryotes.

Reference Books:

1.Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter (2014)6th Edition. Molecular Biology of the Cell, Garland Science publisher.

2. Harvey Lodish, Arnold Berk, Chris A Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Matthew P Scott (2012). 7th edition. Molecular Cell Biology, Macmillan Publishers
7. **Geoffrey M. Cooper** and **Robert E. Hausman (**2016).The Cell: A molecular approach.7th edition. Publisher: Sinauer Associates, USA.
8. Lehninger and D L Nelson (2012) Principles of Biochemistry. 6th edition. Macmillan Publications
9. Lewin, Benjamin; Krebs, Jocelyn E.; Goldstein, Elliott S.; Kilpatrick, Stephen T. (2014), Genes XI, Jones and Bartlett Learning
10. Jeremy M Berg, John L Toymoczko and LubertStryer (2015) Biochemistry. 8th Edition Macmillan Publications
11. Karp, G. (2013). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
12. James D Watson, Tania A Baker., Stephen P Bell, Alexander Gann.,Michael Levine, Richard Losick (2014), Molecular Biology of the Gene: 7th Edition, Pearson Education
13. T. A. Brown (2007). 3rd edition. Genomes 3. GS Garland Science, Taylor and Francis Group
14. Snyder and Champness (2007) 3rd edition. Molecular Genetics of Bacteria, ASM Press

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F2200	**IMMUNOLOGY & MEDICAL BIOTECHNOLOGY**	HC	3	1	0	4	4

Prerequisites/Pre reading for the course:

1. Basic knowledge about bacterial and viral infection, antigen-antibody reaction.
2. Knowledge about developmental biology and concept of stem cells and recombinant DNA technology.
3. Basic knowledge of metabolism is a prerequisite.

Course Objectives:

The overall objectives of the course are:

1. Explore the fascinating field of immunology, organization and function of the immune system.
2. Provide deeper insight into production of diverse immune globulins from a single gene complex.
3. Understand the mechanism of the reaction of antibodies against antigens and also the advance concept of recombinant therapeutic products.

Course Outcomes:

After completing the course, the student should be able to

1. Understand the basic and advanced medical related issues in the society, by exploring the world of immunology and its relevant interactions.

2. Explore the recent research advancement in the medicinal research areas, including immunodiagnostics.

3. Develop skills in understanding disease biology and specific markers leading to the knowledge of disease diagnosis and management.

4. Exploit the knowledge in the development of therapeutic strategies for the treatment of genetic and acquired diseases.

Mapping of Course Outcomes with program Outcomes

Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16F2200	CO1	2	3	2	3		3				3	3	3	
	CO2	2	3	3	3			3			3	3	3	3
	CO3	2	2	3			3				3	3	3	3
	CO4	2	3	2	3		3	3			3	3	3	3

Course Content: **Total Hours-52 hrs**

Unit-I **13 hrs**

Fundamental concepts of the immune system- Innate and acquired immunity, complement cascade and inflammatory responses, primary, secondary lymphoid organs and cells of immune system. Antigens-immunogens, haptens, Major Histocompatibility Complex. Disease susceptibility; Immune responses-Immunoglobulin's, multigene organization of immunoglobulin genes, Immunoglobulin super family and cell-mediated immune responses. Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation-endogenous and exogenous antigens, non-peptide bacterial antigens and super-antigens.

Unit II **13 hrs**

Clinical Immunology-Hypersensitivity-classification and types, immunosuppressive therapy, autoimmune diseases- causes, symptoms and diagnosis. Immunological techniques-Precipitation, agglutination and complement-mediated immune reactions; RIA, ELISA, Western blotting, immune fluorescence, flow cytometry; Production of monoclonal antibodies.

Unit III **13 hrs**

Fundamentals of Medical Biotechnology: Evaluation of organ functions: liver, kidney, cardiac and gastric function tests. Significance of biochemical markers, Human Diseases – Symptoms and Treatment: Tumors, Types, pre-disposing factors, cellular changes involved in tumor formation, genes associated with cancer (oncogenes, tumor suppressive genes etc.), tumor detection methods, tumor markers. Genetically inherited diseases: Phenylketonuria, Alkaptonuria, Galactosemia, Von"Gierke disease, Lesch-Nyhan syndrome, Gout, Sickle cell anaemia, Beta Thalesimia and Diabetes.

Unit IV **13 hrs**

Molecular Therapeutics: Gene therapy-Inherited and acquired diseases for gene therapy, Gene delivery: retrovirus- and adenovirus-mediated gene transfer; Liposome- and nanoparticle-mediated gene delivery.

Nanobiotechnology: introduction, types and synthesis of nanomaterials, protein- and DNA-based nano structures, Applications of nanomaterials as therapeutics, nanobiosensors, drug and gene delivery, disease diagnostics and therapy, risk potential of nanomaterials.

Reference Books:

1. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.
2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt (2011). 12^{th} edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London
3. Ian Tizard R. (2013). Immunology, 9th edition, Elsevier publisher.
4. K.M.Pavri. (1996), Challenge of AIDS, 2^{nd} edition, National Book Trust, India.
5. Abbas & Lichtman & Pillai (2014). Cellular and Molecular immunology,8^{th} edition, Elsevier publisher
6. C.Vaman Rao.(2012), An Introduction to Immunology. 2^{nd} edition , Narosa publishing house
7. William E Paul (2012). Fundamentals in Immunology. 7^{th} edition, Raven Press. NY
8. Bernhard Palsson and Sangeeta N Bhatia (2004)., Tissue Engineering, 2nd Edition, Prentice Hall,
9. Pamela Greenwell, Michelle McCulley (2008). Molecular Therapeutics: 21st century medicine, 1st Edition, Springer,
10. Andrew Read and Dian Donnai (2007). New Clinical Genetics, Scion Publishing Ltd, Oxfordshire, UK,.
11. James W Goding (1996). Monoclonal antibodies: Principles and Practice, 3rd Edition, Academic Press,
12. George Patrinos and Wilhelm Ansorage (2005). Molecular Diagnostics, 1st Edition, Academic Press,
13. Lela Buchingham and Maribeth L Flawsm (2007), Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, 1st Edition, F A Davis Company, Philadelphia, USA.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F2300	**BIOPROCESS ENGINEERING**	HC	3	1	0	4	4

Prerequisites/Pre reading for the course:

Students should have basic knowledge of microbiology, biochemistry and instrumentation.

Course Objectives:

The overall objectives of the course are:

1. Acquire the skills employed in upstream and downstream processes in fermentation technology.
2. Integrate the research perspectives in the field of bioprocess engineering with the industrial requirements.
3. Optimize the fermentation techniques and formulate the downstream products for maximum productivity.
4. Construct a business plan for industrial important product obtained through fermentation.

Course Outcomes:

After completing the course, the student should be able to

1. Describe the microbial growth and cultivation with respect to modes of fermentation and comprehend the role of biotechnology in improving microbial cells as factories.

2. Choose the ideal bioreactor models according to the final product, the microbial strain And market requirement employed in the process.

3. Optimise a suitable scheme of bioproduct separation and purification based upon the molecular characteristics of the product and other process criteria.

4. Apply the knowledge of fermentation process in the production of value added commercial products.

Mapping of Course Outcomes with program Outcomes

Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16F2300	CO1	2		3	3							1	2	2
	CO2		3	3	3	2		3				3	2	2
	CO3			3	3			3				3	2	2
	CO4				3					3	3	3	2	2

Course Content: **Total Hours: 52 hrs**

UNIT I **13 hrs**

Introduction to Bioprocess Engineering: Basic concepts of bioprocess engineering- A brief survey of organisms, processes, products. Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Industrial strain improvement for better productivity; Fermentation media and Fermentation Process: Natural and synthetic media; Sterilization- Dry and moist heat; Types of fermentation process- submerged, surface and solid state; Modes of cultivation- batch, fed-batch and continuous fermentation; Kinetics of fermentation, bioprocess control, monitoring of variables-Dissolved oxygen (DO), temperature, agitation, pH and pressure.

UNIT II **13 hrs**

Bioreactors: Architecture of advanced bioreactors and their working mechanisms; Design features; Heat and Mass transfer; Specialised bioreactors- design and their functions; Bioreactors- Airlift Bioreactor and its applications, Tubular, Membrane bioreactor-features and applications, Tower bioreactor-features and applications, Fluidized-bed and Packed-bed bioreactor-features and applications; photo bioreactors and disposable reactors bioreactor-features and applications.

UNIT III **13 hrs**

Downstream processing : Overview of unit operations and their principles; Physical and rheological characteristics of fermentation broths; Pre-treatment-Cell disruption, heating and chemical treatment; solid-liquid separation- filtration and centrifugation; Product isolation- Adsorption, precipitation and extraction; Purification- Chromatography- Size exclusion, affinity and ion-exchange and HPLC; Finishing operations – Freeze drying and crystallization. Scale up of production.

UNIT IV **13 hrs**

Production of value-added products: Bio preservatives, Biopolymers, Industrial Enzymes, Bio fuels, Cheese, Beer and Single Cell Protein. Production of recombinant proteins having therapeutic and diagnostic applications, and vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture. By-product utilisation in various industries through bioprocess engineering tools.

