REVA UNIVERSITY

Bengaluru, India

Established by GoK & recognised by UGC Act, 1956, as per the section 2(f).
Approved by AICTE, COA and BCI, New Delhi. Accredited by NAAC.

School of Electronics and Communication Engineering

Handbook

B. Tech. in Electronics and Computer Engineering (ECM)

First Year to Fourth Year
(First Semester to Eighth Semester)

2019-23

Rukmini Knowledge Park, Kattigenahalli,
Yelahanka, Bengaluru- 560064, Karnataka, India
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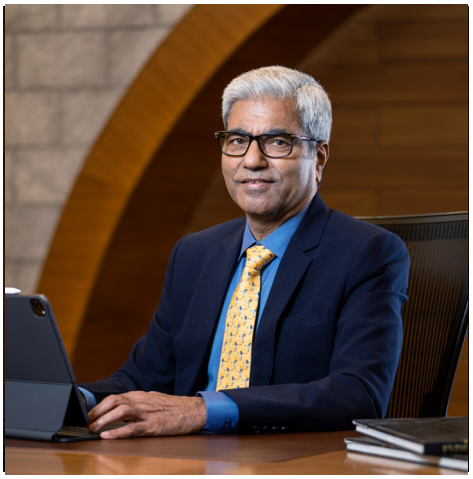
Rukmini Educational
Charitable Trust

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

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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.

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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!

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Director's –Message

Since the inception of REVA University, School of Electronics and Communication Engineering is involved in implementing following best practices in various dimensions such as academics, research, outreach activities, student development programs, project based and research based learning, student centric learning, student competitions, industry and in-house internships, abroad internships, skill enhancement activities, motivation for competitive exams, mini projects, major projects, industry mentored projects, multidisciplinary projects, industry visits, technical talks by industry and academicians, certification programs, etc. Individual students are taken care by 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.

The curriculum is carefully designed to meet the current industry trends and also to provide insight into future technology developments that lead to inculcate lifelong learning abilities in students. Board of Studies (BoS) comprises people from academics, industry, alumni and current students which form the strong backbone for our programs wherein constant updates happen in contents/subjects every semester based on current industry needs. Curriculum has good mix of foundation courses, hardcore courses, softcore courses, practicals and projects along with open electives, softskill and skill development courses.

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 /video contents/quizzes 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. The faculty members have number of publications in reputed national and international journals/conferences. The school is also involved in funded research projects.

I am sure the students choosing B Tech and M. Tech programs in School of Electronics and Communication Engineering in REVA University will enjoy the curriculum, teaching and learning environment, well equipped laboratories, digital classrooms infrastructure and the experienced teachers involvement and guidance.

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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.

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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.

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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.

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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.

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Vision

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

Mission

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

Objectives

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

ABOUT 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. in Electronics and Communication Engineering, Electronics and Computer Engineering, M. Tech. and PhD programs in various specialized streams. The curriculum of both the graduate and the post graduate degree programs has been designed to meet the current industry trends. B. Tech program aims to prepare human resources to play a leading role in the continuing adventure of modern automated systems and communications. The 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. This is reflected in various core subjects offered within the program.

The Master degree programs focus on research and design in the core and IT industries, building and marketing the next generation of product development. These programs provide an opportunity to explore newer dimensions in cutting edge technologies like VLSI, Embedded Systems, Communication and Networking and pursue research in interested domains for doctoral degree.

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 in the field of Electronics and Communication Engineering and explore multidisciplinary which serve the societal requirements.

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- Create state-of-the-art laboratories, resources and exposure to the current industrial trends to enable students to develop skills for solving complex technological problems of current times and also provide a framework for promoting collaborative and multidisciplinary activities.
- Promote the establishment of Centers of Excellence in niche technology areas to nurture the spirit of innovation and creativity among faculty and students.
- Offer ethical and moral value based education by promoting activities which inculcate the leadership qualities, patriotism and set high benchmarks to serve the society.

BoS

Sl. No.	Name, Designation & Affiliation	Status	Correspondence Address
1	**Dr. R. C. Biradar** Director, School of ECE, REVA University	**Chair Person**	Dr. R C Biradar, Director, School of ECE, REVA University, Rukmini Knowledge Park, Yelahanka, Bangalore - 560 064
2	**Dr. Rathna G. N.** Principal Research Scientist, E&E Dept., IISc.	**Member**	Dr. Rathna G. N., Principal Research Scientist, DES, E&E Dept. Office Room No. 211, Indian Institute of Science, Bangalore-560 012
3	**Dr. T. Srinivas** Associate Professor,IISc. Bangalore	**Member**	Dr. T. Srinivas, SPW 102, Electrical Communication Engineering, Indian Institute of Science, Bangalore 560012
4	**Mr. Vinod Chippalkatti**Vice President-SEBU Centum Electronics Ltd	**Member**	Mr. Vinod Chippalkatti**,** Vice President- SEBU Centum Electronics Ltd
5	**Dr. G. T. Raju** Vice Principal, RNSIT, Bangalore	**Member**	Dr. G. T. Raju,Vice Principal RNSIT, Dr. Vishnuvardhana Road, Channasandra Post, Bangalore – 560061
6	**Mr. Jwalanth Joshipura** Director, SoC Design, NXP Semiconductors India Pvt. Ltd.	**Invited Member**	Mr. Jwalanth Joshipura, Director, SoC Design, NXP Semiconductors India Pvt. Ltd. Bangalore.
7	**Mr. Rajakrishnamoorthy** Director, Cognizant	**Member**	Mr. Rajakrishnamoorthy, Director, Cognizant, Bangalore
8	**Dr. Bharathi S. H.** Professor, School of ECE, REVA University	**Member (Internal)**	Dr. Bharathi S. H., Professor, School of ECE, REVA University, Yelahanka, Bangalore 560064
9	**Dr. Rohini Deshpande Professor & Head ECM Dept., School of ECE, REVA University**	**Member (Internal)**	Dr. Rohini Deshpande, Professor, School of ECE, REVA University, Yelahanka, Bangalore 560064
10	**Dr. Geetha D** Professor, School of ECE, REVA University	**Member (Internal)**	Dr. Geetha D,Professor,School of ECE, REVA University, Rukmini Knowledge Park, Yelahanka, Bangalore 560 064
11	**Dr. P. I. Basarkod** Professor, School of ECE, REVA University	**Member (Internal)**	Dr. P. I. Basarkod,Professor, School of ECE, REVA University, Rukmini Knowledge Park, Bangalore 560 064
12	**Dr. Prashanth V. Joshi** Assoc.Professor, School of ECE, REVA University	**Member (Internal)**	Dr. Prashanth V. Joshi,Assoc.Professor, School of ECE, REVA University, Rukmini Knowledge Park, Bangalore 560 064

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13	**Dr. Manjunath R. Kounte** Assoc.Prof.School of ECE, REVA University	**Member (Internal)**	Dr. Manjunath R. Kounte, Professor, School of ECE, REVA University, Rukmini Knowledge Park, Bangalore 560 064
14	**Mr. Sumanth B. Pathi** Senior Lead Engineer, Qualcomm India Pvt. Ltd	**Member Alumni**	Mr. Sumanth B Pathi, Senior Lead Engineer, Qualcomm India Pvt. Ltd. Bagmane Constellation, Marathalli, Bangalore - 560037
15	**Ms. Chandana**	**Current Student**	**7th Sem, B. Tech, ECE**

Programme Overview

The B. Tech in Electronics and Computer Engineering 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 core Electronics and Computer Engineering with a flexibility to explore any one of the four areas like circuits and devices, signal processing, communication engineering and programming where in an ample number of courses the included that provide 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 support to explore the areas of their interest.

In recent past, Electronics and Computer Engineering is emerged as bridging course that connects the technologies from core computer Engineering and Semiconductor Physics to the modern technologies such as Artificial intelligence, deep learning, machine learning and finally, merging all the software devices of these technologies with IT. The structure of the course has undergone a face-lift with the introduction of subjects from computer science and engineering and thereby provides the flexibility for students choose for IT sectors apart from core Electronics and Computer Engineering. Thus, students in Electronics and Computer Engineering have the flexibility to broaden their horizons in software related industries. The advantage for Electronics and Computer Engineering students is that they are required in both hardware development sectors as well as software development sectors that broadens the area from core electrical engineering to multidisciplinary areas such as robotics, mechatronics, aviation, medical electronics, space exploration, etc.

The program is thus designed to expose students to various subjects having applications in smart system design, wired and wireless communication technologies, information processing, security systems, cloud based applications, information technology and electronics related industries 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. Electronics and Computer Engineering provides the students to choose their career in any one of the following areas.

1. *Analog and Radio Frequency Electronic Circuits:* Without these, there would be no cell phones, no Wifi, not even television.
2. *Communication and Signal/ Image Processing:* It is concerned with the transmission, storage, and analysis of information signals. While traditionally electronics engineers worked on communicating and analyzing speech, audio, image, and video signals, nowadays they work on a much wider variety of problems, such as recovering and analyzing physiological and genomic signals, ecological and environmental signals, consumer preference data, financial time series, and many others. These technologies make it possible for computers to analyze data from magneto-resonance imaging and other medical imaging devices to not only display images but identify diseases. Computer vision experts teach computers how to recognize faces, while image processing people can de-blur images, extract features, and even make art.
3. *Computer and Digital Systems:* Our society is advancing faster technologically than ever before with the help of computers. These digital systems are everywhere, from your dishwasher and wristwatch to the Mars rovers, and everything in between.
4. *Networking:* The Internet is having a profound impact on society, bringing people across the world together to work collaboratively from different countries. It also spreads and promotes democracy.
5. *Control Systems, Robotics, and Intelligent Transportation:* Automation to reduce human toil in the workplace; enhance safety in manufacturing systems, automobiles (via anti-skid braking systems or self-driving vehicles), and aircraft (e.g., via auto-pilots); biomedical applications including automatic drug delivery (e.g., insulin control for diabetics), controlled prostheses, and robotic surgery; pollution reduction in automobiles and aircraft.
6. *Electromagnetics and Microwaves:* Communication via radio waves is essential for mobile devices, radios, and the internet. Radio- and microwaves can also be used for sensing, for example in air traffic control radar. The ability of microwaves to see through clouds and rain also makes them very useful for measuring Earth's climate and the influence of global change.
7. *Fibre Optics:* Using light to solve engineering problems runs the gamut from fiber optics to lasers for eye surgery. A thorough understanding of the interaction of light with matter even

helps animators creativity. Optics are widely applicable in many fields, including all types of engineering, as well as medicine, architecture (lighting), entertainment, and many others.

The benefits of choosing Electronics and Computer Engineering are as follows.

- Ample opportunities exist in the field of embedded systems, signal processing, and communication engineering jobs including the IT sector. Flexibility to choose various fields upon graduation
- Great number of opportunities also exists in the field of defence to work in the areas of signal processing and communication.
- They can find Placements in industries related to mechatronics, AI, robotics, cloud computing etc.
- They can find Placements in software related industries.
- Provides a platform to venture into a startup and establish as an entrepreneur.
- Provides a platform to focus on the research and innovation which leads to socio-economic reforms.

Program Educational Objectives (PEO's)

The programme educational objectives of the Electronics and Computer Engineering of REVA University is to prepare graduates

PEO-1	To have successful professional careers in industry, government, academia and military as innovative engineers.
PEO-2	To successfully solve engineering problems associated with the life cycle of Electronics and Computer Systems by communicating 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 lifelong learning and seeking higher education.
PEO-4	To be active members ready to serve the society locally and internationally and will take up entrepreneurship for the growth of economy and to generate employment.

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Program Outcomes (POs)

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

1. Isolate and solve complex problems in the domains of Electronics and Computer Engineering using latest hardware and software tools and technologies, along with analytical and managerial skills to arrive at cost effective and optimum solutions either independently or as a team.

Ref: RU/BoS/ECE/CEC/May-2021-9

2. Implant the capacity to apply the concepts of electronics, communications, signal processing, VLSI, embedded systems, etc in the design, development and implementation of application oriented engineering systems.
3. Design, Model, Analyse and Build Electronics and Computer Systems to solve real life and industry problems.

REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Engineering Graduate Degree Programs, 2020

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

1. Title and Commencement:

1.1. These Regulations shall be called the **"REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Engineering Graduate Degree Programs, 2020".**

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

2. The Programs:

The following programs and all Engineering Graduate Degree programs to be instituted and introduced in REVA University in coming years shall follow these regulations.

B Tech in:

Bioelectronics Engineering
Civil Engineering
Computer Science and Engineering
Computer Science and Information Technology
Computer Science and Systems Engineering
Computer Science and Engineering (AI and ML)
Electrical and Electronics Engineering
Electrical and Computer Engineering
Electronics and Communication Engineering
Electronics and Computer Engineering
Information Science and Engineering
Mechanical Engineering
Mechatronics Engineering

3. Definitions:

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

(i) L= Lecture (ii) T= Tutorial (iii) P=Practice; where:

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

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

P stands for **Practice** session and it consists of Hands on Experience / Laboratory Experiments / Field Studies / Case Studies that equip students to acquire the much required skill component.

4. Courses of study and Credits

4.1. The study of various subjects in 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.

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

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

4.1.3. A course shall have either or all the four components. That means a course may have only lecture component, or only practical component or combination of any two or all the three components.

4.1.4. ***The concerned BoS will assign Credit Pattern for every course based on the requirement. However, generally, courses can be assigned with 1-4 Credits depending on the size of the course.***

4.1.5. Different 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.

Ref: RU/BoS/ECE/CEC/May-2021-9

d. Soft Core Course (SC):

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

e. Open Elective Course:

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

f. Project Work / Dissertation:

Project work / Dissertation denoted as "D" is a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Minor project normally will be assigned with 4-6 credits and a major project/dissertation will be assigned with 8-16 credits. **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.**

5. Eligibility for Admission:

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

Sl. No.	Program	Duration	Eligibility
1	Bachelor of Technology (B Tech)	4 Years	Passed 10+2 examination with Physics and Mathematics as compulsory subjects along with one of the Chemistry Biotechnology / Biology / Technical Vocational subject Obtained at least 45% marks (40% in case of candidate belonging to SC/ST category) in the above subjects taken together.
2	Bachelor of Technology(B Tech)	Lateral entry to second year	**(A)** Passed Diploma examination from an AICTE approved Institution with at least 45% marks (40% in case of candidates belonging to SC/ST category) in appropriate branch of Engineering / Technology.

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			(B) Passed B. Sc Degree from a recognized University as defined by UGC, with at least 45% marks (40% in case of candidates belonging to SC/ST category) and passed XII standard with mathematics as a subject. **(C)** Provided that in case of students belonging to B. Sc. Stream, shall clear the subjects of Engineering Graphics / Engineering Drawing and Engineering Mechanics of the first year Engineering program along with the second year subjects. **(D)** Provided further that, the students belonging to B. Sc. Stream shall be considered only after filling the seats in this category with students belonging to the Diploma stream. **(E)** Provided further that students, who have passed Diploma in Engineering & Technology from an AICTE approved Institution or B. Sc Degree from a recognized University as defined by UGC, shall also be eligible for admission to the first year Engineering Degree courses subject to vacancies in the first year class in case the vacancies at lateral entry are exhausted. However the admissions shall be based strictly on the eligibility criteria as mentioned in A, B, D, and E above.
3	Bachelor of Technology (B Tech)	Lateral entry to fourth year (final year)	(F) Any candidate with genuine reason from any University / Institution in the country upon credit transfer could be considered for lateral admission to the respective semester in the concerned branch of study, provided he/she fulfils the university requirements.
4	B Sc (Honors) in Computer Science (with specialization in Cloud and Big Data)	4 Years (8Semesters)	Pass in PUC /10+2 examination with Physics, Mathematics as compulsory subject along with at least one of the Chemistry,/ Bio-Technology / Biology / Computer Science / Electronics / Technical Vocational subjects and obtained minimum 45% marks (40% in case of candidates belonging to SC / ST category) in the above subjects taken together of any board recognized by the respective State Government / Central Government / Union Territories or any other qualification recognized as equivalent there to.

Ref: RU/BoS/ECE/CEC/May-2021-9

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

6. Scheme, Duration and Medium of Instructions:

6.1. 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.

6.2. The medium of instruction shall be English.

7. Credits and Credit Distribution

7.1. A candidate has to earn 192 credits for successful completion of B Tech degree with the distribution of credits for different courses as given in Table-1 below:

Course Type	**Credits**
	For B Tech Degree (8 Semesters)
Foundation Core Course	A minimum of 08
Hard Core Course	A minimum of 136, but not exceeding 156
Soft Core Course	A minimum of 24 but not exceeding 44
Open Elective	A minimum of 04
Total	**192**

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

Sl. No.	**Course Title**	**Number of Credits**
1	English for Technical Communication	4
2	Environmental Studies	2
3	Indian Constitution and Professional Ethics	2

Ref: RU/BoS/ECE/CEC/May-2021-9

7.3. A candidate can enrol 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.

7.4. 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.

8. Assessment

b) Each course is assessed for a total weight of 100%. Out of the total 100% weight; 50% weight is for Continuous Internal Assessment (CIA or IA) and the remaining 50% for the Semester End Examination (SEE). This applicable for theory, laboratory, workshop, studio and any such courses

c) Out of 50% weight earmarked for Internal Assessment (IA)- 10% is for Quizzes, 15% for test-1, 15% for test-2 and 10% for Assignments and this is applicable for theory based courses

d) The quizzes, tests and assignments are conducted as per the semester academic calendar provided by the University

The details as given in the table

Component	Description	Conduction	Weight Percentage
C1	Quizzess	At the end of each class	10
C2	Test-1: IA1	6th week from the starting date of semester	15
	Test-2: IA2	12th week from the starting date of semester	15
C3	1 Assignment	7th week	05
	2 Assignment	13 th week	05
C4	SEE including practical	between 17th Week-20th Week	50

Ref: RU/BoS/ECE/CEC/May-2021-9

Results to be Announced	By the end of 21st Week

Note: IA or CIA includes C1,C2, C3

Each test must be conducted for a duration of 60 minutes, setting the test question paper for a maximum of 30 marks. The final examination must be conducted for a duration of 3 hours and the question paper must be set for a maximum of 100 marks.

e) Students are required to complete courses like communication skills, technical English, Professional ethics and Indian Constitution, Environmental Sciences, technical skills, placement related courses, Open electives and any such value addition or specialized courses through online platforms like SWAYAM/NPTEL/Any other reputed online education aggregator. Students are required to choose the courses on the advice of their course coordinator/Director and required to submit the course completion certificate along with percentage of marks/grade scored in the assessment conducted by the online education aggregator. If the online education aggregator has issued a certificate along with the grade or marks scored to students, such courses will be considered for SGPA calculations, in case the aggregator has issued only a certificate and not marks scored, then such courses will be graded through an examination by concerned School, in case, if grading is not possible, students will be given a pass grade and award the credit and the credits will not be considered for SGPA calculations. The Online/MOOCs courses will not have continuous internal assessment component

f) Such of those students who would like to discontinue with the open elective course that they have already registered for earning required credits can do so, however, they need to complete the required credits by choosing an alternative open elective course.

9. Setting question paper and evaluation of answer scripts.

i. For SEE, three sets of question papers shall be set for each theory course out of which two sets will be by the internal examiners and one set will be by an external examiner. In subsequent years by carrying forward the unused question papers, an overall three sets of question papers should be managed and depending on the consumption of question papers either internal or external examiner be called for setting the question paper to maintain an overall tally of 3 papers with the conditioned mentioned earlier. The internal examiner who sets the question paper should have been course tutor

ii. The Chairman of BoE shall get the question papers set by internal and external examiners.

iii. The Board of Examiners shall scrutinize and approve the question papers and scheme of valuation. It is the responsibility of the BoE to see that all questions contained in the question paper are within the prescribed syllabus of the concerned course.

iv. There shall be single valuation for all theory papers by internal examiners.

However, there shall be moderation by the external examiner who has the subject background. In case no external examiner with subject background is available, a senior faculty member within the discipline shall be appointed as moderator.

v. The SEE examination for Practical work / Field work / Project work/Internship will be conducted jointly by internal and external examiners as detailed below: However, the BoE on its discretion can also permit two internal examiners.

vi. If a course is fully of (L=0):T:(P=0) type or a course is partly P type i.e, (L=3): (T=0) (P=1), then the examination for SEE component will be as decided by the BoS concerned.

10. Evaluation of Practical's and Minor Project / Major Project / Dissertation

10.3.1. A practical examination shall be assessed on the basis of:

a) Knowledge of relevant processes;

b) Skills and operations involved;

c) Results / products including calculation and reporting.

10.3.2. In case a course is fully of P type (L=0:T=0:P=4), the performance of a candidate shall be assessed for a maximum of 100 marks as explained below:

a) Continuous Internal assessment (CIA) = 50 marks

b) Semester end practical examination (SEE) = 50 marks

The 25 marks for continuous assessment shall further be allocated as under (IA or CIA):

i	Conduction of regular practical throughout the semester	20 marks
ii	Maintenance of lab records	10 marks
iii	Laboratory test and viva	20 marks
	Total	50 marks

The 50 marks meant for Semester End Examination, shall be allocated as under:

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

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	Total	50 marks

10.3.3. The SEE for Practical work will be conducted jointly by internal and external examiners. However, if external examiner does not turn up, then both the examiners will be internal examiners.

10.3.4. In case a course is partly P type i.e, (L=3): (T=0) (P=1), then the examination for SEE component will be as decided by the BoS concerned.

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

10.4. Evaluation of 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:

1	First project presentation describing the problem definition	Should be done a semester before the project semester	Weightage: 0%
2	Project Progress presentation-1	7^{th} week from the start date of project semester	Weightage: 25%
3	Project progress presentation-2	14^{th} Week from the start date of project semester	Weightage -25%
4	Final project Viva and Project Report Submission	17^{th} -20^{th} Week of project Semester	Weightage: 30% for Project Report Weightage : 20% for Final Viva Voce

11. Provision for Appeal

Ref: RU/BoS/ECE/CEC/May-2021-9

If a candidate is not satisfied with the evaluation of C1,C2 and C3 components, he/she can approach the grievance cell with the written submission together with all facts, the assignments, test papers etc, which were evaluated. He/she can do so before the commencement of semester-end examination. The grievance cell is empowered to revise the marks if the case is genuine and is also empowered to levy penalty as prescribed by the university on the candidate if his/her submission is found to be baseless and unduly motivated. This cell may recommend taking disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the grievance cell is final.

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

- The Registrar (Evaluation) - Ex-officio Chairman / Convener
- One Senior Faculty Member (other than those concerned with the evaluation of the course concerned) drawn from the school / department/discipline and/or from the sister schools / departments/sister disciplines – Member.
- One Senior Faculty Members / Subject Experts drawn from outside the University school / department – Member.

12. Eligibility to Appear for Semester End Examination

12.1. Only those students who fulfil a minimum of 75% attendance in aggregate of all the courses including practical courses / field visits etc, as part of the course(s), as provided in the succeeding sections, shall be eligible to appear for SEE examination.

12.2. Requirements to Pass a Course

Students are required to score a total minimum of 40% (Continuous Internal assessment and SEE) in each course offered by the University/ Department for a pass (other than online courses) with a minimum of 13 (25% of 50) marks in final examination

12.3. Requirements to Pass the Semester

To pass the semester, a candidate has to secure minimum of 40% marks in each subject / course of the study prescribed in that semester.

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

13.1. 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 C4 examination of failed courses of previous semesters concurrently with odd semester end examinations (C4) and / or even semester end examinations (C4) 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:-

b. 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 C4 examination of 1 failed Course of First Semester concurrently with Third Semester C4 examination. Likewise, he / she is eligible to appear for C4 examination of 3 failed Courses of Second Semester concurrently with Fourth Semester C4 examination. However, he / she has to clear all the failed Courses of First and Second Semesters before seeking admission to Fifth Semester.

c. 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 C4 examination of 2 failed Courses of Third Semester concurrently with Fifth Semester C4 examination. Likewise he / she is eligible to appear for C4 examination of 2 failed Courses of Fourth Semester concurrently with Sixth Semester C4 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.

d. 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 C4 examination of 4 failed Courses of Fifth Semester concurrently with Seventh Semester C4 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.

e. Student "D" passed in 1to 4 semesters, but failed in 3 courses of 5^{th} Semester and in 1 course of 6^{th} Semester. He / She has also passed all the courses of First to Fourth Semesters. Student "D" is also eligible to seek admission for 7^{th} Semester and appear for C4 examination of 3 failed courses of 5^{th} Semester concurrently with 7^{th} Semester C4 examination and one failed course of 6^{th} Semester concurrently with 8^{th} Semester C4 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.

13.1. 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 (C4) and he / she shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

Ref: RU/BoS/ECE/CEC/May-2021-9

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

14. Attendance Requirement:

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

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

14.3. Any student with less than 75% of attendance in aggregate of all the courses including practical courses / field visits etc, during a semester shall not be permitted to appear to the end semester (C4) examination and such student shall seek re-admission as provided in 7.8.4.

14.4. 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 C4, and subsequently a notification pertaining to the above will be brought out by the Director of the School before the commencement of C4 examination. A copy of this notification shall also be sent to the office of the Registrar & Registrar (Evaluation).

15. Absence during Mid Semester Examination:

In case a student has been absent from a mid semester (C1,C2 and C3) examination due to the illness or other contingencies he / she may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Head of the School, for make-up examination. The Head of the School may consider such request depending on the merit of the case and after consultation with course instructor and class teacher, and arrange to conduct a special test for such candidate(s) well in advance before the C4 examination of that respective semester. Under no circumstances C1,C2& C3 test shall be held after C4 examination.

16. Grade Card and Grade Point

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

16.2. **Final Grade Card:** Upon successful completion of 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).

Ref: RU/BoS/ECE/CEC/May-2021-9

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

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

O - Outstanding; A-Excellent; B-Very Good; C-Good; D-Fair; E-Satisfactory; F - Fail

Here, P is the percentage of marks (P=[C1+C2+C3+C4] secured by a candidate in a course which is **rounded to nearest integer**. V is the credit value of course. G is the grade and GP is the grade point.

16.3.1. Computation of SGPA and CGPA

The Following procedure to compute the Semester Grade Point Average (SGPA)
The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student in a given semester, i.e:

SGPA (Si) = ∑(Ci x Gi) / ∑Ci where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

Illustration for Computation of SGPA and CGPA

Illustration No. 1

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit x Grade)
Course 1	4	A+	9	4X9=36
Course 2	4	A	8	4X8=32
Course 3	3	B+	7	3X7=21
Course 4	3	O	10	3X10=30
Course 5	3	P	5	3X5=15
Course 6	3	B	6	3X6=18
Course 7	2	O	10	2X10=20
Course 8	2	A	8	2X8=16
	24			188

Thus, **SGPA = 188 ÷ 24 = 7.83**

Ref: RU/BoS/ECE/CEC/May-2021-9

Illustration No. 2

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

Thus, **SGPA = 175 ÷ 24 = 7.29**

Illustration No.3

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

Thus**, SGPA = 199 ÷ 24 = 8.29**

16.4. Cumulative Grade Point Average (CGPA):

16.4.1. 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.

Ref: RU/BoS/ECE/CEC/May-2021-9

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

16.4.2. CONVERSION OF GRADES INTO PERCENTAGE:

Conversion formula for the conversion of CGPA into Percentage is:

Percentage of marks scored = CGPA Earned x 10 (to be discussed)

its normally CGPA x 9.5

Illustration: CGPA Earned 8.10 x 10=81.0

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

Overall percentage=10*CGPA

Ref: RU/BoS/ECE/CEC/May-2021-9

17. Challenge Valuation:

a. A student who desires to apply for challenge valuation shall obtain a photo copy of the answer script by paying the prescribed fee within 10 days after the announcement of the results. He / She can challenge the grade awarded to him/her by surrendering the grade card and by submitting an application along with the prescribed fee to the Registrar (Evaluation) within 10 days after the announcement of the results. This challenge valuation is only for C3 component.

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.

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

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
B20EM1010	CO 1	3	3	1										3	3	3
	CO 2	3	2	1										3	3	3
	CO 3	3	2	1										3	3	3
	CO 4	3	2	1										3	3	3

Mapping of PEOS with Respect to POs

	PO 1	P 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
PEO 1	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO 2	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO 3	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO 4	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

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School of Electronics & Communication Engineering
B. Tech in Electronics and Computer Engineering (ECM)
Scheme 2019-2023

Sl. No.	Course Code	Course Title	Course Type	Credit Pattern and Value				Weekly Contact Hours	Teaching School/Dept.
				L	T	P	C		
First Semester: Physics Cycle									
1	B19EM1010	Engineering Mathematics-I	HC	3	1	0	4	5	Mathematics
2	B19EM1020	Engineering Physics	HC	2	1	0	3	4	Physics
3	B19EM1030	Elements of Mechanical Engineering	HC	1	1	0	2	3	Mechanical
4	B19EM1040	Basic Electrical & Electronics	HC	2	1	0	3	4	ECE
5	B19EM1050	Computer Concepts and C Programming (I)	HC	2	0	1	3	5	C&IT
6	B19EM1060	Constitution of India and Professional Ethics	FC	2	0	0	2	2	Arts & Humanities
7	B19EM1070	Technical English-1	FC	0	0	2	2	4	English
8	B19EM1080	Basic Electrical & Electronics Lab	HC	0	0	2	2	3	ECE
9	B19EM1090	Engineering Physics Lab	HC	0	0	2	2	3	Physics
		Total Credits for the First Semester:					**23**	33	
Second Semester: Chemistry Cycle									
1	B19EM2010	Engineering Mathematics-II	HC	3	1	0	4	5	Mathematics
2	B19EM2020	Engineering Chemistry	HC	3	0	0	3	3	Chemistry
3	B19EM2030	Analog Electronics	HC	3	0	0	3	3	ECE
4	B19EM2040	Python Programming (I)	HC	1	1	1	3	5	C&IT
5	B19EM2050	Environmental Sciences	FC	2	0	0	2	2	Arts & Humanities
6	B19EM2060	Technical English -2	FC	0	0	2	2	4	English
7	B19EM2070	Computer Aided Engg. Drawing	HC	1	0	1	2	5	Mechanical
8	B19EM2080	Analog Electronics Lab	HC	0	0	2	2	3	ECE
9	B19EM2090	Engineering Chemistry Lab	HC	0	0	2	2	3	Chemistry
		Total Credits for the Second Semester:					**23**	33	
Note: Analog Electronics subject is a project based learning. Students are required to do Mini Project on Electronic Circuits									

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Third Semester:									
1	B19EM3010	Linear Integrated Circuits	HC	2	1	0	3	4	ECE
2	B19EM3020	Data Structures and Applications	HC	3	0	1	4	3	C&IT
3	B19EM3030	Digital Electronics & Verilog	HC	3	0	0	3	5	ECE
4	B19EM3040	Object Oriented Program -ming Using C++ (I)	HC	3	0	1	4	5	C&IT
5	B19EM3050	Discrete Mathematics and Graph Theory	HC	2	1	0	3	4	C&IT
6	B19EM306X	Soft Core – 1 (SC-1)	SC	3	0	0	3	3	ECE/ C&IT
7	B19EM3070	Linear Integrated circuits & IC's Lab	HC	0	0	2	2	3	ECE
8	B19EM3080	Digital Electronics & Verilog Lab	HC	0	0	2	2	3	ECE
9	B19EM3090	Soft Skill - 1	RULO	0	0	2	2	2	UIIC/ ECE
10	B19EM3X10	Yoga/Music/Sports/ Dance/Theater	RULO	0	0	2	2	2	Physical Education/ Performing Arts
Total Credits for the Third Semester:							**28**	**34**	
Fourth Semester:									
1	B19EM4010	Introduction to Data Science	HC	3	0	0	3	4	C&IT
2	B19EM4020	Design and Analysis of Algorithms	HC	3	0	0	3	4	C&IT
3	B19EM4030	Relational Data Base Management System (I)	HC	2	0	1	3	4	C&IT
4	B19EM4040	Microcontrollers and Applications	HC	3	0	0	3	3	ECE
5	B19EM4050	Computer Organization and Architecture	HC	3	0	1	4	5	ECE
6	B19EM406X	Soft Core -2 (SC-2)	SC	3	0	0	3	3	ECE/ C&IT
7	B19EM4070	Microcontrollers and applications Lab	HC	0	0	2	2	3	ECE
8	B19EM4080	Design & Analysis of Algorithms Lab	HC	0	0	2	2	3	C&IT
9	B19EM4091	Soft Skill-2	RULO	0	0	2	2	2	UIIC/ECE
10	B19EM4101	Skill Development	RULO	0	0	0	2	2	UIIC/SDC
Total Credits for the Fourth Semester:							**27**	**33**	

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Fifth Semester:									
1	B19EM5010	Embedded Systems	HC	3	0	0	3	3	ECE
2	B19EM5020	Unix Shell Programming	HC	3	0	1	4	4	C&IT
3	B19EM5030	Machine Learning	HC	3	0	0	3	5	C&IT
4	B19EM5040	Entrepreneurship & innovator skills	HC	2	0	0	2	2	Mgmt./ECE
5	B19EM505X	Soft Core – 3 (SC-3)	SC	3	0	0	3	3	ECE/ C&IT
6	B19EM506X	Soft Core – 4(SC-4)	SC	3	0	0	3	3	ECE/ C&IT
7	B19EM507X	Soft Core – 5(SC-5)	SC	3	0	0	3	3	ECE /C&IT
8	B19EM5080	Embedded System Lab	HC	0	0	2	2	3	ECE
9	B19EM5090	Machine Learning Lab	HC	0	0	2	2	3	ECE
10	B19EM5X10	Soft Skill-3	RULO	0	0	2	2	2	UIIC/ ECE
11	B19EM5X20	MOOCs-Swayam/NPTEL/ EDx/ COURSERA	RULO	0	0	2	2	2	Others
Total Credits for the Fifth Semester:							**29**	**33**	
Sixth Semester:									
1	B19EM6010	Web Technologies	HC	2	1	0	3	4	ECE
2	B19EM6020	CMOS Circuits	HC	3	0	0	3	3	ECE
3	B19EM6030	Data Communication and Networks (I)	HC	3	0	1	4	5	ECE
4	B19EM604X	Soft Core – 6(SC-6)	SC	3	0	3	3	3	ECE/ C&IT
5	B19EM605X	Soft Core – 7(SC-7)	SC	3	0	3	3	3	ECE/ C&IT
6	B19EM606X	Soft Core – 8(SC-8)	SC	3	0	3	3	3	ECE/ C&IT
7	B19EM6070	Web Technologies Lab	HC	0	0	2	2	3	C&IT
8	B19EM6080	CMOS Circuits Lab	HC	0	0	2	2	3	ECE
9	B19EM6090	Soft Skill -4	RULO	0	0	2	2	3	UIIC/ ECE

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10	B19EM6X10	MOOCs-Swayam/NPTEL/EDx/ COURSE	RULO	0	0	2	2	2	Others
Total Credits for the Sixth Semester:							**27**	**32**	
Seventh Semester:									
1	B19EM7010	IOT and Cyber Physical Systems	HC	3	0	1	4	3	ECE
2	B19EM702X	Soft Core –9 (SC-9)	SC	3	0	0	3	3	ECE/ C&IT
3	B19EM703X	Soft Core – 10(SC-10)	SC	3	0	0	3	3	ECE/ C&IT
4	B19EM704X	Soft Core – 11(SC-11)	SC	3	0	0	3	3	ECE/ C&IT
5	B19EM705X	Open Elective	OE	4	0	0	4	4	ECE
6	B19EM7060	Project Dissertation Phase-I	HC	0	0	4	4	4	ECE
Total Credits for the Seventh Semester:							**21**	22	
Note: The project work phase-1 of project dissertation of 8thSemester will begin in 7thSemester, where student has to form a project group and perform literature survey and define the problem tools and technologies to be used. Options for 8thSemester must be selected in 7thSemester.									
Eighth Semester:									
1	B19EM8011/12/13	Internship/Global Certification Program/ Soft Core-12 Alternative	SC	3	0	0	3	3	ECE/Others
2	B19EM8021/22/23	Internship/Global Certification Program/ Soft Core-13 Alternative	SC	3	0	0	3	3	ECE/Others
3	B19EM8030	Project & Dissertation Phase - II	HC	0	0	8	8	8	ECE
Total Credits for the Eighth Semester:							**14**	**14**	
Total Credits for all Eight Semesters:							192		

Total Credits = 192 (including Credits for Sports/Yoga/Music/Dance/Theatre)

Code for the representation of the Soft Core & OE /Specialization Groups

A : Electronics/VLSI, B : Computer, C : Communication, D : Interdisciplinary

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Sl. No.	Soft-core Group No. / Semester	Name of the Course	Course Code	L	T	P	C	Specialization Group
1	SC-1 / Sem-3	Signals and Systems	B19EM3061	3	0	0	3	A
2		Operating systems	B19EM3062	3	0	0	3	B
3		Instrumentation Engineering	B19EM3063	3	0	0	3	C
5	SC-2 / Sem - 4	Solid state Devices Theory	B19EM4061	3	0	0	3	A
6		Software Engineering	B19EM4062	3	0	0	3	B
7		JAVA Programming	B19EM4063	3	0	0	3	C
9	SC-3/ Sem- 5	Microelectronics	B19EM5051	3	0	0	3	A
10		Virtualization and Cloud Computing	B19EM5052	3	0	0	3	B
11		Analog Communication	B19EM5053	3	0	0	3	C
12		Research Methodology & IPR	B19EM5054	3	0	0	3	D
13	SC-4 / Sem 5	ARM Processors	B19EM5061	3	0	0	3	A
14		Agile Software Development and DevOps	B19EM5062	3	0	0	3	B
15		Digital Signal Processing	B19EM5063	3	0	0	3	C
16		Automotive Electronics	B19EM5064	3	0	0	3	D
17	SC-5 / Sem 5	Control Systems	B19EM5071	3	0	0	3	A
18		Formal Languages & Automata Theory	B19EM5072	3	0	0	3	B
19		RF and Antennas	B19EM5073	3	0	0	3	C
20		Mechatronics	B19EM5074	3	0	0	3	D
21	SC-6 / Sem 6	Real Time Systems	B19EM6041	3	0	0	3	A
22		Optimization Techniques	B19EM6042	3	0	0	3	B
23		Digital Communication	B19EM6043	3	0	0	3	C
24		Project Management	B19EM6044	3	0	0	3	D
25	SC-7 / Sem 6	Component Engineering	B19EM6051	3	0	0	3	A
26		Complier Design	B19EM6052	3	0	0	3	B
27		Image Processing	B19EM6053	3	0	0	3	C
28		Robotics & Automation	B19EM6054	3	0	0	3	D
29	SC-8 / Sem 6	MEMS	B19EM6061	3	0	0	3	A
30		Cryptography and Network Security	B19EM6062	3	0	0	3	B
31		Wireless Communication	B19EM6063	3	0	0	3	C
32		Alternate Engineering	B19EM6064	3	0	0	3	D

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33	SC-9 / Sem 7	Analog Mixed Mode VLSI	B19EM7021	3	0	0	3	A
34		Big Data Analytics	B19EM7022	3	0	0	3	B
35		Parallel Processing	B19EM7023	3	0	0	3	C
36		Avionics	B19EM7024	3	0	0	3	D
37	SC-10 / Sem 7	ASIC Design	B19EM7031	3	0	0	3	A
38		C# and .NET	B19EM7032	3	0	0	3	B
39		Multimedia Communication	B19EM7033	3	0	0	3	C
40		Natural Language Processing	B19EM7034	3	0	0	3	D
41	SC-11 / Sem 7	SOC Design	B19EM7041	3	0	0	3	A
42		Computer System Performance Analysis	B19EM7042	3	0	0	3	B
43		Computer vision and pattern recognition	B19EM7043	3	0	0	3	C
44		Reliability Engineering	B19EM7044	3	0	0	3	D
45	SC-12 / Sem 8	Low power VLSI	B19EM8011	3	0	0	3	A
46		Pervasive & Ubiquitous Computing	B19EM8012	3	0	0	3	B
47		Satellite Communication	B19EM8013	3	0	0	3	C
48								
49	SC-13 / Sem 8	Cognitive Computing	B19EM8021	3	0	0	3	A
50		Social Network Analysis	B19EM8022	3	0	0	3	B
51		Wireless and Mobile Networks	B19EM8023	3	0	0	3	C
52								
53	OE / Sem 7	Embedded Systems	B19EM7051	4	0	0	4	*
54		Robotics and Automation	B19EM7052	4	0	0	4	*
55		IoT and Cyber physical system	B19EM7053	4	0	0	4	*

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Detailed Syllabus

Semester I:

B19EM1010	Engineering Mathematics-I	L	T	P	C
Duration:14 Wks		3	1	0	4

Prerequisites:

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

Course Description:

This course covers the topics: Successive derivatives, mean value theorems, Taylor's series, partial derivatives, extreme values, multiple integrals, differential equations. The purpose of this course is to provide students with skills and knowledge required to perform mathematical procedures and processes for solution of engineering problems. This course is widely used particularly in the field of Electronics and Communication Engineering, for ex., Differential equations are used in AC power analysis, AC circuit analysis, E&M, transmission lines, control systems, signal conditioning/processing, etc.

Course Objectives:

The objectives of this course are:

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. Explain nth derivatives, mean value theorems, Taylor's series.
2. Explain partial derivatives, Taylor's expansion, extreme values, and Lagrange multipliers.
3. Evaluate multiple and improper integrals.
4. Solve different types of linear differential equations.

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	PSO1	PSO2	PSO3
B19EM1010	CO 1	3	3	3		1				3			3	3	1	1
	CO 2	3	3	3		1				3			3	3	1	1
	CO 3	3	3	3		1				3			2	3	1	1

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	CO 4	**3**	**3**	**3**	**1**	**1**				**3**			**3**	**3**	**1**	**1**

Course Contents:

Unit-1: Differential Calculus-I
[13 Hrs]

Successive differentiation-nth derivatives (no proof and simple problems), Leibnitz Theorem (without proof) and problems. Mean value theorem theorems-Rolle's theorem (no proof), Lagrange's mean-value theorems, Cauchy's mean-value theorem problems, mean value theorem of integral calculus (no proof). Taylors series and Maclaurin's series expansionfor function of one variable(only problems).

Polar curves- Angle between the radius vector and the tangent, angle between two curves, Pedal equation for polar curves.

Unit-2: Differential Calculus-II **[13 Hrs]**

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

Indeterminate forms and solution using L'Hospital's rule.

Partial Differentiation: Partial derivatives-Euler's theorem-problems, Total derivative and chain rule.

Unit-3: Differential Calculus-III and Differential equations
[13Hrs]

Jacobians-definition and problems (only to find *J*and illustrative example to verify $JJ'=1$). Taylor's Expansion of function of two variables (only problems- up to 2nd order).Maxima and Minima for a function of two variables (simple problems). Differential equations: Exact equation and reducible to exact form (1. Close to expression M or N and find IF, 2. y f(x) dx+x g(y) dy).

Unit-4: Integral Calculus **[13 Hrs]**

Reduction formulae for the integrals of $\sin^n x$, $\cos^n x$,$\sin^m x\cos^n x$ and evaluation of these integrals with standard limits(direct result) - Problems.

Multiple Integrals – Double integrals, change of order of integration (simple problems), and triple integrals.Beta and Gamma functions, properties, Relation between beta and gamma functions and simple problems.

Text books:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43nd edition, 2015.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 10th edition, 2015.

Reference Books:

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 19th edition, 2013.
2. R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, 5thedition, 2014.

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B19EM1020	Engineering Physics	L	T	P	C
Duration:14 Wks		2	1	0	3

Prerequisites:

Knowledge of Basic physics and mathematics of pre-university level.

Course Description:

Engineering Physics provides the fundamental knowledge of basic principles of Physics which is required for foundation in engineering education irrespective of branch, it provides the knowledge of quantum mechanics and its importance and applications. It also provides the knowledge of different theories of solids to explain electrical conductivity of materials and recent trends in NDT and nano technology.

Course Objectives:

The objectives of this course are:

1. To make students learn and understand basic concepts and principles of physics to analyze practical engineering problems and apply its solutions effectively and meaningfully.
2. To understand building up of models, design issues, practical oriented skills and problem solving challenges are the great task of the course.
3. To know about Semiconductors and practical applications is the prime motto to introduce new technology at the initial stage of Engineering.
4. Students should be getting knowledge of different physical systems, basic quantum mechanics and nanomaterials etc.

Course Outcomes:

By the end of the course, the students will be able to….