Reference Books:

1. Satyanarayana, U (2005). “Biotechnology” Books and Allied (P) Ltd..
2. Kumar, H.D (1998). “A Textbook on Biotechnology” 2nd Edition. Affiliated East West Press Pvt. Ltd.
3. Balasubramanian, D. etal (2004.). “Concepts in Biotechnology” Universities Press Pvt. Ltd.,
4. Ratledge, Colin and Bjorn Kristiansen (2001). “Basic Biotechnology” 2nd Edition Cambridge University Press.
5. Dubey, R.C (2006). “A Textbook of Biotechnology” S. Chand and Co. Ltd.
6. Bailey and Ollis (1986). “Biochemical Engineering Fundamentals”, McGraw Hill (2nd Ed.),
7. Shuler and Kargi (1992). “Bioprocess Engineering “, Prentice Hall.
8. Pauline Doran (1995). Bioprocess Engineering Calculation, Blackwell Scientific Publications.
9. Peter F. Stanbury, Stephen J. Hall and A. Whitaker (2016), Principles of Fermentation Technology, third edition, Science and Technology Books.
10. Brod. H.Vester A, Kauling J (2012). Opportunities and limitations of disposable technologies in biopharmaceutical processes.ChemIng Tech 84(5):633-645

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F2400	**BIOCHEMICAL TECHNIQUES & ENZYMOLOGY**	HC	3	1	0	4	4

Prerequisites/Pre reading for the course:

Students need to be familiar with the concepts of industrial fermentation.

Students should also have basic knowledge physiology and biochemistry involved in microbial metabolism.

Course Objectives:

The overall objectives of the course are:

1. Help the students to develop knowledge in research in biochemical analysis and estimation.
2. Upgrade knowledge on important protocols and techniques in biochemistry.

3. Enable the students to apply scientific principles and methods to identify and solve problems associated with biochemical techniques and enzymology.

4. Apply critical thinking and analytical evaluation to biochemical techniques and analysis of the quantitative data.

Course Outcomes:

After completing the course, the student should be able to:

1. Acquire the fundamental skills and knowledge related to concepts and techniques of chromatography.
2. Illustrate the different spectroscopy techniques for the analysis of a particular compound.
3. Understand the classification and activity of enzymes and coenzymes involved in enzymology studies.
4. Comprehend the concepts in enzyme kinetics.

Mapping of Course Outcomes with program Outcomes

Course Code	POs/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
MSBT16F2400	CO1	2	2	2	1	1			1	2		2	1	3
	CO2	2	2	3	1	1	2	1	1	2	1	2	1	2
	CO3	2	1			1				1	1	2	2	
	CO4	1		2	1	1		1	1	2	1	2	1	1

Course Content: **Total Hours: 52 hrs**

Unit I **13 hrs**

Separation techniques: Chromatography, Electrophoresis and Centrifugation - Basic principles, planar and column chromatography. Theory, principles and applications of Paper, Thin Layer, Gel Filtration, Ion Exchange, Affinity, Reverse phase chromatographic techniques, GLC and HPLC.

Electrophoresis Techniques - Principles and types, Agarose- Gel Electrophoresis, Isoelectric focusing, PAGE, SDS-PAGE and 2-D gel electrophoresis.

Centrifugation Techniques – Basic principles of centrifugation- Sedimentation coefficient; Preparative, analytical and gradient centrifugation and their applications.

Unit II **13 hrs**

Spectroscopy –Electromagnetic spectrum and interaction of radiation with matter, UV and Visible spectroscopy; Beer-Lambert's law and its limitation; IR spectroscopy- Principles, NMR and ESR, CD/ORD, X-ray crystallography.

Radioactivity - Introduction to Isotopes, detection and measurement of radioactivity, Autoradiography, Radio-labelling procedures.

Unit III **13 hrs**

Introduction to Enzymes – Characteristics, Classification and properties of enzymes, enzyme substrate complex. Concept of active centre, binding sites, specificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rates. Activation energy. Transition state theory.

Structure and mechanism of action of some important co-enzymes NAD+, FAD, FMN, TPP, pyridoxal phosphate, lipoic acid, Coenzyme A and Vitamin B_{12}. Isozymes and Allosteric enzymes.

Unit IV **13 hrs**

Enzyme Kinetics-Michaelis - Menten Equation - form and derivation, steady-state enzyme kinetics. Significance of V_{max} and K_m. Bisubstrate reactions. Graphical procedures - advantages and disadvantages of alternate plotting. Enzyme activity, international units, specific activity, turnover number, end-point kinetic assay. Regulation of enzymes: Covalent and noncovalent modification; Enzyme inhibition - types of inhibitions - competitive, non-competitive and uncompetitive, mode of action of inhibitors and experimental determination.

Reference Books:

1. Nelson, D.L., Cox, M.M. Lehninger. (2013). Principles of Biochemistry, 6th edition Pub WH Freeman Co.
2. Keith Wilson and John Walker, (2010) Biochemical techniques, 7th edition ,Cambridge University.
3. Daniel, L, Purich, Melvin, I. Simon, John, N., Abelson. (2009). Contemporary enzyme kinetics and mechanism, 3rd edition, Elsevier publisher.
4. Trevor Plamer and Philip Bonner, (2007). Enzymes,2nd edition, Woodhead Publishers
5. Voet, D. and Voet, J.G. (2009), Biochemistry 3rd edition, John Wiley and sons.
6. Rodney Boyer(2000), Modern experimental Biochemistry. 3rd edition, Benjamin and Cummings publisher.
7. David Plummer(2004), An introduction to practical Biochemistry, 3rd edition, Tata McGraw-Hill Education Pvt. Ltd

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F2500	**MOLECULAR BIOLOGY, IMMUNOLOGY & MEDICAL BIOTECHNOLOGY (PRACTICAL)**	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Fundamentals involved in molecular biology, biochemical techniques, plant morphology, anatomy and microbiology is a prerequisite for this course.

Course Objectives:

The overall objectives of the course are:

1. Familiarise with the concepts of molecular biology on experimental basis.
2. Inculcate analytical and research skills.
3. Expose students to the techniques employed in medical laboratories and allied research labs

Course Outcomes:

After completing the course, the student should be able to:

1. Apply basic laboratory skills required for DNA isolation and bacterial conjugation.
2. Analyze, interpret and report the results of estimation of various components in biological samples.
3. Perform experiments related to purification and separation of antibodies through various techniques.

4. Analyse and interpret the technique of ELISA.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16F2500	CO1	2	3	3					2		3	2		2
	CO2	2	3	3	3				2		3	3	2	2
	CO3	2	3	3		2			2		3	3	2	2
	CO4	2	3	3					2		3	3	2	2

Course Contents:

1. Purification of IgG by column chromatography
2. Enzyme linked immunosorbent assay
3. Ouchterlony double diffusion
4. Rocket Immunoelectrophoresis
5.Isolation of plasmid DNA and analysis by electrophoresis
6. Isolation of genomic DNA and analysis by electrophoresis
7.Study of bacterial transformation
8. Study of conjugation in *E.coli*
9. Analysis of acid and alkaline phosphatase from serum samples
10. Estimation of Creatine and Creatinine from urine samples
11. Estimation of Cholesterol by Zak's Method
12. Estimation of Blood Urea by diacetyl monoxime method

Reference Books:

1. Ausubel F.M., Brent R., Kingston R.E., Moore D.D. et al (2003). Short protocols in molecular biology (4th Ed), Wiley publishers. India.
2. Sambrook J et al (2001). Molecular cloning Volumes I, II and III. Cold Spring Harbor laboratory Press, New York, USA
3. Keith Wilson and John Walker (2000), Practical Biochemistry- 5th edition, Cambridge University Press, UK
4. Bertram G. Katzung (2004) Basic and Clinical Pharmacology, 9th Edition, Mc GrawHill Publications
5. Devlin TM (2002), Text book of biochemistry with Clinical Correlations 5th edition
6. Richard B Silverman (2014), Organic Chemistry of Drug design and Drug action Elsevier Science, Academic Press
7. Warren Levinson, Ernest Jawetz (2003), Medical Microbiology and Immunology: Examination and Board Review 7th edn. McGraw Hill Publications
8. Jawetz, Melnuk and Adelgerg (2015), Medical Microbiology, Appleton and Lange
9.. Kuby (2007). Immunology by Goldsby, Kindt, and Osborne
10. Nelson, D.L., Cox, M.M (2005). Lehninger Principles of Biochemistry . 4th edition Pub WH Freeman Co.
11. Elliott, W.H., Elliott, D.C(2005). Biochemistry and Molecular Biology 3rd Indian edition, Pub. Oxford.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.

MSBT16F2600	**BIOCHEMICAL TECHNIQUES &BIOPROCESS ENGINEERING (PRACTICAL)**	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Students should have basic knowledge of microbiology, biochemistry and working principles of analytical instruments.

Course Objectives:

The overall objectives of the course are:

1. Educate the student how to perform and use the chromatographic techniques for identification and separation of compounds.
2. Gain knowledge about the enzyme kinetics practically.
3. Get hands on with respect to various types of fermentation techniques.
4. Acquire the practical skills in enzyme essays and antibiotic production and purification.

Course Outcomes:

After completing the course, the student should be able:

1. Operate the instrument independently and identify and characterize the compound.
2. Analyse the enzyme kinetics for each reactions which are carried out by the Enzymes.
3. Demonstrate the various techniques associated with the fermentation process such as sterilization, media preparation and bioprocess control.
4. Apply the knowledge of fermentation for the pilot scale production and purification of industrially important fermentation products such as wine and antibiotics.

Mapping of Course Outcomes with program Outcomes

Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16F2600	CO1	2	3	3					2		3	3	1	2
	CO2	2	3	3	3				2		3	2	2	2
	CO3	2	3	3		2			2		3	3	2	2
	CO4	2	3	3					2		3	3	2	2

Course Content:

1) Separation of amino acids by circular Paper chromatography and TLC
2) Separation of bio molecules by Column chromatography
3) Determination of total activity of pea esterase

4) Determination of K_m and V_{max} of pea esterase
5) Determination of optimum pH of pea esterase
6) Determination of optimum temperature of pea esterase
7) Growth of Bacteria – Estimation of Biomass, Calculation of Specific Growth Rate
8) Enzyme immobilization – Gel entrapment/ Cross linking
9) Estimation of lactic acid in dairy products
10) Production and estimation of alpha amylase by solid-state fermentation
11) Production of wine and estimation of alcohol content by specific gravity method
12) Production of penicillin and antimicrobial assay

Reference Books:

1) Martin Holtzhauer (2007). Basic Methods for the Biochemical Lab;, Springer,
2) Keith Wilson and John Walker(2010)., Principles and Techniques of Biochemistry and Molecular Biology, 7th Edn ,Cambridge University Press,
3) Trevor Palmer, Horwood (2001), Enzymes: Biochemistry, Biotechnology and Clinical Chemistry:).,
4) Robert A. Copeland, by Wiley-VCH Inc. (2000).Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis
5) Jordening H J and Josef Winter.(2005). Environmental biotechnology: concepts and applications (2nd Ed.) Wiley and Sons Publishers.UK
6) Daniel Vallero.(2010). Environmental Biotechnology: A Biosystems Approach (1st Ed.) Academic press. New York
7) Wang LK.(2010). Handbook of Environmental Engineering (1st Ed.) Springer Publishers
8) Evans G G and Judy Furlong.(2011)., Environmental Biotechnology: Theory and Application (2nd Ed.).Wiley publishers.
9) Wang L.K., Ivanov V., Tay J.H., HungY.T(2010). Handbook of Environmental Engineering (1st Ed.) Springer Publishers

Gareth G. Evans (2010)., Judy Furlong Environmental Biotechnology: Theory and Application (2nd Ed.).Wiley publishers.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16 F2710	**ENTREPRENEURSHIP & BUSINESS PLAN PRESENTATION**	SC	3	1	0	4	4

Prerequisites/Pre reading for the course:

Students are expected to be familiar with the basic business disciplines, concept of setting up a business, marketing, finance, operations and accounting in terms of general as well as Biotechnology entrepreneurship

Course Objectives:

The overall objectives of the course are:

1. To explore the fascinating field of Entrepreneurship– study of the entrepreneur.
2. To explore the start-ups related to biotechnology and understand the marketing concepts.

3. To enable students to understand the concept of project management and types of ownership seen in enterprises.
4. To provide insights about the support system from public and private sectors in establishing start-ups, and get trained in preparing first draft of their own business plan.

Course Outcomes:

After completing the course, the student should be able to:

1. To comprehend the concept of entrepreneurship and traits of entrepreneurs
2. Understand the trends seen in biotech start-ups and familiar with the various marketing strategies.
3. To know the concept of project planning and the steps to be taken for successful execution of project and types of enterprises.
4. Design strategies for successful implementation of creative ideas by understanding the concepts required to set up biotech business, know the source of finance for biotech business venture.

Mapping of Course Outcomes with program Outcomes

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO2	PSO 3
MSBT16 F2710	CO1	1			3		1	3	1	2	2	1		1
	CO2	1			1	1		1	2		1	1		1
	CO3			1	1			2	2	3	1		1	2
	CO4	1						2	3	3	2			3

Course Content:

Total Hours: 26 hrs

Unit I 6 hrs

Introduction to Entrepreneurship: Entrepreneur, Creativity, Innovation; Entrepreneurship in Biotechnology; Entrepreneurial traits and motivation, theories of Entrepreneurship, Franchising.

Unit II

Entrepreneurship in Biotechnology-I 7 hrs

Biotech enterprises, Major start-ups in Biotechnology, Small business strategic planning, Pricing and promotion, Marketing management. Digital marketing: Internet marketing, mobile marketing, Social media marketing.

Unit III 6 hrs

Entrepreneurship in Biotechnology-II: Quality control in Biotech industries, Entrepreneurial Finance: Basics of Financial Analysis. Project management; Sole proprietorship, partnership, cooperation society, private and public limited companies.

Unit IV 7 hrs

Innovation in Creative Economy: Venture creation and simulation; Desirables in start-up, steps for starting a small industry, medium and large scale industry, Location of an enterprise, incentives and subsidies for start-ups, role of various agencies; Biotech Consortium India Limited and its activities, exploring export possibilities and Global business.

Submission of Business Plan Report and Presentation.

Reference Books:

1. Scarborough, N. M. (2016). Essentials of entrepreneurship and small business management. Pearson..
2. Marriot, S. (2010). Entrepreneurship: Owning your future.
3..Kuratko, D. F. (2016). Entrepreneurship: Theory, process, and practice. Nelson Education.
4. Hisrich, Robert D., Peters, Michael P., and Shephered, (2007):Entrepreneurship, Tata mcgraw-hill; sixth edition, 2007.

Course Code	Forensic Biology	Course Type	L	T	P	C	CH
MSBT16F2720		SC	2	1	0	3	4

Prerequisites/Pre reading for the course:

Students should have Critical thinking capacity. They should have knowledge of crime scene.

Course Objectives:

The Objectives of this course is:

1. To teach the methodology involved in forensic investigation**.**
2. To understand and utilize the facilities available at forensic laboratories.
3. To document and analyze the crime scene.
4. To analyze the biological and entomological evidences for interpretation.

Course Outcomes:

By the end of the Course students will be able to:

1. Outline the protocol of forensic science investigation.
2. Involve in forensic investigation.
3. Categorize the evidences and analyze them.
4. Explore the significance of different biological evidences and their significance in interpretation.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
	CO1	3	3	3			3				3	3	3	3
	CO2	3	3	3	3		3	3			3	3	3	3
	CO3	3	3	3	3		3				3	3	2	
	CO4	3	3	3	3		3	3	3		3	3	3	3

Course Content

Unit-I 13hrs

Introduction, definition, Scope and branches of forensic science. Basic principles of forensic science. Organizational set up of Forensic Science Laboratories – Central F.S.L. and State F.S.L. Crime Scene Investigation: Crime scene characteristics, sketching, photography, location, collection and preservation of exhibits/evidences. Physical evidence; types, significance and analysis. Investigation of sexual offenses.

Unit II **13 hrs**

Fundamentals of Biology, Biological Evidence: Nature, location, collection, identification, evaluation and importance of hair, fibres, grains, seeds, leaves, wood, diatoms etc. Role of Forensic Biologists. Wildlife Forensics: Wildlife species in traditional medicine, trade in wild life material, identification of pugmarks of various animals. Forensic Entomology: Insects of Forensic Importance, role of insects in forensic investigations, collection of entomological evidence from scene of crime, Forensic entomologist as expert witness.

Unit-III **13hrs**

General Principles of Biological/Biochemical Analysis, Enzyme techniques, Immunochemical techniques, Radio chemical techniques. Human lymphocyte culture techniques: Design and working of tissue culture laboratory, culture media preparation, short term culture, cell harvesting, flow cytometery, automated karytyping with image analysis. Molecular biology techniques, preparation of culture media, isolation of DNA, RNA,purification, restriction, amplification, PCR, estimation & PCR. Immunochemical techniques, immunodiagnostics, RIA, Elisa, Elispot, Immunohistochemistry.

Unit 4 **13 hrs**

History and Development of Fingerprints, classification of fingerprints, Henry system and single digit classification, formation of ridges pattern types and areas, fingerprint Bureau. Chance fingerprints, latent and visible fingerprints, methods of development of fingerprints (Conventional methods). Taking of fingerprints from living and dead persons, preserving, lifting, photography, digital transmission and comparison of fingerprints, Automatic fingerprint identification system. Dermatoglyphics and clinical disorders. Foot Prints : Gaitpattern, casting of foot prints, lifting of latent foot prints. Examination of handwriting, seal impression and other mechanical impressions.

References:

1. Richard Saferstein, 2001, Criminalistic: An Introduction to Forensic Science. 7th edition
2. Prentice-Hall, New Jersey.
3. Moenseens, A.A., Starrs, J.E., Henderson, C.E. and Inabare, F.E., 1995. Scientific
4. Evidence in Civil and Criminal cases, IV edition, Foundation Press, Westbury, New York.
5. James, S.H. and Nordby J.J. Forensic Science : An introduction to Scientific and investigative techniques, CRC Press, USA, 2003.
6. Chowdhri, S., Forensic Biology B.P.R. &D, Govt. of India.
7. Najjar and NacWillim, 1978. Forensic Authropology.
8. Byrd, J.H. and Cartner, J.L., 2001. Forensic Entomology, CRC Press, LIC.
9. Robertson, J., 1999. Forensic Examination of Hair. Taylor & Forensic.
10. Cammins, H. and Middle C., 1961. Fingerprints Palms and Soles. Dover Publications.

11. Bodriak, W.J., Footwear Impression Evidence. Elsevier Science Publ. Co. New York, 1989.
12. Saxena. Saxena's Law and Techniques relating Fingerprints, Foot Prints and Detections of Forgery. Central Law Agency Allahabad.