1. Describe wave mechanics and apply knowledge to solve quantum mechanics basic problems.
2. Understand the basics of quantum computation
3. Explain the basics of semiconductors, diodes & transistor
4. Summarize superconductivity with applications. Compare the different display technologies.
5. Distinguish synthesis of nanomaterials.

Mapping of Course Outcomes with Program Outcomes

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19EM1020	CO 1	3	3	1						2	1		3	1	1	
	CO 2	3	3	2	3	2				1	1		3	2	1	2

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	CO 3	**3**	**1**		**3**	**1**				**2**			**1**	**2**	**1**	
	CO 4	**3**	**1**		**3**	**1**				**1**			**1**	**1**	**2**	**1**
	CO 5	**3**	**1**		**3**	**1**				**1**			**1**	**1**	**2**	**1**

Course Contents:

Unit- 1: Wave mechanics **[10 Hrs]**

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

Quantum Physics: Heisenberg's uncertainty principle, its significance and its applications (nonexistence of electron inside the nucleus). Wave function, properties of wave function and physical significance. Probability density and Normalization of wave function, Schrodinger time- dependent and independent wave equation, Eigen values and Eigen functions. Applications of Schrödinger wave equation – energy Eigen values of a free particle, Particle in one dimensional infinite potential well. Problems.

Unit -2: Semiconductors and Semiconductors devices **[11 Hrs]**

Review of band theory. Intrinsic Semiconductors – extrinsic Semiconductor- expression for carrier concentration (derivation for both holes and electrons) – impurity states in energy band diagram. Formation of P-N junction, depletion region, Biased P-N junction, Zener diode – characteristics.Photo diodes, LED (principle, working and applications). Transistors: Transistor action, Characteristics (CB,CC,CE mode), Bipolar Junction Transistors - Junction Field-Effect Transistors- Metal-Semiconductor FETs (MeSFETs) - Metal-Oxide-Semiconductor FETs working and characteristics.

Unit- 3: Superconductors **[10 Hrs]**

Critical temperature (T_c), Critical field (H_c), Critical current density (Jc), Perfect diamagnetism, Meissner effect, Type I and Type II superconductors, Isotope effect, BCS theory of superconductivity, Applications-Superconducting magnets and Maglev vehicle.

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

Unit- 4: Nanomaterials **[11 Hrs]**

Introduction to nanoscience, Nanomaterials and their applications, Synthesis of Nanomaterials using bottom-up method (arc-discharge method), top-down methods (ball milling method),

Carbon Nanotubes: properties and applications.

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

Self-learning component:

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

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Text books:

1. R. K. Gaur and S.L. Gupta, Engineering Physics, DhanpatRai Publications (P) Ltd, New Delhi. Recent edition.
2. M.N. Avadhanulu and P.G. Kshirsagar, A text book of Engineering Physics, S. Chand and Company, New Delhi. Recent Edition.
3. S. O. Pillai, Solid State Physics, New Age International publishers, New Delhi. Recent edition.
4. Janglin Chen, Wayne Cranton, Mark Fihn, "Handbook of Visual Display Technology" Springer Publication, Recent edition.

Reference Books:

1. William T. Silfvast, Laser Fundamentals, Cambridge University press, New York, Recent edition.
2. D. Halliday, R. Resnick and J. Walker, Fundamentals of Physics, John Wiley and Sons, New York, Recent edition.
3. Charls Kittel, Introduction to Solid State Physics, Wiley, Delhi
4. Arthur Beiser, Concepts of modern Physics, Tata McGraw Hill publications, New Delhi 8th Edition.

B19EM1030	Elements of Mechanical Engineering	L	T	P	C
Duration:14 Wks		1	1	0	2

Prerequisites:

Basics of Physics

Course Description:

This is a basic course which explains the basics of mechanical engineering which is required to the knowledge of B Tech students irrespective of their branch. This course deals with working operations of certain motors and machines and gives the insight to materials and their structures, combustion engines, steam engines, power transfer pulleys etc.

Course Objectives:

The objectives of this course are to:

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 machines and its operations in Mechanical Engineering.
4. To give exposure to basic power transmission elements.

Course Outcomes:

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

1. Apply the concepts of steam formation and working principle of turbines in the design of power plants

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2. Apply the concept of refrigeration , air conditioning and working IC engines in the basic design of the vehicles
3. Compare the different kinds of machine tools and select the suitable machine tool for processing the materials.
4. Compare the different metal joining process and apply them real time applications.
5. Analyze the requirements for the transmission of power from driving to driven shafts.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	P O 10	P O 11	P O 12	PS O1	PS O2	PS O3
B19EM1030	CO 1	3	2	2	-	1	-	-	-	-	3	-	-	-	1	1
	CO 2	3	2	2	-	1	-	-	-	-	3	-	-	-	1	1
	CO 3	3	2	1	-	1	-	-	-	-	3	-	-	-	1	1
	CO 4	3	1	1	-	1	-	-	-	-	3	-	-	-	-	-

Course Contents:

Unit - 1: Properties of steam **[11Hrs]**

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

Turbines- Introduction to turbines, Classification of turbines, Working principle and applications of impulse and reaction steam turbines, gas turbines (open and closed cycle type) and pelton turbine.

Unit - 2: Internal Combustion Engines **[10 Hrs]**

Introduction, Classification of IC engines, parts of IC engine, working principle of four stroke (petrol and diesel), differences between petrol & diesel engines, Numerical on BP,IP and Mechanical efficiency.

Refrigeration and Air conditioning- Introduction, Principle of refrigeration, parts of refrigerator, Principle and working of vapor compression refrigeration and vapor absorption refrigeration systems. Refrigerants, Properties of refrigerants Ton of Refrigeration, COP, Working of window air conditioner.

Unit – 3: Machine Tools **[11Hrs]**

Introduction, working principle and classification of lathe, major parts of a lathe and their functions, lathe operations, specifications of lathe, introduction of drilling, parts of radial drilling machine, drilling operations.

Metal joining processes: Introduction, classification of metal joining processes, principle of welding, electric arc welding, soldering and brazing and their differences.

Unit – 4:Power Transmission **[10Hrs]**

Introduction to transmission systems and its classification, types of belt drives**,** velocity ratio, idler pulley, stepped pulley, fast & loose pulley.**Gears** - Definitions, Spur gear terminology, Types and applications of Gears.**Gear Trains** – Simple and compound gear trains, Simple problems on gear trains

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Text Books:

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

Reference Books:

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

B19EM1040	Basic Electrical and Electronics	L	T	P	C
Duration :14 Wks		2	1	0	3

Prerequisites:

Basics of Physics, Mathematics and Number systems.

Course Descriptions:

The Basic Electrical and Electronics typically deals with the study of Electrical parameters like AC and DC voltage and current and behavior of voltage and current in passive elements also in active elements like: BJT, Diodes and FET. The concepts of Electromotive force and Magnetomotive force generated in motors, generators and transformers are explained. The concepts of electrical circuits and electromagnetism are applied to analyze the complex problems arise in the power system networks. Through this course Students will get extensive exposure to digital and analog electronics basics.

Course Objectives:

The objectives of this course are to:

1. Make the students to understand basics of electrical circuits.
2. Study the working principle and construction details of electrical machines.
3. Understand the diode characteristics and its applications.
4. Understand the working principle and characteristics of BJT,FETs
5. Familiarize the students with the number systems
6. Carry out validation of logical expressions using Boolean algebra.

Course Outcomes:

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

1. Describe basic composition of electrical circuits and their behavior.
2. Analyze the working principle and construction details of electrical machines.
3. Assess the outcomes of various diode circuits.
4. Analyze working principle and characteristics in three configurations of BJT.
5. Analyze working principle and characteristics of FET.
6. Design the digital circuits using various logic gates.

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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
B19EM1040	CO1	3	3		2								3		3	
	CO2	3	3		2								3		3	
	CO3	3	3		2								2		3	
	CO4	3														
	CO5	3											3			
	CO6	3	3		2											

Course Contents:

Unit -1: Basics of Electrical Engineering [10 Hrs]

Introduction to electrical engineering, AC, Sinusoidal voltage and currents, Magnitude and phase, polar and rectangular representation R-L, R-C and R-L-C series and parallel circuits(both admittance and impedance method), power factor, phasor diagrams(lead and lag circuits), Kirchhoff's Current Law, Kirchhoff's Voltage law, Mesh and Nodal analysis, Source transformation, Star-delta transformation (for DC Circuits only).

Unit -2: Magnetic Circuits, Motors and Transformers [10 Hrs]

Definition of magnetic circuit and basic analogy between electric and magnetic circuits, Faradays laws, permittivity, permeability, EMF, MMF equations, Reluctance, Energy and power , 3 phase AC(introduction), Comparison between 1 phase and 3 phase AC.

Principle of operation, Construction and EMF equations: DC Generator, DC Motors, Transformers, types of transformer. Numerical examples as applicable.

Unit -3: Semiconductor Diodes and Transistors [12 Hrs]

P-N junction diode, V-I Characteristics, Half-wave rectifier, Full-wave rectifier, Bridge rectifier, Capacitor filter circuit, Zener diode voltage regulators, Clipping and clamping circuit, Numerical examples as applicable.

Bipolar junction Transistors BJT configuration: BJT Operation, Common Base, Common Emitter and Common Collector Characteristics, Numerical examples as applicable, SCR, Introduction to FETs.

Unit -4: Digital Electronics and Number Systems [10 Hrs]

Introduction, Switching and Logic Levels, Digital Waveform. Number Systems and its conversions: Decimal Number System, Binary Number System, Octal Number System, Hexadecimal Number System. Binary addition, Binary subtraction. Boolean Algebra Theorems, De Morgan's theorem.

Digital Circuits: Logic gates, Algebraic Simplification, Realization of all logic and Boolean expressions using Universal gates. Half adder and Full adder Implementations.

Text book/s:

1. Kulshreshtha C,"**Basic Electrical Engineering**" Tata McGraw Hill, 2nd Edition, 2011.
2. David A. Bell, "**Electronic Devices and Circuits**", Oxford University Press, 5th Edition, 2008.
3. D.P. Kothari, I. J. Nagrath, "**Basic Electronics**", McGraw Hill Education (India) Private Limited, 2014.

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Reference Books:

1. Robert L. Boylestad and Louis Nashelsky, "**Introduction to Electricity, Electronics and Electromagnetics**" Prentice Hall, 5th edition, 2001

B19EM1050	Computer Concepts and C programming	L	T	P	C
Duration :14 Wks		2	0	1	3

Prerequisites:

Basics of Mathematics

Course Description:

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

Course Objectives:

The objectives of this course are to:

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

Course Outcomes:

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

1. List out the basic terminology of computer programming.
2. Illustrate the basic principles of Programming in C language
3. Apply the Concepts of C programming language to solve the given problem.
4. Demonstrate the basic concepts of computer graphics

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	PSO1	PSO2	PSO3
B19EM1050	CO1	3	2	3	3	2						1		1		3

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	CO 2	**3**	**2**	**2**	**3**	**2**								**3**	**2**	**2**
	CO 3	**2**	**1**	**2**	**3**	**1**								**2**	**2**	**3**
	CO 4	**2**	**1**	**3**	**3**	**1**						**1**		**2**	**1**	**3**

Course Contents:

Unit -1: Fundamentals of problem solving and introduction to C-language [10 Hrs]

Algorithm and flowchart & advantages of algorithm (pseudo code),basic flow chart symbols**,** structure of c program with example**,** c language & its features, c tokens, data types in c**,** variables, constants, input / output functions

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

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

Unit 2: Branching constructs Conditional statements: [11 Hrs]

if statement, if-else statement, nested if, switch statement.

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

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

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

Unit -3: Functions [10 Hrs]

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

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

Unit -4: Structures & Union [11 Hrs]

Derived types: structures- declaration, definition and initialization of structures, accessing structures, nested structures, arrays of structures, Union, Typedef.

Pointers: Introduction to pointers.

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

Self Learning component:

Fundamentals of computer graphics: output primitives – Line, Circle and Ellipse drawing algorithms - Attributes of output primitives Two dimensional Geometric transformation.

Text Books:

1. B.W. Kernighan & D.M. Ritchie, "C Programming Language", 2nd Edition, Pentice Hall Software Series, 2005.

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

Reference Books:

1. E. Balaguruswamy," Programming in ANSI C", 4th edition, Tata McGraw Hill, 2008.
2. Donald Hearn, Pauline Baker, "Computer Graphics C Version", second edition, Pearson Education, 2004.

Computer Concepts and C Programming Lab

Lab Objectives:

The objectives of this course are to:

1. Learn basic and fundamental C programming concepts
2. Learn searching and sorting algorithms
3. Develop a C program that contains functions and parameters.
4. Develop a C program that contains sequence, selection and iteration control structures.

Lab Outcomes:

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

1. Illustrate the Representation of Numbers, Alphabets and other Characters in the memory of Computer System;
2. Analyze the Software Development Tools; like Algorithms, Pseudo Codes and Programming Structures;
3. Apply different programming constructs to develop a Computer Program.
4. Demonstrate the use of Engineering Solutions to simple (moderate) mathematical and logical problems.

Mapping of Course Outcomes with programme Outcomes Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
B19EM1050(L)	CO1	3	2	3	3	2								1	1	3
	CO2	3	2	2	3	2								3	2	2
	CO3	2	1	2	3	1								2	2	3
	CO4	2	1	3	3	1								2	1	3

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Lab Experiments:

Experiment No.	Program	Course Outcome
1	Introduction to Computer Software & hardware. Types of Operating System. Basic Commands in Unix. Assembling hardware's of computer.	1,2
2	a) Program to print the name, college name, Address of a student. b) A company for aadhar card want's to collect its employees information. Write a program to take input of employee name and age.	1,2
3	a) Program to read and print the size of variables of different data type. b) A person has deposited some amount in bank. Write a program to calculate simple interest and compound interest on amount for a period.	1,2
4	a) Arithmetic operations are widely used in many programs. Write a program to perform addition, subtraction, multiplication, modulo division, and division operations. b) In Delhi, four wheelers run on the basis of even or odd number. Write a program to identify whether vehicle registration number is even or odd.	1,2
5	People frequently need to calculate the area of things like rooms, boxes or plots of land where quadratic equation can be used. Write a program to find the coefficients of a quadratic equation and compute its roots.	2,3
6	a) Consider the age of 3 persons in a family, Write a program to identify the eldest person among three of them. b) Consider student's marks in Computer Test. Write a Program display the grade obtain by student in Computer Test based on range.	2,3
7	Calculator allows you to easily handle all the calculations necessary for everyday life with a single application. Write a program to design a basic calculator that performs the basic operations and you want to give choice to user to perform a. Addition of two numbers b. Subtraction of two numbers c. Multiplication of two numbers. d. Division of two numbers. e. Wrong choice	2,3
8	In a stock market at the end of the day we do the summation of all the transactions. a. Write a program to display numbers (transactions) from1 to n. b. Write a program to find the sum of n natural numbers.	2,3
9	a) Read your ATM Pin Number. Write a program to identify your Pin Number is palindrome or not. b) Read your Landline Number. Write a program to print the reverse of it and also find sum of digits of your Landline Number.	2,3

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10	a) Create a Contact list of n friends, Write a program to read and print the Phone number of your friend's. b) In computer based applications, matrices play a vital role in the projection of three dimensional image into a two dimensional screen, creating the realistic seeming motions. Write a program to perform matrix Multiplication and check compatibility of matrix.	2,3
11	You have joined a startup company of N employees; Write a program is to sort all employee ID.	2,3
12	A student has taken 10 books from the library. Every time he takes the book, Librarian read's its ISBN Number. Write a program to identify whether book is issued to him or not based on ISBN Number.	2,3
13	Suppose students have registered for workshop, and their record is maintained in ascending order based on student id. Write a program to find whether a particular Student has registered for that particular workshop or not.	2,3
14	In a CCP test you scored less marks compared to your friend, Write a program to swap your marks with your friend.	2,3
15	a) In a memory game, you first enter a string wait for a time and again enter second string, Write a program to check both sting were same or not. b) Read your first and last name in two different strings; Write a program to combine these two strings into third string.	2,3
16	a) Assume a person has entered a Password ,Write a program so that he can know the length of his password, b) Read a meaningful word in English, Write a program to identify the word when inversed yields the same or not.	2,3
17	a) Write a c program to implement Digital Differential Analyzer line generating algorithm	3,4
	b) Write a C program to generate a circle using Bresenham's midpoint algorithm.	3,4
	c) Write a C program to implement Bresenham's line drawing algorithm	3,4

B19EM1060	**Constitution of India and Professional Ethics**	**L**	**T**	**P**	**C**
Duration :14 Wks		**2**	**0**	**0**	**2**

Prerequisites:

Basics of Indian Constitution, fundamental rights and duty

Course Description:

The Constitution of India lays down in defining fundamental political principles, establishes the structure, procedures, powers and duties of government institutions and sets out fundamental rights,

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directive principles and duties of Citizen. It helps to know and understand the human values. It also helps to know the meaning of ethics and need of ethics in personal and professional life.

Course Objectives:

The objectives of this course are to:

1. To provide and gain knowledge on Constitution of India.
2. To know and understand about the Fundamental Rights, Duties and other Rights which is been given by our law.
3. To prepare students in the understanding of Constitution perspective and make them face the world as a bonafide citizen.
4. To attain knowledge about ethics and also know about professional ethics.
5. Explore ethical standards followed by different companies.

Course Outcomes:

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

1. Strengthen the knowledge on Indian constitutional law and make the practical implementation of it.
2. Understand the fundamental rights and human rights.
3. Get the knowledge to explain the duties and more importantly practice it in a right way.
4. Adopt the habit of raising their voice against unconstitutionality of any laws and upon any legal discrimination as we have session of debates on Constitutional validity.
5. Get exposed about professional ethics and know about etiquettes about it.
6. Know about ethical standards of different companies which will increase their professional ability.

Mapping of Course Outcomes with Program Outcomes

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19EM1060	CO1						3	1								1
	CO2						3	1								1
	CO3								3		2		2			
	CO4						3	1								1
	CO5						3	1								1
	CO6								3		2		2			

Course Contents:

Unit -1: Constitution of India **[7 Hrs]**

Making of Indian Constitution, features 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 Characteristics. Elements of National Significance; National Flag, National Anthem, National Emblem.

Unit -2: Legislature and Executive **[7 Hrs]**

Organs of the Government; Legislature, Executive and Judiciary. Union and State Executives: President, Vice President, Prime Minister, Cabinet, Governor, Council of Ministers, Electoral process,

Election Commission.

Unit -3: Judiciary **[7 Hrs]**

Supreme Court of Indian, High Court, Right to Information Act 2005, Consumer Protection- Consumer Rights- Caveat Emptor and Caveat Venditor.

Unit 4: Professional Ethics **[7 Hrs]**

Definition Scope and need of Ethics for professional, Personal Ethics and Business Ethics, Ethical Standards, Duties of Employers and Employees. Due Care theory, Environmental Ethics, Ethical Code of Conduct in ethics. Best Ethical Companies in India and Abroad; Corporate Social Responsibilities, Code of Conduct and Ethical Excellence.

Text Books:

1. M V Pylee, An introduction to Constitution of India.
2. M Govindarajan, S Natarajan, V S Senthil Kumar, Engineering Ethics.
3. Dr.Durga Das Basu, Introduction to constitution of India.

B19EM1070	Technical English-I	L	T	P	C
Duration:14 Wks		0	0	2	2

Course Outline:

This is a 2 credit course for first Semester consisting of 4 hours of teaching learning per week, inclusive of direct classroom teaching and practice in language lab.

Prerequisites:

Fundamentals in Spoken English.

Course Description:

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

Course Objectives:

The objectives of this course are to:

1. To develop basic communication skills in English for the learners of Engineering and Technology.
2. To prioritize listening and reading skills among learners of Engineering and Technology.
3. To simplify writing skills needed for academic as well as workplace context.
4. To examine that the learners use the electronic media such as internet and supplement the learning materials used in the classroom.

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Course Outcomes:

On completion of the course, learners will be able to:

1. Interpret audio files and comprehend different spoken discourses/ excerpts in different accents (Listening Skills).
2. Demonstrate speaking ability with clarity, confidence and comprehension and communicate with one or many listeners using appropriate communicative strategies (Speaking Skills).
3. Make use of reading different genres of texts adopting various reading strategies (Reading Skills).
4. Develop the ability to write cohesively, coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic (Writing Skills).

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 2	PO 3	PO 4	PO 5	P 7	PO8	PO 9	PO 10	P O 11	PO 12	PS O1	PS O2	PS O3
B19EM1 070	CO1		1					3	3			3			
	CO2		1					2	3			3			
	CO3		2					2	3			3			
	CO4		1					3	3			3			

Course Contents:

Unit -1:Functional English **[14 Hrs]**
Grammar: Prepositions; Modal Auxiliaries
Listening: Listening to audio (verbal & sounds)
Speaking: Debating Skills
Reading: Skimming a reading passage; Scanning for specific information
Writing: Email communication

Unit -2: Interpersonal Skills **[14 Hrs]**
Grammar: Tenses; Wh-questions
Listening& Speaking: Listening and responding to video lectures / talks
Reading: Reading Comprehension; Critical Reading; Finding key information in a given text
Writing: Process descriptions (general/specific); Recommendations

Unit -3: Multitasking skills **[14 Hrs]**
Grammar: Conditional Sentences
Listening & Speaking: Listening to specific task; focused audio tracks and responding
Reading: Readingand interpreting visual material
Writing: Channel conversion (flowchart into process); Types of paragraph (cause and effect / compare andcontrast / narrative / analytical); Note Taking/ Note Making

Unit -4: Communication skills **[14 Hrs]**
Grammar: Direct and indirect speech

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

Reference Books:

1. Green, David. Contemporary English Grammar Structures and Composition. New Delhi: MacMillan Publishers, 2010.
2. Thorpe, Edgar and Showick Thorpe. Basic Vocabulary. Pearson Education India, 2012.
3. Leech, Geoffrey and Jan Svartvik. A Communicative Grammar of English. Longman, 2003.
4. Murphy, Raymond. Murphy's English Grammar with CD. Cambridge University Press, 2004.
5. Rizvi, M. Ashraf. Effective Technical Communication. New Delhi: Tata McGraw-Hill, 2005.
6. Riordan, Daniel. Technical Communication. New Delhi: Cengage Publications, 2011.
7. Sen et al. Communication and Language Skills. Cambridge University Press, 2015.

B19EM1080	Basic Electrical and Electronics Lab	L	T	P	C
Duration :14 Wks		0	0	2	2

Prerequisites:

Semiconductor Physics, Basics of Electrical & Electronics, Principles of Electronics.

Course Description:

All basic electronic devices and their characteristics, applications will be studied. Using these devices the small electronic circuits can be constructed and checked. In order to introduce the students with basic components of electronics this lab is furnished with advanced CROs, function generators and digital multimeters. Students can perform practical on P-N junction diode, Zener Diode, rectifiers and filters, transistor biasing and their characteristics in different modes, RC coupled amplifiers and FETs.

Course Objectives:

The objectives of this course are to:
1. Demonstrate the application of KCL and KVL in DC circuit
2. To make students understand about leading and lagging concepts of electrical circuits.
3. Demonstrate working of DC motor.
4. Demonstrate the basic operation of diode and diode circuits like rectifiers, clippers and Clampers.
5. Demonstrate the basic operation of Zener diode circuit.
6. Analyse the input and output characteristics of Common Emitter configuration of BJT.
7. Demonstrate the characteristics of SCR.
8. Design various logic circuits.

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Course Outcomes:

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

1. Understand the application of KCL and KVL in DC circuit.
2. Compare leading and lagging electrical circuits.
3. Understand working principle of DC motor.
4. Design and test various diode circuits like rectifiers, clippers and clampers.
5. Assess the voltage and current characteristics of nonlinear devices like Diode, Zener diode and BJT.
6. Design and test the characteristics of an electronics device like SCR.

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	PS O1	PS O2	PS O3
B19EM 1080	CO1	3	3		3								3	3		
	CO2	3	3		3								3	3		
	CO3	3			3								3	3		
	CO4	3	3										3	3		
	CO5	3	3			2							3	2		
	CO6	3	3			3							2	2		

Lab Experiments

Introduction to basics of electronic components and instruments

1. To verify KCL and KVL
2. Testing of Lead & Lag networks by using R-C components.
3. To Study and test the working of DC motor
4. Study and analysis of V-I Characteristics of Silicon, Germanium and Zener PN Junction diodes (Both Forward and Reverse Characteristics).
5. To find the Voltage regulation of Zener diode
6. Design half wave, **Full wave-center tap** and Bridge rectifier with and without capacitive filter and measure efficiency and ripple factor.
7. Design of Clippers and clampers with reference voltages.
8. Study and analysis of V-I Characteristics of SCR.
9. Study and analysis of input output characteristic of CE configuration of BJT.
10. Verification of basic logic gates using discrete components.

Text book/s:

1. Kulshreshtha C,"**Basic Electrical Engineering**" Tata McGraw Hill, 2nd Edition, 2011.
2. David A. Bell, "**Electronic Devices and Circuits**", Oxford University Press, 5th Edition, 2008.
3. D.P. Kothari, I. J. Nagrath, "**Basic Electronics**", McGraw Hill Education (India) Private Limited, 2014.

Ref: RU/BoS/ECE/CEC/May-2021-9

Reference Book:

1. Robert L. Boylestad and Louis Nashelsky, "**Introduction to Electricity, Electronics and Electromagnetics**" Prentice Hall, 5th edition, 2001

B19EM1090	Engineering Physics Lab	L	T	P	C
Duration:14 Wks		0	0	2	2

Prerequisites:

Knowledge of Higher secondary/Pre University level Physics.

Course Description:

Engineering Physics lab provides the fundamental knowledge of basic principles of Physics experiments which is required for foundation in engineering education irrespective of branch, it provides the knowledge of quantum mechanics and its importance and applications. It also provides the knowledge of different practical aspects of solids to explain electrical conductivity of materials, series and parallel resonance circuits.

Course Objectives:

The objectives of this course are to:

1. To make the students gain practical knowledge to co-relate with the theoretical studies.
2. To achieve perfectness in experimental skills and the study of practical applications will bring more confidence and ability to develop and fabricate engineering and technical equipments.
3. Design of circuits using new technology and latest components and to develop practical applications of engineering materials and use of principle in the right way to implement the modern technology.

Course Outcomes:

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

1. Gain knowledge of new concept in the solution of practical oriented problems and develop skills to impart practical knowledge in real time solution.
2. Apply the knowledge of new technology and comparison of results with theoretical calculations.
3. Design circuits with practical knowledge.
4. Use measurement technology, usage of instruments for real time applications in engineering studies.

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Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	P 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	P O 10	P O 11	P O 12	PS O1	PS O2	PS O3
B19EM 1090	CO1	3	3	3	2					2			2	2	2	1
	CO2	2	3	3	1	1				2			2	2	2	2
	CO3	1	2	3	2	1				2			2	2	1	2
	CO4	2	2	2	1					2			2	1	1	2

Lab Experiments

2. Band gap of intrinsic Semi-conductor using four probe method
3. Value of planck's constant by using light emitting diode
4. I–V Characteristics of Zener Diode. (Determination of knee voltage, zener voltage and forward resistance)
5. To find the laser parameters–wavelength and divergence of laser light by diffraction method.
6. Photo Diode Characteristics (Study of I–V characteristics in reverse bias and variation of photocurrent as a function of reverse voltage and intensity)
7. Dielectric constant of a capacitor by charging and discharging of a capacitor.
8. Attenuation and propagation characteristics of optical fibre cable.
9. Determination of particle size using laser.
10. Construction and study of IC regulation properties of a given power supply
11. Determination of numerical aperture of a given optical fibre.
12. Determination of electrical resistivity of germanium crystal and study the variation of resistivity with temperature by four probe method
13. Characteristics of Transistor (Study of Input and Output characteristics and calculation of input resistance, output resistance and amplification factor.
14. Series and parallel LCR Circuits (Determination of resonant frequency and quality factor)

Text books:

1. Thiruvadigal, J. D., Ponnusamy, S.Sudha.D. and Krishnamohan M., "Physics for Technologists", Vibrant Publication, Chennai, 2013
2. R.K.Shukla and Anchal Srivastava, "Practical Physics", 1st Edition, New Age International (P) Ltd, New Delhi, 2006.

Reference Books:

1. G.L.Souires, "Practical Physics:", 4th Edition, Cambridge University, UK, 2001.
2. D. Chattopadhyay, P. C. Rakshit and B. Saha, "An Advanced Course in Practical Physics", 2nd ed., Books & Allied Ltd., Calcutta, 1990.
3. Advanced Practical Physics – B.L. Worshnop and H.T. Flint (KPH)
4. Practical Physics – S. L. Gupta &V. Kumar (PragatiPrakashan).
5. Advanced Practical Physics Vol. I& II – Chauhan & Singh (PragatiPrakashan).

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Semester - II:

B19EM2010	Engineering Mathematics – II	L	T	P	C
Duration: 14 Weeks		3	1	0	4

Prerequisites:

Knowledge of basics of derivatives, vectors, and complex numbers.

Course Description:

This course covers the topics: Linear Algebra differential equations Vector calculus, inverse Laplace transforms, This course is widely used in all streams of Engineering, particularly in the field of Electronics and Communication Engineering, for ex., Electromagnetic field theory, Control systems, Analog and Digital communication.

Course Objectives:

The objectives of this course are to:

1. To understand the concepts of Linear algebra and its applications in various fields of engineering and Technology.
2. To understand the concepts of Integral calculus and its applications.
3. To familiarize with partial differential equations and its applications to standard problems like Heat, Wave and Laplace.
4. To impart the Knowledge of Laplace transforms and its applications in the field of engineering.

Course Outcomes:

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

1. Apply the knowledge of Linear Algebra in Image processing and digital signal processing.
2. Apply the knowledge of Integral calculus to perform integration and other operations for certain types of functions and carry out the computation fluently.
3. Apply the knowledge of partial differential equations in the field of signals and systems, control systems, magnetic wave theory.
4. Apply the knowledge of Laplace transformation from the time domain to the frequency domain, which transforms differential equations into algebraic equations and convolution into multiplication.

Course Code	POS/COs	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
B19EM2010	CO1	3	3	2	1					3			3	3	2	1

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	CO 2	**3**	**3**	**3**	**1**					**3**			**3**	**3**	**2**	**1**
	CO 3	**3**	**3**	**3**	**1**					**3**			**3**	**3**	**2**	**1**
	CO 4	**3**	**3**	**3**	**1**					**3**			**3**	**3**	**2**	**1**

Course Contents:

Unit-1: Linear Algebra **[13 Hrs]**

Rank of matrix, Echelon form, (*reference-Normal form: one example), Solution of a system of linear equations by Gauss elimination (*reference-Gauss –Jordan methods: one example), Gauss seidel iterative method, Rayleigh Power method to find the largest eigen value and corresponding eigen vector. Linear and Inverse transformation.

Diagonalisation of a matrix, Reduction of a quadratic form to canonical form by orthogonal transformation.

Unit-2: Differential Equations: **[13Hrs]**

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 (simple problems), Cauchy's and Legendre's linear differential equations.

Partial differential equations: Formation of Partial differential equations, Solution of Lag ranges linear PDE.

Unit-3: Vector Calculus **[13 Hrs]**

Curves in space, tangents and normal, Velocity and acceleration related problems, scalar and vector point functions-Gradient, Divergence and curl, directional derivatives. Solenoidal and irrotational vector fields. Vector identities-div ($\emptyset A$), curl ($\emptyset A$), curl (grad$\emptyset$), div (curl A).

Line integral-Circulation-work, Surface integral: Green's Theorem, Stokes Theorem.

Volume integral: Divergence theorem. (All theorems without proof, no verification, only evaluation).

Unit-4: Laplace Transforms: **[13 Hrs]**

Definition, Transforms of elementary functions, properties of Laplace Transforms (without proof) problems. Transforms of periodic functions (only statement and problems), Unit step functions and unit impulse functions.

Inverse Laplace transforms- Problems, convolution theorem (without proof) no verification and only evaluation of problems, solution of linear differential equation using Laplace transforms.

Text books:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43nd edition, 2015.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 10th edition, 2015.

Reference Books:

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 19th edition, 2013.
2. R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, 5th edition, 2014.
3.

Ref: RU/BoS/ECE/CEC/May-2021-9

B19EM2020	Engineering Chemistry	L	T	P	C
Duration : 14 WKS		3	0	0	3

Prerequisites:

Pre University level Knowledge in Chemistry, Physics and Mathematics.

Course Description:

Engineering chemistry provides the very basic knowledge required for engineering students to understand its importance in technology. It provides the knowledge of quantum mechanics, battery technology its importance and applications. It also provides knowledge about corrosion science, construction of PCB's and engineering materials

Course Objectives:

Engineering chemistry covers the very basic knowledge required for engineering students to understand its importance in technology. All the branches directly or indirectly deal with the principles of chemistry, for example;

1. Explaining theories of chemical bonding and molecular structure.
2. Define electro negativity, electron affinity and ionization potential, atomic structure, basics of quantum chemistry and its applications.
3. Cell and Batteries deals with basic principles, types of electrodes and their importance in some applications and materials required for designing and proper functioning of batteries.
4. 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.
5. 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.
6. To learn the basic concepts of nanotechnology and Nano materials. Compare the size dependency properties of Nanomaterials. And also summarize applications of Nano materials.

Course Outcomes:

On the successful completion of this course, Students shall be able to

1. Acquire the knowledge about the concepts of chemistry in respect to Atomic and Molecular structure, electrochemical cells, fuel cells, mechanism of corrosion and factors that influence
2. Apply the knowledge of corrosion science and metal finishing which is essential for the construction of PCBs and Circuits.
3. Apply the knowledge of band theory conductors, Semiconductors, super conductors for electronic devices and chip design.
4. Explain the recent trends in Nano Science and Technology and meet the applications of industrially based polymers, Nano Materials and various engineering materials in different fields.

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Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ Cos	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19EM2020	CO1	2	1		1		1						2	1	1	
	CO2	2	1	3	2	2	3	3		1	1	1	1	1	1	2
	CO3	2	2	3	2	1	3	1		1	1		1	2	2	1
	CO4	2	2	2	2	2	1	2					1	1	1	

Course Contents:

Unit –1: **Atomic, Molecular Structure and Periodic Properties** **[10Hrs]**

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

Periodic properties: Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electro negativity.

Self Study: Molecular orbitals of diatomic molecules and plots of the multicentre orbitals. Polarizability, oxidation states, coordination numbers and geometries.

Unit – 2: Energy Storage and Conversion Devices **[11 Hrs]**

Battery: Introduction to electrochemistry, Basic concepts of Cells and Battery, Battery characteristics Primary (Leclanche Cell), Secondary (Lead-Acid), Lithium batteries, Advantage of use of Li as electrode material (Lithium & Lithium ion), super capacitors.

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: Introduction to Electromagnetic spectrum and light-mater interaction, Production of Si from chemical method, Single crystal Si Semiconductor by Crystal pulling technique (Czocharlski method), and zone refining.

Band structure of solids and the role of doping on band structures.Properties of Silicon, advantages, P-N Junction diode, antireflective coatings.Construction, working of photovoltaic cells, applications, advantages and disadvantages.

Self Study: Reserve battery, Alkaline Fuel Cell, Design of solar cells-Modules, Panels and arrays.

Unit-3: Science of Corrosion and Its Control **[10 Hrs]**

Corrosion: Electrochemical theory of corrosion, galvanic series, types of Corrosion- differential metal corrosion, differential aeration corrosion (Pitting & water line), boiler corrosion, and grain boundary corrosion, Factors affecting rate of corrosion-Primary, secondary.

Corrosion control: Galvanizing & tinning, cathodic protection & Anodic Protection.

Metal Finishing: Theory of electroplating. Factors required to study electroplating. Effect of plating variables on the nature of electro-deposit- electroplating process, Electroplating of gold. Electro less plating of copper and nickel, PCB manufacture by Electro less plating of copper.

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Self Study: Energy concept (Pourbiax) under different pH conditions. Corrosion Studies on Al, Fe with pourbiax diagram. Inorganic Coatings-Anodizing &Phospating, and Corrosion Inhibitors

Unit -4: Chemistry of Engineering Materials **[11 Hrs]**

Semiconducting and Super Conducting materials-Principle and some example.

Magnetic materials: Principle and types of magnetic materials-applications of magnetic materials in storage devices.

Polymers: Introduction, Glass transition temperature (tg) - definition, significance. Structure-Property relationship – tensile strength, plastic, deformation, chemical resistivity, crystallinity and elasticity.

Adhesives: properties, synthesis and applications of epoxy resin.

Polymer composites: (carbon fibre and Kevlar, synthesis, advantages, applications).

Conducting polymers: Mechanism, synthesis and applications of polyacetyline, synthesis of polyaniline and its applications. Liquid Crystals: Introduction, classification and applications.

Nanomaterials-Introduction – Definition, classification based on dimensionality (0D, 1D and 2D), quantum confinement (electron confinement). Size dependent properties- surface area, magnetic properties (GMR phenomenon), thermal properties (melting point), optical properties and electrical properties. Properties and applications of Carbon Nanomaterials (Fullerenes, Carbon nanotubes, Graphenes).

Self Study: Types of polymerization - Addition and Condensation (two example; Polyester and Teflon), Biocompatible materials, Nano electronics, Nano medicines and energy conversion devices, Applications of Nano materials- in hyperthermia (magnetic property), in corrosion control (Nano-coatings).

Text Books:

1. A Text book of Engineering Chemistry by S. S. Dhara, S. Chand Publications, New Delhi.
2. Text Book of Engineering Chemistry, Shashichawla, Dhanapathirai Publications.
3. P.W. Atkins, Physical Chemistry, Oxford university press.
4. Engineering Chemistry: Fundamentals and Applications -Shikha Agarwal-Cambridge University Press.

Reference Books:

1. Polymer chemistry by V.R. Gowrikar, N.N. Vishwanathan and J. Sreedhar by Wiley eastern Ltd.
2. Corrosion engineering by Mars G. Fontana, Tata Mcgrahill Publishing pvt. Ltd, Third edition.
3. Introduction to Nanotechnology by Charles P. Poole Jr., Frank J. Owens Wiley India Publishers.
4. Composite materials – Science and Engineering by Krishan K Chawla, Springer International edition, Second edition.

B19EM2030	Analog Electronics	L	T	P	C
Duration: 14Weeks		3	0	0	3

Prerequisites:

Basic Electrical and Electronics,

Course Description

Analog Electronics is the base of Electronics & Communication stream. In this course the working of various amplifiers is explained. Students learn how BJT work at low and high frequencies, what happens in FET amplifiers, Power amplifiers, feedback amplifiers, tuned amplifiers and different types of oscillators and their working is analyzed. Introduction to Op-Amps is given in the end of the course.

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Course Objectives:

The objectives of this course are to:

1. To understand operation of semiconductor devices.
2. To understand how devices such as semiconductor diodes and Bipolar Junction transistors are modeled and how the models are used in the design and analysis of useful circuits.
3. To apply concepts for the design of Amplifiers
4. To verify the design and construct circuits, take measurements of circuit behavior and performance, compare with predicted circuit models and explain discrepancies using simulators.
5. To implement mini projects based on concept of electronics circuit.

Course Outcomes:

On completion of this course the student will be able to

1. Analyze dc circuits and relate ac models of semiconductor devices with their physical Operation,
2. Develop the capability to analyze and design simple circuits containing non-linear elements such as transistors using the concepts of load lines, operating points and incremental analysis;
3. Develop experience in building and trouble-shouting simple electronic analog and digital circuits(PBL)
4. Assess the concepts of both positive and negative feedback in electronic circuits

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
B19EM 2030	CO1	3	2	1		3								1	2	1
	CO2				1	3									2	1
	CO3					1				3	2	1		3		1
	CO4	2	2	1		1										1

Course Contents:

Unit-1: Transistor Biasing and BJT AC analysis **[11 Hrs]**

Transistor Biasing: (BJT Version) Operating Point, Fixed Bias, Voltage-Divider Bias Configurations, Emitter-Follower , Bias Stabilization, Problems linked to above topics, Simulation using TINA/PSPICE/Multisim Simulator.

BJT AC Analysis: The r_e Transistor Model, Modeling of Voltage-Divider Bias and Emitter-Follower Configurations, Two-Port Systems Approach, Cascaded Systems, Darlington Connection, Problems linked to above topics, Simulation using TINA/PSPICE/Multisim Simulator.

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Unit-2: BJT Frequency Response Feedback Amplifiers [10 Hrs]

Logarithms, Decibels, General Frequency Considerations, Normalization Process, Low-Frequency Response-BJT Amplifier with R_L, Millers Effect Capacitance, High Frequency Response-BJT Amplifier, Multistage Frequency Effects. Problems linked to above topics, Simulation using TINA/PSPICE/Multisim Simulator.

Feedback Amplifiers: Feedback Concepts, Feedback Connection Types, Practical Feedback Circuits-Voltage Series Feedback and Current-Series Feedback . Problems linked to above topics. Simulation using TINA/PSPICE/Multisim Simulator.

Unit-3: Oscillator Circuits and Power Amplifiers [11 Hrs]

Oscillator Circuits: Condition for oscillations, Oscillator operation, Phase Shift Oscillator, Colpitts, Hartley and Crystal Oscillators. Problems linked to above topics. Simulation using TINA/PSPICE/Multisim Simulator.

Power Amplifiers: Series-Fed Class A Amplifier, Transformer-Coupled Class A Amplifier, Class B Amplifier Ciruits-Transformer-coupled Push-Pull Circuits, Complementary-symmetry Circuits, Class C and Class D amplifiers. Problems linked to above topics. Simulation using TINA/PSPICE/Multisim Simulator.

Unit-4: FETs and Op-Amps [10 Hrs]

Field Effect Transistors: Construction and Characteristics of JFETs, Transfer Characteristics, Important relations, Depletion-Type MOSFET, Enhancement-Type MOSFET.

Introduction to Operational Amplifiers: Basic Operational Amplifier Circuit, The 741 IC Op-Amp, Voltage Follower, Non-inverting and Inverting Amplifiers. Operational Amplifier Parameters. Problems linked to above topics. Simulation using TINA/PSPICE/Multisim Simulator.

Project Based Learning

Design a public address system which includes a DC Power supply, Two-stage audio preamplifier and a power amplifier connected to speaker.

Text Books:

1. Robert L. Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory”, PHI/Pearson Education, 11th edition, 2015.
2. David A. Bell, “Electronic Devices & Circuits”, Prentice Hall of India/Pearson Education, 4th edition, 2007.
3. David A. Bell, “Operational Amplifiers and Linear ICs”, Prentice Hall of India, 2nd edition, 2006.

Reference Books:

1. Jacob Millman & Christos. C. Halkias, Satyabrata Jit, “Electronic Devices and Circuits “,Tata McGraw Hill, 2nd edition, 2008.
2. Floyd, “Electronic Devices”, Prentice Hall of India, Pearson Education, 6th Edition, 2010.
3. Anil Kumar Maini, VarshaAgrawal,”Electronic Devices and Circuits”, John Wiley & Sons, 2009.

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B19EM2040	Python Programming (I)	L	T	P	C
Duration:14 Wks		1	1	1	3

Prerequisites:

Computer concepts and C programming

Course Description:

Python is a language with a simple syntax, and a powerful set of libraries. This course is an introduction to the Python programming language for students without prior programming experience. We cover data types, control flow, object-oriented programming, and graphical user interface-driven applications. The purpose of this course is to provide the solid foundations in the basic concepts of Python programming language. The Python Programming Language are a very important to develop Application Software, System Software, Operating Systems, and Network Simulators as it employs Object Oriented Programming (OOP) aspect. This course has important features of OOP like Polymorphism, Inheritance which are not present in C Programming Language.

Course Objectives:

The objectives of this course are to:

1. To present the syntax and semantics of the python, as well as basic data types offered by the language.
2. To learn how to write functions and pass arguments in Python.
3. To learn how to read and write files in Python.
4. To learn how to design object-oriented programs with Python classes.
5. To learn how to use class inheritance and polymorphism in Python for reusability.
6. To learn how to use Iterators, generators and decorators in python programs.

Course Outcomes:

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

1. Use the built-in data types and operators in python programming.
2. Build effective python programs using functions, modules, and packages and by accessing files and directories.
3. Design object-oriented programs using python classes and objects.
4. Demonstrate and use the concept of inheritance and polymorphism for code reusability.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COs	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
B19EM2040	CO1	3	3	2	1	2				2			1	4	3	2
	CO2	4	4	3	1	3				2			1	4	3	3
	CO3	4	4	3	1	3				2			1	4	3	3
	CO4	3	3	2	1	3				2			1	3	3	2

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Course Contents:

Unit 1: Introduction to python: **[6L+5T]**

Features of python programming, application of python, Getting started, keywords and identifier, Python Indentation, statements and comments, variables, Data types: numbers, list, tuple, strings, set, dictionary, type conversion, arrays v/s lists, python I/O, python operators, branching and looping statements.

Unit 2: Python functions and file handling **[6L+5T]**

Python functions: Syntax of functions, arguments and return values, scope and lifetime of variables, python global keyword, python modules and packages.

Python files: Python file operation, directory, exceptions, exception handling and user defined exceptions.

Unit 3: Classes and objects: **[6L+5T]**

Introduction to object-oriented programming, class, objects, attributes and methods, creating an object in python, self-parameter, constructors in python, deleting attributes and objects.

Unit 4: Inheritance, Polymorphism, and Advanced concepts **[6L+5T]**

Inheritance: Python inheritance syntax, Examples on single inheritance and multiple inheritance.

Polymorphism: Method overloading, operator overloading examples.

Advanced concepts: Introduction to Iterators, generators and decorators.

TextBooks:

1. Allen Downey, Think Python: How to Think like a Computer Scientist, Green Tea Press Needham, Massachusetts, 2nd edition.
2. Kenneth A. Lambert, Fundamentals of Python: First Programs (introduction to Programming), 1st Edition, CENAGE Learning.
3. Charles R. Severance, Python for everybody: Exploring data using python 3, Shroff publishers, 2017.

Reference Books:

1. John M. Zelle, PYTHON Programming: An Introduction to Computer Science, Franklin, Beedle& Associates.
2. Michael Dawson, Python Programming for the Absolute Beginners, 3rd Edition, CENAGE Learning.
3. Springer, Kent D. Lee, Python Programming Fundamentals, 2nd Edition.
4. John V. Guttag, Introduction to Computation and Programming using Python, MIT Press.

Python Programming Lab

1. Basic programs

1a Program to demonstrate basic data types in python
1b Program to demonstrate list, tuple, dictionary and sets in python
1c Program that shows Indentation Error.

2. Branching and looping statements

2a Write a python program to find the largest of 3 numbers. (Using branching statements)
2b Write a python program to get a list as input from user and find the largest element of the list.

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2c Write a python program to sort the list in ascending order (Bubble sort algorithm).

3. Operators and functions
3a Write a python program to compute distance between two points taking input from the user (Pythagorean Theorem).
3b Write a python program to implement Simple Calculator by Making Functions.
3b Write a function that receives marks scored by a student in 3 subjects and calculates the average and percentage of these marks. Call this function and display the results.

4. File operation: Write a program to access (read/write) a file and display its contents.
5. Exceptions: Write a program to depict exception handling in python for Zero Division Error
6. Classes and objects: Write a program to create a class named **student** with attributes **Name**, and **SRN** and member function **show** to display the data members of the object. Create two objects of student class, read and display the contents of objects.
7. Inheritance: Create a base class **person** with data members name, age and derived class **student** with data members name, age, SRN and college. Write a program to demonstrate single inheritance.
8. Polymorphism: Create a class named **point** with data members x, and y. Write a program to implement + operator overloading for two objects P1 and P2 of type point.

9. Iterators: Write a program to demonstrate an Iterator in Python. Use the next ( ) function to manually iterate through all the items of an iterator.

10. Generators: Write a program to generate a Fibonacci series by adopting generators approach in python.

B19EM2050	Environmental Sciences	L	T	P	C
Duration: 14 Wks		2	0	0	2

Prerequisites:

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

Course Description:

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

Course Objectives:

The objectives of this course are to:

1. Graduates will be familiar with current and emerging environmental engineering and global issues, and have an understanding of ethical and societal responsibilities.

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2. Graduates will have the ability to obtain the knowledge, and will recognize the need for engaging in life-long learning.
3. Will find the need of various types of energy (conventional & non-conventional) resources and natural resources.
4. Acquire knowledge with respect to biodiversity, threats, conservation and appreciate the concept of ecosystem.
5. Acquiring knowledge about environmental pollution-sources, effects and control measures of environmental pollution, degradation and waste management.
6. Explore the ways for protecting the environment.

Course Outcomes:

After successful completion of the course, the students will be able to

1. Adapt the environmental conditions and protect it
2. Estimate the role of individual, government and NGO in environmental protection.
3. Interpret the new renewable energy resources with high efficiency through active research.
4. Analyze the ecological imbalances and protect it.

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	PSO 1	PSO 2	PSO 3
B19EM2050	CO1	1			2	1	3	3			1	1	1		1	1
	CO2						3	3		1		1	1	1		1
	CO3		1			2	3	3			1		2		1	1
	CO4	1					3	3		1			1	1	1	

Course Contents:

Unit-1: Multidisciplinary Nature of Environmental Studies **[7 Hrs]**

Introduction to Environment, objectives and guiding principles of environmental education, Components of environment, Structure of atmosphere, Sustainable environment/Development, Impact of technology on the environment in terms of modern agricultural practices and industrialization, Environmental Impact Assessment

Environmental protection – Role of Government-Assignments of MOEF, Functions of central and state boards, Environmental Legislations, Initiative and Role of Non-government organizations in India and world. **Self study:** Need for public awareness on the environment, Gaia Hypothesis

Unit-2: Environmental pollution, degradation & Waste management **[7 Hrs]**

Environmental Pollution – Definition, sources and types, Pollutant-Definition &classification,

Concepts of air pollution, water pollution, Soil pollution, Automobile pollution-Causes, Effects & control measures.

Environmental degradation – Introduction, Global warming and greenhouse effect, Acid rain-formation & effects, Ozone depletion in stratosphere and its effect.Solid Waste management – Municipal solid waste, Biomedical waste, Industrial solid waste and Electronic waste (E-Waste).

Self study: Case studies of London smog, Bhopal gas tragedy, marine pollutions and study of different waste water treatment processes. Disaster management, early warning systems-bio indicators for Tsunami and other natural disasters.

Unit-3: Energy & Natural resources [7Hrs]

Energy: Definition, classification of energy resources, electromagnetic radiation-features and applications,Conventional/Non-renewable sources – Fossil fuels based(Coal, petroleum & natural gas), nuclear energy, Non-conventional/renewable sources – Solar, wind,hydro, biogas, biomass, geothermal, ocean thermal energy, Hydrogen as an alternative as a future source of energy.

Natural resources:water resource(Global water resource distribution, Water conservation methods, Water quality parameters, Uses of water and its importance), Mineral resources (Types of minerals, Methods of mining & impacts of mining activities),Forest wealth (Importance, Deforestation-Causes, effects and controlling measures)

Self study: Remote sensing and its applications, Chernobyl (USSR) nuclear disaster and Fukushima (Japan) nuclear disaster. Hydrology & modern methods adopted for mining activities.

Unit-4: Ecology and ecosystem [7Hrs]

Ecology: Definition, branches, objectives and classification, Concept of an ecosystem- Structure and functions, Characteristics of an Ecosystem-Ecosystem Resilience, Ecological succession and productivity, Balanced ecosystem, Components of ecosystem-abiotic and biotic, biological diversity Biogeochemical cycles and its environmental significance – Carbon and nitrogen cycle, Energy flow in ecosystem, food chains –types, food web & Ecological Pyramids.

Self study: Need for balanced ecosystem and restoration of degraded ecosystems.

Text Books:

1. "Environmental Studies", by R.J. Ranjit Daniels and JagadishKrishnaswamy, (2017), Wiley India Private Ltd., New Delhi, Co-authored &Customised by Dr.MS Reddy & Chandrashekar, REVA University.
2. "Environmental Studies" by Benny Joseph, Tata McGraw – Hill Publishing Company Limited.
3. Environmental Studies by AnilkumarDey and Arnab Kumar Dey.
4. Environmental Studies by Dr.S.M.Prakash, Elite Publishers Mangalore, 2007
5. "Environmental Studies", by R.J. Ranjit Daniels and JagadishKrishnaswamy, (2009), Wiley India Private Ltd., New Delhi.

Reference Books:

1. BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
2. Rajagopalan R. 2005,"Environmental Studies – from Crisis to cure", Oxford University Press
3. Environmental Science by Arvind walia, Kalyani Publications, 2009
4. Jadhav, H &Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284p.
5. Sharma B.K., 2001. Environmental Chemistry, Geol Publ. House, Meerut.

Ref: RU/BoS/ECE/CEC/May-2021-9

B19EM2060 Duration :14 Wks	Technical English -II	L 0	T 0	P 2	C 2

Prerequisites:

Technical English- 1

Course Description:

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

Course Outline: This is a 2 credit course for second Semester consisting of 4 hours of teaching learning per week, inclusive of direct classroom teaching and practice in language lab.

Course Objectives:

The objectives of this course are to:

1. To utilize the ability of using language skills effectively in real-life scenarios.
2. To develop the learners' competence in employability skills.
3. To improve the habit of writing, leading to effective and efficient communication.
4. To prioritize specially on the development of technical reading and speaking skills among the learners.

Course Outcomes:

On completion of the course, learners will be able to:

1. Organize their opinions clearly and meaningfully.
2. Demonstrate the ability to speak appropriately in social and professional contexts.
3. Build inferences from the text.
4. Take part in interviews confidently & Develop accurate writing skills using different components of academic writing.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COs	PO 1	P 2	PO 3	PO 4	PO 5	P 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19EM2060	CO1	0	1	0	0	0	0	3	3	0	0	3	0	0	0
	CO2	0	1	0	0	0	0	2	3	0	0	3	0	0	0
	CO3	0	3	0	0	0	0	2	3	0	0	3	0	0	0
	CO4	0	2	0	0	0		2	3	0	0	3	0	0	0

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Course Contents:

Unit-1: Language Acquisition **[14 Hrs]**

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

Unit-2: Persuasive Skills **[14 Hrs]**

Grammar: Compound words; Phrasal verbs,

Listening: Listening to situation based dialogues

Speaking: Group Discussions,

Reading: Reading a short story or an article from newspaper; Critical reading,

Writing: Formal letters (Accepting/ inviting/ declining); Personal letters (Inviting your friend to a function, congratulating someone for his / her success, thanking one's friends / relatives)

Unit-3: Cognitive Skills **[14 Hrs]**

Grammar: Homonyms; homophones, **Listening:** Listening to conversations; Understanding the structure of conversations, **Speaking:** Presentation Skills, **Reading**: Extensive reading

Writing: Report Writing (Feasibility/ Project report - report format – recommendations/ suggestions - interpretation of data using charts, PPT); Precis Writing

Unit-4: Employability Skills **[14 Hrs]**

Grammar: Idioms; Single Word Substitutes,

Listening: Listening to a telephone conversation; Viewing model interviews (face-to-face, telephonic and video conferencing),

Speaking: Interview Skills, Mock Interviews,

Reading: Reading job advert Semen's and the profile of the company concerned,

Writing: Applying for a job; Writing a cover letter with Resume / CV

Reference Books:

1. Bansal, R.K. and J.B. Harrison. Spoken English. Orient Blackswan, 2013.
2. Raman, Meenakshi and Sangeeta Sharma. Technical Communication. Oxford University Press, 2015.
3. Thorpe, Edgar and Showick Thorpe. Objective English. Pearson Education, 2013.
4. Dixson, Robert J. Everyday Dialogues in English. Prentice Hall India Pvt Ltd., 1988.
5. Turton, Nigel D. ABC of Common Errors. Mac Millan Publishers, 1995.
6. Samson, T. (ed.) Innovate with English. Cambridge University Press, 2010.
7. Kumar, E Suresh, J. Savitri and P Sreehari (ed). Effective English. Pearson Education, 2009.
8. Goodale, Malcolm. Professional Presentation. Cambridge University Press, 2013.

Ref: RU/BoS/ECE/CEC/May-2021-9

B19EM2070	Computer Aided Engineering Drawing	L	T	P	C
Duration :14 Weeks		1	0	1	2

Prerequisites:

Basic Knowledge on geometry and their construction

Course Description:

Computer Aided engineering drawing is the primary medium for communicating engineering design. In this course, to begin with Students are trained on skills of Sketching, Scaling and Dimensioning. The students are introduced to orthographic projections and they are trained to draw orthographic projections of Points, Lines, Planes and Solids. They are further trained to draw Development of Lateral surfaces, Isometric Projections.

Course Objectives:

The objectives of this course are to:

1. Comprehend general projection theory, with emphasis on orthographic projection to represent in two-dimensional views.
2. Introduce dimension and annotation for two-dimensional engineering drawings.
3. Understand the application of industry standards and best practices applied in engineering graphics.
4. Emphasize freehand sketching to aid in the visualization process and to efficiently communicate ideas graphically.
5. Introduction of CAD software for the creation of 2D engineering drawings.

Course Outcomes:

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

1. Identify industry Drawings and able to develop independent thinking and problem solving capabilities
2. Express components descriptions as per the commonly practiced standards
3. Visualize 2D and simple 3D drawings of simple machine component.
4. Comprehend the computer aided drawing of simple objects/tools/instruments /elements/ structures belonging to the engineering field and industry specific drawings

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COs	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
B19EM 2070	CO1	3	2	1		2								2	1	2
	CO2	3	2			1								1		2
	CO3	3	2	1		2								2		2
	CO4	3	3	2		3				2	1			3	2	3

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Course Contents:

Unit – 1: Introduction to Drawing **[12Hrs]**

Introduction to Engineering Drawing: Introduction, Drawing Instruments and their uses, BIS conventions, Drawing sheets, Dimensioning, regular polygons and their construction and brief introduction to solid edge software.

Projection of points: Points in different quadrants.

Projection of Straight Lines (First-angle Projection only): Parallel to 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, Projection of Planes, perpendicular to VP and inclined to HP – Inclined to both the planes.

Unit – 2: Projection of Prisms **[10 Hrs]**

Square, pentagonal and hexagonal prisms, cylinder, Solids in simple position (only resting on HP on one of the base corner or base edge of solid), Axis parallel to VP plane and inclined to HP, Axis inclined to both plane (only change of position method).

Unit – 3: Projection of Pyramids **[10Hrs]**

Square, pentagonal and hexagonal pyramids, cone, Solids in simple position (only resting on HP on one of the base corner or base edge of solid), Axis parallel to VP p and inclined to HP, Axis inclined to both plane (only change of position method).

Unit - 4: Development of Lateral surfaces of solids **[10 Hrs]**

Regular prisms and pyramids only.

Isometric Projection: Isometric axes, Lines and Planes, Isometric Scale, Isometric Projection of Planes, Prisms, Pyramids, Cylinders, Cone and Sphere, Combination of Solids (Maximum Two solids).

Text Books:

1. Text Book on Engineering Drawing, Dr. K S Narayanswamy and Prof.Mahesh L, REVA University, WILEY Publishers 2017.
2. Engineering Drawing – N.D.Bhatt and V.M. Panchal, 48th Edition, 2005 – Charotar Publishing House, Gujarat.
3. Engineering Graphics - K.R. Gopalakrishna, 32nd Edition, 2005 – Subhas Publishers, Bangalore

Reference Book:

1. Engineering Drawing – P. S. Gill, 11th Edition, 2001 – S. K. Kataria& Sons, Delhi.

Ref: RU/BoS/ECE/CEC/May-2021-9

B19EM2080	Analog Electronics Lab	L	T	P	C
Duration: 14 Weeks		0	0	2	2

Prerequisites:

Basic Electrical and Electronics lab

Course Description:

Analog Electronics lab is first step in the design of Amplifiers for the ECE students.The practical design aspects of various amplifiers is introduced and measurements are taken. Power amplifiers are designed and the efficiency is measured. The concepts of positive feedback amplifiers is also introduced by desigining various oscillators. The students also design the circuits using simulators.

Course Objectives:

The objectives of this course are to:

1. Understand and estimate the gain and input/output resistances of single and two-stage amplifiers
2. Perform DC and AC analysis of the BJT amplifier and understand the bode plots.
3. To learn different biasing techniques and behavior of BJT amplifiers, at low and high frequencies.
4. To understand the principle of operation of different oscillators circuits.
5. Simulation and design of electronic circuits using SPICE or other analog simulator

Course Outcomes:

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

1. Design different BJT negative and positive feedback amplifiers.
2. Design and Assess the amplifier parameters like gain, BW, Zin and Zout , efficiency, etc.
3. Compile the experiment's procedures and results by writing a formal report.
4. Analyze all the above experiments using suitable simulation software.

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
B19EM 2080	CO1	3	2	1		3								1	2	1
	CO2				1					3					2	1
	CO3					3				3	3	1		2		1
	CO4	2	2	1		3										1

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Lab Experiments

1. Design a Single stage BJT CE Amplifier and obtain frequency response curve and find Bandwidth, Input & Output Impedances.
   Challenging Experiment: Connect above amplifier to Analog Discovery Module & find frequency response curve.
2. Design a Two stage voltage series BJT Amplifier and Obtain frequency response curve, also find Bandwidth, Input & Output Impedances
3. Design a CE mode Cascode amplifier and plot frequency response. Also find Gain & Bandwidth.
4. Design a Class - C tuned Amplifier & find its Efficiency.
   Challenging Experiment: FindFrequency response of Class - C tuned Amplifier by using Analog Discovery Module.
5. Design a BJT Darlington emitter follower and find Gain, Input & Output Impedances.
6. Rig-up an R-C Phase Shift oscillator for $f_o \leq 10$ KHz & Crystal oscillator for f_o>1MHz.
7. Design a BJT Hartley &Colpitt's Oscillators for frequency ≥100kHz & simulate the circuit in Multisim.
8. Demonstrate the working of Class-B push pull power amplifier using transistors find its Efficiency & also simulate the same in Multisim.
9. Design an OPAMP Inverting & Non Inverting Amplifier.
   Challenging Experiment: Conduct the Experiment by using Analog Discovery Module.
10. Mini Project.

B19EM2090	Engineering Chemistry Lab	L	T	P	C
Duration :14 WKs		0	0	2	2

Prerequisites:

1. Handling glassware, apparatus, acids, bases, toxic chemicals and safety precautions in the laboratory
2. Chemical awareness and basic chemical reactions.

Course Description:

Engineering chemistry lab provides the very basic knowledge required for engineering students to understand its importance in technology and practical life. It provides the knowledge of quantum mechanics, battery technology its importance and applications. It also provides knowledge about corrosion science, construction of PCB's and engineering materials, testing the chemicals in laborotary etc

Course Objectives:

The objective of this course is:

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

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Course Outcomes:

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

1. Analyze the amount of material present in the sample by different instrumental methods.
2. Evaluate the amount of oxygen demand, alkalinity, and hardness of the different water samples.
3. Estimate impurities in water.
4. Test the ions present in unknown substance/ores using titrimetric and instrumental metals

Mapping of Course Outcomes with Program Outcomes

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19EM2090	CO1	1	1	1	1		2						1	1		
	CO2	1		1			2	2					1			
	CO3	1	1				2	2					1			1
	CO4	1	2	1			1	1					1			1

Lab Experiments

1. Potentiometric Estimation of Mohr's salt.
2. Colorimetric estimation of copper.
3. Conductometric estimation of acid mixture using standard NaOH.
4. Determination of pKa of given weak acid using pH meter.
5. Determination of viscosity co-efficient of a given organic Liquid.
6. Determination of total hardness of the given water sample.
7. Determination of calcium oxide in the given cement sample.
8. Determination of COD of the given waste water sample.
9. Determination of percentage of copper in the given brass sample.
10. Determination of iron in the given sample of Hematite ore using potassium dichromate.
11. Estimation of Alkalinity of the given water sample using standard HCl solution.
12. Flame photometric estimation of sodium in the given water sample.
13. Electroplating of Copper and Nickel.
14. Determination of Calcium in a milk sample.

Text Books:

1. Sunita Rattan, Experiments in Applied Chemistry, S.K. Kataria& Sons, Second edition, 2008.
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
4. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry.

Ref: RU/BoS/ECE/CEC/May-2021-9

Semester – III

B19EM3010	Linear integrated circuits	L	T	P	C
Duration:14 Weeks		3	0	0	3

Prerequisites:

Basic Electronics, Analog Electronic Circuits, Basics of OP-AMP

Course description

This course is basically a study of the characteristics, operations, stabilization, testing, and feedback techniques of linear integrated circuits. The course includes applications in computation, measurements, instrumentation, and active filtering.

Course Objectives:

The objectives of this course are to:

1. Interpret and explain frequency response and compensation techniques of Operational amplifier.
2. Illustrate how operational amplifiers can be used in linear and nonlinear applications.
3. Introduce the concepts of waveform generation and introduce some special function ICs.
4. Explain and introduce the theory and applications of analog multipliers, PLL, voltage regulators, IC555 timer applications.
5. Introduce the basic building blocks of linear integrated circuits and explain System design.

Course Outcomes:

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

1. Examine the stability of an op-amp circuit using frequency compensation techniques.
2. Design and simulate op-amp circuits for linear and non-linear applications.
3. Apply experience in building and trouble-shouting simple electronic analog and digital circuits(PBL)
4. Analyze systems like PLL, counters , Converters, frequency synthesizers function generators for simple applications.

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
B19EM3010	CO1	3	2	1		3								1	2	1
	CO2				1	3									2	1
	CO3					3				3	2	1		1		3
	CO4	2	2	1		1										1

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Course Contents:

Unit -1: **[11 Hrs]**

OP-AMPS Frequency Response, Compensation and applications

Circuit stability, frequency and phase response, frequency compensating methods, bandwidth, and slew rate effects, Zin mod compensation.

Linear Applications:Voltage sources, current sources and current sinks, Current amplifiers, Instrumentation amplifier, precision rectifiers,

Unit -2: **[10 Hrs]**

Non-linear applications of ICs

Clamping circuits, peak detectors, Sample and hold circuit, V-I and I-V converter, Log and Antilog amplifiers, Multiplier and Divider, Triangular/Rectangular waveform generators, waveform generator design. Crossing detectors, Inverting Schmitt trigger circuits, Active filters- first and second order low pass and high pass filters,

Unit-3: Voltage regulators, 555 timer and PLL **[10 Hrs]**

Series op-amp regulator, IC voltage regulator, 723 general purpose regulators, 555 timer-basic timer circuit, 555 timer used as Astable and Monostablemultivibrator, Basic block of PLL, Applications of PLL.

Unit-4: System design using ICs **[11 Hrs]**

system design Principles,Frequency counter, DACs and ADCs, Digital voltmeter, Digital programmable frequency generator, frequency synthesizer, function generator, Display system design, Traffic controller design.

Text Books:

1. D. Roy Choudhury and Shail B Jain, " Linear Integrated Circuits", New Age International, 2nd edition, 2006
2. David A Bell, "Operational amplifiers and Linear ICs", PHI/Pearson, 2nd edition, 2004
3. B. S. Sonde, " Introduction to System Design Using Integrated Circuits", New Age International, 1992,

Reference Books:

1. Thomas L. Floyd, David Buchla, "Basic Operational Amplifiers and Linear Integrated Circuits", Prentice Hall, 1999
2. Gayakwad, Op-amp and linear Integrated circuits, , Pearson, 4th edition, 2004
3. Op Amps for Everyone, Bruce Carter, ISBN: 978-0-12-391495-8, Fourth Edition.
4. BIS, ISO standards and Datasheets

Ref: RU/BoS/ECE/CEC/May-2021-9

B19EM3020	Data Structures and Applications	L	T	P	C
Duration :14Wks		3	1	0	4

Prerequisites:

Computer Concepts and C Programming, Computer Organization, & C++.

Course Description:

This course covers the design, analysis, and implementation of basic data structures using C++. This course shall implement some of the data structures and basic aspects of C++ are also covered. A brief discussion of the C++ programming language is done. Survey of fundamental data structures (array, vector, lists, queue, stack, trees) and how to use them in C++. This course then delves deeper into the design, analysis and implementation of such data structures.

Course Objectives:

The objectives of this course are to:

1. Discuss insights into the basic concepts of data structures and algorithms.
2. Implement basic concepts about stacks, queues, lists, and Trees
3. Explain a concise about searching and sorting techniques.
4. Discuss insights into programming skills to implement data structures for real time applications.

Course Outcomes:

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

1. Identify and classify various types of data structures.
2. Implement data structures like stack, queue, linked list, and tress using C++ programs.
3. Classify and describe various sorting and searching techniques.
4. Demonstrate and use sorting and searching techniques.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 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
B19EM 3020	CO1	2	1	2					2	3			3			
	CO2	2	3	3	3		2		3	2	1	2	3		2	3
	CO3	1	2	3					2	2			2		2	
	CO4	3	2	3			3		3		2		3	2	3	

Course Contents:

Unit-1: Introduction to Data structures and Algorithms [10 Hrs]

Data, Data Types, Abstract Data Types and Examples, Algorithms, Arrays: One Dimensional and Two Dimensional, Structures: Introduction to structures and nested structures.

Unit-2: Linear Data Structures [11 Hrs]

Pointers: Introduction, Recursion; Stacks, Queues: Simple, circular and priority Queues, Linked Lists: Singly and Doubly Linked List; Operations and Array Representation of all above Data Structures.

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Unit-3: Non-Linear Data Structure **[10 Hrs]**
Tree Introduction and Terminologies, Binary Tree and Binary Search Tree, Binary Tree representation, Operations on Binary/Binary Search Tree, Binary Tree traversal, Binary Search tree implementation: Adding and Removing Node.

Unit-4: Sorting and Searching: **[11 Hrs]**
Introduction and list of all Searching Techniques, Linear Search and Binary Search; Introduction and list all Searching Techniques, Insertion Sort, Bubble sort, and Quick Sort.

Text Books:
Langsam, Augenstein, Tenenbaum, "Data Structures Using C and C+", Pearson Education, India, 2nd Edition, 2015.
Seymour Lipschutz, "Data Structure with C", TMH Education India, 2010.

Reference Books:
G. A. V. Pai, "Data Structures and Algorithms", TMH, 2008.
Debasis ,Sarnanta, "Classic Data Structures" , PHI, 2nd Edition, 2009.

B19EM3030	Digital Electronics & Verilog	L	T	P	C
Duration :14Wks		3	1	0	4

Prerequisites:
Number system, Logic gates, Boolean algebra

Course Description:
Electronics is classified based on the type of signal/information in to Analog Electronics and Digital Electronics. Digital Electronics deals with signal/information represented using discrete values of 0's and 1's (Binary). Digital electronics are designed using logic gates/circuits and are usually represented using Boolean Equations. Digital Electronics is further classified in to Combinational Logic/Circuits and Sequential Logic/Circuits.
Hardware Description Language (HDL) is a computer –Aided Design tool for modern design and synthesis of digital systems. Due to the complexity in design of digital systems, such systems cannot be realized using discrete integrated circuits. They are usually realized using high density, programmable chips, such as Field programmable Gate Arrays (FPGAs).
The two widely used hardware description languages are VHDL and Verilog. This course develops students' ability to understand and design the basic building blocks of modern digital systems and provides them with a fundamental knowledge for complicated digital hardware design

Course Objectives:
The objectives of this course are to:
1. Provide the basics behind the digital circuit design in terms of all the necessary building blocks.
2. Illustrate Boolean laws and systematic techniques for minimization of expressions.
3. Introduce the Basic concepts of combinational and sequential logic.
4. Provide foundations of different styles of descriptions in HDLs.
5. Highlight the Design techniques of digital modules by using different styles of HDL descriptions.

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Course Outcomes:

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

1. Design digital circuits using gates, encoders, decoders, multiplexers and de-multiplexers
2. Interpret the output and performance of given combinational and sequential circuits.
3. Summarize the different styles of Verilog programming and its applications.
4. Distinguish Verilog models for realizing combinational and sequential 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
B19EM3030	CO1	2	3	3						3				3		3
	CO2	3	3	3	1					3						
	CO3	2	1			3								3		2
	CO4	3	3	2	3											

Course Contents:

Unit -1: Principle and Minimization Techniques of combinational Circuits [6L+5T]

Introduction to combinational logic circuits, generation of switching equation from truth table. Minimization Techniques: Boolean algebra, expression minimization. Min-term, Max-term, Sum of Products (SOP), Product of Sums (POS), Karnaugh map, incompletely specified functions, Introduction to Digital Logic Families.

Analysis and Design of Combinational Circuits

Adder/Subtractor, Carry Look Ahead adder, BCD adder. Principle of Encoder and Decoder with cascading of decoders. Principle of Multiplexers and Demultiplexer with cascading of Mux and Boolean function implementation using Mux and decoders, Comparators.

Unit -2: Introduction to Sequential circuit [6L+5T]

Basic bi-stable element, S R Latch, Flip-flops - SR, JK, D, T, and Master-Slave – Characteristic table and equation. Registers, Shift Register, Counters: Binary Ripple Up/Down Counter, Design of synchronous Mod- n counter using flip-flop.

Design & Applications of Digital Circuits [6L+5T]

Sequential Design: Introduction to Mealy and Moore Model circuits. State machine notation, Synchronous sequential circuit analysis and construction of state table and diagram. Case study: sequence generator.

Unit -3: Verilog Programming concepts [6L+5T]

Structure of Verilog Program, Operators, Data types

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Data Flow Description:
Highlights of Data-Flow Descriptions, Structure of Data-Flow Description, Data Type –Vectors, Introduction to signal declaration and assignment statements, Assigning delays to signal assessment statement, Programs based on Data Flow Description.
Case Study: 1. Ripple carry adder and 2. Carry look ahead adder

Unit -4: Introduction to Behavioral Description [6L+5T]
Highlights and Structure of HDL Behavioral Description, Introduction to formats of sequential statements with examples. Programs Based on Behavioral Description
Structural Description: Highlights of Structural Description, Organization of the Structural Description

Case Study:
1. Design of Shift register module using behavioral description
2. Booth algorithm implementation using behavioral description 3. Design of four bit ripple carry adder using structural description.

Text Books:

1. John M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 1st Edition, 2001.
2. Nazeih M Botros,"HDL Programming : VHDL and Veriolog" Dreamtech Press, 6th Edition 2006.

Reference Books:

1. Samir Palnitkar "Verilog HDL"–-Pearson Education
2. Donald D Givone, "Digital Principles and Design", Tata McGraw-Hill 1st Edition, 2002.
3. D P Leach, A P Malvino, &GouthamSaha, "Digital Principles and applications", Tata McGraw-Hill, 7th Edition, 2010.
4. Moshe Morris Mano, "Digital Design" Prentice Hall, 3rd Edition, 2008.
5. Chales H Roth,Jr., "Fundamentals of Logic Design", Cengage learning, 5th Edition, 2004

B19EM3040	Object oriented Programming using C++(I)	L	T	P	C
Duration :14Wks		2	0	1	3

Prerequisites:

Programming with C.

Course Description:

The purpose of this course is to provide the solid foundations in the basic concepts of C++ programming language. The C++ Programming Language are a very important to develop Application Software, System Software, Operating Systems, and Network Simulators as it employees Object Oriented Programming (OOP) aspect. This course has important features of OOP like Polymorphism, Inheritance, and exception handling, which are not present in C Programming Language. By studying this course, it will help students to get placed in IT Company.

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Course Objectives:

The objectives of this course are to:

1. Discuss insights of object-oriented programming (OOP) features and basics of C++ language.
2. Explain the syntax and Semantics of the C++ language as well as basic data types offered by the language.
3. Implement the fundamental OOP concepts like Classes, Objects, Inheritance and Polymorphism.
4. Discuss advanced C++ features file handling and exception handling.

Course Outcomes:

After completion of the course a student will be able to

1. Identify and classify C++ data types and operators.
2. Apply object-oriented features like classes and objects in C++ programs.
3. Demonstrate and use the concept of inheritance and polymorphism for code reusability.
4. Apply concepts like exception handling, threads, and files to write robust programs in C++.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 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
B19EM3040	CO 1	3	3	2		2				2			1	3	3	3
	CO 2	3	4	3		3				2			1	3	4	3
	CO 3	3	3	3		2				2			1	3	4	3
	CO 4	3	4	3		3				2			1	3	4	3

Course Contents:

Unit-1: The Basic C++ Language **[11 Hrs]**

The General Form of a C++ Program, Basic Datatypes: Literal, Variables, const-Qualifier, Pointer, Strings, Reference, Bool, Enumeration, Array types. Operators: Arithmetic Operators, Equality, Relational and Logical operators, Assignment operators, Increment and Decrement operator, Conditional Operator, Branching and Looping Statements.

Teaching is supported by programming examples

Unit-2: Classes and Objects **[10 Hrs]**

Functions, Procedure Oriented vs Object-Oriented Programming, Features of Object-Oriented Programming, Class, Object, Data Member, Member Functions, Static Class Members, Constructors and its Types, Destructors, Friend Functions, Dynamic Memory Allocation-New and Delete Keywords.

Teaching is supported by programming examples

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Unit-3: Inheritance and Polymorphism **[11 Hrs]**

Inheritance: Different types of Inheritances, Single Inheritance – Public, Private and Protected. Multiple Inheritance, Polymorphism: Introduction, Compile Time Polymorphism (function overloading) and Run Time Polymorphism (Virtual Functions). Operator Overloading: + operator Teaching is supported by programming examples

Unit-4: Files and Exception Handling **[10 Hrs]**

Files and Streams: Opening a file, closing a file, writing to a file, Reading from a file, File Position Pointers. Exception Handling: Exception handling fundamentals, throwing exceptions, catching exceptions, Standard Exceptions, Defining a New Exception.

Teaching is supported by programming examples

Text Books:

1. Stanley B. Lippmann, JoseeLajore: "C++ Primer", Pearson Education, 4th Edition, 2005
2. Herbert Schildt , "The Complete Reference C++", McGraw-Hill, 4thEdition, 2003.

Reference books:

1. Bjarne Stroustrup, " The C++ Programming Language", Pearson Education, 4th Edition, 2003.
2. R.G.Dromey, "How to Solve it by Computer", Pearson, 2nd Edition, 2015.

Supporting experimentation

1. a) Write a simple C++ program to read and display a student Name and SRN.
b) Write a C++ program using Pointers and References concept to solve theProgram-1a
c) Write a C++ program using arrays to read and display four student's SRN.
2. Write a C++ program to read 2 students 6 subject marks (out of 100), calculate the total marks of each student and display total marks of both students. Also find and display who has scored the highest total among the two students.
3. Write a C++ program to read 4 students 6 Subjects marks (out of 100) using any looping structure, calculate and display the total marks of each student?
4. Write a C++ program to create a Student class with two data members StudentName, SRN and member functions get_data, put_data to read and display the contents of the data members. Create two objects of Student class. Read and display the contents of the objects using member functions of the Student class.
5. Rewrite the code in Program 4 by using the concept of class constructor and destructor.
6. Rewrite the code in Program-4 by making use of dynamic memory allocation.
7. Write a C++ program to implement single inheritance. Create a base class Student with two data members SRN,Total Marks and with two member functions get_data, put_data to read and display information. Create a derived class EligibleStudent using public inheritance from base class. Create objects of base and derived classes and display information? (Note: class EligibleStudent should contain list of students those are eligible for final C3 exam).
8. Write a C++ program to implement exception handling mechanism?

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B19EM3050	Discrete Mathematics & Graph Theory	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Knowledge In High School Mathematics and Logic.

Course Description:

The main objective of this course is to provide an understanding of the concepts and application of set theory, logic, relations and functions, principles of counting and to know the algebraic structure with one binary operation and two binary operations. Also to provide the understanding of the concepts and application of graph theory.

Course Objectives:

1. Explain the strategies for potential proofs in logical sequential order without mathematical symbols.
2. Demonstrate how to carry out the operations on discrete structures such as sets, relations and functions.
3. Illustrate the use of Algebraic structures and how to carry out operations on them.
4. Explain induced subgraphs, cliques, matchings, covers in graphs
5. Illustrate the different types of graphs viz. Hamiltonian and/or Eulerian
6. The students should be made to be exposed to the techniques or proofs and analysis.
7. Model real world problems in the form of algorithmic steps using graph theory.
8. Apply graph theory based tools in solving practical problems

Course Outcomes:

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

CO1: Discuss diagram strategies for potential proofs in logical sequential order without mathematical symbols (plain English). Construct mathematical arguments using logical connectives and quantifiers
CO2: classify different types of relations and functions and be able to summarize their properties.
CO3: Use graphs as a tools to visualize and simplify situations.
CO4: Apply algorithm to solve problems, (Critical Thinking)

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
B19EM3050	CO1	3	2													
	CO2	3	3	2	1											

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	CO 3	3	3	2												
	CO 4	3	3	3												

Course Contents:

Unit-1 : Set Theory & Logic **[13 Hrs]**

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

Unit-2 : Relations **[13 Hrs]**

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

Unit-3: Introduction: **[13 Hrs]**

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

Unit-4: Eulerian and Hamiltonian Graph and Graph coloring: **[13Hrs]**

Operation on graphs, Definition of Euler Trail, Euler graph, Standard theorems on Euler graphs Hamiltonian Path, Hamiltonian Cycle and Hamiltonian Graph, Standard theorems on Hamiltonian Graph, Planar graph, Detection of Planarity, Geometric dual, Euler formula, Graph coloring, Chromatic polynomial, Map coloring, Four color theorem, Five Color theorem,, Matching, Network flow and its applications, Cut set, Cut vertex, Chord, Properties of Cut set, Max flow Min cut theorem.

Self-learning component: Function Composition and Inverse Functions, Equivalence Relations and Partitions, Application of concepts to Data mining techniques like Classification, Association, Clustering, Regression Analysis.

Text Books:

1. Kenneth H Rosen , Discrete mathematics and its application, McGraw Hill, Sept. 2002
2. Englewood cliffs, Graph theory and its applications tp Engineering and computer science, Prentice Hall, 1974.
3. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", Prentice-Hall, 2014. 2. Ralph P Grimaldi, Discreteand Combinatorial mathematics, Pearson Education, 5th edition, 2014.

Reference Books:

1. V.Krishnamurthy, Combinatorics: Theory and Applications, East-West Press Pt. Ltd., Delhi, 1986.

Ref: RU/BoS/ECE/CEC/May-2021-9

2. J. Tremble, Manohar, Discrete Mathematical Structures with applications to computer Science McGraw Hill pub. 1975.
3. Richard Kohar, Basic Discrete Mathematics: Logic, Set Theory, and Probability, World Scientific Publishing Company, 1st Edition, 2017
4. Oscar Levin, Discrete mathematics: An Open Introduction, CreateSpace Independent Publishing Platform, 2nd edition, 2016
5. Springer Journal of Number Theory and Discrete Mathematics.
6. Frank Harary, "Graph Theory", Narosa, 2013. 2. J.A Bondy and U.S.R Murthy, Graph Theory with applications, Macmillan, 2013 3. GeirAgnarsson and Raymond Geenlaw ; Graph Theory modeling, Applications and algorithms, Pearson Education, 2007. 4. Douglas B, "Introduction to Graph Theory", Prentice Hall of India, 2nd edition, 2015.

B19EM3070	Linear Integrated circuits & IC's Lab	L	T	P	C
Duration:14 Weeks		0	0	2	2

Prerequisites:

Electronic Circuits

Course Description:

This laboratory course is introduced for the students to explore the applications in linear ICs. The students will learn filtering concepts of various filters. Precision rectifier oncepts are also introduced. A fundamental concept in system design is introduced by designing waveform generators and PLL. The students also design the applications using industry standard simulators.

Course Objectives:

The objectives of this course are to:
1. Understand and design various applications of Op-Amp and measure the physical Parameters.
2. Structured systematically to upgrade graduates skills and knowledge to the more advanced in-depth skills and knowledge in electronics.
3. Infer the DC and AC characteristics of operational amplifiers and design the linear and non-linear applications using operational amplifiers.
4. Simulation and design of electronic circuits using SPICE or other analog simulators.

Course Outcomes:

On completion of this course the student will be able to:
Design and test amplifiers, precision rectifiers, filters and waveform generators.
Experiment with as part of a team effectively.
Compile the experiment's procedures and results by writing a formal report
Demonstrate linear and nonlinear applications using simulator tools.

Ref: RU/BoS/ECE/CEC/May-2021-9

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	P O 10	P O 11	P O 12	PS O1	PS O2	PS O3
B19EM 3070	CO1	3	2	1		3								1	2	1
	CO2				1					3					2	1
	CO3					3				3	3	1		2		1
	CO4	2	2	1		3										1

Lab Experiments

Study the characteristics of negative feedback amplifiers and design of Instrumentation amplifier.

1. Designing and testing of second order low pass filter and high pass filter
2. Design of second order band pass.
3. Designing and testing of Schmitt Trigger circuit for the given values of UTP and LTP
4. Designing and testing of Astable multi-vibrator circuits using IC 555 for given frequency and duty cycle
5. Designing and testing of PLL.
6. Design a function generator and convert it into VCO/FM generator.
7. Designing and testing of a rectangular and triangular wave generator.
8. Designing and testing of integrator and differentiator circuit.
9. Designing and testing of a voltage regulator circuit using op-Amp

B19EM3080	Digital Electronics and Verilog Lab	L	T	P	C
Duration :16Wks		0	0	2	2

Prerequisites:

Number system, Fundamentals of Digital Electronics, programming skills.

Course Description:

Electronics is classified based on the type of signal/information in to Analog Electronics and Digital Electronics. Digital Electronics deals with signal/information represented using discrete values of 0's and 1's (Binary). Digital electronics are designed using logic gates/circuits and are usually represented using Boolean Equations. Digital Electronics is further classified in to Combinational Logic/Circuits and Sequential Logic/Circuits.

Hardware Description Language (HDL) is a computer –Aided Design tool for modern design and synthesis of digital systems. Due to the complexity in design of digital systems, such systems cannot be realized using discrete integrated circuits. They are usually realized using high density, programmable chips, such as Field programmable Gate Arrays (FPGAs).

The two widely used hardware description languages are VHDL and Verilog. This course develops students' ability to understand and design the basic building blocks of modern digital systems and provides them with a fundamental knowledge for complicated digital hardware design.

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Course Objectives:

The objectives of this course are to:

1. Design, realization and verification of Boolean Theorems, logic expressions
2. Realize various arithmetic, data path modules, memory modules
3. Understand the FPGA design flow
4. Simulate, synthesize various digital blocks by using Verilog code

Course Outcomes:

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

1. Demonstrate circuits using combinational gates/MSI chips
2. Develop and debug the codes for various digital combinational and sequential blocks
3. Implement and analyze the digital blocks on the targeted FPGA device

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	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19EM3080	CO 1	3	3	3						3			3	3	1	2
	CO 2	3	3	2						3			3	3	1	2
	CO 3	3	3	3						3			3	3	1	2

Lab Experiments

1. Realization of parallel Adder and Subtractor.
2. Realization of 3 bit Binary to Grey code conversion and vice versa using basic/Universal gates.
3. Realization of 4:1 MUX and 1:4 DEMUX using basic/universal gates.
4. Arithmetic circuit realization (Half/Full, Adder/Subtractor) using MUX.
5. Construction and verification of JK master slave, T, D flip flop using logic gates.
6. Construction and realization of n- bit ripple up/down counter using IC 7476 and other logic gates.
7. Design and verification of n-bit synchronous counter using 7476 JK, T and D flip flops.
8. Write a Verilog program for the following modules.
   Decoder ,Encoder with and without priority
   Multiplexer, De-multiplexer, Comparator
9. Write a Verilog code to describe function of full adder in data flow, behavioral and structural style
10. Write Verilog code for a 4-bit binary, BCD counters with synchronous and asynchronous reset
11. Write a Verilog code to control speed and directions of a Stepper motor
12. Demo experiments
13. Write a HDL code to generate waveforms of different frequency and amplitude using a DAC.
14. Interfacing the Hexa keyboard with the FPGA board.

Challenge experiment:

1. Design and implement universal shift register.

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Semester- IV

B19EM4010	Introduction to Data Science	L	T	P	C
Duration :14 Weeks		3	0	0	3

Prerequisites:

Probability and Statistics, Programming Language (C/C++/Java), Database Management Systemsand Introduction to Data mining.