THIRD SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16 F3 3100	**PLANT AND AGRICULTURAL BIOTECHNOLOGY**	HC	3	1	0	4	4

Prerequisites/Pre reading for the course:

Prior knowledge of concepts in Botany with respect to anatomy, histology, plant biochemistry in terms of metabolism & pathways involved and basic concepts in molecular biology.

Students should also have basic knowledge in plant physiology.

Course Objectives:

The overall objectives of the course are:

1. Introduce the underlying principles involved in plant tissue culture.
2. Familiarize the students with the concepts and techniques in plant genetic engineering.
3. Understand the significance of plant cell culture for the production of secondary metabolites in industry and research.

Course Outcomes:

By the end of the course, the students will be able to:

1. Apply the concepts of plant tissue culture techniques for micro propagation with the associated Advantages and disadvantages.
2. Comprehend various plant transformation techniques for better plant productivity and express the pros and cons of genetically engineered crops.
3. Choose & implement alternative plant biotechnology tools in place of genetic modification by engineering.
4. Design the process of secondary metabolite production using plant cell cultures.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16 F3 3100	CO1	2	3	2	3	3	3	3				1	2	2
	CO2	2	3	3	3				2	2	1		3	2
	CO3	3			3	3		2		2			2	3
	CO4	3	3	3	3							3	3	2

Course Content: **Total Hours 52 hrs**

Unit I **13 hrs**

Introduction to Plant tissue culture: Plant tissue culture media, explants and Growth regulators, Micropropagation, axillary bud proliferation method, Meristem culture and production of virus-free plants, somatic embryogenesis, organogenesis, protoplast culture, protoplast fusion and somatic hybridisation, Cybrids. Somaclonal variation, Anther culture. *Invitro*germplasm conservation-Cryopreservation. Plant tissue culture certification.

Unit II **13 hrs**

Plant transformation for productivity and performance : *Agrobacterium* mediated gene transfer, Ti and Ri plasmids as vectors, Binary & cointegrate vectors, plasmid vectors, plant viral vectors, Selectable markers and Reporter genes. Direct gene transfer methods-Microprojectile and Electroporation, Plant growth regulators; Biofertilizers-types and production; Mycorrhiza-VAM, *Rhizobium, Azotobacter*, Phosphate Solubilising bacteria , Biopesticides -Types and production,. Strategies for engineering stress tolerance; herbicide, viral and bacterial resistance in crops, Bt Cotton and other transgenic crops. Integrated pest management.

Unit III **13 hrs**

Plant metabolic engineering and products : Shikimic Acid pathway in secondary metabolite production, Production of bioactive secondary metabolites by plant tissue culture (Optimisation of media and culture conditions, organ culture, two phase system, Hairy root culture, Biotransformation, Elicitation). Transgenic plants for the production of recombinant therapeutic protein, recombinant antibody, industrial enzyme, biodegradable plastics and edible vaccines.

Unit IV **13 hrs**

Post-harvest technology and GM crops: RNAi and antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene and polygalacturonase); delay of softening and ripening of fleshy fruits. Post-harvest protection of cereals, millets and pulses. Current status of transgenic plants in India and other countries, Ethical issues associated with GM crops and GM food.

Reference Books:

1. Adrian Slater, Nigel W. Scott, Mark R. Fowler. (2008).Plant Biotechnology: An Introduction to Genetic Engineering by Oxford University Press.
2. Bhojwani. S.S and Razdan by M.K (2004). Plant tissue culture, Oxford and IBH Publishing Co, New Delhi.
3. Bob Buchanan, Wilhelm Gruissem, Russell Jones. (2002). Biochemistry and Molecular Biology of Plants. John Wiley and Sons.
4. Gamborg O.L. and Philips G.C. (1998) Plant cell, tissue and organ culture (2nd Ed.) Narosa Publishing House. New Delhi.
5. Gistou, P and Klu, H (2004). Hand book of Plant Biotechnology (Vol. I and II). John

6. Hammond J, P McGravey and Yusibov.V (2000). Plant Biotechnology, Springer verlag.
7. Kirakosyan A and Kaufman P.B. (2009) Recent Advances in Plant Biotechnology
8. Razdan. M.K. (2003). An introduction to Plant Tissue Culture. Oxford and IBH Publishing Co, New Delhi.
9. Slatu (2003). The genetic manipulation of plants. Oxford University Press.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16 F3 3200	**GENETIC ENGINEERING**	HC	3	1	0	4	4

Prerequisites/Pre reading for the course:

Strong knowledge of Molecular biology, Microbiology and fermentation technology is essential

Course Objectives:

The overall objectives of the course are:

1. Acquaint the students to versatile tools and techniques employed in RDT
2. Familiarize the students in professional, legal & ethical aspects of GMOs.
3. Emphasize the importance of research in the field of Genetic Engineering.
4. Expose students to the applications of recombinant DNA technology

Course Outcomes:

After completing the course, the student should be able to:

1. Understand the basic knowledge in gene manipulations.
2. Understand and apply different gene transfer methods
3. Analyze DNA using different genetic engineering techniques
4. Assess the ethical and environmental issues related to Genetic Engineering

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0302	CO1	3					2				1	3	3	
	CO2	2	3	3	2			1	2		1	3	3	2
	CO3	3	2	3	3	1	3	2	1	2	1	3	2	
	CO4	3	3	3	1	2	2		3	2	1	3	3	1

Course Content: **Total hours: 52 hrs**

Unit I **13hrs**

Tools in Genetic Engineering: Restriction endonucleases and modification methylases, exonucleases, enzymes for end modification of DNA., exonucleases, ligases and mechanism of ligation.

Cloning vectors: Plasmids as vectors, pBR322, pUC –Series. Phage vectors-M13 phage vectors, Cosmids & Phagemids, Yeast Vectors, YAC and BAC vectors, Adenoviruses, Retroviruses, Ti Plasmid, Expression vectors.

Unit II **13 hrs**

Transformation and library construction – Chemical based transformation - Calcium chloride method and Calcium phosphate precipitation methods, liposome mediated and DEAE dextron methods. Physical methods - Microinjection, Biolistics, Electroporation and Gene gun methods. Genomic and c-DNA libraries -Construction of library and its applications, problems, advantages and disadvantages. Screening methods for cloned libraries.

Unit III **13 hrs**

DNA analysis: Radioactive and non-radioactive labelling of DNA and RNA probes. Fluorescence *in situ* hybridization, chromosome walking. Analysis of gene and gene products: DNA finger printing - RFLP, RAPD, DNA sequencing. Blotting techniques - Southern, Northern and Western blotting techniques. PCR and its variants.

Unit IV **13 hrs**

Applications: Transgenic animals and plants, production of recombinant pharmaceuticals, Safety of recombinant DNA technology: Restriction and regulation for the release of GMOs into environment. Ethical, legal, social and environmental Issues related to rDNA Technology.

Reference Books:

1. Boylan, M. and Brown, K.E. (2003). Genetic Engineering- Science and Ethics on the New Frontier. Pearson Education (Singapore) Pte. Ltd.
2. Brown, T.A. (2001).Gene Cloning and DNA Analysis-An Introduction 4th edn. Blackwell Science.
3. Winnacker. (2003), From Genes to Clones: Introduction to Gene Technology. WILEY-VCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi
4. Old R.W., Primrose S.B (2001). Principles of gene manipulation - An introduction to genetic engineering (5th Ed.), Blackwell Scientific Publications, UK.
5. S. B. Primrose, Richard M (2006). Twyman. Principles of gene manipulation and genomics (7th Ed.) John Wiley and Sons publishers.
6. Nicholl D.S.T (2008). Introduction to Genetic Engineering Cambridge (3rd Ed.) University press.UK.
7. Benjamin Lewin (2004), Genes VIII (3rd Ed.) Oxford University and Cell Press,NY
8. Jeremy W. Dale, Malcolm von Schantz, Nicholas (2012) Plant - From Genes to Genomes: Concepts and Applications of DNA Technology, 3rd Edition.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F3300	**PLANT, AGRICULTURAL BIOTECHNOLOGY &GENETIC ENGINEERING LABORATORY (PRACTICAL)**	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Fundamentals involved in molecular biology, biochemical techniques, plant morphology, anatomy and microbiology is a prerequisite for this course.

Course Objectives:

The overall objectives of the course are:

1. Develop the capabilities of knowledge ability, comprehension and applications of plants in cell and tissue culture systems.
2. Acquire practical skills and confidence to carry out research in the domains of plant and agricultural biotechnology.
3. Get exposure of various genetic manipulation techniques having industrial implications.
4. Exploit the knowledge of gene manipulations in related areas of research

Course Outcomes

After completing the course, the student should be able to:

1. Formulate & prepare plant tissue culture media based on the type of micropropagation.
2. Standardize the protocol for the micro propagation of specific plant species and recalcitrant species.
3. Develop system for the large scale production of mushroom.
4. Perform various molecular biology techniques such as cloning, PCR and apply it in optimized way in research as well as in industry.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0305	CO1	2	3	2	3	3			2	2			3	2
	CO2	2	3	3	3	3	3				1		2	3
	CO3	3	3	3	3	3							2	3
	CO4	3	3	3	3			2	2	1			3	3

Course Content:

1. Preparation of plant tissue culture media (MS and Nitsch Media)
2. Shoot tip, anther and single node culture
3. Study of VAM and isolation of VAM spores.
4. Study of biocontrol agents (*Trichoderma harzianum*, *Trichoderma viridae* and *Aspergillus awamori)* using dual culture method.
5. Anther culture for the production of haploid plants.
6. Mushroom cultivation using paddy straw mushroom.