Course Description:

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

Course Objectives:

The objectives of this course are to:

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

Course Outcomes:

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

1. Make use of the concepts of Data Science in developing the real world applications.
2. Apply the SQL commands in developing the real-world applications.
3. Build the data analytics solutions for real world problems, perform analysis, interpretation and reporting of data.
4. Create the real world AI based solutions using different machine learning algorithms

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
B19EM4010	CO1	1		2		2			1	2		1		1		
	CO2		2	1	2		1				1		1			1
	CO3	1	2	3		1					1					1
	CO4		1	1	2	1	2					2		1		

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Course Contents:

UNIT – 1
Introduction to Microsoft Excel
Creating Excel tables, understand how to Add, Subtract, Multiply, Divide in Excel. Excel Data Validation, Filters, Grouping. Introduction to formulas and functions in Excel. Logical functions (operators) and conditions. Visualizing data using charts in Excel. Import XML Data into Excel How to Import CSV Data (Text) into Excel, How to Import MS Access Data into Excel, Working with Multiple Worksheets.

UNIT – 2
Introduction to Data Science
What is Data Science? Probability theory, bayes theorem, bayes probability; Cartesian plane, equations of lines, graphs; exponents.
Introduction to SQL
SQL: creation, insertion, deletion, retrieval of Tables by experimental demonstrations. Import SQL Database Data into Excel

UNIT – 3
Data science components
Tools for data science, definition of AI, types of machine learning (ML), list of ML algorithms for classification, clustering, and feature selection. Description of linear regression and Logistic Regression. Introducing the Gaussian, Introduction to Standardization, Standard Normal Probability Distribution in Excel, Calculating Probabilities from Z-scores, Central Limit Theorem, Algebra with Gaussians, Markowitz Portfolio Optimization, Standardizing x and y Coordinates for Linear Regression, Standardization Simplifies Linear Regression, Modeling Error in Linear Regression, Information Gain from Linear Regression.

UNIT – 4
Data visualization using scatter plots, charts, graphs, histograms, and maps
Statistical Analysis: Descriptive statistics- Mean, Standard Deviation for Continuous Data, Frequency, Percentage for Categorical Data
Applications of Data Science
Data science life cycle, Applications of data science with demonstration of experiments by using Microsoft
Excel.

Textbooks:

1. B.S. Grewal, “Higher Engineering Mathematics”, 43nd edition, Khanna Publishers, 2015.
2. Ramakrishnan and Gehrke , “Database Management systems”, Third Edition, McGraw Hill Publications, 2003.
3. Kenneth N. Berk, Carey, “Data Analysis with Microsoft Excel”, S. Chand & Company,2004.

REFERENCE BOOKS:

1. B.V. Ramana, “Higher Engineering Mathematics”, 19th edition,Tata McGraw Hill Publications, 2013.

Ref: RU/BoS/ECE/CEC/May-2021-9

2. ErwinKreyszig, “Advanced Engineering Mathematics”, 9th edition,Wiley Publications, , 2013.
3. Seymour Lipschutz, John J. Schiller, “Schaum's Outline of Introduction to Probability and Statistics”, McGraw Hill Professional, 1998.

Course Code	Design and Analysis of Algorithms	L	T	P	C
B19EM4020		3	0	0	3

Prerequisites:

Programming for Problem Solving, Object Oriented Concepts, Data Structures

Course Description:

Course describes the various techniques for designing algorithms and for analyzing the time and space efficiency of algorithms. The algorithm design techniques include divide-and-conquer, Decrease-and-Conquer Approach, Greedy algorithms, Dynamic programming and Space and Time Trade-Offs. The algorithm analysis includes computational models, Best/Average/Worst case analysis, and computational complexity (including lower bounds and NP-completeness).

Course Objectives:

The objectives of this course are to:

1. To provide an understanding of algorithmic way to solve Engineering challenges and describe basics of algorithms in various domains.
2. To provide and understanding the use of appropriate algorithmic design techniques for a given problem.
3. To design of algorithms using the dynamic programming; greedy method, Backtracking, Branch and Bound strategy, and recite algorithms that employ this strategy.
4. To discuss the various design approaches based on time and space efficiency.

Course Outcomes:

1. To determine various aspects of algorithm development of engineering challenge.
2. Determine the right combination of data structures that need to be used for solving the algorithm using a typical computer system.
3. Apply the algorithmic way of solutions development for typical challenges.
4. To design the pseudo code level of solution and optimum utilization of computing system.

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
B19EM 4020	CO1	4	2	3										3	2	3
	CO2	3	2	1										2	1	3
	CO3	4	1	2										3	2	3
	CO4	3	2	1										3	2	1

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Course Contents:

Unit-1: Introduction-Notion of an Algorithm and Brute Force Approach [11 Hrs]
Fundamentals of Algorithmic Problem Solving; Fundamentals of the Analysis of Algorithm Efficiency- The Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non-recursive Algorithms, Mathematical Analysis of Recursive Algorithms. Brute Force Approach: Selection sort, Bubble sort, Sequential search, and String Matching.

Unit-2: Divide-and-Conquer and Decrease-and-Conquer Approach [10 Hrs]
Divide and Conquer: Merge sort, Quicksort, Binary Search; Multiplication of Large Integers, Decrease-and-Conquer- Insertion Sort, Topological Sorting, Depth-First Search and Breadth-First Search.

Unit-3: Greedy Approach and Dynamic programming [11 Hrs]
Greedy Technique: Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman trees and codes. Dynamic Programming: Fibonacci numbers, Binomial coefficient, The Knapsack Problem and Memory Functions, Warshall's Algorithm, Floyd's Algorithm for the all-pairs shortest paths problem.

Unit-4: Space and Time Trade-Offs [10 Hrs]
Space and Time Trade-Offs: Sorting by Counting, Input Enhancement in String Matching, Coping with the Limitations of Algorithm Power. Backtracking: N-Queens Problem, Subset-Sum Problem, and Hamiltonian Circuit Problem. Branch-and-Bound: Assignment Problem, Knapsack Problem, Travelling Salesman Problem.

Text Books:

1. Anany Levitin, Introduction to the Design and Analysis of Algorithms, Pearson, 3rd Edition, 2012.
2. Ellis Horowitz, Satraj Sahni and Rajasekaran,Computer Algorithms/C++, Universities Press, 2nd Edition, 2014.
3. Kleinberg, Algorithm Design, Pearson Education, 1st Edition, 2013.
4. Michael Goodrich, Roberto Tamassia, Algorithm Design and Applications, Wiley Publishers, 1st Edition, 2014
5. Recommended Learning Resources (Reference books):
6. Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein, Introduction to Algorithms, PHI, 3rd Edition.
7. The design and analysis of computer algorithms, 4th Edition Addison-Wesley
8. ACM Transactions on Algorithms.
9. ACM Journal of Algorithms and Computational Technology.

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B19EM4030	Relational Data Base Management System (i)	L	T	P	C
Duration 14 weeks		2	0	1	3

Prerequisites:

This subject requires the student to know about Basics of computer and fundamental concepts of set theory.

Course Description:

Database Management Systems (DBMS) are vital components of modern information systems. ... In the first half of the course the relational data model, relational query languages, relational database design and conceptual data modeling are reviewed. It then focuses on XML, RD, OWL, parallel, and noSQL databases.

Course Objectives:

1. Memorize the basics terminologies of Databases, Conceptual design using ERD.
2. Demonstrate the relational database system using relational algebra.
3. Apply to create the Relation or a Table in a DATABASE using SQL.
4. Analyze the Database applications for real world problems by using different Normalization techniques.

Course Outcomes:

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

1. Define the basic terminologies of RDBMS.
2. Discuss the relational data model and relational algebra
3. Demonstrate the table or a relation in Database and ER Model.
4. Survey the different database applications for real word problems using normalization techniques.

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
B19EM4030	CO1	3	1	2										2	3	1
	CO2	3	2	1										3	2	1
	CO3	3	1	2										2	3	1
	CO4	3	1	2										1	2	3

Course Contents:

Unit-1: Introduction to Databases and Conceptual Modelling [11 Hrs]

Introduction, characteristics of the database approach, data models, schemas, instances, database languages and interfaces, Using high-level conceptual data models for database design, a sample database application, entity types, attributes, keys, relationship types, weak entity types, ER diagrams, naming conventions, design issues.

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Unit-2: Relational Data Model and Relational algebra [10 Hrs]

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

Unit-3: SQL [11 Hrs]

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

Unit-4: Database Design Theory and Normalization [10 Hrs]

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

Text Books:

1. Elmasri and Navathe, "Fundamentals of Database Systems", 5th Edition, Pearson Education, 2007.
2. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems", 3rd Edition, McGraw Hill, 2003

Reference Book:

1. Silberschatz, Korth and Sudharshan, "Database System Concepts", Fourth Edition, Mc-GrawHill, 2002

RDBMS: List of lab Experiments

1.Consider the following relations:
Student (snum: integer, sname: string, major: string, level: string, age: integer)
Class (name: string, meets at: string, room: string, d: integer)
Enrolled (snum: integer, cname: string)
Faculty (fid: integer, fname: string, deptid: integer)
The meaning of these relations is straightforward; for example, Enrolled has one record per student-class pair such that the student is enrolled in the class. Level is a two character code with 4 different values (example: Junior: JR etc)
Write the following queries in SQL. No duplicates should be printed in any of the answers.

i. Find the names of all Juniors (level = JR) who are enrolled in a class taught by Prof. ABC
ii. Find the names of all classes that either meet in room R217 or have five or more Students enrolled.
iii. Find the names of all students who are enrolled in two classes that meet at the same time.
iv. Find the names of faculty members who teach in every room in which some class is taught.
v. Find the names of faculty members for whom the combined enrolment of the courses that they teach is less than five.

2.The following relations keep track of airline flight information:
Flights (no: integer, from: string, to: string, distance: integer, Departs: time, arrives: time, price: real)
Aircraft (aid: integer, aname: string, cruisingrange: integer)

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Certified (eid: integer, aid: integer)
Employees (eid: integer, ename: string, salary: integer)
Note that the Employees relation describes pilots and other kinds of employees as well; Every pilot is certified for some aircraft, and only pilots are certified to fly.
Write each of the following queries in SQL.

i. Find the names of aircraft such that all pilots certified to operate them have salaries more than Rs.80, 000.
ii. For each pilot who is certified for more than three aircrafts, find the eid and the maximum cruising range of the aircraft for which she or he is certified.
iii. Find the names of pilots whose salary is less than the price of the cheapest route from Bengaluru to Frankfurt.
iv. For all aircraft with cruising range over 1000 Kms. Find the name of the aircraft and the average salary of all pilots certified for this aircraft.
v. Find the names of pilots certified for some Boeing aircraft.
vi. Find the aids of all aircraft that can be used on routes from Bengaluru to New Delhi.

3. Consider the following database of student enrollment in courses & books adopted for each course.
STUDENT (regno: string, name: string, major: string, bdate:date)
COURSE (course #:int, cname:string, dept:string) ENROLL (regno:string, course#:int, sem:int, Marks:int)
BOOK _ ADOPTION (course# :int, sem:int, book-ISBN:int)
TEXT (book-ISBN:int, book-title:string, publisher:string, author:string)

i. Create the above tables by properly specifying the primary keys and the foreign keys.
ii. Enter at least five tuples for each relation.
iii. Demonstrate how you add a new text book to the database and make this book be adopted by some department.
iv. Produce a list of text books (include Course #, Book-ISBN, Book-title) in the alphabetical order for courses offered by the 'CS' department that use more than two books.
v. List any department that has all its adopted books published by a specific publisher.
vi. Create suitable front end for querying and displaying the results.

4.The following tables are maintained by a book dealer.
AUTHOR (author-id:int, name:string, city:string, country:string)
PUBLISHER (publisher-id:int, name:string, city:string, country:string)
CATALOG (book-id:int, title:string, author-id:int, publisher-id:int, category-id:int, year:int, price:int)
CATEGORY (category-id:int, description:string)
ORDER-DETAILS (order-no:int, book-id:int, quantity:int)

i. Create the above tables by properly specifying the primary keys and the foreign keys.
ii. Enter at least five tuples for each relation.
iii. Give the details of the authors who have 2 or more books in the catalog and the price of the books is greater than the average price of the books in the catalog and the year of publication is after 2015.
iv. Find the author of the book which has maximum sales.
v. Demonstrate how you increase the price of books published by a specific publisher by 10%.
vi. Create suitable front end for querying and displaying the results.

5. Consider the following database for a banking enterprise:

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BRANCH(branch-name:string, branch-city:string, assets:real)
ACCOUNT(accno:int, branch-name:string, balance:real)
DEPOSITOR(customer-name:string, accno:int)
CUSTOMER(customer-name:string, customer-street:string, customer-city:string) LOAN(loan-number:int, branch-name:string, amount:real)
BORROWER(customer-name:string, loan-number:int)

i. Create the above tables by properly specifying the primary keys and the foreign keys
ii. Enter at least five tuples for each relation
iii. Find all the customers who have at least two accounts at the Main branch.
iv. Find all the customers who have an account at all the branches located in a specific city.
v. Demonstrate how you delete all account tuples at every branch located in a specific city.

B19EM4040	Microcontrollers and Applications	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Number system, combinational circuits, sequential circuits

Course Description:

This course introduces 8051 microcontroller to provide basic understanding of architecture, instruction set, assembly level programming, interfacing to various sensors, relays, motors, actuators through various types of serial and parallel communication. Timers and interrupt functions are illustrated through the selection and control activities using suitable programming platforms such as Assemblers, C compilers, Kiel, , etc. This fundamental knowledge on microcontrollers lead to explore large number of controller families like Raspberry Pi, ATMEGA, TI and PIC that are used in industrial and automation applications.

Course Objectives:

Course objectives are:
To explain the architecture of Microcontroller 8051.

1. To introduce Microcontroller 8051 Architecture and insight into instruction set of microcontrollers 8051.
2. To introduce assembly and C programming for 8051.
3. To provide insight into timer, serial communication, and interrupts modules of 8051.
4. To interface a microcontroller with peripheral devices.

Course Outcomes:

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

1. Describe the Architecture of 8051 microcontroller.
2. Describe Instruction Set of 8051
3. Calculate Program Execution Time and Write Assembly and C Programs for 8051.
4. Interface various peripherals.

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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
B19EM4040	CO1	3	2	1	1	3									2	1
	CO2				1	3									2	1
	CO3										2	1	2			

Course Contents:

Unit -1: 8051 Architecture, Addressing Modes **[10 Hrs]**

Introduction to Microprocessors and Microcontrollers, RISC & CISC CPU Architectures, Harvard & Von Neumann CPU architecture. The 8051 Architecture, Memory organization, Addressing Modes, Data transfer Instructions, Stack, Assembly language programs.

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Unit -2: Instruction Set, Interrupts **[11 Hrs]**

Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instruction. Assembler Directives. Instruction delay calculations.

Basics of interrupts, 8051 interrupt structure. Assembly and C programs.

Unit -3: Introduction to Timers/counters and Serial Communication. **[11 Hrs]**

Introduction to Timers and Counters, Timer delay calculations,

Serial Communication: Data communication, connections to RS-232, UART. Timers/counters, Interrupts and Serial communication programming in Assembly and C.

Unit -4: Interfacing and Applications **[10 Hrs]**

8051 Memory Interfacing, Interfacing 8051 to LCD, parallel and serial ADC0804, DAC, Stepper motor and DC Motor, Interfacing Programming in C.

Introduction to Arduino and Raspberry Pi : Architecture and programming.

Text books:

1. Kenneth J. Ayala, "The 8051 microcontroller architecture, programming and applications" Thomson publication, 3rd edition, 2007
2. Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D, McKinlay "The 8051 Microcontroller and Embedded Systems using assembly and C" PHI, 2006/Pearson 2006.
3. Jermy Blum "Exploring Arduino: Tools and Techniques for Engineering" Wizardry 1st Edition, Kindle Edition

Reference Books:

1. V. Udayashankar and Malikarjunswamy, "The 8051 Microcontroller", TMH, 2009.
2. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2005.

Ref: RU/BoS/ECE/CEC/May-2021-9

B19EM4050	Computer Organization and Architecture	L	T	P	C
Duration :14 Wks		3	1	0	4

Prerequisites:

Basic electronics, Numbering system, Digital fundamentals.

Course Description:

The course covers the basic principles of computer organization, operation and performance and peripheral devices. It provides an overview of computer hardware and software and how the basic functional units are interconnected to form a complete computer system. The basics of I/O data transfer synchronization, interrupts and Direct Memory Access methods are presented. Bus protocols and standards are also presented with PCI, SCSI, and USB standards being used as representative commercial examples. Detailed coverage of the use of pipelining and multiple function units in the design of high-performance processors.

Course Objectives:

Course objectives are to:

1. Illustrate the fundamental concepts of computer system architecture.
2. Interpret significance of interrupts.
3. Differentiate the various ways of communicating with I/O devices and standard I/O interfaces.
4. Examine the different hierarchical memory system including cache memories and virtual memory.

Course Outcomes:

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

1. Summarize the computer system organization and its operations
2. Appraise the concepts of hardware interface.
3. Interpret the various bus operations and protocols
4. Distinguish the different types of memories and their performance.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 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
B19EM4050	CO 1	1						3					3	3		
	CO 2	1	2					3		1			3	3		
	CO 3	1	2	2			1	3		1			3	3	2	

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	CO 4	1	2	3			1	3					3			

Course Contents:

Unit-1: Basic Structure of Computers: [11Hrs]

Computer types, Functional units, Basic operational concepts, Bus structures, Performance-processor clock, Basic performance equation, clock rate, performance measurement.

Machine Instructions and Programs: Numbers, arithmetic operations and characters, Memory location and Addresses, Memory operations, Instructions and instruction sequencing, Addressing modes, Assembly language, Stack and Queues and Subroutines.

Unit-2: Basic Input/Output and Processing Unit [10Hrs]

Accessing I/O Devices; Interrupts; enabling and disabling interrupts, Handling multiple devices, Device requests, Exceptions.

Basic processing unit: Instruction Execution, Load Instructions, Arithmetic and Logic Instructions, Store Instructions, Hardware Components, Register File, ALU, Datapath.

Unit-3: Input/output Organization [10Hrs]

Direct Memory Access, Bus Operation: Synchronous Bus, Asynchronous Bus, Arbitration, Interface Circuits, Parallel Interface, Serial Interface, Interconnection Standards: Universal Serial Bus (USB), PCI Bus, SCSI Bus, UART.

Unit-4: Memory system [11Hrs]

Basic Concepts, Semiconductor RAM Memories, Static Memories, Dynamic RAMs, Synchronous DRAMs, Read-only Memories, ROM, PROM, EPROM, EEPROM, Flash Memory, Memory Hierarchy, Cache Memories, Performance Considerations, Virtual Memory.

Text Book:

1. Carl Hamacher, Z Varnesic and S Zaky, “Computer Organization”, McGraw Hill, Fifth Edition, 2002.

Reference Books:

1. David A. Patterson and John L. Hennessey, “Computer Organization and Design“, Morgan Kauffman, Elsevier, Fifth Edition, 2014.
2. William Stallings “Computer Organization and Architecture”, Pearson Education, Seventh Edition, 2006.
3. Govindarajalu, “Computer Architecture and Organization, Design Principles and Applications”, Tata Mc Graw Hill, First Edition, New Delhi, 2005.
4. Morris Mano and Charles R Kime, “Logic and Computer Design Fundamentals”, Pearson Education Asia, Second Edition, 2004.

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B19EM4070	Microcontrollers and Applications Lab	L	T	P	C
Duration :14 Wks		0	0	2	2

Prerequisites:

Number system, combinational circuits, sequential circuits, theory concepts of microcontroller

Course Description:

This course introduces 8051 microcontroller to provide basic understanding of architecture, instruction set, assembly level programming, interfacing to various sensors, relays, motors, actuators through various types of serial and parallel communication. Timers and interrupt functions are illustrated through the selection and control activities using suitable programming platforms such as Assemblers, C compilers, Kiel, , etc. This fundamental knowledge on microcontrollers lead to explore large number of controller families like Raspberry Pi, ATMEGA, TI and PIC that are used in industrial and automation applications.

Course Objectives:

Course objectives are:

1. To explain the architecture of Microcontroller 8051.
2. To demonstrate programing microcontroller 8051 and Raspberry Pi on a simulator.
3. To apply the knowledge of microcontroller 8051 and Raspberry Pi to design an embedded systems using various interfaces.
4. To summarize the embedded system design with the specified constraints using microcontroller 8051 and Raspberry Pi.

Course Outcomes:

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

1. Analyze a given problem and design a suitable embedded system using microcontroller 8051 or Raspberry Pi.
2. Apply the knowledge of programming in assembly language and C language to receive data, process it and control the various actuators.
3. Summarize the embedded system design and operations using microcontroller 8051 or Raspberry Pi.

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	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19EM4070	CO1	3	2	1	1	3									2	1
	CO2				1	3									2	1
	CO3										2	1	2			

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Lab Experiments

Section-A (Assembly Language Programming)

1. Data Transfer Instructions: Block Data Transfer and Exchange between internal and external Data memory with and without overlap, Sorting, largest and smallest number in an array.
2. Arithmetic Instructions: 32-bit multi-precision Addition, Subtraction, Multiplication of 2 16-bit numbers and Division (16-bit by 8 bit).
3. Logical Instructions: 8x8 multiplication using shift Add technique. ASCII to packed BCD and Vice versa, Code Conversions. Exchange Two numbers without the use of 3rd location. Implementation of Boolean expressions (Bit Manipulation).
4. Timers: Wave form generation with varying Duty Cycle using Interrupt and Polling Techniques.
5. Serial Communication: Serial data transmission with Polling and Interrupt technique (Regular and Look up table).

Section-B (Embedded C Programming)

1. Display the ASCII value of Key pressed on LCD.
2. Count the incoming pulses using counters.
3. DC Motor speed control using external interrupt.
4. Stepper motor interfacing by controlling the steps and direction.
5. Interfacing DAC to generate various waveforms with output voltage varying between -12V to 12V with Amplitude and Frequency control.
6. Case Studies on RaspberryPi Microcontrollers

Course Code	Design and Analysis of Algorithms Laboratory	L	T	P	C
B19EM4080		0	0	2	2

Prerequisites:

Programming for Problem Solving, Design of Algorithms

Course Description:

Design, develop, and implement the specified algorithms for the following problems using any language under LINUX /Windows environment. Any tool can be used for development and demonstration. Installation procedure of the required software must be demonstrated, carried out in groups and documented in the journal.

Course Objectives:

1. Design and implement various algorithms using any programming language.
2. Employ various design strategies for problem solving.
3. Measure and compare the performance of different algorithms and analyze the performance using best/average/ worst case analysis.

Course Outcomes:

The students should be able to:

1. Design algorithms using appropriate design techniques such as brute-force, divide and conquer Greedy, dynamic programming.
2. Develop variety of algorithms such as sorting, graph related in a high level language.
3. Analyze and compare the performance of algorithms using language features.

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4. Apply and implement learned algorithm design techniques and data structures to solve real-world problems.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS / COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19EM 4080	CO1	4	3	2										3	2	3
	CO2	3	2	1										2	1	3
	CO3	4	1	2										2	1	3
	CO4	3	2	1										3	2	1

List of Lab Experiments:

1. Search for a given pattern in a text string using Brute Force String Matching.
2. Sort a set of elements in ascending order using Insertion Sort algorithm.
3. Sort a set of elements in ascending order using Quick Sort algorithm.
4. Sort a set of elements in ascending order using Merge Sort algorithm.
5. Obtain the DFS and BFS ordering of vertices in a given digraph.
6. Find Minimum Cost Spanning Tree of a given undirected graph using Prim's algorithm.
7. Find MST of a given undirected graph using Kruskal's algorithm.
8. From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.
9. Design and Implement 0/1 Knapsack problem using Dynamic Programming.
10. Implement All-Pairs Shortest Paths Problem using Floyd's algorithm.
11. Design and implement to find a subset of a given set S = {Sl, S2,.....,Sn} of n positive integers whose SUM is equal to a given positive integer d. For example, if S ={1, 2, 5, 6, 8} and d= 9, there are two solutions {1,2,6}and {1,8}. Display a suitable message, if the given problem instance doesn't have a solution.
12. Sort a given set of elements in ascending order which has duplicate entries. Use the sorting by counting algorithm.

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Semester- V

B19EM5010	Embedded Systems	L	T	P	C
Duration : Wks		3	0	0	3

Prerequisites::

Basic Electronics, Analog Electronics, C/C++ Programming, Microcontrollers

Course Description:

Embedded systems have become the next inevitable wave of technology, finding application in diverse fields of engineering. Microprocessors, together with sensors and actuators, have become embeddable in almost everything. The purpose of the course is to provide the students with the basic information about embedded systems which can be defined as a control system or computer system designed to perform a specific task.

Course Objectives:

The objectives of this course are:

1. Demonstrate the optimal composition and characteristics of an embedded system.
2. Explain A/D conversion process.
3. Demonstrate the protocols and software tools employed in embedded system design.
4. Discuss Hardware/Software co-design techniques for microcontroller-based embedded systems.

Course Outcomes:

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

1. Outline the optimal composition and characteristics of an embedded system.
2. Develop an application using A/D conversion process.
3. Summarize the protocols and software tools employed in embedded system design.
4. Make use of Hardware/Software co-design techniques for microcontroller-based embedded systems.

Mapping of Course Outcomes with Program Outcomes

Cours Code:	POS/ COs	PO 1	P O 2	PO 3	PO 4	P O5	PO 6	P 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
B19EM5010	CO1	3	3	2										3	2	3
	CO2	3	2	2										2	1	3
	CO3	3	2	2										2	1	3
	CO4	3	2	2										3	2	1

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Course Contents:

Unit1: Introduction to Embedded Systems: What is an Embedded System? Embedded vs General computing system, classification, application, and purpose of ES. Typical Embedded Systems: Core of an Embedded System, Memory, Sensors, Actuators, LED, Opto-Coupler, Communication Interface, Reset circuits, RTC, WDT, Application and Domain Specific ES examples.

Unit2: Characteristics, Attributes, Hardware Software Co-Design and Program Modelling:
Characteristics and Quality Attributes of Embedded Systems. Hardware Software Co-Design Introduction, Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to UML, Hardware Software Tradeoffs.

Unit3: Real Time Basics and Real Time Operating System:
Realt time systems definition and Types of the Real Time Systems, Operating Systems Basics: The Kernel, Monolithic Kernel and Microkernel, Types of Operating Systems, General Purpose OS, Real-Time OS: The Real-Time Kernel, Hard Real-Time, Soft Real-Time.
Tasks, Process and Threads: Process, Structure of Process, Process State and State Transitions, Process Management,
Threads: Concept, Concept of Multithreading, Thread Standards: POSIX threads, Win32 Threads, Java Threads, Thread Pre-Emption, Types of Threads, Thread Binding, Thread vs Process.

Unit4: Real Time Operating System Concepts:
Multiprocessing and Multitasking: Types of Multitasking.
Task Scheduling: Concepts, Non-Preemptive Scheduling: FCFS/FIFO Scheduling, LCFS/LIFO Scheduling, Shortest Job First Scheduling, Priority Based Scheduling.
Preemptive Scheduling: Shortest Remaining Time Scheduling, Round Robin Scheduling, Priority based Preemptive scheduling.
Putting them altogether, Task Communication, Task Synchronization, Device Drivers, How to Choose an RTOS(Self Study/Case Study).

TEXTBOOKS:

1. Shibu K V, "**Introduction to Embedded Systems**", Tata McGraw Hill Education Private Limited, 2009.
2. Lyla B. Das, Embedded System: An Integrated Approach, Pearson, 2013

REFERENCE BOOK:

1. Frank Vahid, Tony D. Givargis, Embedded System Design – A Unified Hardware/Software Introduction, John Wiley, 2002.
2. Jonathan W. Valvano, Embedded Microcomputer Systems, 3rd. edition, Cengage Learning, 2011.
3. David E. Simon, An Embedded Software Primer, Pearson Ed., 2005.
4. Raj Kamal, Introduction to Embedded Systems, TMH, 2002.
5. KVKK Prasad, Embedded / Real Time Systems, Dreamtech Press, 2005.
6. Peter M, Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, and Internet of Things, Springer, 3rd Edition, 2018
7. James K Peckol, "**Embedded Systems**", A contemporary Design Tool - John Weily, 2008

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B19EM5020	Unix Shell Programming	L	T	P	C
Duration :14 Weeks		3	0	1	4

Prerequisites:

Basic computer skills

Course Description:

The course is aims to present the UNIX environment and to provide the most basic commands to students with UNIX knowledge. The course covers UNIX system and use different commands, UNIX directories and files, File attributes and permissions, changing file permissions. Course also provides basic knowledge about Vi editor-Input mode commands. Command mode commands, the ex-mode commands, Use of editors and regular expressions, Filters, File links – hard and soft links, the shells interpretive cycle and illustrating the mechanism of process creation. After studying this course, students will be able to Explain UNIX system and use different commands, Compile certain functions on different subsystems and demonstrate use of editors and its usage in UNIX environment.

Course Objectives:

This course will enable the students to:

1. Illustrate the UNIX system architecture and use of basic Commands.
2. Use of editors and networking commands.
3. Demonstrate writing shell scripts.
4. Categorize, compare and make use of UNIX system calls

Course Outcomes:

After studying this course, students will be able to:

1. Explain UNIX system and use different commands.
2. Write Shell scripts for certain functions on different subsystems.
3. Demonstrate use of editors and shell script writing
4. Compare and use unix system calls

Mapping of Course Outcomes with Program Outcomes

Cours Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
B19EM5020	CO1	3	3	2										3	2	3
	CO2	3	2	2										2	1	3
	CO3	3	2	2										2	1	3
	CO4	3	2	2										3	2	1

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Course Contents:

Unit-1: Introduction, UNIX Architecture [11 Hrs]

Introduction, Brief history. Unix Components/Architecture. Features of Unix. The UNIX Environment and UNIX Structure, Posix and Single Unix specification. The login prompt. General features of Unix commands/ command structure. Command arguments and options. Understanding of some basic commands such as echo, printf, ls, who, date, passwd, cal, combining commands. Meaning of Internal and external commands. The type command: knowing the type of a command and locating it. Man command.

Unit-2: Unix files [10 Hrs]

Unix files. Naming files. Basic file types/categories. Organization of files. Hidden files. Standard directories. Parent child relationship. The home directory and the HOME variable. Reaching required files- the PATH variable, manipulating the PATH, Relative and absolute pathnames. Directory commands – pwd, cd, mkdir, rmdir commands. The dot (.) and double dots (..) notations to represent present and parent directories and their usage in relative path names. File related commands – cat, mv, rm, cp, wc and od commands. File attributes and permissions and knowing them. The ls command with options. Changing file permissions: the relative and absolute permissions changing methods. Recursively changing file permissions. Directory permissions.

Unit-3: The vi editor [11 Hrs]

The vi editor. Basics. The .exrc file. Different ways of invoking and quitting vi. Different modes of vi. Input mode commands. Command mode commands. The ex mode commands. Illustrative examples Navigation commands. Repeat command. Pattern searching. The search and replace command. The set, map and abbr commands. Simple examples using these commands.

Unit-4: Shell programming [10 Hrs]

Shell programming. Ordinary and environment variables. The .profile. Read and read only commands. Command line arguments. exit and exit status of a command. Logical operators for conditional execution. The test command and its shortcut. The if, while, for and case control statements. The set and shift commands and handling positional parameters. The here (<<) document and trap command. Simple shell program examples. File inodes and the inode structure. File links – hard and soft links. Filters. Head and tail commands. Cut and paste commands. The sort command and its usage with different options.

Text Books:

1. Sumitabha Das., Unix Concepts and Applications., 4th Edition., Tata McGraw Hill
2. Behrouz A. Forouzan, Richard F. Gilberg: UNIX and Shell Programming- Cengage Learning – India Edition. 2009.

Reference Books:

1. M.G. Venkatesh Murthy: UNIX & Shell Programming, Pearson Education.
2. Richard Blum, Christine Bresnahan : Linux Command Line and Shell Scripting Bible, 2nd Edition , Wiley,2014.

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PRACTICE SESSION:

Sl. No.	**Name of the Practice Session**	**Tools and Techniques**	**Expected Skill/Ability**
1	Getting Familiar with Linux	UNIX OS/ Any Flavor of Linux	C Programming
2	Practice session on basic Unix Utilities, Practice Session on File related Utilities	UNIX OS/ Any Flavor of Linux	C Programming
3	Execution of various file/directory handling commands.	UNIX OS/ Any Flavor of Linux	C Programming
4	Execution of various Vi Mode editor input, command, and ex mode commands.	UNIX OS/ Any Flavor of Linux	C Programming
5	Simple shell script for basic arithmetic and logical calculations.	UNIX OS/Any Flavor of Linux	C Programming
6	a). Shell script that displays list of all the files in the current directory to which the user has read, write, and execute permissions. b). Write a shell script to print the first n Fibonacci numbers.	UNIX OS/ Any Flavor of Linux	C Programming
7	a). Shell script to list all the directory files in a directory. b). Shell script to find factorial of a given integer.	UNIX OS/ Any Flavor of Linux	C Programming
8	a). Shell script that receives any number of file names as arguments checks if every argument supplied is a file or a directory and reports accordingly. Whenever the argument is a file, the number of lines on it is also reported. b). Shell script to determine whether a given number is a prime number or not.	UNIX OS/ Any Flavor of Linux	C Programming
9	a). C program to emulate the Unix ls -l command. b). C program to list for every file in a directory, its inode number and file name.	UNIX OS/ Any Flavor of Linux	C Programming
10	a). C program that demonstrates redirection of standard output. b). C program to count the number of words, lines and characters of a given text file.	UNIX OS/ Any Flavor of Linux	C Programming

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B19EM5030	Machine Learning	L	T	P	C
Duration:14 Weeks		3	0	0	3

Prerequisites:

Data Structure, Algorithms and Mathematics

Course Description:

The course provides students with some knowledge on the basic principles of machine learning which is the study of computer algorithms that can improve automatically through experience and using data. It is seen as a part of artificial intelligence. Machine learning algorithms build a model based on sample data, known as "training data", to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of applications, such as in medicine, email filtering, speech recognition, and computer vision, where it is difficult or unfeasible to develop conventional algorithms to perform the needed tasks.

Course Objectives:

This course will enable the students to:

1. Discuss the basic theory underlying machine learning.
2. Explain machine learning algorithms to solve problems of moderate complexity for data analysis.
3. Illustrate the concept of Genetic Programming and Artificial Neural Network.
4. Discuss the implementation of Machine learning algorithms and modules.

Course Outcomes:

After studying this course, students will be able to:

CO1: Explain the basics of machine learning concepts.
CO2: Understand machine learning algorithms for intelligent applications.
CO3: Apprehend how to perform evaluation of learning algorithms and model selection.
CO4: Implement machine learning applications.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 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
B19EM5030	CO1	3	3	2									1	3	2	
	CO2	3	3	3	2								1	3	2	
	CO3	3	3	2	2								1	3	2	
	CO4	3	3	3	2								1	2	2	

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Course Contents:

UNIT-1:
Introduction: Well-Posed Learning Problems, designing a Learning System, Perspectives and Issues tin Machine Learning Examples of Machine Learning Applications, Learning Associations, Classification, Regression, Unsupervised Learning, and Reinforcement Learning. Supervised Learning. Concept Learning and the General-to-Specific Ordering: A Concept Learning Task, Concept Learning as Search, FIND-S.

UNIT-2:
Dimensionality Reduction: Subset Selection, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis. Classification.

UNIT-3:
Clustering: Introduction, kmeans, nearest neighbor, expectation maximization algorithm, Supervised learning after clustering, hierarchical clustering, choosing the number of clusters. Decision Tree Learning.

UNIT-4:
Artificial Neural Networks: Introduction, Perceptrons, Multilayer Networks and the Back propagation Algorithm.
Reinforcement Learning: Introduction, Learning task, Q-learning.
Design and Analysis of Machine Learning Algorithms and experiments using WEKA//Rapid Miner Tool

Text books:

1. Tom Mitchell: Introduction to Machine Learning , McGraw Hill 2013

Reference Books:

1. l. EthemAlpaydin: Introduction to Machine Learning, Second edition MIT press, 20l0. Chapters l, 2, 6, 7, l9.
2. YoshuaBengio and Aaron Courville,Deep Learning -Ian Good fellow, , MIT Press book,20l6
3. Richard o. Duda, Peter E. Hart and David G. Stork, pattern classification, John Wiley & Sons Inc., 200l
4. Chris Bishop, Neural Networks for Pattern Recognition, Oxford University Press, l995

B19EM5040	Entrepreneurship & Innovator Skills	L	T	P	C
Duration :14Wks		2	0	0	2

Prerequisites:

No Pre-requisite required

Course Description:

Management and Entrepreneurship will teach you how to start your own business, grow a family business or innovate inside an existing organization. Studying this entrepreneurship will not only provide you with the management skills and entrepreneurial qualities, it will also offer you networking opportunities to enable you to start and run businesses effectively and imaginatively.

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Course Objectives:

The objectives of this course are:

1. To provides a platform to sensitize the hidden entrepreneurial traits of management students.
2. To also expose students to the Entrepreneurial and project management concepts and processes used in practice.

Course Outcomes:

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

1. Explain the fundamental concepts and process of managing an Entrepreneurial project.
2. Demonstrate the skill of managing an Entrepreneurial project.
3. Identify & manage an Entrepreneurial project in practice.
4. Identify and manage project processes

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 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
B19EM5040	CO 1	3	3	2					2			2	1	3	2	
	CO 2	3	3	3					2			2	1	3	2	
	CO 3	3	3	2					2			2	1	3	2	
	CO 4	3	3	3					2			2	1	2	2	

Course Contents:

Unit-1: Entrepreneurship **[11 Hrs]**

Meaning, Evolution and Development; Functions of an Entrepreneur; Types of entrepreneur; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneur – an emerging class. Family Business History: Types and Importance of family business; Succession in family business; Pitfalls of the family business; Improving family business performance.

Unit-2: Creativity and Innovation **[10 Hrs]**

Sources of New Ideas, Ideas into Opportunities; Creative problem solving: Heuristics, Brainstorming, Synaptic; Sources and Transfer of Innovation. International Entrepreneurship The nature, Importance & Opportunities; International versus domestic entrepreneurship; Entrepreneurship entry into international business, exporting, direct foreign investment, barriers to international trade. Managing growth and diversification: strategies; franchising, joint ventures, Acquisitions and mergers.

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Unit-3: Institutions Supporting Entrepreneurs **[11 Hrs]**

A brief overview of financial institutions in India Central level and state level institutions; SIDBI, NABARD, IDBI, SIDO, Indian Institute of Entrepreneurship, DIC, Single window system; Latest Industrial policy of Government of India; FMME; Guidelines for starting new SMEs. Sources and ways of raising capital; Informal risk capital and venture capital; Business Planning Meaning and Business planning process.

Unit-4: Project Management **[10 Hrs]**

Definition and Process; Project Management hierarchy programs, projects, processes, activities, tasks; Conceptual idea of the triple constraint: Time, cost, scope; Planning & scheduling Tools Brainstorming, Fishbone diagrams, Bar charts, Gantt Charts, WBS, Network diagrams CPM and PERT – Concept and applications; Accelerating projects "crashing".

Text books:

1. Hisrich, Robert D. Peters, Michael P. Shepherd, Dean A , "Entrepreneurship", Tata McGraw Hill, 9th Edition, 2014.
2. Vasant Desai, "The Dynamics of Entrepreneurial Development and Management",Himalaya Publishing House, 5th Edition, 2014.
3. Clements, James P. Gido, Jack., "Effective Project Management", Cengage Learning, New Delhi, 2006.
4. Mantel, Samuel J. Meledith, Jack R. Shafer, Scott M , "Project Management : Core Text Book", John Wiley & Sons, New Delhi, 8th Edition, 2012.

Code: B19EM5080	Embedded System Lab	L	T	P	C
Duration :14 Wks		0	0	2	2

Prerequisites:

Programming for Problem Solving, Design of Algorithms, C Programming

Course Description:

Design, develop, and implement the specified algorithms for the following problems using any language under LINUX /Windows environment. Any tool can be used for development and demonstration. Installation procedure of the required software must be demonstrated, carried out in groups, and documented in the journal.

Course Objectives:

1. Demonstrate the optimal composition and characteristics of an embedded system.
2. To understand and implement the concepts of Embedded System.
3. Discuss Hardware/Software co-design techniques for microcontroller-based embedded systems.

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

1. Outline the optimal composition and characteristics of an embedded system.
2. Develop an application using A/D conversion process.
3. Summarize the protocols and software tools employed in embedded system design.
4. Make use of Hardware/Software co-design techniques for microcontroller-based embedded systems.

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	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19EM5080	CO1	3	3	2										3	2	3
	CO2	3	2	1										2	1	3
	CO3	3	1	2										2	1	3
	CO4	3	2	1										3	2	1

List of Lab Experiments:

1. Write a program for singly Thread Creation and Termination using POSIX threads.
2. a) Write a program for creating independent threads each of which will execute some random function and use concept of Mutual Exclusion (Task Synchronization).
   b) Write a program to create N number of threads and to count how many threads are being executed. Use concept of Mutual Exclusion.
3. Write a program to create independent threads each of which will execute some function and wait till threads are complete before main continues. Unless we wait run the risk of executing an exit which will terminate the process and all threads before the threads have completed.
4. Write a program to create the N number of threads and find the how many threads are executed. Use concept of Mutual Execution.
5. Write a program to create two threads T1 and T2. Thread T1 should count numbers between 1-3 and 8-10 by calling the function FunctionCount1 and thread T2 should count numbers between 4-7 by calling the function FunctionCount2. Program should print the final count value.
6. Design and execute a program using POSIX thread library to create the number of threads specified by the user, each thread independently generates a random integer as an upper limit and then computes and prints the number of primes less than or equal to that upper limit, along with the upper limit.
7. Write a program to implement a process with a producer thread and a consumer thread which make use of a bounded buffer (Size can be prefixed at suitable value) for communication. Use any suitable synchronization construct.
8. Write a program to implement the usage of an Anonymous Pipe with size of 512bytes for data sharing between parent and child process using Inheritance Handling mechanism.

Reference Books:

1. Jonathan W. Valvano, “Embedded Microcomputer Systems: Real Time Interfacing” Thomson
2. David E Simon, “An Embedded Software Primer”

Ref: RU/BoS/ECE/CEC/May-2021-9

Code: B19EM5090	Machine Learning Lab	L	T	P	C
Duration :14 Wks		0	0	2	2

Prerequisites:

Programming for Problem Solving, Design of Algorithms

Course Description:

Design, develop, and implement the specified algorithms for the following problems using any language under LINUX /Windows environment. Any tool can be used for development and demonstration. Installation procedure of the required software must be demonstrated, carried out in groups, and documented in the journal.

Course Objectives:

1. Demonstrate the basic theory underlying machine learning.
2. Illustrate machine learning algorithms to solve problems of moderate complexity for data analysis.
3. Illustrate the concept of Genetic Programming and Artificial Neural Network.
4. Discuss the implementation of Machine learning algorithms and modules.

Course Outcomes:

The students should be able to:

1. Perform coding of machine learning concepts.
2. Implement machine learning algorithms for intelligent applications.
3. analyze how to perform evaluation of learning algorithms and model selection.
4. Implement machine learning applications.

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
B19EM 5090	CO1	3	3	2		1								3	2	3
	CO2	3	2	1		1								2	1	3
	CO3	3	1	2		1								2	1	3
	CO4	3	2	1		1								3	2	1

List of Lab Experiments:

1. Introduction to WEKA, installation of WEKA Tool and demonstration.
2. Perform data preprocessing.
3. Perform classification to the dataset.
4. Perform Clustering using k-means for the contact lens dataset.
5. Perform Logic Regression for Iris data set.
6. To Visualize the results using the Tool.
7. To Analyze the results using the Tool.
8. Apply ID3 decision tree algorithm to House database.
9. Apply CART decision tree algorithm To IRIS database.

Ref: RU/BoS/ECE/CEC/May-2021-9

Semester- VI

B19EM6010	Web Technologies	L	T	P	C
Duration :16 Wks		3	0	0	3

Prerequisites:

Basic programming knowledge, Object oriented concepts

Course Description:

This course introduces students to basic web design using HTML,CSS,JavaScript and PHP. Throughout the course students are introduced to planning and designing effective web pages. Implementing web pages by writing HTML and CSS code, enhancing web pages with the use of page layout techniques, text formatting, tables, images, and multimedia; and producing a functional, multi-page website. Validating the user data using Client side scripting language JavaScript and PHP is used to process the forms. Upon successful completion of this course, students will have a good foundation in web design and data validation using HTML,CSS, JavaScript and PHP and students will be prepared to study more advanced web design topics.

Course Objectives:

1. To Illustrate the Semantic Structure of HTML and CSS.
2. To Compose forms and tables using HTML and CSS.
3. To Design Client-Side programs using JavaScript.
4. To impart skills required to develop web applications and services.
5. To provide students with conceptual and practical knowledge of web applications.

Course Outcomes:

Impletion of this course, the student will be able to:

1. Adapt XHTML and CSS syntax and semantics to build web pages.
2. Identify tools and technologies for Web applications.
3. Develop Client-Side Scripts using JavaScript and Server-Side Scripts using PHP to Generate and display the contents dynamically.
4. Describe and transform data using XHTML and its related technologies.

Mapping of Course Outcomes with Program Outcomes

Ref: RU/BoS/ECE/CEC/May-2021-9

Course Code	POS/ COs	PO 1	P 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
B19EM6010	CO 1	3	3	2		2							1	3	2	
	CO 2	3	3	3		2							1	3	2	
	CO 3	3	3	2		2							1	3	2	
	CO 4	3	3	3		2							1	2	2	

Course Contents:

Unit-1

Fundaments of Computers and Internet **[11 Hrs]**

Introduction to Computers and Internet, World Wide Web, Web Browsers, Web Servers, Uniform Resource Locators, MIME, Hypertext Transfer Protocol.

Introduction to XHTML-1: Standard XHTML document structure, Basic Text Markup, Images, Hypertext Links, Creation of Lists in XHTML, Creation of Forms.

Unit- 2 **[10 Hrs]**

XHTML-2: Creation of Tables and Frames in XHTML, Syntactic differences between HTML and XHTML.

Cascading Style Sheets: Introduction, Levels of Style sheets, Style specification formats, Selector forms, Property value forms, Font properties, List properties, Color, The Box Model, Background Images, The and tags.

Unit-3 **[11 Hrs]**

The Basics of JavaScript: Overview of JavaScript, Object Orientation and JavaScript, General Syntactic characteristics, Screen output and keyboard input, Control statements, Functions, Arrays in JavaScript, Constructors, Pattern Matching using Regular Expressions, Events and Event handling.

Unit-4 **[10 Hrs]**

PHP: Introduction, PHP Basics, General Syntactic characteristics, Control statements, Arrays, Functions, Pattern Matching, Files, Cookies, Session Tracking, Database Access with PHP and MySQL.

List of Experiments:

1. Create a XHTML form which includes Name, Address and Comment, Hyperlinks, Images Lists.
2. Validate the user input using JavaScript. (Ex: Validating the student SRN).
3. Create a XHTML form with SRN, Name, and Address fields and it also includes tables and Forms. On submitting the form, it should store the values in MySQL table.

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4. PHP code to store current date-time in a COOKIE and display the 'Last visited on' date-time on the web page.
5. PHP code to store page views count in SESSION and to show the count on web page.

Text Books:

1. Robert W. Sebesta, "Programming the World Wide Web", 7th Edition. Addison-Wesley, 2012.
2. Kogent Learning Solutions Inc., "Web Technologies HTML, CSS, JavaScript, ASP.NET, Servlets, JSP, PHP, ADO.NET, JDBC and XML Black Book", Dream tech Press, ISBN-13: 978-9351192510, Paperback – 19 Dec 2013

B19EM6020	CMOS Circuits	L	T	P	C
Duration :16 Wks		3	0	0	3

Prerequisites:

Semiconductor Physics and devices, BJTs and FETs, Digital Electronics.

Course Description:

The course introduces basic theories and techniques of digital VLSI design using CMOS and its variants. The student will understand how the digital circuits can be integrated into the semiconductor chip (ICs). The students will develop the skills required to become VLSI designers, researchers and design tool builders. The course is conceptual, problematic and application oriented

Course Objectives:

The objectives of this course are:

1 Understand the characteristics of CMOS circuits
2 Provide knowledge to design integrated circuits using Computer Aided Design (CAD) Tools.
3 Describe the general steps required for processing of ICs
4 Design of digital sub blocks of integrated circucits
5 Introduce the concepts and techniques of modern integrated circuit design and testing

Course Outcomes:

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

1. Illustrate the engineering behind the design and analysis of integrated circuits with fabrication technology details.
2. Sketch the physical design/layouts in CMOS and nMOS technology
3. Contrast different flavors of CMOS technology.
4. Express the basic storage concept ,memory circuits and VLSI testing concepts

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Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 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
B19EM6020	CO 1	3	3	2		2							1	3	2	
	CO 2	3	3	3		2							1	3	2	
	CO 3	3	3	2		2							1	3	2	
	CO 4	3	3	3		2							1	2	2	

Course Contents:

Unit 1: Basic MOS Technology **[11 Hrs]**

Integrated circuits era. Moore's law and its implications. Classification of MOS transistors, Enhancement mode transistor action, depletion mode transistor action, NMOS IC fabrication. CMOS, N-well, P-well and Twin tub process details. Introduction to BiCMOS technology.

MOS Transistor Theory: Introduction, MOS Device Design Equations, second order effects, The Complementary CMOS Inverter – DC Voltage Transfer Characteristics, Noise margin. Static Load MOS Inverters. Pass transistors transmission Gate, problems on pass transistors and TGs, CMOS Tristate Inverter.

Unit 2: Circuit Design Process **[10 Hrs]**

Stick Diagrams and Layout of Digital Circuits Stick diagram concept, examples for standard gates. Design Rules, Basic Physical Design/Layout of logic gates and logic functions.

Unit 3: CMOS Logic Structure **[11 Hrs]**

Basic Circuit Concepts: MOS layers. Sheet resistance, Area capacitances, Capacitance calculation, Delay UNIT, Inverter delays, Problem of driving large capacitive loads.

CMOS Logic Structures CMOS Logic, Bi CMOS Logic, Pseudo-NMOS Logic, Dynamic CMOS Logic, Clocked CMOS Logic, Pass Transistor Logic, CMOS Domino Logic and Cascaded Voltage Switch Logic (CVSL)

Unit 4: Memories and Testing **[10 Hrs]**

Memory: Timing considerations, Memory elements, Memory cell arrays.

Testing and Verification: Introduction, Testers, Test Fixtures and Test Programs, Logic Verification Principles, Manufacturing Test Principles, DFT.

Text Books:

1. Neil H. E. Weste, David Money Harris, "CMOS VLSI Design- a circuits and systems perspective", 2thEdition, Addison-Wesley, 2010.

Ref: RU/BoS/ECE/CEC/May-2021-9

2. Sung- Mo Kang and Yusuf Leblebici, “CMOS Digital Integrated Circuits: Analysis and Design”, Tata McGraw-Hill, 3rd Edition, 2007.
3. Basic VLSI DESIGN , Douglas A Pucknell, Kamran Eshraghian EEE 3rd Edition

Reference Books:

1. R. Jacob Baker**, “CMOS Circuit Design, Layout and Simulation”,** John Wiley India Pvt. Ltd, 2008.
2. Wayne Wolf, **“Modern VLSI Design: System on Silicon”,** Prentice Hall PTR/Pearson Education, 2nd Edition, 1998.

B19EM6030	Data Communication and Networks(I)	L	T	P	C
Duration:14 Wks		3	0	1	4

Prerequisites:

Digital Communication, C and C++.

Course Description:

The main objective of this course is to provide a foundational view of communication networks: the principles upon which the Internet and other computer networks are built; how those principles translate into deployed protocols and hands-on experience on solving challenging problems with network protocols. Computer communication networks course will include topics such as link-layer technology, routing protocols, the Internet Protocol, reliability, flow control, congestion control, and their embodiment in TCP and UDP. The course will involve a significant amount of network simulator tool to design the basic network topologies and protocols

Course Objectives:

The objectives of this course are to:
1. Understand the basics of data communication and networking.
2. Classify multiple access methods and identify different LANs.
3. Illustrate functions of network layer and demonstrate different routing protocols
4. Discuss transport layer and application layer protocols

Course Outcomes:

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

1. Explain the fundamental concepts of basic networking, Protocols, Standards and Layered models
2. Differentiate multiple access methods and LANs

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3. Demonstrate the concepts of network layer and build sub-nets and routing mechanism.
4. Evaluate different transport t layer protocols and application layer protocols

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 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
B19EM6030	CO 1	3	3	2		2							1	3	2	
	CO 2	3	3	3		2							1	3	2	
	CO 3	3	3	2		2							1	3	2	
	CO 4	3	3	3		2							1	2	2	

Course Contents:

Unit-1: Introduction to Data Communication and Networking. [11 Hrs]
Layered tasks, OSI Model, TCP/IP Suite, and Comparison of OSI Model & TCP/IP Suite. Addressing of TCP/IP Model. Framing, Flow and Error Control, Protocols**:** Noiseless channels and noisy channels, HDLC

Unit-2: Multiple Access &LANs. [10 Hrs]
Random access, Controlled access, Channelization. Wired LAN, Ethernet, IEEE standards, Standard Ethernet. Changes in the standards, Fast Ethernet, Gigabit Ethernet, Wireless LAN IEEE 802.11

Unit -3: Network Layer. [11 Hrs]
Network Layer**:** Logical addressing, Ipv4 addresses, Ipv6 addresses, Internetworking, Ipv4 Header Format and Ipv6 Header Format, Transition from Ipv4 to Ipv6. Distance vector routing, link state routing.

Unit-4: Transport layer & Application Layer. [10 Hrs]
Process to Process Delivery, UDP, TCP, SCTP, Domain Name System, Resolution,

Text Book:

1. B Forouzan "Data Communication and Networking", 4th Ed, TMH 2006.

Reference Books:

1. James F. Kurose, Keith W. Ross "Computer Networks", Pearson Education, 2nd Edition, 2003.
2. Wayne Tomasi" Introduction to Data communication and Networking" Pearson Education 2007.
3. S. Keshav, "An Engineering Approach to Computer Networking", Pearson Education.

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Lab Experiments

Part A (Programs on different Layers)

1. Write a program for bit stuffing & de-stuffing using HDLC.
2. Write a program for character stuffing & de-stuffing using HDLC.
3. Write a program to implement Selective Repeat ARQ protocol.
4. Write a program to implement CSMA/CD protocol.
5. Write a program for distance vector algorithm to find the shortest path for transmission.

Part B – Programs on Networking

1. Create a three node network topology and connect the duplex links between them.
2. Simulate a four node point-to-point network, and connect the links as follows: n0-n2, n1-n2 and n2-n3. Apply TCP agent between n0-n3, n1-n3. Apply relevant applications over TCP agents by changing the parameters and hence determine the number of packets transmitted.
3. Simulate a four node point-to-point network, and connect the links as follows: n0-n2, n1-n2 and n2-n3. Apply UDP agent between n0-n3, n1-n3. Apply relevant applications over UDP agents by changing the parameters and hence determine the number of packets transmitted.
4. Simulate a three nodes point-to-point network and connect the duplex links between them. Set the queue size, vary the transmission speeds (bandwidth) and find the number of packets dropped.
5. Simulate an Ethernet LAN using N-nodes (6-10) with UDP/TCP connection. Apply relevant applications over UDP/TCP agents by changing the parameters and hence determine the number of packets transmitted.
6. Simulate a wireless network for 6 nodes. Apply UDP agent between the nodes. Apply relevant applications over UDP agents by changing the parameters and hence determine the number of packets transmitted.

B19EM6070	Web Technologies Lab	L	T	P	C
Duration:14 Wks		0	0	2	2

Prerequisites:

Basic programming knowledge, Object oriented concepts

Course Description:

This course introduces students to basic web design using HTML, CSS, JavaScript and PHP. Throughout the course students are introduced to planning and designing effective web pages. Implementing web pages by writing HTML and CSS code, enhancing web pages with the use of page layout techniques, text formatting, tables, images, and multimedia; and producing a functional, multi-page website. Validating the user data using Client side scripting language JavaScript and PHP is used to process the forms. Upon successful completion of this course, students will have a good foundation in web design and data validation using HTML,CSS, JavaScript and PHP and students will be prepared to study more advanced web design topics.

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Course Objectives:

The objectives of this course are:

1. To Illustrate the Semantic Structure of HTML and CSS.
2. To Compose forms and tables using HTML and CSS.
3. To Design Client-Side programs using JavaScript.
4. To impart skills required to develop web applications and services.
5. To provide students with conceptual and practical knowledge of web applications.

Course Outcomes:

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

1. Adapt XHTML and CSS syntax and semantics to build web pages.
2. Identify tools and technologies for Web applications.
3. Develop Client-Side Scripts using JavaScript and Server-Side Scripts using PHP to Generate and display the contents dynamically.
4. Describe and transform data using XHTML and its related technologies.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 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
B19EM6070	CO 1	3	3	2		2							1	3	2	
	CO 2	3	3	3		2							1	3	2	
	CO 3	3	3	2		2							1	3	2	
	CO 4	3	3	3		2							1	2	2	

Lab Experiments

1. In today's digital world, information dissemination through printed documents consume lot of time. To overcome this drawback it is better to adopt digital technology for information dissemination, like e-journals, e-books, e- advertisements, etc. Information dissemination through Internet in the form of web content is essential and convenient option. Design and develop a static web pages for an online Book store. The pages should resemble like www.amazon.comThe website should consist of. Home page, Registration & Login, User profile page, Books catalog, Shopping cart, Payment by credit card, and order confirmation.

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2. Internet or online services works on clients and server model. A client is a web browser through which users make requests, which contain input required, for service from the server to perform tasks. Server is a program running on a dedicated computer. Performance of any service or server depends on its throughput. Server throughput deteriorates when users send more and more invalid requests for service and thus results in wastage of server resources that are very precious. As a solution to this problem design a web page that takes student details such as Name, branch, Semester, University, date of admission, mobile number, email id and check for validity or correctness of the input data by writing a JavaScript to validate these fields.

3. Clients interact with servers by sending service requests that contain input required to complete the requested task or service. Input required for requested service may be collected through a web page that acts as an interface between users and the server, in the form of text fields, text areas, radio buttons, push buttons and so on. Hence it is better to instruct or help clients to input correct data through web page by displaying appropriate error messages or alerts as and when users supply wrong input using event handlers. To demonstrate this task, design and develop a web page using JavaScript, XHTML that collects the SRN (Valid format is: Any letter followed by two digits, followed by two letters then followed by three digits). Include event handler for the form elements that collects information to validate the input. Messages must be produced in the alert windows as and when errors are
    a. detected.

4. Dynamic web content is the information that is retrieved from one or more web servers depending upon what information client have requested for, and composed in response to users' requests. Advanced web technologies play a vital role in storage, processing and retrieval of dynamic web content from web servers. Hence it is important to use advanced web technologies such as XML to improve the efficiency in data retrieval. Create and save XML document for students information and display the same using cascaded style sheet.

5. Information technology has become part and parcel of humanity to such an extent that people can shop anything online, from anywhere, at anytime using an electronic device that has access to Internet. This has brought in the concept of virtual stores which provide products at less cost. To improve sales it is mandatory to organize items catalog based on item name, item price, and manufacturer so on. For such online shopping sites, look and feel is an obvious requirement which can be achieved using CSS 3 XSLT. Design a document using CSS and XSLT to create a catalog of items for an online electronic shopping

6. In any business organization, employees keep traveling across different geographical locations and at the same time they want to be connected to their organization's computing resources such as email server, database server, file server, etc. to retrieve information such as sales details, assigning tasks to employees, and upload inspection site details, so on.
7. Using PHP develop a web page that accepts book information such as ISBN number, title, authors, edition and publisher and store information submitted through web page in MySQL database. Design another web page to search for a book based on book title specified by the user and displays the search results with proper headings.

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8. PHP is a server scripting language, and a powerfultool for making dynamic and interactive Web pages. Write a PHP program to store current date-time in a COOKIE and display the 'Last visited on' date-time on the web page upon reopening of the same page.
9. *PHP* (recursive acronym for *PHP*: Hypertext Preprocessor) is a widely- used open source general-purpose scripting language that is especially suited for web development and can be embedded into HTML. Write a PHP program to store page views count in SESSION, to increment the count on each refresh, and to show the count on web page.
10. Databases are the storage systems used by most of information technology enterprises as back end. When users generate data using GUI, for ex. personal information, data are sent to back end database for storage and also users can retrieve this data as and when required from the back end (database) to the front GUI. In the real world there are several databases such as Oracle, DB2, MySQL, SQL Server, MS-Access, DBMongo, etc. To illustrate the process of generating data from the front end and store it on back end database then retrieve the available data from the back end database, write a Perl program to read personal information of a person such as first name, last name, age, permanent address and pin code entered by the user into a table created in MySQL. Read the same
information from the database and display on the front end.

B19EM6080	CMOS Circuits Lab	L	T	P	C
Duration:14 Wks		0	0	2	2

Prerequisites:

Digital Electronics, fundamentals of CMOS

Course Description:

The lab introduces basic theories and techniques of digital VLSI design using CMOS and its variants. The student will understand how the digital circuits can be integrated into the semiconductor chip (ICs). The students will develop the skills required to become VLSI designers, researchers and design tool builders. The course is conceptual, problematic and application oriented.

Course Objectives:

1. Introduce the concepts and techniques of modern integrated circuit design and testing
2. Provide experience in designing integrated circuits using Computer Aided Design (CAD) Tools.
3. Be able to design CMOS combinational and sequential logic at the transistor level, with mask
layout

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Course Outcomes:

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

1. Design and implement digital integrated circuits
2. Measure the performance parameters of digital integrated circuits & systems using CAD tools
3. Demonstrate and calculate device parameters & system aspects of analog IC design

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/COs	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
B19EM6080	CO1	3	3	2		2							1	3	2	
	CO2	3	3	3		2							1	3	2	
	CO3	3	3	2		2							1	3	2	
	CO4	3	3	3		2							1	2	2	

Part A
Basic Digital Gates

1. Design an Inverter with given specifications*, completing the design flow mentioned below:

a. Draw the schematic and verify the following
   i) DC Analysis
   ii) Transient Analysis
b. Draw the Layout and verify the DRC, ERC
c. Check for LVS
d. Extract RC and back annotate the same and verify the Design

2. Design a 2-input NAND & NOR gate with given specifications*, completing the design flow mentioned below:

a. Draw the schematic and verify the following
   i) DC Analysis
   ii) Transient Analysis
b. Draw the Layout and verify the DRC, ERC
c. Check for LVS
d. Extract RC and back annotate the same and verify the Design

3. Design a 2-input AND & OR gate with given specifications*, completing the design flow mentioned below:

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a. Draw the schematic and verify the following
    i) DC Analysis
    ii) Transient Analysis
b. Draw the Layout and verify the DRC, ERC
c. Check for LVS
d. Extract RC and back annotate the same and verify the Design

4. Design a 2-input EX-OR & EX-NOR gate with given specifications*, completing the design flow mentioned below:
a. Draw the schematic and verify the following
    i) DC Analysis
    ii) Transient Analysis
b. Draw the Layout and verify the DRC, ERC
c. Check for LVS
d. Extract RC and back annotate the same and verify the Design

Part B
Analog Circuits

1. Design the circuit of CSA 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
c. Check for LVS

2. Design the circuit of CDA 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
c. Check for LVS

3. Design the Differential amplifier 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
c. Check for LVS

4. Design a two stage op-amp with given specification*
a. Draw the schematic and verify the following

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i) DC Analysis
ii). AC Analysis
iii) Transient Analysis

b. Draw the Layout and verify the DRC, ERC
c. Check for LVS

5. Design a 4 bit R-2R based DAC for the given specification and completing the design flow mentioned using given op-amp in the library**.

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
c. Check for LVS

* Appropriate specification should be given.
** Applicable Library should be added & information should be given to the Designer.

Semester- VII

B19EM7010	Internet of Things & Cyber physical system	L	T	P	C
Duration:14 Wks		3	0	1	4

Prerequisites:

Embedded systems, Computer concept networking Course

Course Description:

IoT is the technology enabling the inter-connection of all types of devices through the internet to exchange data, optimize processes, monitor devices in order to generate benefits for the industry, the economy, and the end user. It is composed of network of sensors, actuators, and devices, forming new systems and services. Many protocols are used for faithful transmission data based on the applications. The Cyber Physical Systems (CPS) is an engineering discipline and specifies the integrations of and interaction between computation and physical processes. CPS integrates the dynamics of the physical processes with those of the communications, computation and networking, and analysis techniques for the integrated systems.

Course Objectives:

The objectives of this course are to:

1. Discuss the architecture of Internet of Things and connected world.
2. Contrast various hardware, communication and sensing technologies, cloud services to build IoT applications
3. Understand about modelling of cyber-physical systems

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4. Describe the design of cyber physical system.

Course Outcomes:

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

1. Describe the IoT system architecture and system design.
2. Use protocols, cloud services and communication API's for developing Applications
3. Apply the core principles behind Cyber physical system
4. Discuss the abstraction in designing the cyber physical system

Mapping of Course Outcomes with Program Outcomes

Course Code	CO/ POs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
B19EM7010	CO1	3	2	3	2	3	2	2		1		1		3	2	3
	CO2	3		3		3								3	2	3
	CO3	3	2	3	2	3					2			3	3	3
	CO4	3	1				1							3	2	

Course Contents:

Unit -1: Introduction & Concepts of IoT
IoT Definition & Characteristics of IoT, Physical Design of IoT: Thing in IoT, IoT Protocols, Logical Design of IoT: Function Block, Communication Models, Communication API, IoT Enabling Technologies: WSN, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded System, IoT Levels and Deployment Templates, Applications of IoT

Unit -2: IoT System Design
IoT Design methodology, IoT Protocol – MQTT, CoAP, Introduction to Cloud storage Models: WAMP, Xively Cloud for IoT, Python Web Application Framework-Django, Designing a RESTful based Web API. Data Analytics for IoT – Apache Hadoop, Apache Oozie. Case studies illustrating IoT design – Home Automation, Cities, Environment, Agriculture

Unit -3: Introduction & Modelling of Cyber Physical System
Definition & Example of CPS system, Design Process, Modelling Dynamic Behaviours – Continuous Dynamics: Newtonian Mechanics, Actor Model, Discrete Dynamics: Discrete Systems, Notion of State, Finite-State Machines, Extended State machines

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Unit -4: Designing of Cyber Physical System
Embedded architecture: Types of processors, Parallelism, Pipelining, Multicore Architectures, Multitasking: Process, Process Management, States of Process, Process Schedulers, Process Control Block, Interrupts, Threads & its types. Scheduling: Levels, Different of Types, Different process scheduling algorithms.

Textbooks:
Arshdeep Bagha and Vijay Madisetti Internet of Things: A Hands-on Approach
Edward A. Lee and Sanjit A. Seshia, "Introduction to Embedded Systems, A Cyber-Physical Systems Approach", Second Edition, MIT Press

Reference Books:
Pethuru Raj and Anupama C. Raman (CRC Press), The Internet of Things: Enabling Technologies, Platforms and Use Cases
Adrian McEwen, Hakim Cassimally, 'Designing the Internet of Things', Wiley, 2014.
Olivier Hersent, David Boswarthick, Omar Elloumi, 'The Internet of Things: Key Applications and Protocols', Wiley, 2015.
Rajeev Alur, "Principles of Cyber-Physical Systems", MIT Press
Danda B. Rawat, Joel J.P.C. Rodrigues, Ivan Stojmenovic, "Cyber-Physical Systems: From Theory to Practice", CRC Press

Internet of Thing and Cyber Physical System lab

List of Experiments:

1. To simulate an IoT based smart home wireless system using cisco packet tracer
2. To simulate an IoT based smart home wired system using cisco packet tracer
3. To simulate an IoT based automate web camera system using cisco packet tracer
4. To simulate an IoT based smart RFID system using cisco packet tracer
5. To simulate an IoT based automatic lawn sprinklers system using cisco packet tracer
6. To simulate an IoT based smoke detection with fire prevention system using cisco packet tracer
7. To simulate an IoT based humidity monitoring system through programming the MCU using cisco packet tracer
8. To simulate an IoT a smart streetlamp system by programming the MCU using cisco packet tracer
9. To simulate the working of IoT protocol (MQTT) using cisco packet tracer
10. To Simulate an IoT smart home system with has an internet service provider, cable model client & 3g/4g cell client using cisco packet tracer.

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SC-1

B19EM3061	Signals and Systems	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:

Differential and Integral Calculus, Geometric Series.

Course Description:

The course covers the fundamentals of signal and system analysis tackling both continuous-time (CT) and discrete-time (DT) systems. The course provides the necessary background needed for understanding analog and digital signal processing, automatic control, analog and digital communications, and probability and random processes. The course focuses on the study of linear timeinvariant (LTI) systems and their analysis in the time domain or in the frequency domain. Fourier analysis in the course includes Fourier series for periodic continuous-time signals, the continuous-time Fourier Prerequisites: Course Description: Ref: RU/BoS/ECE/CEC/Nov-2018-7 3 transform (CTFT) and the discrete-time Fourier transform (DTFT). In addition the course includes a chapter on Z transform

Course Objectives:

The objectives of this course are:

1. To provide insight into fundamentals of Continuous and Discrete-time signals and systems, their properties and representations.
2. To introduce time domain representation of Linear Time invariant Systems such as Convolution Sum, Convolution Integral.
3. To provide understanding of signal representation in Fourier domain such as Fourier Series, Fourier transform, discrete time fourier transform.
4. To provide insights into applications of fourier transform.
5. To provide brief understanding of signal representation in Z-domain.
6. To give a brief insight into application of z-transform to solve impulse function of LTI systems etc.

Course Outcomes:

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

1. Illustrate the operations on Signals. [a, b, f]
2. Summarize the properties of Systems. [a, b, f]
3. Apply Convolution operation on an LTI System. [a, b, e, f]
4. Represent continuous time periodic signals in frequency domain using fourier series. [a, e, f]
5. Interconvert signal between Time and Frequency domain using Fourier Transform. [a, b, e,f]
6. Derive the condition for Signal reconstruction using sampling theorem. [a, f]
7. Represent the discrete time signals in Z-domain
8. Determine the behavior of Causal LTI system using properties of Z-Transform. [a, b, e, f]

Mapping of Course Outcomes with Program Outcomes

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Course Code	POS/ COs	PO 1	P 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
B19EM3061	CO 1	3	3	2		2							1	3	2	
	CO 2	3	3	3		2							1	3	2	
	CO 3	3	3	2		2							1	3	2	
	CO 4	3	3	3		2							1	2	2	

Course Contents:

Unit-1: Introduction to Signals and Systems [7L+7T]

Definitions of a signal and system, Elementary signals, Basic operations on signals, Classification of signals, Properties of systems

Unit-2: Analysis of Linear Time Invariant Systems and Fourier Series [6L+7T]

Time domain representation of LTI system: Impulse response representation, Convolution Sum, Convolution Integral, Convolution Properties, Causality and Stability. Fourier Representation of Periodic Signals: Introduction to CTFS and DTFS, definition, properties and basic problems

Unit-3: Fourier Representation for Aperiodic signals [7L+7T]

FT representation of aperiodic CT signals - FT, definition, FT of standard CT signals, Properties and their significance.

FT representation of aperiodic discrete signals-DTFT, definition, DTFT of standard discrete signals, Properties and their significance

Unit-4: Applications of FT and Z-Transforms [6L+7T]

Application of FT: Sampling theorem and reconstruction of signals.

Properties of Z transform , ROC, Inversion of Z – transforms, transform analysis of LTI Systems, Unilateral Z-Transform and its application to solve difference equations

Text Book:

1. Simon Haykins, “Signals and Systems”, John Wiley, India Pvt Ltd, Second Edition, 2008.

Reference Books:

1. Michael Roberts, “Fundamentals of signals and systems”, TATA McGraw Hill, Second Edition ,2010
2. Allan V. Oppenheim, S. Wilsky and S. H. Nawab, “Signals and Systems”, Pearson Education, Second Edition, 1997.
3. D. Ganesh Rao and Satish Tunga, “Signals and Systems”, Pearson/Sanguine Technical Publishers, 2004
4. Uday Kumar S. “Signals and Systems”, Prism books Pvt. Ltd, 6th Edition 2015

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B19EM3062	Operating systems	L	T	P	C
Duration:14 Weeks		3	0	0	3

Prerequisites:

Computer Concepts and C Programming, Computer Organization

Course Description:

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

Course Objectives:

1. Introduce the history, basics and structure of Operating System
2. Describe process concepts and scheduling techniques
3. Familiarize with physical and virtual memory management techniques
4. Describe UNIX kernel, data structures and internal representation of files in UNIX operating system
5. Illustrate Interposes communication mechanisms

Course Outcomes:

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

1. Explain the history, basics and structure of operating systems
2. Implement various process management and scheduling schemes
3. Design and develop memory management techniques
4. Demonstrate the internals of UNIX operating system
5. Use the computing environment and various services of operating system for development of applications.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 2	PO 3	PO 4	PO5	PO 6	P 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19EM3062	CO1	3	3	2		2							1	3	2	
	CO2	3	3	3		2							1	3	2	
	CO3	3	3	2		2							1	3	2	
	CO4	3	3	3		2							1	2	2	

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Course Contents:

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

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

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

Unit – IV: UNIX kernel and its files: Introduction to Kernel: Architecture of the UNIX operating system, Introduction to system concepts, Kernel data structures, System Administration, Internal representation of Files: Inodes, structure of a regular file, Directories, Conversion of a path Name to an Inode, Super block, Inode assignment to a new file, Allocation of disk blocks, other file types.

Text Books:

1. Abraham Silberschatz, Peter BearGalvin, Greg Gagne,Operating System Principles, Wiley Asia Student Edition 2009.
2. William Stallings, Operating Systems: Internals and Design Principles, Prentice Hall of India, seventh edition 2011.
3. Maurice J. Bach ; The Design of the UNIX Operating System; Pearson Education; Prentice Hall of India, 2004.

Reference Books:

1. D. M. Dhamdhere; Operating Systems: A Concept-Based Approach; Tata McGraw-Hill,2002.
2. Charles Crowley; Operating System: A Design-oriented Approach; Irwin Publishing, 2002.
3. Gary J. Nutt; Operating Systems: A Modern Perspective; Addison-Wesley, 2011.

B19EM3063	Instrumentation Engineering	L	T	P	C
Duration: 14Weeks		3	0	0	3

Prerequisites:

Engineering Physics, Principles of Electronics.

Course Description:

Instrumentation Engineering refers to the study of all measuring instruments that are required for engineering the systems. This course deals with measuring equipments such as voltmeter, multimeter,

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signal generator, function generator, bridges and transducer. Principal and working of all the above equipments is dealt in detail. This course also covers measurement errors faced during engineering the systems.

Course Objectives:

The objectives of this course are to:

1. Introduce the various measurement errors.
2. Describe the operation of different voltmeters and multimeters ,signal generators.
3. Provide detailed study of electronic component measuring methods.
4. Provide detailed study of transducers.

Course Outcomes:

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

1. Describe the characteristics of various types of measurement systems and errors in measuring Instruments.
2. Describe the concepts of Voltmeters and Multimeters.
3. Explain the working principle of various signal generators.
4. Analyze the circuits for the measurement of Resistance, Capacitance, Inductance, and Frequency.
5. Describe the characteristics and application of different transducers.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 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
B19EM3063	CO 1	2	3	2	1								1	3	2	
	CO 2	3	3	3	1								1	3	2	
	CO 3	2	3	2	1								1	3	2	
	CO 4	3	3	3	1								1	2	2	

Course Contents:

Unit 1 : Introduction to Measurement, Errors

Measurement Errors : Introduction, Significance of measurements, methods of Measurements, Gross errors and systematic errors, Absolute and relative errors, Accuracy, Precision, Resolution and Significant figures.

Introduction, Multirange voltmeter, extending voltmeter ranges, Loading, AC voltmeter using-Rectifiers – Half wave and full wave, Peak responding and True RMS voltmeters

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Unit 2: Digital Voltmeters and Oscilloscopes

Digital Voltmeters: Introduction, RAMP technique, DVM's based on V–T, V–F and Successive approximation principles, 3 Digit, Resolution and sensitivity, Digital Multimeters, Digital frequency meters, Digital measurement of time: Time base selector, Time measurement.

Oscilloscope: Principle of operation and specifications, Dual beam and dual trace CRO

Unit 3: Signal generators

Introduction to oscillators, Fixed and variable AF oscillator, Standard signal generator, Laboratory type signal generator, AF sine and Square wave generator, Function generator, Square and Pulse generator, Sweep generator, Frequency synthesizer.

Unit 4 : Measurement of R, L, C and Transducers

Measurement of resistance, inductance and capacitance: Introduction, Wheatstone's bridge, Kelvin Bridge, AC bridges, Capacitance Comparison Bridge, Maxwell's bridge, Wien's bridge, Wagner's earth connection.

Transducers: Introduction, Electrical transducers, selecting a transducer, Resistive transducer, Resistive position transducer, Strain gauges: Resistance wire gauge, Inductive transducer, Differential output transducer and LVDT.

Textbooks:

1. H. S. Kalsi, "Electronic Instrumentation", TMH, Third edition 2012
2. David A Bell, "Electronic Instrumentation and Measurements, Pearson Education, 2006.

Reference books:

1. John P. Beately, "Principles of measurement systems", 3rd Edition, Pearson Education, 2000
2. Cooper D & A D Helfrick, "Modern electronic instrumentation and measuring techniques", PHI, 1998.

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SC-2

B19EM4061	Solid state Devices Theory (SSDT)	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Fundamentals of Physics

Course Description

This course is about basic semiconductor physics and the physics devices like PN junction, (BJT), and MOSFET. The course contents gives insight into basics of quantum mechanics and solid-state physics (energy bands, electrons and holes, the Fermi function), doping and carrier densities, carrier transport and generation-recombination, in addition the semiconductor equations, which provide a complete, semi-classical, mathematical description of electrons and holes in semiconductors, subject to some important simplifying assumptions. In addition the course applies these concepts to PN junction, (BJT), and MOSFET with their fabrication procedures

Course Objectives:

The objectives of this course are:

1. Present brief idea about the Solid State Devices.
2. Give brief introduction to Fabrication Process.
3. Present the idea of Energy Band Diagrams.
4. Give a brief description of Metal Oxide Silicon Systems.
5. Present the concept of MOSFET.

Course Outcomes:

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

1. Describe the operation of MOSFET.
2. Explain the process of IC Fabrication
3. Describe the operation of PN Junction Diode

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
B19EM4061	CO1	2	3	2	1								1	3	2	
	CO2	3	3	3	1								1	3	2	
	CO3	2	3	2	1								1	3	2	
	CO4	3	3	3	1								1	2	2	

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Course Contents:

Unit 1: The PN Junction Diode **[10 Hrs]**
Introduction, Space Charge Region, Analytical relations at Equilibrium, Conditions in the diode with voltage applied, Currents in diode.

Unit 2: Fabrication Technology **[10 Hrs]**
Introduction, Why Silicon, Purity of Silicon, Czochralski process, Fabrication process, Fabrication of resistors and capacitors

Unit 3: Bipolar Transistors **[11 Hrs]**
Structure and Basic operation, Fabrication, Circuit arrangements, Currents in active region, BJT as a current amplifier, Transistor parameters, modes of operation.

Unit 4: Metal-Oxide-Silicon Systems **[11 Hrs]**
Energy band diagrams, Band Bending and effect of Bias voltages, Analytical relations for charge densities, Construction and operation of MOSFET, Regions of operation, Secondary effects.

Text Book:
1. Kanaan Kano, "**Semiconductor Devices**", Pearson Education, 2004.

Reference Book:
1. Streetman, Banerjee, " Solid State Electronic Devices", PHI Learning, 2006.

B19EM4062	Software Engineering	L	T	P	C
Duration :14 Weeks		3	0	0	3

Prerequisites:

Basic computer concepts

Course Description:

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

Course Objectives:

1. To impart the knowledge of basic SW engineering methods and practices, and their appropriate application;
2. To give an understanding of software requirements and the SRS document.
3. Introduce an understanding of different software architectural styles.
4. To give an understanding of approaches to verification and validation including static analysis, and reviews.

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5. To give an understanding of software testing approaches such as unit testing and integration testing.
6. To give an understanding on quality control and how to ensure good quality software.
7. To give an understanding of some ethical and professional issues those are Important for software engineers.

Course Outcomes:

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

1. List the basics of the life cycle of software
2. Analyze the requirements of a software development project
3. Implement a software development project in a team
4. Verify and validate a software development project.
5. Describe and manage the core ethical issues of software development process.
6. Infer the importance of software engineering for the development of a software project.
7. Develop a positive attitude towards the development of a software project in a team and develop skill to work as software designer.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 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
B19EM4062	CO 1	2	3	2	1								1	3	2	
	CO 2	3	3	3	1								1	3	2	
	CO 3	2	3	2	1								1	3	2	
	CO 4	3	3	3	1								1	2	2	

Course Contents:

Unit-1 **[12 Hrs]**

Overview: Introduction: FAQ's about software engineering, Professional and ethical responsibility. Socio-Technical systems: Emergent system properties; Systems engineering; Legacy systems. Software Processes: **S**oftware Processes: Models, Process iteration, Process activities; The Rational Unified Process; Computer-Aided Software Engineering.

Unit-2 **[12 Hrs]**

Requirements: Software Requirements: Functional and Non-functional requirements; User requirements; System requirements; Interface specification; the software requirements document. Requirements Engineering Processes: Feasibility studies; Requirements elicitation and analysis; Requirements validation; Requirements management.

Unit-3 **[12Hrs]**

System Models, Software Design & Development: System Models: Context models; Behavioral models; Data models; Object models; structured methods. Architectural Design: Architectural design decisions; System organization; Modular decomposition styles; Control styles, Object-

Oriented design: Objects and Object Classes; An Object-Oriented design process; Design evolution. Rapid Software Development: Agile methods; Extreme programming; Rapid application development. Software Evolution: Program evolution dynamics; Software maintenance; Evolution processes; Legacy system evolution.

Unit-4
[12 Hrs]
Verification and Validation: Verification and Validation: Planning; Software inspections; Automated static analysis; Verification and formal methods. Software testing: System testing; Component testing; Test case design; Test automation. Project Management: Management activities; Project planning; Project scheduling; Risk management.

Text Books:
1. Ian Sommerville, **"Software Engineering"**, Eighth Edition, Person Education, 2007.
2. Roger.S.Pressman,**"Software Engineering -A Practitioners Approach"**, Seventh Edition, McGraw-Hill, 2007

Reference Book:
1. Pankaj Jalote, **"An Integrated Approach to Software Engineering"**, Wiley India, 2009.

B19EM4063	Java Programming	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Programming fundamentals, C, C++.

Course Description:

Java is among the most popular programming languages out there, mainly because of how versatile and compatible it is. Java can be used for a large number of things, including software development, mobile applications, and large systems development. Knowing Java opens a great deal of doors for you as a developer. Java is the one of the most popular programming languages in the world today. It works on any platform (Windows, Mac, Linux, etc), and is the core language used in developing Android apps.

Course Objectives:

The objectives of this course are:
1. To provide strong foundation for "object Oriented Programming Language (OOPL)"
2. To introduce difference data types, operators and control flows in Java Programming
3. To introduce classes, objects, inheritance and applets
4. To introduce string handlings, exception handling, packages and interfaces
5. To introduce threads and applets in Java Programming.

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Course Outcomes:

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

1. Identify different Java properties which are unique compared to C++ language.
2. Define class, objects, inheritance and applets
3. Apply JAVA programming concepts like: classes, inheritance, exceptions handling, packages, and interfaces to write JAVA programs and applets.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
B19EM4063	CO1	2	3	2	1								1	3	2	
	CO2	3	3	3	1								1	3	2	
	CO3	2	3	2	1								1	3	2	
	CO4	3	3	3	1								1	2	2	

Course Contents:

Unit-1:Java Revolution and Object-Oriented Fundamentals[11Hrs]
Revolutionary programming language; Object -Oriented Fundamentals: Object oriented programming, how java is better than C++; Java Language Introduction: Hello World, Step by step, Variables; Types; Flow Control.

Unit-2: Classes and Inheritance [10 Hrs]
Object references, Instance variables, the new operator, The Dot operator, Method declaration, Method calling, this, Constructors, Method overloading; Inheritance: Super, Method Overriding, Dynamic method dispatch; final, finalize, static.

Unit-3: Packages, Interfaces and String Handling [11 Hrs]
The package statement, Compiling classes in packages, the import statement, Access protection; Interfaces: The interface statement, The implement statement, Variables in interfaces; String Handling: string creation, concatenation, & conversion.

Unit-4: Exception Handling, Threads, and Applets [10 Hrs]
Fundamentals, Exception types, try and catch, Multiple catch clauses, Nested try statements; Threads: Single threaded event loop, The java thread model, Thread, Runnable, Thread priorities; Introduction to Applets, Simple Applet program.

Text Book:

1. Patrick Naughton, “The Java Handbook”, Tata McGraw-Hill, 2006

Reference Books:

1. Herbert Schildt “The Complete Reference – Java 2”, Fifth Edition, Tata McGraw-Hill 2002
2. Bruce Eckel, “Thinking in Java”, III Edition, Pearson 2004.

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SC-3

B19EM5051	Microelectronics	L	T	P	C
Duration: 14 Wks		3	0	0	3

Prerequisites:

Basic Electronic Circuits.

Course Description:

Microelectronics is the miniaturized electronic circuits that make up integrated circuits such as microcontrollers, micro- processors, FPGAs, operational amplifiers, analog-to-digital converters and many other functions. Microelectronics deals with the designing and manufacturing of very small electronic designs and components made up of semiconductor materials. The ability to use large number of components at relative low cost and the ability to match components accurately on-chip makes the design of integrated circuits and systems different from a similar design using discrete components.

Course Objectives:

The objectives of this course are to:

1. Understand the importance of MOS devices, in the field of analog VLSI design.
2. Explain the basic operation & design of single stage amplifiers.
3. Analyze and design simple current mirrors, and cascode current mirrors.
4. Analyze high frequency response of amplifier circuits.
5. Provide a quantitative analysis of differential amplifier with different loads.
6. Characterize and analyze the performance of different digital logic.

Course Outcomes:

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

1. Employ the concept of MOS devices in various MOS amplifier applications, and design discrete MOS circuits.
2. Analyze integrated circuit amplifiers and building blocks of analog IC's.
3. Illustrate the concept of current mirrors and apply the concept for the design of differential amplifiers.
4. Construct small signal models and high frequency models of amplifier circuits for analysis.
5. Analyze high frequency operation of analog IC building blocks
6. Characterize the performance of digital circuits.
7. Design digital logic circuit using dynamic logic circuits.

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Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 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
B19EM5051	CO 1	2	3	2	1								1	3	2	
	CO 2	3	3	3	1								1	3	2	
	CO 3	2	3	2	1								1	3	2	
	CO 4	3	3	3	1								1	2	2	

Course Contents:

Unit 1: MOSFETS **[10 Hrs]**

Device Structure and Physical Operation, Current –Voltage Characteristics, MOSFET Circuits at DC, MOSFET as an amplifier and as a switch, depletion type MOSFET.

Unit 2: Single Stage MOS Amplifiers **[11Hrs]**

Biasing in MOS amplifier circuits, Small Signal operations & model, Single Stage MOS Amplifier, High frequency MOSFET model, Frequency response of Common Source Amplifier, Common Source Amplifier with active load, High frequency model.

Unit 3: Integrated Circuit Amplifiers **[10Hrs]**

IC design philosophy, IC biasing- Current sources, current mirrors, current steering MOS circuits, high frequency models, Common gate Amplifier with active load, Cascode Amplifier, Source follower, MOS differential pair, Small Signal operation of MOS differential pair.

Unit 4: Digital CMOS Logic Circuits **[11Hrs]**

Digital circuit design overview, Design and performance analysis of CMOS inverter, CMOS logic gate circuits, Pseudo NMOS logic circuits, Pass transistor logic circuits, Dynamic logic circuits.

Reference Books:

1. "Microelectronic Circuits", Adel Sedra and K.C. Smith, 5th Edition, Oxford University Press, Interantional Version, 2009.
2. "Fundamentals of Microelectronics" , Behzad Razavi, John Wiley India, Pvt. Ltd, 2008.
3. "Microelectronics – Analysis and Design", Sundaram Natarajan, Tata McGraw-Hill, 2007

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B19EM5052	Virtualization and Cloud Computing	L	T	P	C
Duration:14 Weeks		3	0	0	3

Prerequisites:

Computer Networks, Operating Systems.

Course Description:

The course introduces the cloud environment in detail and explains how to use cloud infrastructure in real time environment .Virtualization in Cloud Computing. Virtualization is the creation of a virtual (rather than actual) version of something, such as a server, a desktop, a storage device, an operating system or network resources. The fundamental knowledge about cloud and virtualisation technique is explained which helps in creating real time application connecting with IoT.