7. DNA finger printing analysis.
8. Electrophoresis digested DNA and determination of its molecular weight of DNA fragment
9.Ligation of DNA and analysis by electrophoresis
10.Determination of molecular weight of proteins by SDS PAGE and analysis by western blotting
11. GFP Cloning
12.DNA amplification by PCR

Reference Books:

1. Aneja K R. (2011). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International Publishers.
2. Christou P and Klee H. (2004). Handbook of Plant Biotechnology. John Wiley and Sons.
3. Dixon RA. (2003). Plant Cell Culture. IRL Press.
4. George EF, Hall MA and De Klerk GJ. (2008). Plant Propagation by Tissue Culture. Agritech Publ.
5. Ausubel F.M., Brent R., Kingston R.E., Moore D.D. et al (1999). Short protocols in molecular biology (4th Ed), Wiley publishers. India. 1999.

6. Sambrook J et al (2001). Molecular cloning Volumes I, II and III. Cold Spring Harbor laboratory Press, New York, USA
7. Keith Wilson and John Walker (2000), Practical Biochemistry- 5th edition, Cambridge University Press, UK .

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F3410	**ANIMAL BIOTECHNOLOGY**	SC	3	1	0	4	4

Prerequisites/Pre reading for the course:

Basic knowledge of Biotechnology and concepts of cloning is essential**.**

Course Objectives:

The overall objectives of the course are:

1. Explore the applications of concepts in animal biotechnology in various fields.
2. Provide perspective on the recent advances in the field of animal biotechnology.
3. Understand the pros and cons of applications of animal biotechnology in society.
4. Familiarize the concept and techniques of transgenic animals.

Course Outcomes:

After completing the course, the student should be able to:

1. Explain the fundamental techniques and scientific principles followed for animal cell culture.
2. Acquire knowledge of isolation, maintenance, growth of cell culture, animal cloning, and applications in industry.
3. Understand the techniques and applications of transgenic plants in the field of medicine.
4. Acquire knowledge of stem cell biology and its implications.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16F3410	CO1	2	3	3			3		3		3	3	3	
	CO2	2	2	3	3				3		3	3	3	
	CO3	2	3	3	3		3		3		3	3	3	3
	CO4	2	2	3	3	2	3	3	3		3	3	3	3

Course Content: **Total Hours: 52 hrs**

Unit I **13 hrs**

Introduction to Animal Cell Culture - Culture medium: natural media, synthetic media, sera.

Introduction to balanced salt solutions- HBSS, EBSS, simple growth medium- MEM, RPMI-1640. Physical, chemical and metabolic functions of different constituents of culture medium, role of carbon dioxide, serum and supplements. Behaviour of cells, properties, utility. Explant culture and suspension culture.

Unit II **13 hrs**

Characteristics and maintenance of cell lines: Definition of cell culture ; Primary cell culture, Secondary culture and cell line preparation; characteristics, maintenance and management of cell lines; cell adaptation. Measurement of viability and cytotoxicity. Cell cloning, cell synchronization and cell manipulation. Various methods of separation of cell types, advantages and limitations; flow cytometry.

Unit 3 **13 hrs**

Transgenic models and cell cloning – Cloning of Dolly; Transgenic animals –generation of Knockout mice, conditional gene knockout, knocking mice, generation of disease models in mice, transgenic ruminants generation and their applications, transgenic silkworm generation. Baculo virus expression system and its applications; Rabies vaccine generation using transgenic.

Unit IV **13 hrs**

Commercial applications of cell culture - Mass production of biologically important compounds (e.g. Vaccines). Harvesting of products, purification, and assays. Three dimensional cultures and tissue engineering for skin, bone. Pharmaceuticals from animal systems for humanized pharmaceuticals - Animal system as bioreactors.; Cryopreservation. Stem cell biology - concept, methods and applications in medicine.

Reference Books:

1. John M. Walker (2007). Animal cell Biotechnology: Methods and protocols – Nigel Jenkins (Ed), Humana press, New Jersey.
2. Watson J.D.et al (2007). Molecular Biology of Gene (6th Ed.) Publisher Benjamin Cummings.
3.Berger S. L. and A.R. Kimmel (1996). Methods in enzymology guide to molecular cloning Techniques (Vol 152). Academic Press Inc. San Diego

5. Glick, B.R. and Pasternak J.J (2003). Molecular Biotechnology. A- M Press, Washington DC
6. Jenni, P, Mather and David Barnes (2001). Methods in Cell Biology (Vol 37) Academic Press.
7. Ratlege, C. and B. Kristiansen (2001), Basic Biotechnology. Cambridge Univ. Press, London
8. Watson J.D. et al (2004). Molecular Biology of the Gene (6th Ed), The Benjamin Curmnings Pub. Co.Inc.USA
9. Jan Freshnev. R (2010). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (6th Ed.) Wiley and amp; Sons.
10. M.M. Ranga (2010). Animal biotechnology, Agrobios (India).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F3420	**TOXICOLOGY**	SC	3	1	0	4	4

Prerequisites/Pre-reading for the course

Students should have knowledge on chemistry, biochemistry and basics of Biotechnology, which will help them to understand the adverse effects of chemical substances, diagnosis and treatment.

Course Objectives:

The overall objectives of the course are:

1. Help to the students to build knowledge on toxic substances that react with living organism.
2. Focus on the toxicology of mammalian body systems with emphasis on dose-response, mechanism and the sites of action of major groups of chemical toxicants and biological toxins.
3. Provide an opportunity to conduct research in an area of toxicology.

Course Outcomes:

After completing the course, the student should be able to:

1. Understand the molecular mechanism of cell regulations based on various proteins, lipids and hormones that expose to the various chemical exposure and these bio molecules involved in the disease conditions.
2. Describe the human health and diseases based on signs, symptoms, diagnostics and treatment. Students also understand toxic exposure to the disease treatment.
3. Analyse and interpret the toxic substances used for prolonged exposures based on acute, sub-Acute and chronic studies.
4. Understand the concept of safety measures in pharmacology.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16F3420	CO1	3	2	2	3	1				3	2	3	2	
	CO2	1	2	3	3		1		3	2	1	3	3	1
	CO3	2	3	2	1				1	3	3	3	3	
	CO4	3	3	3	2	1	1		2	3	1	3	3	

Course Content: **Total Hours: 52 hrs**

Unit I **13 hrs**

Molecular Mechanisms in Cell regulation- Biosynthesis of Chemical Mediators such as mediators of inflammation and allergy, Histamine, Bradykinin, Eicosanoids: prostaglandins, thromboxanes, leukotrienes and related compounds, EDRF and vascular substances, oxygen free radicals, Cox- l and Cox-2 and their pathophysiological roles.

Unit II **13 hrs**

Health disorders-Hypertension, Ischaemic heart disease, Cardiac arrhythmias and dyslipidaemia, CNS: Parkinson's disease and Alzheimer's disease, Musculoskeletal: Rheumatoid & Osteoarthritis, GIT: Peptic ulcer, Inflammatory bowel diseases, Endocrine: Obesity, Diabetes mellitus, Osteoporosis,

Thyroid and parathyroid disorders, Infectious: UT infections, RT infections, GI infections (Bacterial and protozoal), Malaria, Tuberculosis, AIDS, Malignant: Leukaemia, Lymphomas and solid tumours.

Unit III **13 hrs**

Toxicity studies-Acute, sub-acute and chronic studies: Protocols, objectives, methods of execution and regulatory requirement. Reproductive toxicology assessment: Male reproductive toxicity, spermatogenesis, risk assessment in male reproductive toxicity, female reproductive toxicology, oocyte toxicity, alterations in reproductive endocrinology, relationship between maternal and developmental toxicity.

Unit IV **13 hrs**

Mutagenicity: *In vitro* tests for gene mutations in bacteria, chromosome damage, gene mutations in vivo (micronucleus tests and metaphase analysis) in rodents. Carcinogenicity studies: *In vivo* and *In vitro* studies e. Toxicological requirements for biological and bio-tech products: Safety analysis, concept of safety Pharmacology, antibodies, transmission of viral infections, residual DNA.

Reference Books:

1. Goodman and Gilman (2001). The Pharmacological Basis of Therapeutics. (International Edition) McGraw Hill, New York , 10th edition.
2. Rang HP, Dale MM and Ritter JM (1999). Pharmacology , Churchill Livingstone, London, 6th 3. Edition.
3. Bertram G Katzung (2001). Basic and Clinical Pharmacology by (International Edition) Lange Medical Book/McGraw-Hill, U.S.A. 8th Edition.
4. D.R. Laurence, P.N (1997). Clinical Pharmacy by Bennett & Mi. Brown, 8th Edition Churchill Livingstone.
5. Roger and Walker (2012). Clinical pharmacy and therapeutics, Churchill Livingstone Publication Experimental and surgical techniques in the rat, 2nd edition.
6. Braunwald, Fauci, Kasper, Hauser, Longo Jameson (2001), Harrison's Principles of Internal Medicine. (McGraw Hill, New York, 9th Edition.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F3510	**CLINICAL DATA SCIENCE**	SC	3	1	0	4	4

Prerequisites/Pre reading for the course:

Students should have basic knowledge of Life Science including microbiology, biochemistry and human physiology.