Course Objectives:

The objective of this course is to:

1. Provide knowledge in different layers of cloud computing, Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS);
2. Illustrate the use of various cloud computing technologies;
3. Illustrate how to store the data in cloud storage.
4. Introduce Virtualization technologies: Hypervisor, emulation, and application VM; Platform virtualization, storage virtualization, and network virtualization;
5. Provide Introduction to cloud security and secure computation in the cloud.

Course Outcomes:

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

1. Explain virtualization and their role in elastic computing.
2. Characterize the distinctions between Infrastructure, Platform and Software as a Service (IaaS, PaaS, SaaS) abstractions;
3. Analyze the advantages and disadvantages of Public and Private Clouds.
4. Create and deploy various cloud applications
5. Design of Cloud security solutions

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
B19EM5052	CO1	1	1											1		
	CO2	1	2	3										1	2	3
	CO3	1	2	3										1		3
	CO4	1	2											1		

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Course Contents:

Unit-1: Introduction to Cloud Computing Overview [11 Hrs]Cloud Computing Overview, Origins of Cloud computing, Cloud components, Essential characteristics – On-demand self-service, Broad network access, Location independent resource pooling, Rapid elasticity, Measured service. Cloud scenarios – Benefits: scalability, simplicity, vendors, security. Risks and Challenges.

Unit-2: Cloud architecture, Service & Deployment models [10 Hrs]
SPI framework, SPI V/s traditional IT Model. Cloud Service Models: Software as a Service, Platform as a Service, Infrastructure as a service, SaaS service providers – Google App Engine, Salesforce.com and Google platform, Benefits, Evaluating SaaS. PaaS service providers – Right Scale and Salesforce.com, Benefits of PaaS. IaaS: IaaS service providers – Amazon EC2.
Cloud Deployment Models: Public clouds, Private clouds, Community clouds and Hybrid clouds, Advantages of Cloud computing.

Unit-3: Cloud Databases and File Systems in cloud [11 Hrs]
Cloud database, Cloud file system, Cloud programming model. Cloud data security and existing solutions.
Cloud Middleware and Best Practices: Concept and need of Cloud middleware, QoS Issues in Middleware, Data migration and streaming in cloud, Best practices of Cloud computing.

Unit-4:Virtualization Techniques [10 Hrs]
Virtualization and cloud computing, Need of virtualization, Virtualization Technology, Overview of Virtualization, Types of virtualization: CPU virtualization, Memory virtualization, Device and I/O virtualization, OS Level virtualization, Network virtualization, Server virtualization, Desktop, Data, Storage and Application virtualization.

Text Books:

1. Anthony T.Velte , Toby J. Velte Robert Elsenpeter, “Cloud computing a practical approach”, TATA McGraw- Hill , New Delhi – 2010.
2. A. Srinivasan and J. Suresh. “Cloud Computing: A practical approach for learning and implementation”, Pearson publication, Second addition 2017.
3. Rishabh Sharma, “Cloud Computing: Fundamentals, Industry Approach and Trends”, Wiley Publications, First Edition 2015.

References:

1. Michael Miller, “Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online”, Que 2008.
2. Sandeep Gupta, Frank Adelstein, Golden Richard, Loren Schweibert. “Fundamentals of Mobile and Pervasive Computing”, McGraw Hill Publication 2004.

Ref: RU/BoS/ECE/CEC/May-2021-9

B19EM5053	Analog Communication	L	T	P	C
Duration:14 Wks		3	0	0	3

Prerequisites:

Fourier Transform, Gaussian Process, Correlation and Co-variance function.

Course Description:

This course provides the basics of analog communication systems such as amplitude modulation and demodulation, DSB-SC modulation, and demodulation, SSB and VSB modulation and demodulation. Later, comparison of various modulation schemes is carried out to differentiate all amplitude modulation schemes. Frequency division multiplexing and frequency translation are demonstrated with block diagram. Angle modulation and demodulation techniques are illustrated to provide a better insight of the course. Finally, the course provides introduction to noise and analyze the receiver model in presence of the noise. This fundamental knowledge on analog communication helps to explore and apply the techniques in design of various analog communication systems.

Course Objectives:

The objectives of this course are to:

1. Introduce the various Analog modulation & demodulation schemes.
2. Sketch the time domain and frequency domain description of Analog modulation schemes.
3. Present the concept of Phase locked loop (PLL).
4. Introduce the fundamental concepts of noise in communication systems and demonstrate the receiver model in presence of noise.

Course Outcomes:

After the completion of the course the student will be able.

1. Apply Fourier analysis to communication signals.
2. Analyze and differentiate types of modulators Such as AM, DSBSC, SSB, VSB and FM.
3. Apply the concept of Phase locked loop in FM detection.
4. Compute PSD, SNR, Figure of Merit for different Modulation techniques.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
B19EM5053	CO1	1	1	1										1	1	1
	CO2	2	2	3										1	2	3
	CO3	2	2	3										1	1	3
	CO4	1	2	1										1	1	1

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Course Contents:

Unit -1: Amplitude Modulation [10 Hrs]

Introduction to communication system, need for Modulation, AM: Time-Domain Description, Frequency–Domain Description, Power Relations in AM Wave, Generation of AM Wave: Square Law Modulator, Switching Modulator, Detection of AM Waves: Square law Detector, Envelope Detector. Double Side Band Suppressed Carrier Modulation (DSBSC): Time-Domain Description, Frequency-Domain Representation. Generation of DSBSC Waves: Balanced Modulator, Ring Modulator, Coherent Detection of DSBSC Modulated Waves, Costas Loop.

Unit -2: Single Side-Band Modulation (SSB) and Vestigial Side-Band Modulation (VSB) [11 Hrs]

Quadrature Carrier Multiplexing, Introduction to Hilbert Transform, properties of Hilbert Transform, Pre-envelope, Complex-envelope, Single Side-Band Modulation, Frequency-Domain Description of SSB Wave, Time-Domain Description, Phase Discrimination Method for Generating an SSB Modulated Wave. Demodulation of SSB Waves, VSB: Frequency Domain Description, Generation of VSB Modulated Wave, Coherent detection of VSB, Comparison of Amplitude Modulation Techniques. Frequency Division Multiplexing, Frequency Translation.

Unit -3: Angle Modulation and Demodulation [10 Hrs]

Basic Definitions, FM,PM,Narrow Band FM, Wide Band FM(with Bessel function), Transmission Bandwidth of FM Waves, Generation of FM Waves: Indirect FM And Direct FM. Demodulation of FM Wave- Balanced Frequency discriminator, zero crossing detectors, Phase Locked Loop, Non-linear Model of Phase Locked Loop, Linear Model of Phase Locked Loop.

Unit -4: Introduction to Noise and Noise in Continuous Wave Modulation Systems [11 Hrs]

Introduction, Autocorrelation and power spectral density, Mean, co-variance, Shot Noise, Thermal Noise, White Noise, Noise Equivalent BW, Narrow Bandwidth, Noise Figure, Equivalent Noise Temperature, Cascade Connection of Two-Port Networks, Receiver Model, Noise in AM Receivers, Noise In DSB-SC Receivers, Pre-Emphasis And De-Emphasis in FM.

Text Books:

1. Simon Haykins, "An Introduction to Analog and Digital Communication", John Wiley, 3rd Edition 2003.
2. Simon Haykins, "Communication Systems", John Willey 4th Edition, 2001.

Reference Books:

1. B. P. Lathi, "Modern digital and analog Communication systems", Oxford University press, 3rd Edition, 2005.

Kennedy, Davis," Electronic Communication Systems ", Tata Mcgraw-Hill, 4th Edition, 1999.

Ref: RU/BoS/ECE/CEC/May-2021-9

B19EM5054	Research Methodology & IPR	L	T	P	C
Duration:14Wks		3	0	0	3

Prerequisites:

No Prerequisites

Course Description:

The course aims to give a broad understanding of research methodology, including qualitative and quantitative methods. The main components of a research framework i.e., problem definition, research design, data collection, ethical issues in research, report writing, and presentation are discussed. Once equipped with this knowledge, participants would be well-placed to conduct disciplined research under supervision in an area of their choice. In addition to their application in an academic setting, many of the methodologies discussed in this course would be similar to those deployed in professional research environments. Also IPR frameworks are discussed to give them insight into the patent drafting.

Course Objectives:

The objectives of this course are to:

1. Develop the most appropriate methodology for their research studies, irrespective of their discipline.
2. Enhance the research skills and equip them to carry out individual or team research work according to scientific/technology requirements.
3. Introduce different IPR Legislations and IPR filing procedures.

Course Outcomes:

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

1. Identify and describe researchable ideas, projects and themes
2. Develop the thesis layout and document using the LATEX tool.
3. Identify different IPR Legislations
4. Understand other forms of IPR Legislations

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 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
B19EM5054	CO 1	2	3	2	1								1	3	2	
	CO 2	3	3	3	1								1	3	2	
	CO 3	2	3	2	1								1	3	2	
	CO 4	3	3	3	1								1	2	2	

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Course Contents:

Unit-1: Research and Types of research [11 Hrs]

Meaning of Research- Objectives of Research- Motivation in Research. Research methods v/s Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical. Research Process. Criteria of good Research. Defining the Research Problem - Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem, Technique Involved in Defining a Problem, Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design, Different Research Designs.

Unit-2: Thesis writing and Ethics. [11 Hrs]

Structure and components of scientific reports - Types of report – Technical reports and thesis, Significance –Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation – Practice – Making presentation – Use of visual aids - Importance of effective communication. **LATEX**: Introduction to LATEX and it's usage in documentation, preparation of thesis, technical papers and articles.

Unit- 3: Intellectual Property Rights [10 Hrs]

Intellectual Property Rights: Introduction, Legislations covering IPR in INDIA; Patents: Conditions to be satisfied by an invention to be patentable, Patentable inventions under patent Act 1970,Types of patents which are not patentable in INDIA, Term of patent in INDIAN system, Essential patent documents to be submitted, Creteria for naming inventors in an application of patent, Where to apply ?How to apply?, Why provisional specification, Complete specification, Hierarchy of officers in patent office, Register of patents ,working of patents and company licensing, Revocation of patents, Term of patents, Patent of addition

Unit-4: Other Intellectual Property Rights [10 Hrs]

Copy Right; Trade Marks; Geographical Indications; Industrial Designs; Layout Design of Integrated designs; Plant verity; International Patenting; Case studies

Text Books:

1. Kothari, C. R. **"**Research methodology: Methods & techniques". New Delhi: New Age International (P) Ltd, 2004.

References:

1. "LATEX Documentation" available at http://www.latex-project.org/
2. "Patent Manual", available at http://www.bits-pilani.ac.in/uploads/Patent_ManualOct_25th _07.pdf

Ref: RU/BoS/ECE/CEC/May-2021-9

SC-4

B19EM5061	ARM Processors	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Familiarity with Digital Electronic Circuits, Hexadecimal Number System.

Course Description:

Progress in the ARM microcontroller community since the publication of the first edition of this book has been impressive, significantly exceeding our expectations and it is no exaggeration to say that it is revolutionizing the world of Microcontroller Units (MCUs). There are many thousands of end users of ARM-powered MCUs, making it the fastest growing MCU technology on the market. As such, the second edition of Joseph's book is very timely and provides a good opportunity to present updated information on MCU technology.

Course Objectives:

Course objectives are to:

1. Understand the architectural features and instruction set of 32 bit microcontroller ARM Cortex M3.
2. Program ARM Cortex M3 using the various instructions and C language for different applications.
3. Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
4. Develop the hardware software co-design and firmware design approaches.
5. Explain the need of real time operating system for embedded system applications.

Course Outcomes:

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

1. Solve basic binary math operations using the microcontroller.
2. Demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microcontroller.
3. Program using the capabilities of the stack, the program counter, and the status register and show how these are used to execute a machine code program.
4. Develop industrial applications and requirements.
5. Interface various peripherals.

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Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO 1	P 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
B19EM5061	CO 1	2	2	1									1	3	2	
	CO 2	3	3	3									1	3	2	
	CO 3	2	3	2									1	3	2	
	CO 4	3	3	3									1	2	2	

Course Contents:

Unit 1: ARM-32 bit Microcontroller. **[7 Hrs]**

Architecture of ARM Cortex M3, Various Units in the architecture, Debugging architecture. General Purpose Registers, Special Registers,

.

Unit 3: Instruction Sets. **[7 Hrs]**

Assembly basics, Instruction list and description, Useful instructions, Memory mapping, Bit-band operations and CMSIS, Assembly and C language Programming Time delay calculations,

Unit 3: Exceptions and Interrupts. **[7 Hrs]**

Exceptions, interrupts, stack operation, reset sequence, programming in Assembly and C

Unit 4: Programming. **[7 Hrs]**

Timers/counters, Serial Communication: Data communication, connections to RS-232 programming in Assembly and C .

Text books:

1. Joseph Yiu, "The Definitive Guide to the ARM Cortex-M3", 2nd Edition, Newnes,(Elsevier), 2010.

Knowledge of Analog circuits, Network analysis, Integration and differentiation, Matrix, Laplace Transform.

Ref: RU/BoS/ECE/CEC/May-2021-9

B19EM5062	Agile Software Development and DevOps	L	T	P	C
Duration :14 Weeks		3	0	0	3

Prerequisites:

Any Programming Language

Course Description:

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

Course Objectives:

Course objectives are to:

1. Discuss the importance of the software development process.
2. Explain the workflow of Automating process.
3. Illustrate with case study, the importance of DevOps.
4. Describe the software life cycle using a case study.

Course Outcomes:

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

CO1. Outline the importance of the software development process.
CO2. Design the workflow of Automating process.
CO3. Make use of DevOps.
CO4. Develop an application using software life cycle.

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	PSO1	PSO2	PSO3
B19EM5062	CO 1	1	1	1										1	1	1
	CO 2	2	2	3										1	2	3
	CO 3	2	2	3										1	1	3
	CO 4	1	2	1										1	1	1

Ref: RU/BoS/ECE/CEC/May-2021-9

Course Contents:

Unit 1: UNIT- 1

Introduction

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

UNIT- 2 Agile Application Lifecycle Management

Goals of Agile Application Lifecycle Management, Why Is Agile ALM Important? Where Do I Start? Understanding the Paradigm Shift, Rapid Iterative Development, Remember RAD? , Focus on 12 Agile Principles, Agile Manifesto, Fixed Timebox Sprints, Customer Collaboration, Requirements, and Documentation.

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Unit 3: Automating the Agile ALM:

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

Unit 4: DevOps:

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

Textbooks:

1. Bob Aiello and Leslie Sachs, “Agile Application Lifecycle Management Using DevOps to Drive Process Improvement”, Addison Wesley, First printing, June 2016.

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Reference books:

1. Roger S, "Software Engineering – A Practitioner's Approach", seventh edition, Pressman, 20l0.
2. Roger Pressman, Ian Sommerville, "Software Engineering", 9th edition, 20l0.
3. Hans Van Vliet, "Software Engineering: Principles and Practices", 2008.

B19EM5063	Digital Signal Processing	L	T	P	C
Duration 14 Wks		3	0	0	3

Prerequisites:

Fourier Transform, Z-transform, LTI System Representation.

Course Description:

The signal for processing is mathematically modeled as a function or a sequence of numbers that represent the state or behavior of a physical system. The examples of the signals range from speech, audio, image and video in multimedia systems, electrocardiograms in medical systems, to electronic radar waveforms in military. Signal processing is concerned with the representation, transformation, and manipulation of signals and the information they contain. For example, we may wish to remove the noise in speech to make it clear, or to enhance an image to make it more natural. Signal processing is one of the fundamental theories and techniques to construct modern information systems. During the last half century, lots of theories and methods have been proposed and widely studied in digital signal processing. In this semester, we only study the Discrete Fourier Transform and Fast Fourier Transform and IIR and FIR filter designs.

Course Objectives:

The objectives of this course are to:

1. Explain the concept of DFT and FFT.
2. Calculate the DFT of a sequence, relate it to the DTFT, and use the DFT to compute the linear convolution of two sequences.
3. Design IIR filter using impulse invariant, bilinear transform.
4. Demonstrate FIR & IIR filters for digital filter structures.

Course Outcomes:

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

1. Describe the concept of sampling.
2. Explain the difFerent properties of DFT
3. Compute the convolution of the pair of signals in time domain
4. Distinguish between IIR Filter and FIR Filter.

Mapping of Course Outcomes with programme Outcomes

Ref: RU/BoS/ECE/CEC/May-2021-9

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19EM5063	CO 1	1	1	1	2									1	1	1
	CO 2	2	2	3	3									1	2	3
	CO 3	2	2	3	2									1	1	3
	CO 4	1	2	1	2									1	1	1

Course Contents:

Unit 1: Discrete Fourier Transforms and its Properties **[7T+7L]**

The Discrete Fourier Transform (DFT), Time domain concepts of Circular time shift, time reversal, auto correlation and cross correlation. **Properties of the DFT:** Periodicity, Linearity, Circular time shift, time reversal, circular frequency shift, Symmetry Properties, auto correlation, cross correlation, parseval's theorem.

Unit 2: Fast Fourier Transform Algorithms **[7T+7L]**

Circular Convolution Concept and Its DFT Property, Examples on Time and Frequency domain. A linear filtering approach to computation of the DFT using overlap - add method, efficient computation of the DFT: FFT algorithms, direct computation of the FFT. Radix–2 FFT algorithms.

Unit 3: Design of IIR Filters **[7T+7L]**

Characteristics of commonly used analog filters and design of Butterworth and chebyshev analog filters. Frequency transformations in the analog domain, design of IIR filters from analog filters, IIR butterworth and chebyshev filter design using impulse invariance, and bilinear transformation method.

Unit 4: Design of FIR Filters and Digital Filter Structures **[7T+7L]**

Design of FIR filters, Symmetric and Anti symmetric FIR Filter, Design of Linear phase FIR Filter using Windows (Rectangular, Hamming, & Kaiser Windows).

Implementation of Discrete Time System: Direct Form -I, Direct Form II structures, Cascade Form Structures, Parallel Form Structures for IIR systems, Structure for FIR systems: Direct Form, Cascade Form Structures.

Text Books:

1. Proakis & Monalakis, Digital signal processing – Principles Algorithms & Applications, PHI, 4th Edition, New Delhi, 2007.

Reference Books:

1. Oppenheim & Schaffer, Discrete Time Signal Processing, PHI, 2003.
2. S.K. Mitra, Digital Signal Processing, Tata Mc-Graw Hill, 2nd Edition, 2004.
3. Sanjit K Mitra, Digital signal Laboratory using MATLAB, MGH Edition.2000.
4. Ashok Ambardar, Digital signal processing: A modern Introduction, Cengage Learning, 2009.

Ref: RU/BoS/ECE/CEC/May-2021-9

B19EM5064	Automotive Electronics	L	T	P	C
Duration :16 Wks		3	0	0	3

Prerequisites:

Microcontroller, Instrumentation and Transducers.

Course Description:

Electronics plays a major role in the current automobile industry. From a temperature sensor recording, the temperature outside the car to the Engine Control Unit (ECU), electronics has made driving relatively simpler and safer. It covers the topics on engine management systems, Sensors and actuating systems, Exhaust treatment systems, Automotive Diagnostics. It majorly concentrates on Communication Protocols used to communicate between different ECU's and finally it describes Electronic systems for Passenger Safety and convenience systems

Course Objectives:

Course objectives are to:

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 automotives, modeling and analysis of application software for ECU design and development, design of ECUs for automobiles, design of HIL and fault diagnostics

Course Outcomes:

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

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 programme Outcomes

Course Code	POS / COs	PO 1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19EM5064	CO1	1	1	1										1	1	1
	CO2	2	2	3										1	2	3
	CO3	2	2	3										1	1	3
	CO4	1	2	1										1	1	1

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Course Contents:

Unit-1: Automotive Industry and Modern Automotive Systems [11 Hrs]

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,

Unit-2: Introduction to automotive sensors and instrumentation [10 Hrs]

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: Exhaust After-Treatment Systems [11 Hrs]

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: Electronics for Passenger Safety and Convenience [10 Hrs]

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.

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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, "Automotive Electrical and Electronic Systems, Burlington", MA 01803, Elsevier Butterworth-Heinemann, 2004.
2. Ronald K. Jurgen, "Automotive Electronics Handbook", 2nd Edition, McGraw-Hill, 2007.
3. William B. Ribbens, "Understanding Automotive Electronics, 5th Edition, Newnes, 2006.
4. Robert Bosch GmbH, "Bosch Automotive Electrics & Electronics: Systems and Components, Networking and Hybrid Drive", Robert Bosch GmbH, 3rd Edition, 1999.

SC-5

B19EM5071	Control Systems	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Knowledge of Network analysis, Integration and differentiation, Matrix equations, Laplace Transform

Course Description:

In this course covers the transfer function modelling and state space modelling of electrical and mechanical system . The dynamic and steady state time domain response system is discussed. This course also covers stability criteria and stability analysis of system by root locus, RH critera ,Bode plot and Nyquist plot. The state space modelling methods in different canonical form and transformation from transfer function model to state space and vice versa and different methods of calculating state variable and calculating output variable is covered. The concept of controllability and observabilty and control system design using state space is briefly discussed.

Course Objectives:

The objectives of this course are:

1. To provide an understanding of system modeling.
2. To provide and understanding on the system response with and without feedback.
3. To provide a detailed understanding of time domain and frequency domain behavior of a system
4. To understand stability analysis of the system and its significance
5. To introduce the state variable approach for linear invariant system in both continuous time and discrete time for the analysis and design of system.
6. To design stable system in state space by pole placement method.

Course Outcomes:

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

1. Apply the concept of modeling of systems for simple mechanical and electrical system
2. Able to write the Transfer function using various techniques like using differential equations, Block diagrams, signal flow graphs.
3. Able to apply time domain and frequency domain analyses technique to determine stability of system.
4. Able to design the stable system.
5. Able to model a system in state space and solve state space equation
6. Able to identify the control solution possibility by applying controllability test and observability test.

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	PSO1	PSO2	PSO3
B19EM5071	CO 1	1	3	1	2									1	1	1
	CO 2	2	2	3	2									1	2	3
	CO 3	2	3	3	2									1	1	3
	CO 4	3	2	3	3									1	1	1

Course Contents:

Unit-1: Modeling of Systems **[11Hrs]**

Modeling and writing Transfer function (Both Electrical & Mechanical), Block Diagram reduction, Signal flow graph.

Performance of feedback control system, Test input signals, performance of second order system, S-plane Root location and Transfer function, steady state errors, case study.

Unit-2: Stability of linear feedback system **[10 Hrs]**

Concept of stability, RH Criteria, Relative Stability, RH Application. Case study

Root locus: Introduction to root locus, Procedure and problems, Effect of addition of pole zero to open loop systems. Case study

Unit-3: Frequency Response method **[11 Hrs]**

Introduction to Bode plots Performance measurement from Bode plots, problems on Bode plots case study.

Introduction to Nyquist criteria, Relative Stability, Comparison (Time domain & frequency domain), Problems on Time domain & frequency domain, case study

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Unit-4: state space analysis: **[10 Hrs]**

Introduction, concept of state variable and state model, state model for linear continuous time systems, state variable and linear discrete-time systems, Diagonalization , solution of state equation, concept of controllability and observability ,pole placement by state feedback, problems.

Text Books:

1. J. Nagarath and M.Gopal, "Control Systems Engineering", New Age International (P) Limited, Publishers, Fourth edition – 2005
2. K. Ogata, "Modern Control Engineering ", Pearson Education Asia/ PHI, 4thEdition, 2002

Reference Books:

1. W.Bolton, "Instrumentation and control Systems", Addison Wesley Publishing, ISBN: 0 2 -0 1997.
2. Richard Dorf& Robert H Bishop, "Modern Control Systems", Addison Wesley Publishing; ISBN: 0-201-32677-9, 2008.
3. Benjamin C. Kuo and Farid Golnaagi, "Automatic Control Systems", Wiley Student 8th Edition, 2009.
4. Joseph J Distefano III et al., Schaum'sOutlines, "Feedback and Control System", TMH, 2nd Edition 2007.

B19EM5072	Formal Languages & Automata Theory	L	T	P	C
Duration :14 Weeks		3	0	0	3

Prerequisites:

Basic computer concepts, discrete mathematical structures.

Course Description

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

Course Objectives:

The objectives of this course are to:

1. Introduce theory of automata and formal languages;
2. Prove or disprove theorems in automata theory using its properties;
3. Design grammars and recognizers for different formal languages;
4. Provide the basic knowledge and skills required to design and implement compilers.

Course Outcomes:

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

1. Acquire a fundamental understanding of the core concepts in automata theory and formal languages;

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2. Explain and manipulate the different concepts in automata theory and formal languages Have a clear understanding about the equivalence between deterministic and non-deterministic finite automata; and regular expressions;
3. Design automata; regular expressions and context-free grammars for accepting or generating a certain language;
4. Describe the language accepted by an automata or generated by a regular expression or a context-free grammar;
5. Simplify automata and context-free grammars.

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	PSO1	PSO2	PSO3
B19EM5072	CO 1	1	1	1										1	1	1
	CO 2	2	2	3										1	2	3
	CO 3	2	2	3										1	1	3
	CO 4	1	2	1										1	1	1

Course Contents:

Unit- I:

Introduction to finite automata: Alphabets; Languages; strings; Deterministic and non-deterministic finite automata (with and without epsilon) and their applications.

Unit- II:

Regular Expressions and languages: Regular Expressions; Finite Automata and Regular Expressions; Applications of Regular Expressions; Algebraic laws of regular expression

Unit – III:

Properties of regular languages and context free Grammar: Pumping lemma for regular languages; Closure properties of regular languages; Decision properties of Regular languages; Equivalence and Minimization of Finite Automata; Context Free Grammars; Parse Trees; Ambiguity in Grammars and languages; Applications of Context Free Grammars

Unit- IV:

Push Down Automata: Push down automata (PDA); Languages of a PDA; Equivalence of PDA's and CFG's; Properties of Context Free Languages; Normal Forms(CNF;GNF) for Context Free Grammars; Pumping lemma for CFL's; Closure properties of CFL; Decision properties of CFL's.

Textbooks:

1. John E Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Introduction to Automata Theory, Languages and Computation, 3rd Edition, Pearson Education, 2009.

References:

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1. Peter Linz, An Introduction to formal Languages and Automata, 4th Edition, Jones and Bartlett Publishers, 2006.
2. Kamala Krithivasan, Rama R, Introduction to Formal Languages, Automata Theory and Computation, Pearson, 2009.
3.B N Srinivasa Murthy, Formal Languages and Automata Theory, Sanguine Publishers, 2006.

B19EM5073	RF and Antennas	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Electromagnetism .Frequency Spectrum

Course Description:

The course introduces to the fundamentals of RF and Microwave frequencies, bands and various communication applications. The course gives insight to the fundamentals of antennas and types of antennas for different frequency applications. The course also covers the fundamental knowledge RF and Microwave communications and applications.

Course Objectives:

The objective of this course is to:

1. Understand RF and Microwave frequency spectrum and applications
2. Comprehend the fundamentals of antenna terminologies
3. Explain the construction and working of various types of Antennas
4. Describe the working of different RF and Microwave communication

Course Outcomes:

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

1. List the various frequency bands and application of Electromagnetic spectrum.
2. Distinguish the performance parameters of antenna
3. Categorize the antennas based on frequency and applications
4. Describe the working of different types of RF and Microwave Communication.

Mapping of Course Outcomes with Program 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
	CO1	2	2	1										1	1	1
	CO2	2	2	1										1	1	1
	CO3	2	2	1										1	1	1
	CO4	1	2	1										1	1	1

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Course Contents:

Unit-1: Fundamentals of RF and Microwaves: **[11 Hrs]**

Electromagnetic waves, Electromagnetic wave spectrum , frequency ranges and applications, circuit limitations of High frequency devices**.** types of transmission lines at RF and Microwave frequencies-Parallel wires, Coaxial cables, Micro strip lines ,optical fibers, waveguides (Construction, Specifications and Applications).Microwave semiconductor devices-Varactor diode, Schottky , PIN diodes

Unit-2: Fundamentals of Antenna: **[11 Hrs]**

Introduction to antenna, advantages, Parameters of antenna:-Radiation Pattern, Radiation intensity, Solid angle, Beam width, directivity and gain beam area and effective aperture. Friss free space equation.

Unit-3: Practical Antennas

Horn, Dish, Yagi-Uda, Mobile antennas- Whip, helical, Microstrip patch antenna, Embedded antenna, Wifi antennas-Dipole, Patch, Grid. Antennas specifications for 3G, 4G, 5G wireless networks.

Unit-4:Applications of RF and Microwaves **[10 Hrs]**

Principles of Working of –RADAR, Doppler RADAR, Satellite Communication, Mobile Communication, UMTS, RFID,WLAN ,GPS–Bands and Spectrum allocation

Text Books:

1. Samuel Y. Liao, "Microwave Devices and Circuits", Pearson education, 3rd Edition, 2011.

2. John d. Krauss, "Antennas and Wave propagation" McGraw-Hill International 4th Edition, 2010

Reference Books:

1. . Robert. E.Collin, "Foundation of Microwave Engg" Mc Graw Hill,2001.

2. Harish and Sachidananda." Antennas and Wave Propogation"., Oxford press

B19EM5074	Mechatronics	L	T	P	C
Duration: 14 Wks		3	0	0	3

Prerequisites:

Knowledge of elements of mechanical engineering, digital electronics and Microprocessor.

This course is an introduction to Mechatronic systems, which require integration of the mechanical and electronics engineering disciplines within a unified framework. Topics covered in the course include: Sensors, Transducers, elements of electrical actuation systems and signal conditioning circuits. It also describes the different concepts of system models and controllers. Finally, it covers the concept of of programming logic controllers.

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Course Objectives:

The objectives of this course are:

1. To understand the requirements of Mechatronics systems and recognize its various elements.
2. To understand the actuation systems and signal conditioning circuits.
3. To understand the concepts of system models and controllers
4. To understand the implementation of programmable logic controllers for Mechanical drives.

Course Outcomes:

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

1. Define Mechatronics systems and recognize its various elements.
2. Compile the key elements of electrical actuation systems and signal conditioning circuits.
3. Demonstrate the concepts of system models and controllers.
4. Understand the concepts of programming logic controllers.

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	PSO1	PSO2	PSO3
B19EM5074	CO 1	1	1	1										1	1	1
	CO 2	2	2	3										1	2	3
	CO 3	2	2	3										1	1	3
	CO 4	1	2	1										1	1	1

Course Contents:

Unit-1: Sensors and Transducers **[11 Hrs]**

Introduction to Mechatronics Systems, Measurement Systems, control Systems, Microprocessor basd Controllers. Sensors and Transducers , PerformanceTerminology , Sensors for Displacement, Position and Proximity; Velocity, Motion,Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors Selection of Sensors.

Unit-2: Actuation Systems **[10 Hrs]**

Rotary Actuators, MechanicalActuation Systems, Cams, Gear Trains,Ratchet and pawl Beltand C hain Drives, Bearings.Electrical Actuation Systems, Mechanical Switches Solid State Switches ,Solenoids Constructionand working principle of DC and AC Motorsspeed controlof AC and DC drives, Stepper Motorsswitching circuitries for stepper motor,AC & DC Servo motors.

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Unit-3: System Models and Controllers **[11 Hrs]**

Building blocks of Mechanical, Electrical, Fluid and Thermal systems, Rotational, Translation systems, electromechanical systems, Hydraulic Mechanical Systems. Continuous and discrete process Controllers, Control Mode, Step mode, Proportional Mode, Derivative Mode, Integral Mode, PID Controllers, Digital Controllers, Velocity Control, Adaptive Control, Digital logic control, Microprocessors control.

Unit-4: Programming Logic Controllers **[10 Hrs]**

Programmable Logic Controllers, Basic Structure , Input / Output Processing ,Programming , Mnemonics , Timers, Internal relays and counters , Shift Registers , Master and Jump Controls , DataHandling , Analogs Input / Output, Selection of a PLC.

Text Books:

1. Mechatronics- W. Bolton, Longman, 2nd Pearson Publications, 2007
2. Microprocessor Architecture, programming and applications with 8085.8085A- R.S. Ganokar, Wiley Eastern.

Reference Books:

1. Mechatronics Principles & applications by Godfrey C. Canwerbolu, Butterworth- Heinemann 2006.
2. Mechatronics- danNecsulescu, Pearson Publication, 2007
3. Introduction Mechatronics & Measurement systems, David. G. Aliciatore & Michael B. Bihistand, tata McGraw Hill, 2000.
4. Mechatronics: Sabricentinkunt, John wiley & sons Inc. 2007

SC-6

B19EM6041	Real Time Systems	L	T	P	C
Duration 14 Weeks		3	0	0	3

Prerequisites:

Basics of Embedded Systems, Structure of Embedded System, Programming assembly Language in C.

Course Description:

This course is intended to provide the understanding of hard and soft real-time systems. This is a course on the design and applications of all real time aspects of various system components, like OS, memory, communication, quality of service system principles, resource management and focus on their functionality and implementation platforms. A range of methodologies for specifying and designing hardware and software components of the real time systems is discussed. It also explains about the programming knowledge required to code the real time systems.

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Course Objectives:

The objectives of this course are to:

1. Introduce basic concepts relating to real-time systems and their characteristics.
2. Know the important hardware building blocks for computer used for control.
3. Introduce concepts of RTOS, tasks and resource management.
4. Present specific language features desirable in real-time system design.
5. Review several widely used programming languages in real-time system design.
6. Understand the methodologies to help in the specification, design and construction of real-time software and real-time systems.

Course Outcomes:

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

1. Describe the characteristics of Real-Time Systems.
2. Identify the hardware building blocks for Real-Time Systems.
3. Analyze resource management for real-Time Systems.
4. Categorize programming languages for different real-time systems.
5. Apply the different methodologies for designing Real-Time Systems.

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	PSO1	PSO2	PSO3
B19EM6041	CO 1	1	1	2										1	1	1
	CO 2	3	2	3										1	2	3
	CO 3	2	3	3										1	1	3
	CO 4	1	2	1										1	1	1

Course Contents:

Unit 1:Introduction to Real-Time Systems **[11 Hrs]**

Real Time Systems- Definition, Classification of Real-Time Systems, Time Constraints, Classification of Programs

.

Advanced Hardware Fundamentals: Microprocessors, Buses, Direct Memory Access, Interrupts, Other Common Parts, Built-Ins on the Microprocessor, Conventions Used on Schematics.
Interrupts- Basics, The Shared-Data Problem, Interrupt Latency.

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Unit 2: Operating Systems **[11 Hrs]**

Introduction, Real-Time Multi-Tasking OS, Scheduling Strategies, Priority Structures, Task Management, Scheduler and Real-Time Clock Interrupt Handler, Memory Management, Code Sharing, Resource Control, Task Co-Operation and Communication, Mutual Exclusion.

Unit 3:Programming Languages for Real-Time Systems **[10 Hrs]**

Coding of Real-Time Software, Assembly Language, Procedural Languages, Object-Oriented Languages, Overview of Programming Languages, Automatic Code Generation, Complier Optimizations of Code.

Unit 4: Design of RTS **[10 Hrs]**

General Introduction: Introduction, Specification Document, Preliminary Design, Single-Program Approach, Foreground/Background System.

RTS Development Methodologies: Introduction, Yourdon Methodology, Ward and Mellor Method, Hately and Pirbhai Method.

Text Books:

1. Stuart Bennett, "Real-Time Computer Control", Pearson, Second Edition, 1994.
2. David E. Simon, "An Embedded Software Primer", Pearson Education, 1999.
3. Phillip A. Laplante, Seppo J. Ovaska, " Real-Time System Design and Analysis: Tool for the Practitioner", Wiley, Fourth Edition, 2012.

Reference Books:

1. C.M. Krishna and Kang G. Shin, "**Real Time Systems**", MGH, 1997.
2. Jane W. S. Liu, "**Real Time Systems**," Pearson Education, 2000.
3. Raj Kamal , "**Embedded Systems Architecture, Programming and Design**," Second Edition, TMH, 2003

B19EM6042	Optimization Techniques	L	T	P	C
Duration:14 Weeks		3	0	0	3

Prerequisites:

Discrete mathematics

Course Descriptions:

The Course intends to make students learn the techniques needed for compiler construction and develops analytical skills. The course is conceptual.

Course Objectives:

The objectives of this course are to:

1. To give insights into the optimization techniques, concepts of design space, constraint surfaces and objective function.
2. To provide information on linear programming

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3. To Discuss different types of parsers and syntax directed definition and translation.
4. Demonstrate how code optimization and code generation is done for a given source code.

Course Outcomes:

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

1. Describe the overview of optimization techniques, concepts of design space, constraint surfaces and objective function.
2. Formulate real-life problems with Linear Programming
3. Solve the Linear Programming models using graphical and simplex methods.
4. Analyze the Queuing model for effective customer satisfaction
5. Determine the level of inventory that a business must maintain to ensure smooth operation
6. Apply dynamic programming to optimize multi stage decision problems.

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
B19EM6042	CO 1	3	3	1									3	3		
	CO 2	3	1	2									3	2		
	CO 3	3	2	2									3	2		
	CO 4	3	2	2									3	2		
	CO 5	3	3											3		2
	CO 6	2	3	2										2	1	

UNIT- 1

Introduction to Classical Optimization Techniques:

Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.

Classical Optimization Techniques: Single variable Optimization, Multi variable Optimization with and without constraints, Multivariable Optimization with equality constraints - solution by method of Lagrange multipliers, Multivariable Optimization with inequality constraints - Kuhn – Tucker conditions.

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UNIT -2

Linear Programming: Various definitions, statements of basic theorems and properties, Advantages, Limitations and Application areas of Linear Programming, Graphical method of Linear Programming problem. Simplex Method: Phase I and Phase II of the Simplex Method, The Revised Simplex method, Primal and Dual Simplex Method, Big –M method.

UNIT- 3

Dynamic Programming: Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

Integer Programming: Pure and mixed integer programming problems, Solution of Integer programming problems – Gomory's all integer cutting plane method and mixed integer method, branch and bound method, Zero-one programming.

UNIT- 4

Simulation Modeling: Introduction, Definition and types, Limitations, Various phases of modeling, Monte Carlo method, Applications, advantages and limitations of simulation

Recommended Learning Resources (Textbooks):

1. Engineering optimization: Theory and practice"-by S.S.Rao, New Age International (P) Limited.

2. Operations Research: An Introduction" by H A Taha, 5th Edition, Macmillan, New York.

3. Operations Research by NVR Naidu, G Rajendra, T Krishna Rao, I K International Publishing house, New Delhi.

Reference books

1. Optimization Methods in Operations Research and systems Analysis" – by K.V. Mittal and C. Mohan, New Age, International (P) Limited, Publishers
2. Operations Research – by S.D.Sharma, Kedarnath Ramanath & Co

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B19EM6043	Digital Communication	L	T	P	C
Duration :14 Wks		2	0	1	3

Prerequisites:

Fundamentals of Communication, Probability and Random Process.

Course Description:

Digital communication has proliferated in a big way in previous and today's electronic and telecommunication industries. It allows devices to exchange information digitally while making the communication more clear and accurate without losses. In addition to changing our daily lives, the transformation in digital communications paves a way to many applications in fields such as signal processing, video compression, data compression, mobile technology, etc. This course helps students to get a good idea of how the signals are digitized and why digitization is needed. Various waveform coding techniques are discussed in detail. The clear intentions behind choosing an appropriate digital modulation scheme are taught. This course also covers different techniques to share a common channel among multiple devices for data transmission. Finally, it presents various methods of spread spectrum technology in pursuit of achieving secured communication

Course Objectives:

The objectives of this course are:

1. To provide the basics of digital Communication with respect to Sampling & Quantization.
2. To introduce the fundamentals of Pulse Code Modulation (PCM), Differential pulse code modulation (DPCM) and Delta Modulation (DM) and Adaptive DM methods.
3. To describe the optimum coherent receivers such as correlation receiver and matched filter receiver for AWGN channel.
4. To familiarize with several digital modulation methods like BPSK, BFSK, QPSK, M-ary QAM , M-ary PSK and DPSK schemes, draw constellation diagrams, and compute their probability of error.
5. To present baseband signal shaping.
6. To render the understanding of multiple access techniques.
7. To provide the notion of spread spectrum technique and familiarize the conceptual elements of spread spectrum.
8. To introduce the applications of spread spectrum.

Course Outcomes:

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

1. Describe the importance of sampling and quantization on signals.
2. Apply suitable coding and multiplexing techniques.
3. Illustrate the different digital modulation techniques with transmitter and receiver.

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4. Compare multiple access and spread spectrum techniques.

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	PSO1	PSO2	PSO3
B19EM6043	CO 1	1	1	1										1	1	1
	CO 2	2	2	3										1	2	3
	CO 3	2	2	3										1	1	3
	CO 4	1	2	1										1	1	1

Course Contents:

Unit -1: Digital Communication Fundamentals and Sampling Process [6T+5L]
Digital communication System- Advantage, functionality of blocks, transmission medium, Sampling theorem, Natural sampling, Flat top sampling, sample and hold circuit, Quadrature sampling of band pass signal, Quantization noise and SNR ,Robust quantization, Pulse Code Modulation.

Unit -2: Waveform Coding Techniques [5T+5L]

Time division multiplexing, Line coding, Differential pulse code modulation, Delta modulation, errors in delta modulation (Slope overload and granular), Adaptive delta modulation, Coding speech at low bit rate (Adaptive DPCM, Adaptive Sub-band coding).

Unit -3: Optimum Detection and Digital Modulation Techniques [6T+5L]
Optimum Detection: AWGN Channel, Probability of Error, Correlation receiver, Matched Filter receiver, Detection of signals with unknown phase in noise,
Digital Modulation Techniques: Generation, Coherent Detection, Constellation and error probability of BPSK, BFSK, QPSK, M-ary QAM, M-ary PSK, Non-coherent binary modulation techniques-DPSK.

Unit -4: Baseband Shaping, Multiple Access and spread spectrum techniques [5T+5L]

Synchronization, Inter symbol interference, Eye pattern.
Multiple access: TDMA, FDM/FDMA, CDMA, SDMA, OFDM/OFDMA

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Spread spectrum –Pseudo noise sequence, Notion of spread spectrum, DSSS- Direct sequence spread spectrum, FHSS-Frequency Hop spread spectrum, application of spread spectrum, Applications of spread spectrum (CDMA and Multipath Suppression).

Text Book:

1. Simon Haykin, "Digital Communication Systems", John Wiley publication, 3rd edition, 2008.

Reference Books:

1. Simon Haykin, "Digital Communication Systems", John Wiley publication, 1st edition, 2014.
2. K. Sam Shanmugam, "An introduction to analog and digital Communication system", John Wiley publication, 3rd edition, 2008.
3. BernadSklar, "Digital Communication", Pearson education 2007.

T L Singal, "Digital Communication", McGraw Hill Education 2015

B19EM6044	Project Management	L	T	P	C
Duration :16 Wks		3	0	0	3

Prerequisites:

No Prerequisites

Course Description:

Project management course provides concept of project management that is very much essential to handle projects efficiently. It covers the topics on phases of project life cycle, roles and responsibilities of leaders, Project management and estimation. It also covers the concepts of Project scheduling, coordination and control. Finally, it covers the concept of performance measure in Project management to estimate the quality of project management.

Course Objectives:

The objectives of this course are to:

1. Understand project management, methodology
2. Know the use of project management tools, techniques and skills.
3. Understand how to manage the project cost, quality and delivery.
4. Learn the skill of selection and initiation of individual projects and portfolios of projects In the enterprise.

Course Outcomes:

At the end of this course, student will be able to:

1. Identify specific management needs in the execution of projects at tactical and strategic level.
2. Estimate the project proposals for scope, time and cost to consider its feasibility.

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3. Synthesis the strategies to evolve suitable approach to accomplish the project with effective usage of the resources.
4. Illustrate the team building and leadership skills in planning and implementation of the project.
5. Apply effective management technique in the project execution to fulfill the desired objectives.

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	PSO1	PSO2	PSO3
B19EM6044	CO 1		1	1							1	3		1	1	1
	CO 2	2	2	3							1	3		1	2	3
	CO 3	2	2	3							1	3		1	1	3
	CO 4	1	2	1							1	3		1	1	1

Course Contents:

Unit 1: Concept of Project Management [10 Hrs]
Concept of Project Management: Concept of project, categories of projects, phase of project life cycle, roles and responsibility of a project leader, tools and technology for project management. Organizing and Staffing: Project leader: skills/abilities required for project manager, authorities and responsibilities of project manager, project organization, types of accountability in project execution and control

Unit 2: Project Planning and Estimation [11 Hrs]
Project Planning and Estimation: Feasibility study and report, phased planning, project planning steps: objectives and goals of the project, preparation of cost estimation, finalization of project implementation, evaluation of the project profitability. Project Procedure Manual: Contract management, configuration management, communication management, man management, time management, materials management, cost management, needs for flexibility.

Unit 3 Project Scheduling, Coordination and Control [10 Hrs]
Project Scheduling, Coordination and Control: Project implementation, scheduling-different techniques GANTT charts, bar charts for combined activities, Project direction, communication in a project, project coordination, project control, scope and progress control performance control, schedule control and cost control, case study.

Unit 4: Performance Measures in Project Management [11 Hrs]
Performance Measures in Project Management and Project Inventory Management: Performance indicators, performance improvement for the CM and DM companies for better project management,

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nature of project inventory, supply and transportation of materials. Project Implementation: project work system design, work break down structure (WBS), project execution plan (PEP)

Text Books

1. Herold Kerzner: Project Management, a system approach to planning, scheduling and controlling, CBS publishers and distributors, 2002
2. Chaudhry S: Project Management, McGraw Hill 2010

Reference Books

1. Harvey Maylor: Project Management, 3rd edition, Pearson, 2003.

SC-7

B19EM6051	Component Engineering	L	T	P	C
Duration :14 Weeks		3	0	0	3

Prerequisites:

Basics of Physics, Electrical Components, Electro Mechanical Components.

Course Descriptions:

Component engineering involves the selection, maintenance, design, and construction of smaller components for larger machines. Component engineers are needed in all manufacturing industries, from the auto and space industries to defense. A degree in mechanical, electrical, or metallurgical engineering may be required for those seeking a job in component engineering.

Course Objectives:

The objectives of this course are to:

1. Understand the students to ensure specific components used in manufactured products and systems to make reliable and effective.
2. Comprehend the knowledge in the field of design, assembly, and testing of components to meet the specifications for quality and performance.
3. Develop the knowledge about the basic manufacturing mechanical and electrical systems used in the industry

Course Outcomes:

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

1. Examine and compare the applications of various types of cables, connectors and fuses.
2. Differentiate the various Switches and their usage.

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3. Interpret the construction, working and applications of various types of relays.
4. Summarize the various types of heat sink and heat cooling process.
5. Appraise the reliability and maintainability in industries.

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
B19EM6051	CO 1	3	3										3	3		
	CO 2	3											3	2		
	CO 3	3	2										3	2		
	CO 4	3	2										3	2		
	CO 5	3	3											3		2

Unit 1: **Cables, Connectors and Fuses** **[11 Hrs]**

Cables:

General specifications of cables- characteristic impedance, current carrying capacity, flexibility. Types of cables - construction and applications of coaxial cable, 600 E telephone cable-PASP, Alpeth sheathed cable, FRC cable, twin core cable twisted & shielded type, optical fibre cable

Connectors:

General specifications of connectors- contact resistance, breakdown voltage, insulation resistance, Constructional diagram, applications of BNC, D series, Audio, Video, printer, edge, FRC, RJ 45 connectors. Constructional diagram and applications of phone plug & jacks

Fuses:

Glass, ceramic fuse, resettable fuse, shunt fuse- MOV, HRC fuse

Unit 2: Switches and Relays **[10 Hrs]**

Switches

Switch specifications – voltage rating, contact current rating, contact resistance, characteristics of switch & relay – operating time, release time, bounce time, constructional diagram, application of toggle, rotary, push to on & push to off, rocker.

Relays

Construction, working and application of general-purpose relay, NO, NC contact, reed relays, solid state relays, difference between switch & relay.

Unit 3: Heat Management and parasitic electrical effects **[10 Hrs]**

Heat Transfer, Thermal resistance, Heat sinking, Forced Cooling, advanced heat-removal techniques, parasitic circuit elements, Distributed parameter circuits, problems related to above topics.

Unit 4: Electromagnetic effects and Reliability and maintainability **[11 Hrs]**

Electromagnetic interference, application studies, Failure, The “bathtub” curve, measures of reliability and maintainability, High reliability systems and Maintenance, problems**.**

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Text Books:

1. Stephen Sangwine, "Electronic Components and Technology", 3rd Edition, ISBN 9781315221779
2. Grover & Jamwal, "Electronic Components and Materials", 2nd edition, New Delhi: Shroff Publishers and Distributors, ISBN 81-7366-549-4.
3. SK Bhattacharya, "Electrical and Electronic Engineering Materials", Khanna Publishers, Delhi ISBN: 9788187394247
4. SK Sahdev, "Electrical Engineering Materials", Unique International Publications, Pearson Education India, 2015, ISBN: 9332547114, 9789332547117
5. SM Dhir, "Electronic Components and Materials", Tata Mc Graw Hill, New Delhi, 0074630822, 9780074630822

B19EM6052	Complier Design	L	T	P	C
Duration :14 Weeks		3	0	0	3

Prerequisites:

Finite Automata and formal languages

Course Descriptions:

The Course intends to make students learn the techniques needed for compiler construction and develops analytical skills. The course is conceptual.

Course Objectives:

The objectives of this course are to:

1. Explain the concepts of Object-Oriented programming, Object-Relational Databases and Compilers.
2. Describe how syntax tree can be constructed to check the syntax of the given input.
3. Discuss different types of parsers and syntax directed definition and translation.
4. Demonstrate how code optimization and code generation is done for a given source code

Course Outcomes:

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

1. Outline the concepts of Object-Oriented programming, Object-Relational Databases and Compilers.
2. Construct a syntax tree to check the syntax of the given input.
3. Apply the different types of parsers and syntax directed definition and translation to check the syntax of the given input.
4. Implement code optimization and code generation.

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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
B19EM6052	CO 1	3	3										3	3		
	CO 2	3											3	2		
	CO 3	3	2										3	2		
	CO 4	3	2										3	2		
	CO 5	3	3											3		2

UNIT- 1

Overview of Object-Oriented Concepts, Object and Object-Relational Databases: Introduction to Compilers: Language processors; the structure of a Compiler.

Lexical analysis: Tokens, Regular expressions, Finite state automata, translating regular expressions into finite state automata.

UNIT -2

Syntax analysis 1: Context-free grammars, Derivations and syntax trees, Handling ambiguous grammars, Top-down parsing, Bottom-up parsing – SLR( );

UNIT- 3

Syntax Analysis 2: More powerful LR Parsers;

Syntax-directed translation: Syntax-directed definitions; Evaluation orders for SDDs; Applications of syntax-directed translation; Parser stack implementation of Postfix SDT;

UNIT- 4

Code optimization and generation: Basic blocks and Flow graphs; Optimization of basic blocks;

Intermediate code generation: Variants of syntax trees; Three-address code; Control flow; back patching.

Self-learning component:

More Recent Applications: translating regular expressions into finite state automata; survey of latest compilers for dealing with parallel programming.

Recommended Learning Resources (Text books):

l. A. V. Aho, R. Sethi and J. D. Ullman, Compilers – Principles, Techniques, and Tools, Addison-wesley, Pearson Education, 200l.

Charles N. Fischer, Richard J. leBlanc, Jr., Crafting a Compiler with C, Pearson Education, l99l.

Kenneth C Louden, Compiler Construction Principles & Practice, Cengage Learning, l997.

Reference books

l. A.W. Appel, Modern Compiler Implementation in Java, Cambridge University Press, 2002.

Ref: RU/BoS/ECE/CEC/May-2021-9

B19EM6053	Image Processing	L	T	P	C
Duration : 14Wks		3	0	0	3

Prerequisites

Signals & Systems, Digital Signal Processing, Linear Algebra

Course Description:

This course covers the investigation, creation and manipulation of digital images by computer. The course consists of theoretical material introducing the mathematics of images and imaging. Topics include representation of two-dimensional data, time and frequency domain representations, filtering and enhancement, , convolution, color images, compression and segmentation. This course found wide applications not only in the space program, but also in the areas such as medicine, biology, industrial automation, astronomy, defense and intelligence.

Course Objectives:

1. To recall the mathematical & signal principles, forming the basis for methods for image processing.
2. To understand image representation, enhancement, filtering, restoration, analysis & reconstruction.
3. To know the processing techniques including various image transformations, image reconstruction, segmentation & recognition.
4. To design & conduct imaging experiments using MATLAB.
5. To convert image from RGB to gray, black & white, remove blurring effects, noise reduction, edge detection, compression and segmentation.
6. To understand concepts and types of video ans video compression standards.

Course Outcomes

On completion of this course the student shall be able to

1. Acquire the fundamental concepts of a digital image processing system
2. Identify and exploit analogies between the mathematical tools used for 1D and 2D signal analysis and processing.
3. Analyze 2D signals in the frequency domain through the Fourier transform.
4. Design with Matlab algorithms for digital image processing operations such as histogram equalization, enhancement, restoration, filtering, and de-noising.

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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	PSO1	PSO2	PSO3
B19EM6053	CO 1	2	1	1										1	1	1
	CO 2	2	2	3										1	2	3
	CO 3	2	2	3										1	1	3
	CO 4	1	2	1										1	1	1

Course Content:

Unit-1: Introduction [11hrs]

Image Sampling, Quantization, Resolution, Classification of Digital Images, Image Types, Image File Formats,2D signals, Separable Sequence, Periodic Sequence, 2D convolution, 2D Convolution using graphical Method, Circular and linear Convolution Through matrix Analysis and its applications, 2D Auto correlation, cross correlation. Light and color, Color Formation, Human Perception of color, color Model, The chromaticity Diagram.

Unit-2: Image Transforms [10hrs]

2D Discrete Fourier Transform, Properties of 2D-DFT, DCT , properties ,Haar Transform, properties, Hadamard transform, properties, slant transform ,properties. Image Enhancement in spatial Domain, Enhancement through point operation, Types of Point operation, Histogram Equalization(problems), Linear and Non Linear Grey-level Transformation, Median Filter.

Unit-3: Image Restoration and De-noising [11hrs]

Image Degradation, Types of Image Blur, , Classification of Image Restoration Techniques, Image restoration model, Linear Image restoration techniques and non-linear Image restoration techniques, Wiener filter, Inverse filter, Blind Deconvolution and classification, Image Denoising.

Unit 4: Image Segmentation and Compression [10hrs]

Classification of Image-Segmentation Techniques, Region approach to image segmentation, Clustering Techniques, Image segmentation based on Thresholding, Edge Based Segmentation, Classification of Edges, Edge Detection. Image Compression Scheme, Classification, Huffman Coding, JPEG

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Text Books:

1.S. Jayaraman, S Esskairajan "**Digital Image Processing**", illustrated, Tata McGraw-Hill Education, 2011
2.R. C. Gonzalez and R. E. Woods, "**Digital Image Processing**" 2nd edition, Pearson Education (Asia) Pte. Ltd/Prentice Hall of India, 2004.
3.Anil K. Jain, "**Fundamentals of Digital Image Processing**," Pearson Education (Asia) Pte. Ltd./Prentice Hall of India, 2004.

Reference Books:

1. Z. Li and M.S. Drew, "**Fundamentals of Multimedia**" Pearson Education (Asia) Pte. Ltd., 2004.
2. M. Tekalp, "**Digital Video Processing**", Prentice Hall, USA, 1995.

B19EM6054	Robotics & Automation	L	T	P	C
Duration: 14 Wks		3	0	0	3

Prerequisites:

Embedded System Design, Control systems, Programming skills

Course Description:

Robotics is the interdisciplinary branch of engineering and science that includes mechanical engineering, electrical engineering, computer science, and others. Robotics deals with the design, construction, operation, and use of robots as well as computer systems for their control, sensory feedback, and information processing. Automation and Robotics are two closely related technologies. Automation as the technology that is concerned with the use of mechanical, electronic, and computer based systems in the operation and control of production. The course provides robot classification and anatomy, Robot kinematics, Trajectory Planning and control, Sensors and vision systems used in robots and Robot Programming

Course Objectives:

The objectives of this course are to:

1. Classify Robots and anatomy.
2. Understand Robot kinematics
3. Determine Sensors and vision systems used in robots.
4. Write Robot Program.

Course Outcomes:

At the end of this course, student will be able to:

1. Summarize the basic applications and advantages of using robots in the industry.
2. Do the robot motion analysis.
3. Relate mathematical modeling and trajectory planning scheme in robots.
4. Recognize the different types of sensors and cameras used in the field of robotics.
5. Write robot programs and upgrade knowledge on different types of cell layout applicable in robotics.

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Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
B19EM6054	CO1	1	1	1										1	1	1
	CO2	2	2	3										1	2	3
	CO3	2	2	3										1	1	3
	CO4	1	2	1										1	1	1

Course Contents:

Unit -1: Introduction to robotics [14 Hrs]

Definition, anatomy of robot, classification configurations, robot links and joints, robot specifications, resolution accuracy and repeatability, simple numerical problems, robot drive systems, hydraulic, pneumatic and electric drive systems, wrist and its motions, end effectors, types of end effectors, mechanical grippers, methods of constraining parts in grippers, types of gripper mechanisms, simple numerical problems, vacuum cups, magnetic grippers, adhesive grippers, hooks, scoops and other gripper devices, tool as end effectors, examples.

Unit -2: Robot motion analysis & Robot control [14 Hrs]

Direct kinematics and inverse kinematics, 3D homogeneous transformations, rotation, translation and displacement matrix, composite rotation matrix, rotation matrix about an arbitrary axis, links, joints and their parameters, Denavit-Hertenberg (D-H) representation, application of D-H matrices to different robot configurations.

Basic control systems and models, transfer function with examples, transfer function for spring-mass-damper system, transient response of a second order system, transfer function of a robot joint, different types of controllers, proportional (P) controller, integral (I) controller, derivative (D) controller, PID controller, simple numerical problems

Unit -3 Robot trajectory planning & Robot sensors [14 Hrs]

Trajectory planning, definition, steps in trajectory planning, joint space techniques, use of a p-degree polynomial as interpolation function, cubic polynomial trajectories, linear function with parabolic blends, joint space verses Cartesian space trajectory planning, simple numerical problems on joint space trajectory planning. Classification of robot sensors and their functions, touch sensor, tactile sensor, binary sensor, analog sensor, proximity sensor, range sensor, force and torque sensor.

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Unit -4 Robot sensors and Machine Vision & Robot programming [14 Hrs]

Machine vision, functions of machine vision system, sensing and digitizing, imaging devices, analog to digital signal conversion, quantization and encoding, simple numerical problems, image storage, image processing and analysis, image data reduction, segmentation, feature extraction, object recognition, robotic machine vision applications, inspection, identification, visual servoing and navigation.

Introduction to robot programming, robot cell layout, work cell control and interlocks, manual programming, lead through and walkthrough programming, off-line programming, VAL programming language, example, AML and VAL-II robot programming languages, examples, Programming with graphics, example.

Text Books:

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey: Industrial Robotics, McGraw-Hill Publications, International Edition, 2008.
2. James G. Keramas: Robot Technology Fundamentals, Cengage Learning, International Edition 1999.

Reference Books:

1. Fu K. S., Gonzelez R. C., Lee C. S. G: Robotics: Control, Sensing, Vision, IntelligenceMcGraw Hill Book Co., International edition, 2008.
2. Yorem Koren,: Robotics for Engineers, McGraw-Hill Publication, International edition, 1987
3. Craig, J. J: Introduction to Robotics: Mechanics and Control, Pearson Prentice-Hall Publications, 3rd edition, 2005.
4. Schilling R. J: Fundamentals of Robotics, Analysis and Control, Prentice-Hall Publications, Eastern Economy edition, 2007
5. Appu Kuttan K. K: Robotics, International Publications, First Edition, 2007
6. R. K. Mittal, I. J. Nagrath: Robotics and Control Tata-McGraw-Hill Publications, 2007.

SC-8

B19EM6061	MEMS	L	T	P	C
Duration: 14 Wks		3	0	0	3

Prerequisites:

Engineering Physics, Upper Division standing in Engineering, Chemistry or Chemical Engineering and Material Science, VLSI Technology, Elements of Mechanical Engineering.

Course Description:

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Micro-Electro-Mechanical Systems (MEMS) is a multidisciplinary area that includes a design and fabrication of sensors and actuators which are capable of micron-size mechanical movements. Lectures cover a wide range of topics in design, fabrication and packaging of MEMS.

Course Objectives:

The objectives of this course are:

1. To 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. Understand the chemical and physical vapor processes; heteroepitaxy and defects; substrates and substrate engineering.
5. Convey knowledge of advanced concepts of lithography and etching.
6. Understand electrostatic, thermal, piezoelectric and magnetic actuators at micro scale.
7. Understand the applications of MEMS.
8. Understand device fabrication fundamentals: diffusion, ion implantation

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	PSO1	PSO2	PSO3
B19EM6061	CO 1		1	1							1	3		1	1	1
	CO 2	2	2	3							1	3		1	2	3
	CO 3	2	2	3							1	3		1	1	3
	CO 4	1	2	1							1	3		1	1	1

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Course Contents:

Unit 1: Introduction to MEMS **[11 Hrs]**

Overview of MEMS and Microsystems: What are MEMS, Why Miniaturization, Why micro fabrication, 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 **[11 Hrs]**

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 **[10 Hrs]**

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 **[10Hrs]**

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.
4. S. M. Sze, “VLSI Technology”, McGraw-Hill, Second Edition.
5. Nadim Maluf, Kirt Williams “An Introduction to Microelectromechanical Systems Engineering” Second addition.

B19EM6062	Cryptography and Network Security	L	T	P	C
Duration :14 Wks		3	0	0	3

Ref: RU/BoS/ECE/CEC/May-2021-9

Prerequisites:

Basics of digital communication, computer communication.

Course Description:

It is a concept-oriented course, which deals with principles and practice of cryptography and network security. The course enables student to become master in different encryption techniques such as DES, AES, RSA etc. The student will have knowledge of attacks in distributed system and its counter measures. The student shall be able to explore the state of art technology such as hash functions, authentications, Key management, Key exchange, signature schemes, Transport layer security, web security, etc.

Course Objectives:

The objectives of this course are:

1. Explain the difference between cryptanalysis and brute force attack.
2. Explore the operation of substitution and transposition technique and DES. Present general structure of AES and 4 transformations.
3. Discuss basic principles of public key cryptosystems and familiarise with following algorithms: RSA, Diffie Hellman **key exchange, Elgamal cryptographic system, Elliptic curve.**
4. **Summarise applications of cryptographic Hash functions, Message Authentication Codes and significance of Digital signatures.**
5. Explain issues involved in: public key distribution and analyze risks, asymmetric encryption to distribute symmetric keys, web security threats, overview of SSL, transport layer and HTTPS.

Course Outcomes:

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

1. Illustrate different types of substitution and transposition techniques.
2. Acquire the block cipher knowledge using DES and AES.
3. Describe different public key cryptosystems.
4. Discuss various types of Hash functions and MACs.
5. Illustrate different key management techniques.
6. Describe transport layer security.

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	PSO1	PSO2	PSO3
B19EM6062	CO 1	1	1	1										1	1	1

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	CO 2	2	2	3									1	2	3
	CO 3	2	2	3									1	1	3
	CO 4	1	2	1									1	1	1

Course Contents:

Unit-1: Encryption Techniques & DES **[11 Hrs]**

Security attacks and security mechanisms. Encryption Techniques: Symmetric cipher model, Substitution techniques, Transposition techniques, Rotor machines, Steganography.

Data Encryption Standard (DES): DES encryption and decryption, Strength of DES, Block Cipher design principles.

Unit-2: AES and Public-Key Cryptography **[10 Hrs]**

AES: Structure, transformation functions, key expansion.

Public-Key Cryptography: Principles of public key cryptosystems, RSA Algorithm, Diffie Hellman key exchange, Elgamal cryptographic system, Elliptic curve arithmetic.

Unit-3: Hash Functions, MACs and Digital Signature **[11 Hrs]**

Cryptographic Hash Functions: Two Simple Hash Functions, Hash function based on cipher block chaining, Message authentication requirements.

Message authentication functions: Requirements of MAC, Security of MACs, MAC based on hash functions: HMAC, Digital Signatures.

Unit-4: Key Management and Transport Layer Security **[10 Hrs]**

Key management: Symmetric key distribution using symmetric encryption, Symmetric key distribution using asymmetric encryption, distribution of public keys.

Transport-layer security**:** Web Security Considerations, Secure Sockets Layer, TLS, HTTPS.

Text Book:

1. William Stallings, "Cryptography and Network Security, Principles and Practice", 6th edition, Pearson/Prentice Hall, 2011.

Reference Books:

1. Atul Kahate, "Cryptography and Network Security", 2nd edition, Tata McGraw Hill, 2007
2. Eric Maiwald, "Fundamentals of Network Security", McGraw-Hill, 2003

B19EM6063	Wireless Communication	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Computer Communication Networks, Analog-Digital Modulation techniques, Introduction to Antenna and wave propagation.

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Course Description:

This course introduces students to wireless communication and networks and concentrates on building a firm foundation for understanding the concepts of Cellular communication, Wireless Network Architecture. This course also covers the cellular wireless technologies (Global System for Mobile communication and Coded Division Multiple Access). Students are also introduced to the modern digital modulation techniques and other encoding methods which are used to mitigate wireless propagation effects.

Course Objectives:

The objectives of this course are:

1. Understand the evolution and various generations of wireless networks
2. Understand the needful concepts behind the wireless architecture and operation
3. Understand the system operation for GSM networks
4. Understand the various modulation and coding techniques.

Course Outcomes:

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

1. Categorize wireless telecommunication systems and networks
2. Review wireless network architecture and operation
3. Analyze global system for mobile communication
4. Compare wireless modulation-coding techniques

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	PSO1	PSO2	PSO3
B19EM6063	CO 1	2	1	1										1	1	1
	CO 2	2	2	3										1	2	3
	CO 3	2	2	3										1	1	3
	CO 4	1	2	1										1	1	1

Course Contents:

Unit- 1: Wireless Telecommunication Systems and Networks [11 Hrs]

Introduction, History and Evolution, Different generations of wireless cellular networks 1G, 2G, 3G and 4G networks, Common Cellular System and network components, views of cellular networks, 3G

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cellular systems components, Cellular component identification Call establishment.

Unit-2: Wireless Network Architecture and Operation [10 Hrs]
Introduction, Cellular concept and fundamentals, Capacity expansion techniques, Cellular backbone networks, Mobility management, Radio resources and power management, GSM system overview, GSM and TDMA techniques, GSM Network and system Architecture, GSM channel concepts, GSM identifiers

Unit-3: Global System for Mobile Communication (GSM): [11 Hrs]
Introduction, System operation, Traffic cases, Cal handoff, Roaming, GSM protocol architecture. TDMA systems. CDMA technology, CDMA overview, CDMA channel concept CDMA operations.

Unit- 4: Wireless Modulation-Coding Techniques [10 Hrs]
Introduction, Air interface, Path loss models, Wireless coding techniques, Digital modulation techniques, OFDM, UWB radio techniques, Diversity techniques, Typical GSM Hardware.

Text Book:
1. Wireless Telecom Systems and networks, Mullet: Thomson Learning 2006.

Reference Books:
1. Mobile Cellular Telecommunication, Lee W.C.Y, MGH, 2nd, 2009.
2. Wireless communication- D P Agrawal: 2nd Edition Thomson learning 2007.
3. Fundamentals of Wireless Communication, David Tse, Pramod Viswanath, Cambridge 2005.
4. S. S. Manvi, M. S. Kakkasageri, "Wireless and Mobile Network Concepts and Protocols", John Wiley India Pvt. Ltd, 1st edition, 2010.
5. "Wireless Communication – Principles & Practice", T. S. Rappaport, PHI 2001.

B19EM6064	Alternate Engineering	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Basic Engineering Physics, Basic Electronics.

Course Description:

This course gives an overview of key aspects in solar energy, wind energy, biomass for bioenergy and all other renewable Energy Sources in engineering. A general insight to the fundamental disciplines such as wind measurements, biomass sources, processing systems, human health effects, pollution abatement, energy generating systems using renewable and non-renewable sources of energy on the population. This course also provide an overview of the basic process, by which solar energy is collected and converted to biomass. Emphasis will be given on different strategies to convert biomass to biofuels, the review of the available technologies and how these could meet the growing demand for energy in the future.

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Course Objectives:

At the end of the course, the students are expected

1. To identify the basic concepts, principles, potentials, efficiencies and limitations of various renewable energy sources.
2. To identify formulate and solve problems of renewable energy conversion and storage.
3. To explore society's present needs and future energy demands.
4. To identify the new methodologies / technologies for effective utilization of renewable energy sources.

Course Outcomes:

Upon completion of this course, the students can able to

1. Describe the challenges and problems associated with the use of the current energy sources
2. Explain the potentials for having renewable energy.
3. Explain energy principles and how they relate to using renewable energy sources.
4. Convert units of energy in order to quantify energy demands and make comparisons among energy uses, resources, and technologies.
5. Discuss the energy challenges, global warming and greenhouse effect.
6. List and describe the primary renewable energy resources and technologies.
7. Collect and organize information on renewable energy technologies as a basis for further analysis and evaluation.
8. Explain environmental impact and safety of each source of renewable energy.
9. Explain economic issues around renewable energy sources.
10. Evaluate, compare and select energy systems based on economic and environmental considerations.

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	PSO1	PSO2	PSO3
B19EM6064	CO 1	2	3	1				3						1	1	1
	CO 2	2	3	3				3						1	2	3
	CO 3	2	2	3				3						1	1	3
	CO 4	1	2	1				3						1	1	1

Course Contents:

Unit- 1: Solar Energy [11 Hrs]

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Solar Radiation – Measurements of Solar Radiation – Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation – Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

Unit-2: Wind Energy **[10 Hrs]**

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection – Details of Wind Turbine Generator – Safety and Environmental Aspects.

Unit-3: Bio – Energy **[11 Hrs]**

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration – Biomass Applications.

Unit- 4: Other Renewable Energy Sources **[10 Hrs]**

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage – Fuel Cell Systems – Hybrid Systems.

Text Books:

1. Rai. G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.
2. Twidell, J.W. & Weir, A., "Renewable Energy Sources", EFN Spon Ltd., UK, 2006.

References:

1. Sukhatme. S.P., "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 1996.
3. Tiwari. G.N., Solar Energy – "Fundamentals Design, Modelling & Applications", Narosa Publishing House, New Delhi, 2002.
4. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
5. Johnson Gary, L. "Wind Energy Systems", Prentice Hall, New York, 1985
6. David M. Mousdale – "Introduction to Biofuels", CRC Press, Taylor & Francis Group, USA 2010
7. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2009.

SC-9

B19EM7021	Analog Mixed Mode VLSI	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

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MOSFET, Transistor Level Circuit Design, Analog CMOS IC's

Course Description:

This course focuses on transistor-level design of mixed-signal CMOS integrated circuits. After reviewing fundamentals of MOSFET operation, the course will cover design of analog building blocks such as current-mirrors, bias references, amplifiers, and comparators, leading up to the design of digital-to-analog and analog-to-digital converters. Aspects of subthreshold operation, structured design, scalability, parallelism, low power-consumption, and robustness to process variations are discussed in the context of larger systems

Course Objectives:

The objectives of this course are to:

1. Introduce the concept of analog and digital discrete signals.
2. Provide specifications of data converters.
3. Calculate DAC & ADC parameters
4. Design R-2R Ladder for given parameter.
5. Introduce non linear analog circuits like comparators, and analog multipliers.
6. Demonstrate the sub micron CMOS process flow.
7. Present capacitors, resistors and switches using MOSFETs.

Course Outcomes:

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

1. Describe sample and hold circuits. (a, b, c, d, e)
2. Compare analog and digital signals. (a, b, c, d, e)
3. List DAC and ADC specifications. (a, b, c, d, e)
4. Design R-2R ladder for given specifications. (a, b, c, d, e, f)
5. Differentiate Current Steering and charge scaling DACs and SAR ADC. (a, b, c, d, e)
6. Analyze analog multipliers. (a, b, c, d, e, f)
7. Assess the different MOSFET biasing circuits. (a, b, c, d, e, f,)

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	PSO1	PSO2	PSO3
B19EM7021	CO 1	2	2	2										1	1	1
	CO 2	2	2	3										1	2	3

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	CO 3	2	2	3									1	1	3
	CO 4	1	2	1									1	1	1

Course Contents:

Unit-1: Data Converter Fundamentals **[11 Hrs]**

Analog versus Digital, Discrete Time Signals, Converting Analog Signals to Data Signals, Sample and Hold Characteristics, DAC Specifications, ADC Specifications, Mixed-Signal Layout Issues.

Unit-2:Data Converter Architectures **[10 Hrs]**

DAC Architectures, Digital Input Code, Resistors String, R-2R Ladder Networks, Current Steering, Charge Scaling DACs, Cyclic DAC, Pipeline DAC. ADC Architectures, Flash, 2-Step Flash ADC, Pipeline ADC, Integrating ADC, Successive Approximation ADC.

Unit-3: Non Linear Analog Circuits **[11 Hrs]**

Basic CMOS Comparator Design, characterizing the comparator, Analog Multipliers, Multiplying Quad (excluding stimulation), Level Shifting (excluding input level shifting for multiplier).

Unit-4: Sub-Micron CMOS Circuit Design **[10 Hrs]**

Process Flow, Introduction to triple gate MOSFETs, Capacitors and Resistors, MOSFET Switch & Bidirectional Switches, Delay and adder Elements, Analog Circuits Design, MOSFET Biasing , Basic Op-Amp design.

Text Books:

1. R. Jacob Baker, Harry W Li, David E Boyce, ―Design, Layout, Stimulation, CMOS Circuit", PHI Education, 3rd Edition 2005.
2. R. Jacob Baker, "CMOS- Mixed Signal Circuit Design,(Vol II of CMOS: Circuit Design, Layout and Stimulation), John Wiley India Pvt. Ltd, 2008. 2nd Edition

Reference Books:

1. B Razavi, "Design of Analog CMOS Integrated Circuits‖, First Edition, McGraw Hill, 2001.
2. Phillip. E. Allen and D R Holberg, ―CMOS Analog Circuit Design‖, 2nd Edition, Oxford University Press, 2002.
3. Gray, Meyer, Lewis and Hurst ―Analysis and design of Analog Integrated Circuits‖, 4th Edition Willey International, 2002

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B19EM7022	Big Data Analytics	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Programming Languages (C/C++/Java), Database Management Systems, Data Mining basics, Probability and Statistics.

Course Description:

In this course the fundamentals of large volume, variety and velocity of data is described in detail. Big data analytics is the process of extracting useful information by analysing different types of big data sets. Big data analytics is used to discover hidden patterns, market trends and consumer preferences, for the benefit of organizational decision making. In this, the map-reduce programming, components of hadoop, architecture of map- reduce is taught. It also covers the tools of big data like PIG and HIVE.

Course Objectives:

The objectives of this course are:

1. To provide an understanding of big data for business intelligence.
2. Describes the main trends of Big Data concepts.
3. This course on big data and hadoop introduces key concepts of big data, to manage big data without SQL.
4. Understanding map-reduce analytics using hadoop and related tools.
5. Select the correct Big Data stores for disparate data sets.
6. Process large data sets using Hadoop to extract value.
7. Query large data sets in near real time with PIG tool.
8. To provide big data analytics using R programming.

Course Outcomes:

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

1. Master the concepts of HDFS and MapReduce framework.
2. Understand Hadoop Architecture.
3. Write Simple MapReduce programs.

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4. Perform data analytics using Pig, Hive.
5. Implement best practices for Hadoop development.
6. To learn fundamentals of R programming for data science.

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	PSO1	PSO2	PSO3
B19EM7022	CO 1	2	1	1										1	1	1
	CO 2	2	2	3										1	2	3
	CO 3	2	2	3										1	1	3
	CO 4	1	2	1										1	1	1

Course Contents:

Unit-1: Introduction to Big Data **[10 Hrs]**

Classification of digital data, characteristics of data, Evolution of big data, Challenges with big data, what is big data, traditional business intelligence (BI) versus big data, A typical data warehouse environment, A typical hadoop environment, Top challenges facing big data.

Unit-2: Introduction to Hadoop **[10 Hrs]**

Hadoop Basics, why Hadoop, why not RDBMS, RDBMS versus Hadoop, HDFS, Processing data with Hadoop, Features of Hadoop. NoSQL-Types of NoSQL Databases, Advantages of NoSQL, SQL versus NoSQL.

Unit-3: MapReduce **[11 Hrs]**

Anatomy of a MapReduce job run, Classic MapReduce, YARN, Job scheduling, Shuffle and Sort.
Hadoop Related Tools: Introduction to PIG, What is PIG, The anatomy of PIG, PIG on Hadoop, PIG Latin, Data types in PIG, running PIG, Execution modes, HDFS Commands, Relational operators.

Unit-4: Introduction to R Programming **[11 Hrs]**

History and overview of R, What is R, Basic features of R, Design of the R system, Limitations of R, R nuts and bolts, Entering Input, Evaluation, R objects, Numbers, Attributes, Creating objects, Mixing objects, Explicit Coercion, Matrices, Lists, Factors, Missing values, Data frames, Names, Control Structures, Functions, Loop functions.

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Text Books:

1.Seema Acharya, Subhashini Chellappan, “Big Data and Data Analytics”, First Edition, Wiley, 2015.
2. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012
3. Roger D. Peng “ R Programming for Data Science” First Edition, Leanpub, 2015

References

1. Vignesh Prajapati, “Big data analytics with R and Hadoop”, SPD 2013.
2. Alan Gates, "Programming PIG", O'Reilley, 2011.
3. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.

B19EM7023	Parallel Processing	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Computer Basics

Course Description:

In this course Parallel processing is taught which is a method in computing of running two or more processors (CPUs) to handle separate parts of an overall task. These multi-core set-ups are similar to having multiple, separate processors installed in the same computer. the course focus on memory technology and optimization technique by understanding the different types of parallelism, The course concentrates on reviewing the memory hierarchu and cache performance in parallel processors.

Course Objectives:

The objectives of this course are:

1. To present design of parallel programs and how to evaluate their execution
2. To Give knowledge of the characteristics, the benefits and the limitations of parallel systems and distributed infrastructures
3. Encourage students to Build experience with interdisciplinary teamwork.

Course Outcomes:

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

1. Analyze the requirements for programming parallel and critically evaluate the strengths and weaknesses of parallel programming models and how they can be used to facilitate the programming of concurrent systems.
2. Discuss the difference between the major classes of parallel processing systems and design software solutions for a number of parallel processing models.
3. Design and implement a SIMD and MIMD parallel processing solution.
4. Reason about ways to parallelize a problem and evaluate a parallel platform for a given problem.

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	PSO1	PSO2	PSO3

Ref: RU/BoS/ECE/CEC/May-2021-9

B19EM7023	CO 1	3	3	1									1	1	1
	CO 2	3	3	3									1	2	3
	CO 3	3	2	3									1	1	3
	CO 4	1	2	1									1	1	1

Course Contents:

Unit -1: Introduction and Architecture [10 Hrs]

Classes of computers;Defining computer architecture; Trends in Technology, power in Integrated Circuits and cost; Dependability; Measuring, reporting and summarizing Performance; Quantitative Principles of computer design

Unit -2: Memory Technology and Optimization [11 Hrs]

Introduction to parallelism, shared memory model, distributed memory model,what is instruction level parallelism: concepts and challenges, basic compiler techniques for exposing ILP , Reducing Branch costs with prediction; Overcoming Data hazards

Unit -3: Thread Level Parallelism: Introduction [11 Hrs]

Multiprocessor architecture: issues and approach, challenges of parallel processing, Symmetric shared-memory architectures; Performance of symmetric shared–memory multiprocessors; Distributed shared memory and directory-based coherence; Basics of synchronization; Models of Memory

Unit -4: Review of Memory Hierarchy [10 Hrs]

Introduction: Cache performance, Cache Optimizations, Virtual memory, Advanced optimizations of Cache performance, Memory technology and optimizations, Protection: Virtual memory and virtual machines

Text Books:

1. John L. Hennessey and David A. Patterson, “Computer Architecture – A quantitative Approach”, Morgan Kaufmann / Elsevier Publishers, 5thEdition, 2012.

Reference books:

1. Barry Wilkinson, Michael Allen, “Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers”, Prentice Hall; 2nd edition ; ISBN: 0131405632
2. Advanced Computer Architecture Parallelism, Scalability – Kai Hwang:, Programability, Tata Mc Grawhill, 2003.
3. Parallel Computer Architecture, A Hardware / Software Approach – David E. Culler, Jaswinder Pal Singh, Anoop Gupta:, Morgan Kaufman, 1999.

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B19EM7024	Avionics	L	T	P	C
Duration: 14 Wks		3	0	0	3

Prerequisites:

Instrumentation systems, sensors,Mathematical modeling of System, Microwave signals, Radar systems, Modulation Techniques.

Course Description:

This course covers the different features of Display units, roles of Avionics. The curriculum for the programme is structured as per the requirements of the aviation industry. The field of activity of qualified personnel involves maintenance of various flying instruments in the realm of Avionics and Illustrate the Surveillance and Communications Systems in Avionics. Students are taught existing technology as well as advanced Multi-Functional Display Systems.

Course Objectives:

The objectives of this course are:

1. To introduce the general topics of aircraft Electronics.
2. To summarize the advantages and disadvantages of various avionics system.
3. To understand the different avionics systems of aircraft like display system, navigation system.
4. To identify different aircraft cockpit fittings like display system.

Course Outcomes:

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

1. Describe various avionics items.
2. Identify different aircraft cockpit instruments and displays.
3. Illustrate the avionics systems.

Mapping of Course Outcomes with programme Outcomes

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Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19EM7024	CO 1	1	3	3										1	1	1
	CO 2	2	3	3										1	2	3
	CO 3	3	2	3										1	1	3
	CO 4	3	2	1										1	1	1

Course Contents:

Unit -1: Introduction to Avionics & Display Systems [11 Hrs]

Importance and role of avionics, avionic environment, Regulatory and advisory agencies -Displays and man-machine interaction: Active Matrix Liquid Crystal Display (AMLCD),Head Down Display (HDD), Head Up Display (HUD),Helmet Mounted Display (HMD), OLEDS, Night Vision Goggles,LASERS, Integrated Standby Instrument System (ISIS), data fusion, intelligent displays management,Displays technology, control and data entry, instrument placements.

Unit -2: Aircraft Instruments [10 Hrs]

Inertial reference systems, attitude derivation. RMI, HSI, ADI Magnetic Heading Reference System (MHRS.);Outside world sensor systems: Radar systems - Radar Sensing - Radar Altimeter (RADALT), Doppler Radar, WeatherRadar, RADOME.

Unit -3: Navigation Systems and Flight Control [11 Hrs]

Principles of navigation, Automatic Direction Finding, Very High Frequency Omni-Range (VOR), Distance Measuring Equipment (DME), landing aids (ILS & MLS), Inertial Navigation, GPS-global positioning system.Fly by Wire Flight control features and advantages.

Unit -4: Surveillance & Communication Systems [10 Hrs]

HF, VHF, UHF, Microwaves Signals and Noise, Modulation and demodulation, Antennas, propagation, data links, Telemetry, Transponders, Typical Systems in Aircrafts, ATC Electronic Warfare Basics.

Text Books:

1. Cary R.Spitzer, "Digital Avionics Handbook", CRC Press LLC, 3nd Edition, 2006.
2. **Collinson**, R.P.G, "Introduction to avionics", springer, 3rd Edition, 2011
3. Ian Moir, Allan G.Seabridge," Military Avionics Systems", John Wiley & Sons, Ltd,2009

Reference Books:

1. Ian Moir, Allan G.Seabridge, "Aircraft Systems" Mechanical, Electrical, Avionics Subsystems Integration, ohn Wiley & Sons, 3rdEdition, Ltd 2008
2. Cary R. Spitzer, "Digital Avionics Handbook", , CRC Press LLC, 2nd Edition ,2007.

Ref: RU/BoS/ECE/CEC/May-2021-9

3. Brain Kendal, “Manual of Avionics”, the English Book House, New Delhi, 3rd Edition, 1993.
4. Collinson RPG, “Introduction to Avionics”, Kluwer Academic Publishers, Chapman & Hall, 2nd Edition, 2003.
5. Mauhamed Abdulla, “Avionics made simple”, Available at http://drmoe.org/research/avionics_made_simple, 2005

SC-10

B19EM7031	ASIC DESIGN	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Fundamentals of digital circuits & CMOS.

Course Description:

This course aims to provide a strong foundation for students in understanding the principle aspects of ASIC design. It helps the students in getting familiarized with the methodologies and tools used in designing ASIC chips. Helps in understanding the applying various floor planning, placement and routing aspects and methodologies in refining the ASIC designs.

Course Objectives:

The objectives of this course are to:
1. Present brief idea about the ASIC design.
2. Give brief introduction to logic cell.
3. Present the idea of low level design entry.
4. Give a brief description of floor planning, placement and routing.
5. Present the trends in ASIC.

Course Outcomes:

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

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1. Describe the various logic cells and there utilization in system design. (a, b, e, k)
2. Design schematics and generate net list (b, c, d, f, l)
3. Develop floor planning, placement and routing (b, d, e, f, k)

Mapping of Course Outcomes with programme Outcomes

Course Code	PO S/ CO s	P O1	P O2	P O3	P O4	P O5	P O6	P 7	P O8	P O9	P O 10	P O 11	P O 12	PS O1	PS O2	PS O3
B19EM7031	CO 1	3	3	3										1	1	1
	CO 2	3	2	3										1	2	3
	CO 3	2	3	3										1	1	3
	CO 4	2	1	2										1	1	1

Course Contents:

Unit 1: Introduction **[11 Hrs]**

Full Custom ASICs, Standard Cell based ASICs, Gate array based ASICs, Channeled gate array, Channelless gate array, structured gate array, Programmable logic devices, FPGA, Design flow, Economics of ASICs, ASIC cell libraries, I/O cells, Cell Compilers.

Unit 2: ASIC Library Design and Design entry **[10 Hrs]**

ASIC Library Design: Logical effort: predicting delay, logical area and logical efficiency, logical paths, multistage cells, optimum delay, optimum number of stages, library cell design. Low-Level Design Entry: Schematic Entry: Hierarchical design. The cell library, Names, Schematic, Icons & Symbols, Nets, schematic entry for ASIC'S, connections, vectored instances and buses, Edit in place, Attributes, Netlist screener, Back annotation.

Unit 3: ASIC Construction Floor Planning **[11 Hrs]**

Physical Design, CAD Tools, System Partitioning, Estimating ASIC size, partitioning methods. Floor planning tools, I/O and power planning, clock planning

Unit 4: Placement and Routing **[10 Hrs]**

Placement algorithms, iterative placement improvement, Time driven placement methods. Physical Design flow, global Routing, Detail Routing, Special Routing, Circuit Extraction and DRC.

Text Book:

1. M.J.S .Smith, "Application - Specific Integrated Circuits", Pearson Education, 2003.

Reference Books:

Ref: RU/BoS/ECE/CEC/May-2021-9

1. Jose E.France, YannisTsividis, “Design of Analog-Digital VLSI Circuits for Telecommunication and signal processing”, Prentice Hall, 1994.
2. MalcolmR.Haskard; Lan. C. May, “Analog VLSI Design – NMOS and CMOS”, Prentice Hall, 1998.
3. Mohammed Ismail and Terri Fiez, “Analog VLSI Signal and Information Processing”, McGraw Hill, 1994.

B19EM7032	C++ and .NET	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:

Basic Programming paradigm

Course Description:

The course is geared towards providing students with the knowledge and skills they need to develop C# applications. C# is the core language of the Microsoft .NET framework, designed specifically to take advantage of CLI (Common Language Interface) features. The course focuses on C# program structure, language syntax, and implementation details. It is a simple, object-oriented, and type-safe programming language that is based on the C and C++ family of languages

Course Objectives:

The objectives of this course are to:

1. Explain the need of .NET platform and C#.
2. Introduce the basic features of C# and create a simple C# class.
3. Illustrate the OOPS concepts in C#.
4. Describe the concepts of Delegates and Interfaces

Course Outcomes:

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

1. Demonstrate compilation and execution of simple C# programs.
2. Define, analyze and implement Exception Handling and Object oriented programming in C#.
3. Work with Arrays, Create Generic classes and methods, Collections in C#.
4. Develop stand-alone applications in the .NET framework using C#

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

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B19EM7032	CO 1	3	2	2									1	1	1
	CO 2	2	2	3									1	2	3
	CO 3	3	2	3									1	1	3
	CO 4	2	2	2									1	1	1

Course Contents:

Unit -I: Introducing C++ and .NET Platform : The Philosophy of .NET: Understanding the Previous State of Affairs, The.NET Solution, The Building Block of the .NET Platform (CLR,CTS, and CLS), The Role of the .NET Base Class Libraries, What C# Brings to the Table, An Overview of .NET Binaries (aka Assemblies), the Role of the Common Intermediate Language, The Role of .NET Type Metadata, The Role of the assembly Manifest, Understanding the Common Type System, Intrinsic CTS Data Types, Understanding the Common Languages Specification, Understanding the Common Language Runtime.