Students should be familiar with ethical concepts and safety aspects of scientific research

Course Objectives:

The overall objectives of the course are:

1. Develop knowledge on various kinds of research questions and research design.
2. Acquire basic knowledge on qualitative, quantitative and mixed method research as well as relevant ethical considerations.
3. Enable students to formulate research questions and develop a sufficient coherent research design and choose the right bio-statistical techniques to be used with the research methods.
4. Make informed choices with respect to methodology and research design.

Course Outcomes:

After completing the course, the student should be able to:

1) Understand the applications of bio-statistical procedure to evaluate a product situation, services or a treatment option through biostatistics.
2) Interpret statistical literature, research articles and the claims made on the basis of statistics.
3) Comprehend the research design considerations with respect to equations, formulations, Sample selections and randomization, study design and research protocols.
4) Decide the data types and graphs of samples and different standard errors, confidence intervals and p-values..

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16F3510	CO1	2	2		3						3	3	2	2
	CO2		3	3							3	3	2	2
	CO3			3	3		2			3		3	2	2
	CO4			3	3			3		3	3	3	2	2

Course Content: **Total hours: 52 hrs**

Unit I **13 hrs**

Introduction to Clinical Research: Definition of Clinical research, Terminologies & definitions used in Clinical Research, Difference between Clinical Research and Clinical practice, Types of Clinical research and Phases of Clinical Research, Features of Clinical Trials; The stand of

Clinical Research in Scientific Arena, Basics of Bioavailability & Bioequivalence Studies, Clinical Research Methodology, Career Prospect in Clinical Research

Unit II **13 hrs**

Preclinical Studies: HT screening, In vitro and In vivo studies, animal models of disease, teratogenicity, reproductive toxicity, mutagenicity, carcinogenicity, selection of initial human dose from animal data, Assessment; Extrapolation of animal data to clinical situation; Clinical significances, adverse event, serious adverse event, end point.

Unit III **13 hrs**

Basics of Clinical Pharmacology: Drug, Pharmacology Pharmacokinetics, Pharmacodynamics, Therapeutics, Toxicology, Chemotherapy, Pharmacoepidemiology, Pharmacoeconomics, Pharmacokinetics, Pharmacodynamics, First Human Dose; Drug Development Process: Drug discovery, Preformulation, Formulation & Development, Preclinical testing, Preclinical, toxicity studies, evaluation of drugs and Indian regulatory framework, Clinical Development process

Unit IV **13 hrs**

Clinical Trial Management & Regulatory Affairs: Defining Clinical Trial Process, Basics of Project Management-Definition of project, Stages of Project Development, definition of a clinical trial project management, concept of clinical Trial Management flow; Essential Document preparation (IB, ICF, PIS, TMF, ISF, Advertisements, CDA, CTA etc; Pharma Regulatory Affairs; Drug Policies; Adverse Drug Reactions; Management; Good Manufacturing Practices (GMP).

Reference Books:

1. Who Expert Committee on Specification for Pharmaceutical Preparation WHO-GENEVA, 2005 edition
2. Who Expert Committee on Biological Standardization WHO-GENEVA2003 edition
3. Guidance for Industry, CDER, 2005 edition
4. ICMR Guidelines – 2008, ICMR-New Delhi, 2006 edition
5. Vishal Bansal Parar (2010). Clinical Research Fundamental and Practice –Medical Publisher
6. Dr. S. Gunasakaran and R.Salhesh Kumar (2010). Pharmacovigilance for Beginners –Tatamani Magalir Co-Operative Press,
7. Dr.Ravindra B. Ghooi and Sachin C (2010). Essential of Clinical Research –. Itkar Nirali Prakashan
8. Jaypee Brothers (2009). Basic Principles of Clinical Research and Methodology, Medical Publishers (P) Ltd
9. T.K.Pal and Sangita Agarwal (2009)Clinical Research-, CBS Publishers and Distributors
10. Samir Malhotra, Nusrat Shafiq, Promila Pandhi (2008). A Comprehensive Clinical Research Manual- Jaypee Brothers Medical Publishers (P) Ltd
11. G.N Prabhakaran (2010) .Biostatistics - Jaypee Brothers Medical Publishers (P) Ltd
12. S.K.Gupta (2009) Drug Screening Methods- - Second Edition Jaypee Brothers Medical Publishers (P) Ltd
13. Quality Assurance of Phramaceuticals-VOL1.2WHO-GENEVA 2003 editions

14. Basic Test for Pharmaceuticals dosage forms WHO-GENEVA2008 edition
15. Rakesh Kumar Joshi (2007) .Regulations of Clinical trials - KONGPOSH PUBLISHERS

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F3520	**BIOSTATISTICS AND RESEARCH METHODOLOGY**	SC	3	0	1	4	4

Prerequisites/Pre reading for the course:

Students should have basic knowledge of statistical techniques relevant to life science research.

Basic understanding of research approaches in various domains of life science is essential.

Course Objectives:

The overall objectives of the course are:

1. Develop knowledge on various kinds of research questions and research design.
2. Acquire basic knowledge on qualitative, quantitative and mixed method research as well as relevant ethical considerations.
3. Enable students to formulate research questions and develop a sufficient coherent research design and choose the right bio-statistical techniques to be used with the research methods.
4. Make informed choices with respect to methodology and research design.

Course Outcomes:

After completing the course, the student should be able to:

1) Compute bio-statistical parameters, test hypotheses and analyse parametric and non-parametric assumptions and tests.
2) Apply bio-statistical test parameters in different areas of life sciences including product evaluation, weighing treatment options, etc.
3) Understand concepts of research methodology and frame research problems by applying research designs along with carrying out ethical and responsible animal research.
4) Analyse and report data ethically in high impact journals

Mapping of Course Outcomes with program Outcomes

Course Code	POs/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO2	PSO3
MSBT16F3520	CO1	2	2	3	2		1	1		1	1	2	1	1
	CO2	1	3	3	1		1		1	3	1	3	1	1
	CO3		2	3	1			1	1	1	2	2	1	1
	CO4	1	1	3				1	1	2	1	2	1	

Course Content: **Total Hours: 52 hrs**

Unit I **13 hrs**

Biostatistics I- Importance of statistical analysis in research, Data: types, classification and presentation as tables and graphs, measures of central tendency for grouped and ungrouped data, combined mean, Measures of dispersion, variance, standard deviation (SD), and combined SD, SEM, CoV, Rules of probability, features of normal distribution and related problems.

Unit II **13 hrs**

Biostatistics II-Pearson's correlation and Co-variance, Spearman and Kendall rank correlations and interpretation, multiple correlation, Regression equations and analysis, coefficient of determination and standard error of mean. Parametric and non-parametric data analyses, Concept of hypothesis and hypothesis testing, tests of significance, z test, student's t-test and F test. Chi-square tests for independence and Goodness of fit, Analysis of Variance (ANOVA).

Unit 3 **13 hrs**

Research Methodology and Designs- Definition, criteria, characteristics, objectives and types of scientific research, theory (empirical, deductive and inductive) and hypothesis, Research problems-definition, necessity, selection, objectives, types, methods and components. Research designs: Features, exploratory and descriptive types, Principles of experimental designs, informal and formal research designs, Animal research: Guidelines, ethical committees, animal models, routes of drug administration and LD_{50}, alternatives to animal research.

Unit 4 **13 hrs**

Data Analysis, Interpretation and Reporting: Primary and secondary data, Sample size determination, Data sampling considerations and design process, type I and type II errors, merits and demerits of non-probability and probability sampling techniques, Independent and dependent variables, Observation methods. Data interpretation: Techniques, precision, accuracy and precautions, Research reports: significance, layout, components, and types. Accountability, authorship and acknowledgement criteria, Ethics in research and reporting, plagiarism and online plagiarism software, Review and research articles, Journal impact factors and citations, Academic databases for biological sciences.

Reference Books:

1. Kothari, C. R. (2004), Research Methodology: Methods and Techniques, New Age International Publishers.
2. Sinha, S.C. and Dhiman, A.K., (2002). Research Methodology, EssEss Publications. 2 volumes.
3. Trochim, W.M.K., (2005). Research Methods: the concise knowledge base, Atomic Dog Publishing. 27
4. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., (2002). An introduction to Research Methodology, RBSA Publishers.
5. Wadehra, B.L. (2000). Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.
6. Leedy, P.D. and Ormrod, J.E., (2004). Practical Research: Planning and Design, Prentice Hall.
7. Satarkar, S.V., (2000). Intellectual property rights and Copy right. EssEss Publications

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F3600	**ORGANIC FARMING**	OE	3	1	0	4	4

Prerequisites/Pre reading for the course:

Need to have general awareness on issues related to environment, environment conservation, sustainable agriculture.

Course Objectives:

The overall objectives of the course are::

1. Understand the importance of organic farming in developing a sustainable agriculture system for ensuring adequate food production.
2. Acquire the holistic concept of organic farming as a self-sustainable unit in the ecosystem.
3. Get familiarized with the practices involved in the organic farming system.

Course Outcomes:

After completing the course, the student should be able to:

1. Analyse the advantages of organic farming compared to conventional chemical agriculture.
2. Understand the significance of plant nutrient management following organic practices.
3. Apply the knowledge gathered in implementing the practices in organic crop production and plant protection.
4. Explain the basic principles involved in organic farming production, certification and marketing.

Course Code	POS/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	P O 10	PSO 1	PSO 2	PSO 3
MSBT16F3600	CO1	2	2	2	1	2	1	3	2	4	3	3	1	2
	CO2	2	2	3	1	2	0	2	2	4	3	1	1	3
	CO3	2	2	3	3	2	0	1	2	4	2	1	0	1
	CO4	0	1	2	3	2	1	2	3	4	1	2	2	3

Course Content: **Total Hours:52 hrs**

Unit I **13 hrs**

Introduction to Organic Farming: Organic farming, concept and development of organic farming. Principles of organic farming & need for organic farming, Agencies and institutions related to organic agriculture. Farm components for an organic farm. Benefits of organic farming.Conventional farming v/s organic farming. Scope and present state of organic farming; its relevance to India and global agriculture and future prospects.

Unit II **13 hrs**

Organic Plant Nutrient Management: Organic farming systems: Soil tillage, Choice of Varieties, crop rotation, multiple cropping systems, intercropping. Propagation: planting materials and seed treatments. Water management, Organic manures: Green manuring, Composting: Composting methods, Vermicomposting, Organic amendments and sludges, biogas. Bio-fertilizers-: methods of application and advantages.

Unit III **14 hrs**

Organic Plant Protection: Plant protection: cultural, mechanical methods. Biological methods: botanical pesticides, biopesticide, biocontrol agents. Weed management. National and international Standards for organic inputs- plant protection; Integrated pest management. Organic crop production methods: arecanut, okra. Livestock component and management in organic farming.

Unit IV **12 hrs**

Organic Certification: Farm economy; Basic concept of economics- Demand, supply, Economic Viability of a farm. Basic production principles, Reducing expenses, ways to increase returns. Cost of production system. Marketing, Imports and exports. Policies and incentives of organic production, Farm inspection and certification: Income generation activities: Apiculture, Mushroom production, Terrace farming.

Reference Books:

1. Palaniappan, S.P and Anandurai, K. (1999). Organic Farming – Theory and Practice. Scientific Publ. Rao,
2. B.V.V. (1995). Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective: Publ.3, Parisaraprajna Parishtana, Bangalore.
3. Reddy M.V.. (1995). Soil Organisms and Litter Decomposition in the Tropics. Oxford & IBH.
4. Sharma, A. (2002). Hand Book of Organic Farming. Agrobios.
5. Singh, S. P. (1994). Technology for Production of Natural Enemies. PDBC, Bangalore.
6. Subba Rao, N.S. (2002). Soil Microbiology. Oxford & IBH.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16 F3700	**Minor Project**	HC	0	0	4	2	4

Note: The students will have to undergo domain specific Skill Development course conducted by either external agency or Department of Biotechnology

FOURTH SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F4100	**ENVIRONMENTAL BIOTECHNOLOGY**	HC	3	1	0	4	4

Prerequisites/Pre reading for the course:

The students should have prior knowledge of environmental science and chemistry

The students also should be familiar with concepts of pollutants and wastes

Course Objectives:

The overall objectives of the course are:

1. Introduce the essential and critical principles involved in environmental biotechnology

2. Describe the concepts and techniques in environmental biotechnology with respect to bioremediation.

3. Understand the significance of environmental biotechnology studies to protect the nature

Course Outcomes:

After completing the course, the student should be able to

1. Describe the various methods to prevent pollution
2. Comprehend the various techniques related to water management and waste water treatment in order to conserve water.
3. Understand the importance of microorganisms in degrading the pollutants in the environment.
4. Create awareness about various methods involved in solid waste management for conservation of nature.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16F4100	CO1	2	2	2	2	2	1	2	3	3	3	3	1	
	CO2	1	1	3	2	2	1	3	3	3	3	3	1	1
	CO3	2	2	1	2	2		1	2	3	3	1	1	
	CO4	1	2	1	1	2	1	3	2	3	3	3		

Course Content: **Total Hours: 52 hrs**

Unit I **13 hrs**

Energy & Environment - Renewable and non-renewable sources of energy; Biodiversity and its conservation. Environmental pollution- water, soil and air pollution sources. Global warming, its impact and management, Bio indicators and Bio monitoring: Biosensors and biochips.

Unit II **13 hrs**

Water Management Strategies- Water as a scarce natural resource, water management techniques including rain water harvesting. Sampling Techniques - Methods of Analysis - Characterization Origin of Wastewater - Sources and classification of water pollutants. Waste Water Treatment, Primary treatment - Sedimentation- Flocculation, Flotation.

Unit III **13 hrs**

Bioremediation - Application, specific advantages and disadvantages, land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump-treat method, constructed wet lands, use of bioreactors for bioremediation. Phytoremediation, bioremediation of xenobiotics (heavy metals, pesticides, oil slicks, plastics restoration of coal mines: a case study

Unit IV **13 hrs**

Solid Waste Management & Biodegradation- Definition of solid wastes, Types of domestic solid wastes – collection – transportation – characteristics of solid waste–segregation – types of disposal methods – sanitary land fill – incineration – composting – Vermicompost – recovery of energy from solid wastes; Microbial Degradation of Biopolymers, Cellulose, xylan, starch and other glucans, pectin, lignin and chitin, protein, nucleic acids, lipids and fats and polyhydroxyalkanoates (Bioplastics).

Reference Books:

1. Jordening H J and Josef Winter (2005) Environmental biotechnology: concepts and applications. 2nd edition, Wiley and Sons Publishers.UK.
2. Daniel Vallero., (2010) Environmental Biotechnology: A Biosystems Approach, 1st edition, Academic press. New York.
3. Wang LK (2010) Handbook of Environmental Engineering, 1st edition, Springer Publishers.
4. Evans G G and Judy Furlong., (2011) Environmental Biotechnology: Theory and Application 2nd edition,Wiley publishers.
5. Wang L.K., Ivanov V., Tay J.H., HungY.T (2010) Handbook of Environmental Engineering 1st edition, Springer Publishers
6. Gareth G. Evans, Judy Furlong (2010) Environmental Biotechnology: Theory and Application 2nd edition, Wiley publishers.
7. Fulekar M.H (2010) Environmental Biotechnology, Taylor and Francis group

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F4200	**ENVIRONMENTAL BIOTECHNOLOGY LABORATORY (PRACTICAL)**	HC	0	0	2	2	4

Prerequisites/Prereading for the course

Students should be familiar with the concepts of microbiology and analytical techniques.

Awareness about the risk involved hazards and safety requirement in the laboratory.

Course Objectives:

The overall objectives of the course are:

1. Impart knowledge on the role of pollutants and their effects on health.
2. Learn techniques of controlling the environmental pollution.

3. Facilitate the understanding of the impact of industrial effluents on environment.
4. Understand the role of microorganisms in bioremediation process.

Course Outcomes:

After completing the course, the student should be able to:

1. Analyze the detrimental effects of different pollutants in the environment.
2. Develop remedies to control pollution.
3. Categorize the chemicals depending on their hazardous effect.
4. Establish and practice Vermicomposting.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16F4200	CO1	2	2	2	1	2	1	2	2	3	3	2	0	1
	CO2	1	2	2	2	2	0	2	3	3	3	3	1	2
	CO3	1	2	1	0	1	0	1	1	0	1	1	0	0
	CO4	1	0	0	0	2	0	1	1	1	1	1	0	1

Course Content:
1.Determination of Total dissolved solids
2.Determination of DO and BOD of water sample
3.Determination of COD of water sample
4. Microbial analysis of water by MPN method
5.Estimation of Chromium in Industrial effluent by colorimetric method
6. Estimation of Calcium in water sample by titration method
7. Isolation of bacteriophages from sewage
8. Vermicomposting

Reference Books:

1. A.H. Patel (2011) “Industrial Microbiology” Macmillan
2. Presscott, S.C. and Cecil G. Dunn (2005), “Industrial Microbiology”, Agrobios (India),
3.Cruger,Wulf and Anneliese Crueger (2000), “Biotechnology: A Textbook of Industrial Microbiology”, 2nd Edition, Panima Publishing.
4. Moo-Young, Murrey (2004), “Comprehensive Biotechnology”, 4 Vols. Pergamon Press, (An Imprint of Elsevier)
5. Wang L.K., Ivanov V., Tay J.H., HungY.T (2010) Handbook of Environmental Engineering 1st edition, Springer Publishers
6. Gareth G. Evans, Judy Furlong (2010) Environmental Biotechnology: Theory and Application 2nd edition, Wiley publishers.
7. Fulekar M.H (2010) Environmental Biotechnology, Taylor and Francis group

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F4310	**Genomics & Proteomics**	HC	3	1	0	4	4

Prerequisites for the course

1. Basic knowledge of biology and computer science is required

Course Objectives:

The overall objectives of the course are to:

1. Introduce the basic concepts of bioinformatics.
2. Demonstrate applications of bioinformatics and biological databases in problem solving Pertaining to research.
3. Familiarize with the various aspects of internet applications.
4. Apply the knowledge of biological database for problem solving in the field of research.

Course Outcomes:

After completing the course, the student should be able to

1. Apply the knowledge and basic principles of concepts of biological data
2. Comprehend the role of various softwares and tools in computational drug discovery
3. Acquire problem-solving skills using bioinformatics algorithms to solve biological data structures
4. Understand the various concepts & methods involved in statistical analysis.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16F4310	CO1	3	3	2	2				1	1	2	3	2	2
	CO2	2	2	3	3					1	2	2	2	2
	CO3	2	3	2	2	2	1		2	2	3	3	3	3
	CO4	3	3	3	2	2	1	2	2	2	3	3	2	2

Course content

Unit-I **10hrs**

Introduction to Omics: Basics of Genomics- Structural genomics, Functional and Comparative Genomics; Transcriptomics, proteomics, and metabolomics. Structure and organization of prokaryotic and eukaryotic genomes; Introduction to Metagenomics;

Unit II **14 hrs**

Genomics: Physical mapping, Repetitive and coding sequences, Genetic and physical maps, Methods of physical mapping. Molecular markers, Hybridization based markers restriction fragment length polymorphism (RFLPs), random amplification of polymorphic DNA (RAPDs) and amplified fragment length polymorphisms (AFLP). Multiple arbitrary amplicon profiling using short oligonucleotide primers, SCAR, micro satellites and other markers, length polymorphisms in simple sequences repeats (SSR and ISSR); Approaches to mapping, fluorescence in-situ hybridization (FISH) - DNA amplification markers; RT-PCR, Northern blot, Serial analysis of gene expression (SAGE), Microarray techniques; 16S rRNA typing/sequencing;

Unit III **14 hrs**

Understanding Proteomics: Overview of protein structure-primary, secondary, tertiary and quarternary structure; Relationship between protein structure and function; Outline of a typical proteomics experiment; Identification and analysis of proteins by 2D analysis; Expression analysis and characterization of proteins-separation of proteins-2D PAGE (2DGE), multiplexed analysis, multidimensional liquid chromatography, high throughput screening by Mass spectrometry, MALDI-TOF, peptide fingerprinting, protein micro array antibody arrays.

Unit IV **14 hrs**

Computational analysis of sequences- Finding genes and regulatory regions; Orthologs, homologs, paralogs, gene evolution, protein evolution by exon shuffling; Evolution of a pathogen e.g. a bacterial pathogen; Gene annotation; Similarity searches; Pairwise and multiple alignments; Alignment statistics; Prediction of gene function using homology, context, structures, networks; Genetic variation-polymorphism, deleterious mutation; Comparative genomics- Comparative genomics of relevant organisms such as pathogens and non-pathogens, closely related bacteria; Phylogenetics; Model organisms and other genome projects.

References:

1. Brown TA, Genomes, 3rd Edition, Garland Science, 2006.
2. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, Benjamin Cummings, 2007.
3. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
4. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.
5. Benjamin Lewis. Genes IX (9th Ed.). Jones and Bartlett publishers. USA. 2007
6. Ed. C. Cantor and C.L. Smith, Genomics: The Science and Technology behind the Human Genome Project, Wiley-Interscience, 2000.
7. G. Gibson, S. V. muse, A Primer of Genome Science, Sinauer Associates Inc. Publishers, 2002.
8. H. Rehm, Protein Biochemistry and Proteomics, 4th Edition, Academic Press, 2006.

9. E.de Hoffman and V. Stroobant, Mass Spectrometry, 2nd Edition, Wiley. 2002.
10. Wayne W. Daniel, Biostatistics: A foundation for Analysis in the Health Sciences, 8th Edition, Wiley, 2004.
11. Prem S. Mann, Introductory Statistics, 6th Edition, Wiley, 2006.
12. John A. Rice, Mathematical Statistics and Data Analysis, 3rd Edition, John A. Rice, Duxbury Press, 2006.
13. Cynthia Gibas and Per Jambeck, Developing Bioinformatics Computer Skill, 1st Edition, O'Reilly Publication, 2001.
14. Higgins and Taylor – Bioinformatics, Oxford University Press.
15. Stephen P Hunt and Rick Liveey- Functional Genomics, Oxford University Press.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F4320	**NANOBIOTECHNOLOGY**	SC	3	1	0	4	4

Prerequisites/Pre reading for the course:

Students should be familiar with the basic concepts of chemistry, spectroscopy techniques, microscopy techniques and chromatography techniques

Course Objectives:

The overall objectives of the course are:

1. Explore the students to the knowledge about the nanometric objects.
2. Train students in towards formulation and application of nanofabricated products.
3. Illustrate the creative knowledge of nanobiotechnology which will be helpful in research area
4. Understand the advantageous and harmful aspects of nanotechnology which can be helpful in society

Course Outcomes:

After completing the course, the student should be able to:

1. Explain the basic concepts in nanotechnology.
2. Illustration about various analytical instrumentation techniques for characterization of nanomaterials
3. Identify natural and manmade sources for nanoparticles, the routes of exposure to the human system, the effects and mechanism of action on biological systems
4. Illustrate knowledge about the properties of engineered nanomaterial and its applications

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16F4320	CO1	1	2	1	1	1			3		3	2	1	2
	CO2	2	3	2	3	2			3		3	3	2	2
	CO3	2	3	3	3	2			3		3	3	2	2
	CO4	2	3	3	3	2			3		3	3	2	2

Course Content: **Total Hours: 52 hrs**

Unit I **13 hrs**

Principles, synthesis and characterisation of Nanomaterial : Origin and concepts, General properties of nano materials, Top down and bottom up approaches of synthesis, Nanoparticle synthesis by physical, chemical and biological methods**.**

Unit II **13 hrs**

Characterisation Methodology of Nanomaterial's – Microscopy Techniques, SEM, TEM, AFM, STM, Spectroscopic techniques – UV Vis and FTIR, XRD, DLS methods for particle size analysis, zeta potential, and Electrophoretic mobility.

Unit III **13 hrs**

Nanoparticles & Environment Natural and manmade sources for nanoparticles, fate of nanoparticles in environment, routes of exposure to the human system, their effects and mechanism of action on biological systems at organ and cellular level, High Aspect Ratio Nanoparticles,

Unit IV **13 hrs**

Engineered Nanomaterial and its Applications: Carbon nanotubes, Fullerences, Core shell nanoparticles, Quantum dots, metal nano particles their properties and applications Biomimetic systems for commercial applications.

Nanomedicine : Dendrimers, liposomes, polymer nanocontainers, biologic robots for targeted therapy including cancer treatment and regenerative medicine.

Reference Books:

1.T. Pradeep (2007) Nano: The essentials - Understanding Nanoscience and Nanotechnology, , Tata McGraw- Hill Publishing Company Limited, New Delhi.

2.Charles P.Pooli, J.R., Frank J.Owens, (2003), Introduction to nanotechnology, Wiley Interscience Publications.

3. Ahmad (2010), Principles of Nanoscience and Nanotechnology, M.A. Shah& T., Narosa Publishing House Pvt Ltd, Kolkata.

4. Guozhong Cao, Ying Wang (2011), Nanostructures and nanomaterials: Synthesis, Properties and Applications, Vol 2, World Scientific Publishing.

5.SSR Kumar (2007), Nanomaterials for Cancer Diagnosis, Wiley –VchVerlag GmbH and Co.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
MSBT16F4400	**MAJOR PROJECT AND DISSERTATION**	HC	0	0	8	8	8

Course 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.

Course Code	**PO / CO**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
MSBT16F4400	CO1	2	3	3	3							3	2	2
	CO2	2	2	3	3	3	3					2	3	2
	CO3	2	2	3	3	3	3		3	3	3	3	3	3
	CO4	3	3	3	3	3	3	3	3	3	3	3	3	3

Course Contents:

1. The project work is to be carried out individually or as a group of a maximum of two students.

2. The project shall be allotted at the beginning of the III semester to facilitate students to work on it during the semester break. It is mandatory for students to attend the 8-10 hr session on Research Methodology as a pre-requisite for project work execution.

3. In-house projects are encouraged.

4. Students may be allowed to carry out their project work at other research institutes

5. Faculty members of the respective colleges/ university departments must serve as guides for students engaged in their projects

6. Project students may be permitted to have faculty from other institutions as co-guides.

7. A copy of the dissertation must be submitted to the University for evaluation.

8. Evaluation of the dissertation is to be done by the two external examiners appointed by the University.

9. The project viva voce examination shall be held at the University Department by the BoE (presentation and viva voce).

10. A synopsis of the project justifying its execution is to be submitted before commencing the project.

CAREER DEVELOPMENT & PLACEMENTS

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 Counselling and Placement division, namely Career Development Centre (CDC) headed by well experienced senior Professor and Dean and supported by dynamic trainers, counsellors and placement officers and other efficient supportive team does handle all aspects of Internships and placements for the students of REVA University. The prime objective of the CDC is to liaison between REVA graduating students and industries by providing a common platform where the prospective employer companies can identify suitable candidates for placement in their respective organization. The CDC organizes pre-placement training by professionals and also arranges expert talks to our students. It facilitates students to career guidance and improve their employability. In addition, CDC forms teams to perform mock interviews. It makes you to enjoy working with such teams and learn many things apart from working together in a team. It also makes you to participate in various student clubs which helps in developing team culture, variety of job skills and overall personality.

The need of the hour in the field of Biotechnology is not only knowledge in the subject, but also the skills to do the job proficiently, team spirit and a flavour of innovation. This kept in focus, the CDC has designed the training process, which will commence from second semester along with the curriculum. Special coaching in personality development, career building, English proficiency, reasoning, puzzles, and communication skills to every student of REVA University is given with utmost care. The process involves continuous training and monitoring the students to develop their soft skills including interpersonal skills that will fetch them a job of repute in the area of his / her interest and march forward to make better career. The School of Chemical and Biological 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 centre 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 VikasYojana.

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.

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