Unit- II: C# Programming Language-I: The Anatomy of Basic C# Class, Creating objects: Constructor Basics, The Composition of a C# Application, Default assignment and Variable Scope, The C# Member Initialization Syntax, Basic Input and Output with the Console Class, Understanding Value Types and Reference Types, The Master Node: System, Object, The System Data Types (and C# Aliases), Converting Between Value Types and Reference Types: Boxing and Unboxing, C# Iteration Constructs, C# Controls Flow Constructs, The Complete Set of C# Operators, Defining Custom Class Methods, Understating Static Methods, Methods Parameter Modifies, Array Manipulation in C#, String Manipulation in C#, C# Enumerations.

Unit- III: Object Oriented Programming with C++: Forms defining of the C# Class, Definition the "Default Public Interface" of a Type, Recapping the Pillars of OOP, The First Pillars: C#'s Encapsulation Services, Pseudo- Encapsulation: Creating Read-Only Fields. The Second Pillar: C#'s Inheritance Supports, keeping Family Secrets: The "Protected" Keyword, Nested Type Definitions, The Third Pillar: C #'s Polymorphic Support, Casting Between. Exceptions 1: Ode to Errors, Bugs, and Exceptions, The Role of .NET Exception Handing, the System. Exception Base Class, Throwing a Generic Exception, Catching Exception, CLR System – Level Exception (System. System Exception).

Unit -IV: Exceptions 2: Custom Application-Level Exception (System. System Exception), Handling Multiple Exception, The Family Block, Understanding object Lifetime, The Basics of Garbage Collection, Finalization a Type, The Finalization Process, Building an Ad Hoc Destruction Method, Garbage Collection Optimizations, The System. GC Type. Interfaces: Defining Interfaces Using C# Invoking Interface Members at the object Level, Exercising the Shapes Hierarchy, Understanding Explicit Interface Implementation. Understanding Callback Interfaces, Understanding the .NET Delegate Type, Members of System. Multicast Delegate, The Simplest Possible Delegate Example, Building More a Elaborate Delegate Example.

Text Books:

1. Andrew Troselen; Pro C# with .NET 3.0, Special Edition copyright 2007.

Ref: RU/BoS/ECE/CEC/May-2021-9

2. E Balaguruswamy; Programming in C#, 5th reprint, Tata McGraw Hill 2004.

Reference Books:
1. K. Watson; C. Nagel; J. H Padderson; J.D. Reid; M. Skinner;Beginning Visual C#;Wiley 2010.
2. Anne Boehm; Joel Murach; SPD Murach; ASP.NET 4 Web Programming with C#; 4th Edition; 2010.
3. I. Spanjaars; Beginning ASP.NET 4 in C# and VB; 2011.
4. J. Kanjilal; ASP.NET 4.0 programming; Tata McGraw-Hill.
5. D. Esposito; Programming ASP.NET; Microsoft Press (Dreamtech); 2011.

B19EM7033	Multimedia Communication	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Signal representation, Quantization techniques, Coding theory, and OSI Reference model.

Course Description

The course introduces fundamental technologies for video communications and networking. The primary goal of the course is the development of necessary video-audio skills and understandings need to create effective digital media messages. It includes the introduction to the video system and Fourier analysis with effective representation and processing of video signals. Also, few more concepts covered include properties of the human visual system, motion estimation, basic video compression techniques, video communication standards, and video transport over the Internet and wireless networks.

Course Objectives:

The objectives of this course are:

1. To provide an understanding of impact of multimedia techniques in the day to day life.
2. To provide an understanding of various representations of graphics, image & video.
3. To provide an understanding of the total processing, storing and communication of multimedia data.
4. To provide a comprehensive understanding of multimedia communication over wireless networks.

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Course Outcomes:

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

1. Understand the different representations of graphics, image and video data types in multimedia.
2. Compare the various industry standard compression techniques for digital audio.
3. Understand the processing and storage techniques for video.
4. Compare various industry standard compression techniques for effective bandwidth utilization of the media and storage capacity.
5. Determine impact of multimedia communication techniques in the wireless networks.

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	PSO1	PSO2	PSO3
B19EM7033	CO 1	3	1	1										1	1	1
	CO 2	2	2	3										1	2	3
	CO 3	3	3	3										1	1	3
	CO 4	2	2	1										1	1	1

Course Contents:

Unit 1: Graphics, Image & Video Representation [11 Hrs]

Graphics/Image data types, Popular file formats, Color science – camera systems, XYZ to RGB Transform, Color models in images, Color models in video, Fundamental concepts in video

Unit 2: Digital Audio & Compression Algorithms [10 Hrs]

Digitization of sound, MIDI, Quantization & transmission of audio, Lossless compression: Basics of information theory, Run-Length Coding, Variable Length Coding – Shannon Fano Algorithm, Huffman Coding, LZW, Arithmetic Coding, Lossy compression: Distortion measures, Rate-distortion theory, Quantization, Transform coding.

Unit 3: JPEG & MPEG [11 Hrs]

The JPEG Standard, Video compression based on motion compensation, Search for motion vectors, H.261, H.263, MPEG-1, MPEG-2, MPEG-4, MPEG-7, MPEG-21.

Unit 4: Multimedia Communication [10 Hrs]

Quality of multimedia data transmission, Multimedia over IP, Media- on- Demand (MOD), Multimedia over Wireless Network, C-Bird - A Case Study.

Text Book:

Ref: RU/BoS/ECE/CEC/May-2021-9

1. Ze-Nian Li, Mark S. Drew, “Fundamentals of Multimedia”, Pearson Education, 2008.

Reference Book:

2. Ralf Steinmetz, KlaraNahrstedt, “Multimedia – Computing, Communications & Applications”, Pearson Education, 2004,
3. Resources: http://www.cs.sfu.ca/~mark/ftp/PH/

B19EM7034	Natural Language Processing	L	T	P	C
Duration 14 Weeks		3	0	0	3

Prerequisites:

Machine Learning.

Course Description:

The course provides the basics of Natural-language processing (NLP), which is an area of computer scienceand artificial intelligence concerned with the interactions between computers and human (natural) languages, in particular how to program computers to fruitfully process large amounts of natural language data. Naturallanguage processing (NLP) is the ability of a computer program to understand human language as it is spoken. NLP is a component of artificial intelligence (AI). Challenges in natural-language processing frequently involve speech recognition, natural-language understanding, and natural-language generation

Course Objectives:

1. To Learn the techniques in natural language processing.
2. To be familiar with the natural language generation.
3. To be exposed to Text Mining.
4. To Understand the information retrieval techniques

Course Outcomes:

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

1. Analyze the natural language text
2. Generate the natural language

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3. Do Text mining
4. Apply information retrieval techniques

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	PSO1	PSO2	PSO3
B19EM7034	CO 1	2	1	1										1	1	1
	CO 2	2	2	3										1	2	3
	CO 3	2	2	3										1	1	3
	CO 4	1	2	1										1	1	1

Course Contents:

UNIT 1: Overview and Language Modelling: [10 Hrs]

Overview: Origins and challenges of NLP Language and Grammar-Processing Indian Languages- NLP Applications. Information Retrieval. Language Modelling: Various Grammar- based Language Models-Statistical Language Model.

UNIT 2: Word level and syntactic analysis: [11 Hrs]

Word Level Analysis: Regular Expressions. Finite-State Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word Classes-Part-of Speech Tagging. Syntactic Analysis: Context-free Grammar-Constituency- Parsing-Probabilistic Parsing

UNIT 3: Extracting Relations from Text: From Word Sequences to Dependency Paths: [10 Hrs]

Introduction, Subsequence Kernels for Relation Extraction, A Dependency-Path Kernel for Relation Extraction and Experimental Evaluation. Mining Diagnostic Text Reports by Learning to Annotate Knowledge Roles: Introduction, Domain Knowledge and Knowledge Roles, Frame Semantics and Semantic Role Labelling, Learning to Annotate Cases with Knowledge Roles and Evaluations.
A Case Study in Natural Language Based Web Search: InFact System Overview, The GlobalSecurity.org Experience.

UNIT 4: Evaluating Self-Explanations in iSTART: Word Matching, Latent Semantic Analysis, and Topic Models: [11 Hrs]

Introduction, iSTART: Feedback Systems, iSTART: Evaluation of Feedback Systems,
Textual Signatures: Identifying Text-Types Using Latent Semantic Analysis to Measure the Cohesion of Text Structures: Introduction, Cohesion, CohMetrix, Approaches to Analyzing Texts, Latent Semantic Analysis, Predictions, Results of Experiments.
Automatic Document Separation: A Combination of Probabilistic Classification and Finite-State Sequence Modeling: Introduction, Related Work, Data Preparation, Document Separation as a Sequence Mapping Problem, Results.

Ref: RU/BoS/ECE/CEC/May-2021-9

Evolving Explanatory Novel Patterns for Semantically-Based Text Mining: Related Work, A Semantically Guided Model for Effective Text Mining

Text Books:

1. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.
2. Anne Kao and Stephen R. Poteet (Eds), "Natural Language Processing and Text Mining", Springer-Verlag London Limited 2007.

Reference Books:

1. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", 2nd Edition, Prentice Hall, 2008.
2. James Allen, "Natural Language Understanding", 2nd edition, Benjamin/Cummingspublishing company, 1995.
3. Gerald J. Kowalski and Mark.T. Maybury, "Information Storage and Retrieval systems", Kluwer academic Publishers, 2000.

SC-11

B19EM7041	SOC Design	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Basics of system architecture, Operating system concepts and Microprocessor.

Course Description:

Moore's law has created an era where most electronic systems contain chips that integrate various components such as microprocessor, DSPs, dedicated hardware processing engines, memories, and interfaces to I/O devices and off-chip storage. Most electronic systems today - cell phones, iPods, set top boxes, digital TVs, automobiles contain at least one such "System-on-chip". Designing System-on chips is a highly complex process. This course will present students with an insight into the earlier stages of the System-on-chip design process. In addition to the conceptual foundations, this course will also involve analysis of chip basics, understanding various parameters for the selection of SOC processors and memory design

Course Objectives:

The objectives of this course are to:

1. Provide a comprehensive introduction to the SOC technology.
2. Provide theoretical and practical aspects of SOC design.

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3. Give an overview to SOC design, its challenges and Design flow.
4. To understand the memory design concepts in processors.

Course Outcomes:

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

1. Design the processors keeping area, power, and speed as constraints and to deepen CMOS VLSI design knowledge.
2. Implement network on chip technologies.
3. Analyze memories using reconfigurable architectures for rapid prototyping.
4. Analyze system on chip and board-based systems.

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	PSO1	PSO2	PSO3
B19EM7041	CO 1	2	1	1										1	1	1
	CO 2	2	2	3										1	2	3
	CO 3	2	2	3										1	1	3
	CO 4	1	2	1										1	1	1

Course Contents:

Unit-1: System Approach and Interconnect

[10 Hrs] System Architecture, Components of the System, Hardware and Software, An approach for SoC Design, System Architecture and Complexity.

Interconnect: Introduction, Interconnect architectures for SoC. Bus: Basic architecture. NOC standard buses, Analytic bus models, NOC with switch interconnects.

Unit-2: Chip Basics **[11 Hrs]**

Cycle Time, Die Area and Cost, Ideal and Practical Scaling, Power, Area–Time–Power Trade-Offs in Processor Design, Reliability, Configurability.

Unit-3: Processors **[10Hrs]**

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.

Unit-4: Memory Design: **[11Hrs]**

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.

Text book:

1. Micheal J Flynn and Wayne Luk, **"Computer System Design: System-on-Chip,"** Wiley, First Edition, 2011.

Reference Books:

1. SudeepPasricha and Nikil Dutt, "On- Chip Communication Architectures: System on Chip Interconnect", Morgan Kaufman 2008
2. Rao R. Tummala, Madhavan Swaminathan, "Introduction to system on package SOP-Miniaturization of the entire system", McGraw-Hill 2008.
3. Michael Keating, Pierre Bricaud, "Reuse Methodology Manual for System on Chip designs", Kluwer Edition, 2008.

B19EM7042	Computer System Performance Analysis	L	T	P	C
Duration :14 Weeks		3	1	0	4

Prerequisites:

Nil

Course Description:

Computer Vision is one of the fastest growing and most exciting AI disciplines in today's academia and industry. This course is designed to open the doors for students who are interested in learning about the fundamental principles and important applications of computer vision. The course, introduces a number of fundamental concepts in computer vision, expose students to a number of real-world applications that are important to our daily lives. More importantly, students will be guided through a series of well-designed projects such that they will get to implement using few interesting and cutting-edge computer vision algorithms. The course benefit is to apply computer vision algorithms to solve real world problems.

Course Objectives:

The Course objectives are:

1. To introduce performance evaluation metrics
2. To describe little's law
3. To provide insight into the operational laws.
4. To introduce to the concepts of scheduling policies.

Course Outcomes:

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

1. Identify the need for performance evaluation and the metrics used for it
2. Implement Little's law and other operational laws
3. Apply the operational laws to open and closed systems
4. Use discrete-time and continuous-time Markov chains to model real-world systems

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5. Develop analytical techniques for evaluating scheduling policies

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19EM7042	CO 1	2	3	13										1	1	1
	CO 2	3	2	3										1	2	3
	CO 3	2	3	3										1	1	3
	CO 4	3	2	3										1	1	1

Course Contents:

Unit 1 Introduction **[10 Hrs]**

The art of Performance Evaluation; Common Mistakes in Performance Evaluation, A Systematic Approach to Performance Evaluation, Selecting an Evaluation Technique, Selecting Performance Metrics, commonly used Performance Metrics, Utility Classification of Performance Metrics, Setting Performance Requirements.

Unit 2 Workloads, Workload Selection, and Characterization: **[11Hrs]**

Types of Workloads, addition instructions, Instruction mixes, Kernels; Synthetic programs, Application benchmarks, popular benchmarks. Workload Selection: Services exercised, level of detail; Representativeness; Timeliness, Other considerations in workload selection. workload characterization Techniques: Terminology; Averaging, Specifying dispersion, Single Parameter Histograms, Multi Parameter Histograms, Principle Component Analysis, Markov Models, Clustering.

Unit 3

Monitors, Program Execution Monitors and Accounting Logs: **[11 Hrs]**

Monitors: Terminology and classification; Software and hardware monitors, Software versus hardware monitors, Firmware and hybrid monitors, Distributed System Monitors, Program Execution Monitors and Accounting Logs, Program Execution Monitors, Techniques for Improving Program Performance, Accounting Logs, Analysis and Interpretation of Accounting log data, using accounting logs to answer commonly asked questions.

Unit 4 **[10 Hrs]**

Queuing Models:

Introduction: Queuing Notation; Rules for all Queues; Little's Law, Types of Stochastic Process. Analysis of Single Queue: Birth-Death Processes; M/M/1 Queue; M/M/m Queue; M/M/m/B Queue with finite buffers; Results for other M/M/1 Queuing Systems. Queuing Networks: Open and Closed

Queuing Networks; Product form networks, queuing Network models of Computer Systems. Operational Laws: Utilization Law; Forced Flow Law; Little's Law; General Response Time Law; Interactive Response Time Law; Bottleneck Analysis; Mean Value Analysis and Related Techniques; Analysis of Open Queuing Networks; Mean Value Analysis; Approximate MVA; Balanced Job Bounds; Convolution Algorithm, Distribution of Jobs in a System, Convolution Algorithm for Computing G(N), Computing Performance using G(N), Timesharing Systems, Hierarchical Decomposition of Large Queuing Networks: Load Dependent Service Centres, Hierarchical Decomposition, Limitations of Queuing Theory.

Text Books:

1. Raj Jain, "The Art of Computer Systems Performance Analysis", John Wiley and Sons 2013

Reference Books:

1. Paul J Fortier, Howard E Michel ,"Computer Systems Performance Evaluation and prediction ", Elsevier 2003
2. Trivedi KS, "Probability and Statistics with Reliability, Queuing and Computer Science Applications", Wiley India 2nd Edition,2001

B19EM7043	Computer vision and pattern recognition	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Linear Algebra, Probability, Random Processes.

Course Description:

Computer Vision is one of the fastest growing and most exciting AI disciplines in today's academia and industry. This course is designed to open the doors for students who are interested in learning about the fundamental principles and important applications of computer vision. The course, introduces a number of fundamental concepts in computer vision, expose students to a number of real-world applications that are important to our daily lives. More importantly, students will be guided through a series of well-designed projects such that they will get to implement using few interesting and cutting-edge computer vision algorithms. The course benefit is to apply computer vision algorithms to solve real world problems.

Course Objectives:

The Course objectives are:

5. To review image processing techniques for computer vision.
6. To understand shape and region analysis.
7. To understand three-dimensional image analysis techniques.
8. To understand motion analysis.

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9. To equip with the basic mathematical and statistical techniques commonly used in pattern recognition.
10. To understand variety of pattern recognition algorithms, along with pointers on which algorithms work best under what conditions
11. To acquire overview knowledge of advanced topics in pattern recognition.

Course Outcomes:

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

1. Implement fundamental image processing techniques required for computer vision.
2. Perform shape analysis.
3. Implement boundary tracking techniques.
4. Judge Statistical decision making with error.
5. Execute Non parametric Classification for the data.
6. Organize the data in to clusters.
7. Evaluate neural network weights with different models.

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	PSO1	PSO2	PSO3
B19EM7043	CO 1	2	2	1										1	1	1
	CO 2	3	2	3										1	2	3
	CO 3	2	3	3										1	1	3
	CO 4	1	2	1										1	1	1

Course Contents:

Unit 1 Computer vision **[10 Hrs]**

Achieving Simple Vision Goals, High Level and Low Level, Capabilities, a Range of Representations, the Role of Computers, Computer Vision Research and Applications.

Image formation

Images, Image Model, Image Functions, Imaging Geometry, Reflectance, Spatial Properties, Colour Digital Images, Imaging Devices for Compute r Vision, Photographic Imaging, Sensing Range, Reconstruction Imaging.

Unit 2 Early Processing **[11 Hrs]**

Recovering Intrinsic Structure, Filtering the Image, Template Matching, Histogram Transformations, Background Subtraction, Filtering and Reflectance Models, Finding Local Edges, Types of Edge

Operators, Edge Thresholding Strategies, Three Dimensional Edge Operators, Range Information from Geometry, Stereo Vision and Triangulation, A Relaxation Algorithm for Stereo, Surface Orientation from Reflectance Models, Reflectivity Functions, Surface Gradient, Photometric Stereo, Shape from Shading by Relaxation, Optical Flow, Resolution Pyramids.

Unit 3 **[11 Hrs]**

Introduction: Applications of pattern recognition, statistical decision theory, image processing and analysis

Statistical decision theory- Introduction, Baye's Theorem, multiple features, conditionally independent features, decision boundaries.

Nonparametric Decision Making: Introduction, histograms, Kernel and window estimators, nearest neighbour classification techniques, adaptive Decision boundaries, adaptive discriminate Functions, minimum squared error discriminate functions, choosing a decision making technique.

Unit 4 **[10 Hrs]**

Clustering: Introduction, hierarchical clustering, partitional clustering

Artificial Neural Networks: Introduction, nets without hidden layers. Nets with hidden layers, the back Propagation algorithms, Hopfield nets, an application.

Text Books:

1. Dana H. Ballard, Christopher M. Brown, "Computer Vision", 1982 by Prentice Hall, Inc. Englewood Cliffs, New Jers y 07632.
2. Eart Gose, Richard Johnsonburg and Steve Joust, "Pattern Recognition and Image Analysis", Prentice-Hall of India-2003.
3. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer 2010
4. Forsyth and Ponce,"Computer vision: A modern approach". Prentice Hall, 2002.
5. E. R. Davies, "Computer & Machine Vision: Theory Algorithms Practicalities", ELSEIVER, Academic Press, 2012
6. Duda and Hart, "Pattern recognition (Pattern recognition a scene analysis)".
7. Robert J Schalkoff, "Pattern recognition: Statistical, Structural and neural approaches", John Wiley.

B19EM7044	Reliability Engineering	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Fundamentals of Analog and Digital Electronics, Fundamental Mathematics

Course Description:

In this course, the student shall learn the basic concepts of Reliability Engineering and apply them to constrain a design. Reliability Engineering is engineering that emphasizes dependability in the life cycle management of a product. The student shall be able to predict the ability of a product or system to perform its required functions without failure for a specified time period and when used under the specified conditions. Engineering and analysis techniques are used to improve the reliability or dependability of a product or system. Reliability engineering falls within the maintenance phase of

the software development life cycle(SDLC). The overall aim of the SDLC is to make software and product more reliable.

Course Objectives:

The objectives of this course are:

1. To introduce the subject of reliability engineering.
2. To familiarize the basic mathematics of reliability.
3. To predict the reliability of typical systems with models.
4. To familiarize the electronic systems reliability.
5. To familiarize the concept of design for production, test and maintenance.
6. To introduce reliability of software, software errors and preventions, concepts of fault tolerance, software checking and testing and software reliability prediction.

Course Outcomes:

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

1. Understand principles of reliability engineering.
2. Predict and analyze the reliability of typical systems.
3. Incorporate reliability in electronic systems.
4. Understand the concept of design for production, test and maintenance of systems.
5. Familiarize the reliability of software.
6. Understand software errors, preventions and fault tolerance, software testing.

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	PSO1	PSO2	PSO3
B19EM7044	CO 1	3	3	1										1	1	1
	CO 2	2	2	3										1	2	3
	CO 3	2	3	3										1	1	3
	CO 4	1	2	1										1	1	1

Course Contents:

Unit-1: Introduction to Reliability Engineering **[11 Hrs]**

What is Reliability Engineering? , Reasons for failure, Probabilistic Reliability, Repairable and Non-Repairable Items, The Pattern of Failures with Time (Non-Repairable Items), The Pattern of Failures with Time (Repairable Items).

Reliability Mathematics: Rules of probability, summary of continuous statistical distributions, discrete variations, statistical confidence, hypothesis testing.

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Unit-2: Reliability prediction and modelling

Systems Reliability models, availability of repairable systems, modular design, block diagram analysis,
fault tree analysis, Markov analysis. Case studies from mechanical and electronic systems.

Unit-3: Electronic Systems Reliability **[10 Hrs]**

Reliability of Electronic Components ,Component Types and Failure Mechanisms, Reliability in Electronic System Design , Parameter Variation and Tolerances , Design for Production, Test and Maintenance

Unit-4: Software Reliability **[11 Hrs]**

Introduction, Software in Engineering Systems ,Software Errors , Preventing Errors , Fault Tolerance , Software Checking , Software Testing ,Software Reliability Prediction and Measurement , Case study from industry.

Text Books:

1. Patrick D.T.O'Connor, Practical Reliability Engineering, 5th edition, Wiley India, 2011.

Reference Books:

1. V.N.A. Naikan ,Reliability Engineering and Life Testing, PHI Learning Private Limited, 2009.
2. Charles B. Ebeling, An introduction to Reliability and Maintainability Engineering.
3. Michael R. Lyu ,Handbook of Software Reliability Engineering.

SC-12

B19EM8011	Low Power VLSI	L	T	P	C
Duration :16Wks		3	0	0	3

Prerequisites:

1. Concepts of low power VLSI design and scaling technologies involved.
2. Knowledge on simulation programming with integrated circuits and probabilistic power analysis.
3. Basics of design parameters of low power circuits and low power architecture.
4. Knowledge on clock distribution and architectural level methodologies.

Course Description:

This course deals with issues and models to design low-power VLSI circuits, fundamentals of power dissipation in microelectronic devices, will be able to estimate power dissipation due to switching,

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short circuit. The architectural, algorithm power estimation and optimization techniques will be discussed.

Course Objectives:

The objectives of this course are:

1. To understand different sources of power dissipation in CMOS & MIS structure.
2. To understand the different types of low power adders and multipliers.
3. To focus on synthesis of different level low power transforms.
4. To understand the various energy recovery techniques used in low power design.

Course Outcomes:

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

1. Analyze 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 transformation techniques.
4. Perform the analysis and optimization of power at architectural and algorithm level.

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	PSO1	PSO2	PSO3
B19EM8011	CO 1	2	3	2										1	1	1
	CO 2	3	2	3										1	2	3
	CO 3	2	2	3										1	1	3
	CO 4	3	3	1										1	1	1

Course Contents:

Unit -1: Introduction
[10 Hrs]

Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches, Physics of power dissipation in CMOS devices.

Device & Technology Impact on Low Power: Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation.

Unit -2: Power estimation, Simulation Power analysis [11 Hrs]

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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: Low Power Design Circuit level **[11 Hrs]**
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.

Unit 4: Low power Clock Distribution **[10 Hrs]**
Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network.
Algorithm & Architectural Level Methodologies: Introduction, design flow, Algorithmic level analysis & optimization, Architectural level estimation & synthesis.

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.

B19EM8012	**Pervasive and Ubiquitous Computing**	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:
Basics of computing and networking

Course Description:

Pervasive and Ubiquitous Computing discusses the importance of modern communication systems and evolution of computing networking into various new domains. It highlights the recent trends in Internet of Things and its importance in everyday life.

Course Objectives:
The objectives of this course are to:

1. To Provide a sound conceptual foundation in the area of Pervasive Computing aspects;
2. To Provide a balanced treatment of the mechanisms and environments of ubiquitous computing;
3. To give an insight into successful mobile and pervasive computing applications and services.
4. To provide an insight into characteristics of explicit and Implicit Human-Computer Interface.
5. To Introduce to the architectures of Intelligent Systems.

Course Outcomes:

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

1. Describe the Smart Device, Environment and Interfaces (DEI) model of Ubiquitous Computing Systems. (b, d, f)
2. Identify various devices used in Human Computer Interaction. (b, e)
3. Compare the usability of alternative design of interactions for specific ubiquitous computing systems. (a, b)
4. Describe the role of Sensors and MEMS in development of Context Aware Systems. (b,d,f)
5. Design and implement simple context aware applications, using standard sensor technology. (b, d, f)
6. Differentiate various Intelligent System (b. e)

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	PSO1	PSO2	PSO3
B19EM8012	CO 1	2	3	2										1	1	1
	CO 2	3	2	3										1	2	3
	CO 3	2	2	3										1	1	3
	CO 4	3	3	1										1	1	1

Course Contents:

Unit-1: Ubiquitous Computing [10 Hrs]

Basics and Vision - Living in a Digital World, Modeling the Key Ubiquitous Computing Properties, Architectural Design for UbiCom Systems: Smart DEI Model; Applications and Requirements - Example Early UbiCom Research Projects

Unit-2: Human Computer Interaction [11 Hrs]

Introduction, User Interfaces and Interaction for Four Widely Used Devices, Hidden UI Via Basic Smart Devices, Hidden UI Via Wearable and Implanted Devices, Human-Centred Design (HCD), User Models: Acquisition and Representation, iHCI Design

Unit-3: Tagging, Sensing and Controlling [11 Hrs]

Introduction, Tagging the Physical World, Sensors and Sensor Networks, Micro Actuation and Sensing: MEMS, Embedded Systems and Real-Time Systems, Control Systems (for Physical World Tasks), Robots.

Unit-4: Intelligent Systems (IS) [10 Hrs]

Introduction, Basic Concepts, IS Architectures; Ubiquitous Communication – Introduction, Audio Networks, Data Networks, Wireless Data Networks, Ubiquitous Networks, Service-Oriented Networks.

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Text Books:

1. Stefan Poslad, "**Ubiquitous Computing Smart Devices, Environments and Interactions"**, Wiley, 2009
2. Ed. John Krumm. Chapman, "**Ubiquitous Computing Fundamentals"** Hall/CRC 2009.

Reference books

1. Burkhardt, Henn, Hepper, Rintdorff, Schaeck. "**Pervasive Computing"**, 2002, Addison Wesley.
2. **Ambient intelligence, wireless networking, and ubiquitous computing**. Artech House, Boston : 2006.

B19EM8013	Satellite Communication	L	T	P	C
Duration :14 Wks		3	0	0	3

Prerequisites:

Knowledge of Basic Geometry, Insight of Geography, Fundamentals of Communication Systems and information coding.

Course Description:

The course introduces the students to the basic concept in the field of satellite communication. This will enable the students to know how to place a satellite in an orbit and about the earth & space segment. The satellite services like broadcasting are also studied thoroughly.

Course Objectives:

The objectives of this course are:

1. To provide understanding of different concepts used in a satellite communication system.
2. To get knowledge of satellite communication like orbital mechanics, launching techniques, satellite link design, earth station technology and different access system towards a satellite
3. To Understand Earth and space component.
4. To familiarize with different multiple access like TDMA FDMA and CDMA
5. To learn different communication networks.
6. To know application of satellite communication.

Course Outcomes:

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

1. Describe satellite subsystems, satellite orbits.
2. Describe the topologies of satellite communication networks
3. Design the communication satellite systems
4. Analyze the fundamentals of orbital mechanics.
5. Design link budget for a satellite communication link.

Mapping of Course Outcomes with programme Outcomes

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Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19EM8013	CO 1	2	3	2										1	1	1
	CO 2	3	2	3										1	2	3
	CO 3	2	2	3										1	1	3
	CO 4	3	3	1										1	1	1

Course Contents:

Unit-1: Satellite Systems and Orbits [11 Hrs]

Overview of satellite systems: Introduction, Frequency allocations for satellite systems.

Orbits and launching methods: Kepler's three laws of planetary motion, terms used for earth orbiting satellites, orbital elements, apogee and perigee heights, orbit perturbations, inclined orbits, standard time.

The Geostationary orbit: Introduction, antenna look angles, polar mount antenna, limits of visibility, near geostationary orbits, earth eclipse of satellite.

Unit-2: Space Segment & Earth Segment [10 Hrs]

The Space segment: Introduction, power supply, attitude control, station keeping, thermal control, TT&C subsystem, transponders.

The Earth segment: Introduction, receive-only home TV systems, master antenna TV system, Community antenna TV system, transmit-receive earth station.

Unit-3: Communication Satellite and Satellite link Design [10 Hrs]

Communication Satellites- Satellite subsystem; Attitude control, station keeping, Thermal control , Telemetry, Tracking, Command and Monitoring (TTC&M); power systems, transponders, satellite wide band receiver.

Satellite link design and Satellite access: Atmospheric losses, Basic transmission theory, system noise temperature and G/T ratio; Downlink design-link budget; Uplink design; communication link design procedure.

Unit-4: Satellite Access Techniques and Application [11 Hrs]

Satellite Access: SPADE system, satellite switched TDMA, CDMA.

Satellite Applications: Satellite Mobile Services, VSAT, Radarsat, GPS, Iridium.

Text books:

1. Dennis Roddy, "Satellite Communications", McGraw-Hill international, 4th Edition, 2006.

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Reference Books:

2. Timothy Pratt, Charles Bostian, Jeremy Allnutt. "Satellite Communications", John Wiley Pvt Ltd & Sons, 2nd Edition, 2008.
3. W. L. Pitchand, H. L. Suyderhoud, R.A. Nelson., "Satellite Communication system Engineering", Pearson Education, 2ndEdition 2007.
4. Raja Rao: Fundamentals of Satellite communications, PHI Learning.
5. Monojit Mitra: Satellite Communication: PHI Learning

SC-13

B19EM8021	Cognitive Computing	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:

Computer Languages & Algorithms

Course Description:

This course explores the area of cognitive computing and its implications for today's world of evidence-based decision making. Topics covered include: cognitive computing design principles, natural language processing, knowledge representation, Students will have an opportunity to build cognitive applications, as well as explore how knowledge-based artificial intelligence and deep learning are impacting the field of data science.

Course Objectives:

1. To develop algorithms that use AI and machine learning along with human interaction and feedback to help humans make choices/decisions.

2. To get the detailed about appealing new model for application development.

3. To understand how to evaluate patterns and complex relationships in large unstructured data sets.

4. To understand how Cognitive computing supports human reasoning by evaluating data in context and presenting relevant findings along with the evidence that justifies the answers.

Course Outcomes:

By the end of the course, students should be able to

1. Understand and discuss what cognitive computing is, and how it differs from traditional approaches.
2. Plan and use the primary tools associated with cognitive computing.
3. Plan and execute a project that leverages cognitive computing.
4. Understand and discuss the business implications of cognitive computing.

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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	PSO1	PSO2	PSO3
B19EM8021	CO 1	2	3	2										1	1	1
	CO 2	3	2	3										1	2	3
	CO 3	2	3	3										1	1	3
	CO 4	3	3	1										1	1	1

Course Contents:

Unit 1:

The Foundation of Cognitive Computing **[11 Hrs]**

Introduction to Cognitive Systems and computation, , Knowledge based AI Cognitive systems, Interdisciplinary Nature of Cognitive Science, Cognitive Computing Systems, Representations for Information and Knowledge, Principal Technology Enablers of Cognitive Computing, Cognitive Computing Architectures and Approaches, Cognitive Computing Resources.

Unit 2:

Cognitive Computing and Neural Networks **[10 Hrs]**

Reverse Engineering the Brain Brain Scalability, Neocortical Brain Organization, The Concept of a Basic Circuit, Abstractions of Cortical Basic Circuits, Cognitive Functioning Learning, Memorising, Adaptation, Self Origination, Control, Thinking, Reasoning, Decision Making & Judgement.

Unit 3:

Different modes of Computing: **[10 Hrs]**

Turning machine Lambda, Calculus, Hyper Computing, Super Computing, Pan Computing and Interactive Computing. Computation of Cognitive Functioning in machines: Robotics, Human Robotics Interaction, Hepatic.

Unit 4: **[11Hrs]**

Applications of Cognitive Computing Applications in expert systems, Natural language programming, neural networks, robotics, virtual reality, Future applications

Reference Books:

1. Hurwitz, Kaufman, and Bowles, "Cognitive Computing and Big Data Analytics", Wiley, Indianapolis, IN, 2005, ISBN: 978-1-118-89662
2. Vijay Raghvan, Venu Govindaraju, C.R. Rao, "Cognitive Computing: Theory and Applications", Elsevier publications, eBook ISBN: 9780444637512, Hardcover ISBN: 9780444637444
3. https://www.research.ibm.com/software/IBMResearch/multimedia/Computing_Cognition_WhitePaper.pdf

Ref: RU/BoS/ECE/CEC/May-2021-9

4. Mark Watson, “Introduction to cognitive computing A Guide for Individuals and Small Organizations, leanpub.com/cognitive-computing

B19EM8022	Social Media Analysis	L	T	P	C
Duration :14Wks		3	0	0	3

Prerequisites:

Nil

Course Description:

This course will introduce to social media analysis. Social media analytics is the process of gathering and analyzing data from social networks such as Facebook, Instagram, LinkedIn and Twitter. It is commonly used by marketers to track online conversations about products and companies

Course Objective:

The student should be made to:

1. To introduce to the concept of network science
2. To provide insights into networks
3. To introduce to the concepts of network analysis algorithms
4. To provide detailed information on the real world network analysis.
5.

Course Outcomes:

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

1. Define notation and terminology used in network science.
2. Demonstrate, summarize and compare networks.
3. Explain basic principles behind network analysis algorithms.
4. Analyzing real world network.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3

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	COs															
B19EM8023	CO1	2	3	2										1	1	1
	CO2	3	2	3										1	2	3
	CO3	2	2	3										1	1	3
	CO4	3	3	1										1	1	1

Course Contents

Unit- 1: Introduction [11 Hrs]

Introduction to social network analysis and Descriptive network analysis: Introduction to new science of networks. Networks examples. Graph theory basics. Statistical network properties. Degree distribution, clustering coefficient. Frequent patterns. Network motifs. Cliques and k-cores.

Unit-2: Network structure [10 Hrs]

Network structure, Node centralities and ranking on network: Nodes and edges, network diameter and average path length. Node centrality metrics: degree, closeness and betweenness centrality. Eigenvector centrality and PageRank. Algorithm HITS.

Unit-3: Information and influence propagation [11 Hrs]

Information and influence propagation on networks and Network visualization: Social Diffusion. Basic cascade model. Influence maximization. Most influential nodes in network. Network visualization and graph layouts. Graph sampling. Low dimensional projections

Unit-4: Social media mining [10 Hrs]

Social media mining and SNA in real world: FB/VK and Twitter analysis: Natural language processing and sentiment mining. Properties of large social networks: friends, connections, likes, retweets.

Text Books

1. : David Easley and John Kleinberg, “Networks, Crowds, and Markets: Reasoning About a Highly Connected World” Cambridge University Press, 2010

B19EM8023	Wireless & Mobile Networks	L	T	P	C
Duration :16 Wks		3	0	0	3

Prerequisites:

Wireless communication, computer network, data communication

Course Description:

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This course will introduce to wireless communication and mobile computing. It covers the fundamentals of wireless channels, Mitigation Techniques, Mobile Adhoc Networks, Routing Protocols

Course Objective:

The student should be made to:

1. Know the characteristic of wireless channel
2. Understand the concepts behind various digital signaling schemes for fading channels
3. Understand the various multipath mitigation techniques
4. Know the characteristic of Adhoc networks
5. Understand the concepts routing protocols
6. Understand the security issues in Adhoc networks

Course Outcomes:

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

1. Characterize wireless channels
2. Design and implement various signaling schemes for fading channels
3. Compare multipath mitigation techniques and analyze their performance
4. Characterize Adhoc Networks
5. Compare routing protocols of Adhoc networks

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	PSO1	PSO2	PSO3
B19EM8023	CO 1	2	3	2										1	1	1
	CO 2	3	2	3										1	2	3
	CO 3	2	2	3										1	1	3
	CO 4	3	3	1										1	1	1

Course Contents

Unit- 1: Wireless Channels [11 Hrs]

Large scale path loss – Path loss models: Free Space and Two-Ray models -Link Budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters Coherence bandwidth – Doppler spread & Coherence time, Fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading.

Unit-2: Multipath Mitigation Techniques [10 Hrs]

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Equalization – Adaptive equalization, Linear and Non-Linear equalization, Zero forcing and LMS Algorithms. Diversity – Micro and Macro diversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver.

Unit-3: Mobile Adhoc Networks **[11 Hrs]**

Ad Hoc Networks: Introduction, Issues in Ad hoc wireless networks, Ad hoc wireless internet. Mac Protocols For Ad Hoc Wireless Networks: Introduction, Issues in designing a MAC protocol for Ad hoc wireless Networks, Design goals of a MAC protocol for Ad hoc wireless Networks, Classification of MAC protocols.

Unit-4: Routing Protocols for Ad Hoc Wireless Networks **[10 Hrs]**

Routing Protocols For Ad Hoc Wireless Networks: Introduction, Issues in designing a routing protocol for Ad hoc wireless Networks, Classification of routing protocols, Table drive routing protocol, On-demand routing protocol.

Security: Security in wireless Ad hoc wireless Networks, Network security requirements, Issues & challenges in security provisioning.

Text Books

1. Rappaport,T.S**., "Wireless communications",** Second Edition, Pearson Education, 2010**.**
2. C. Siva Ram Murthy, B.S. Manoj, **"Ad Hoc Wireless Networks: Architectures and Protocols",** Pearson Education, 2004

Reference Books

1. David Tse and Pramod Viswanath**, "Fundamentals of Wireless Communication",** Cambridge University Press, 2005.
2. HoudaLabiod , **"Wireless Ad Hoc and Sensor Networks",** John Wiley & Sons, 2010

OE

B19EM7051	Embedded Systems	L	T	P	C
Duration :16 Wks		4	0	0	4

Prerequisites:

Microcontroller, Operating Systems.

Course Description:

An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today.

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Unit1 gives an introduction to the basic elements of embedded system such as sensors, interfaces, firmware etc
Unit2 discusses about the various aspects of hardware software co design.
Unit3 covers the complete aspects on real time embedded system design.
Unit4 briefly covers the various topics on embedded integrated development environment.

Course Objectives:

Course objectives are to:
1. Give a brief idea about the embedded system components, memory, communication interfaces and other firmware components.
2. Understand the Quality attributes, hardware and Software co-design, Computational models in embedded systems, Unified Modelling languages etc.
3. Understand the firmware system development and firmware development languages.
4. Give a brief description of RTOS, Integrated Development Environment, Simulators and Emulators.
5. To understand the trends in embedded system development.

Course Outcomes:

After completion of the course a student will be able to:
1. Design a module of embedded system
2. Elaborate the quality attributes, hardware-software co-design in embedded systems.
3. Develop a firmware module.
4. Analyse the various tools in RTOS.

Course Contents:

Unit-1: Typical Embedded System **[14 Hrs]**
Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other System Components.

Unit-2: Characteristics and Quality Attributes of Embedded Systems **[14 Hrs]**
Hardware Software Co-Design and Program Modeling: Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modeling Language (Self Study/Case Study), Hardware Software Trade-offs
Embedded Firmware Design and Development: Embedded Firmware Design Approaches, Embedded Firmware Development Languages

Unit-3: Real-Time Operating System (RTOS) based Embedded System Design **[14Hrs]**
Operating System Basics, Types of OS, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling: Putting them altogether, Task Communication, Task Synchronization, Device Drivers, How to Choose an RTOS (Self Study/Case Study).

Unit-4: The Embedded System Development Environment **[14 Hrs]**

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The Integrated Development Environment (IDE) (Self Study/Case Study), Types of Files Generated on Cross-compilation, Disassembler/Decompiler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan.
Trends in the Embedded Industry: (Self Study/Case Study), Processor Trends in Embedded Systems, Embedded OS Trends, Development Language Trends, Open Standards, Frameworks and Alliances, Bottlenecks.

Reference Books:

1. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2009
2. James K Peckol , "Embedded Systems – A contemporary Design Tool", John Weily, 2008.

B19EM7052	Robotics and Automation	L	T	P	C
Duration: 14 Wks		4	0	0	4

Prerequisites:

Embedded System Design, Control systems, Programming skills

Course Description:

Robotics is the interdisciplinary branch of engineering and science that includes mechanical engineering, electrical engineering, computer science, and others. Robotics deals with the design, construction, operation, and use of robots as well as computer systems for their control, sensory feedback, and information processing. Automation and Robotics are two closely related technologies. Automation as the technology that is concerned with the use of mechanical, electronic, and computer based systems in the operation and control of production. The course provides robot classification and anatomy, Robot kinematics, Trajectory Planning and control, Sensors and vision systems used in robots and Robot Programming.

Course Objectives:

The objectives of this course are to:

1. Classify Robots and anatomy.
2. Understand Robot kinematics
3. Determine Sensors and vision systems used in robots.
4. Write Robot Program.

Course Outcomes:

At the end of this course, student will be able to:

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1. Summarize the basic applications and advantages of using robots in the industry [a,b,c,d].
2. Do the robot motion analysis [a,b,c].
3. Relate mathematical modeling and trajectory planning scheme in robots [a,b,c,d].
4. Recognize the different types of sensors and cameras used in the field of robotics [a,b,c,d].
5. Write robot programs and upgrade knowledge on different types of cell layout applicable in robotics [a,b,c,d,e,f].

Course Contents:

Unit -1: Introduction to robotics [14 Hrs]

Definition, anatomy of robot, classification configurations, robot links and joints, robot specifications, resolution accuracy and repeatability, simple numerical problems, robot drive systems, hydraulic, pneumatic and electric drive systems, wrist and its motions, end effectors, types of end effectors, mechanical grippers, methods of constraining parts in grippers, types of gripper mechanisms, simple numerical problems, vacuum cups, magnetic grippers, adhesive grippers, hooks, scoops and other gripper devices, tool as end effectors, examples.

Unit -2: Robot motion analysis & Robot control [14 Hrs]

Direct kinematics and inverse kinematics, 3D homogeneous transformations, rotation, translation and displacement matrix, composite rotation matrix, rotation matrix about an arbitrary axis, links, joints and their parameters, Denavit-Hertenberg (D-H) representation, application of D-H matrices to different robot configurations.

Basic control systems and models, transfer function with examples, transfer function for spring-mass-damper system, transient response of a second order system, transfer function of a robot joint, different types of controllers, proportional (P) controller, integral (I) controller, derivative (D) controller, PID controller, simple numerical problems

Unit -3: Robot trajectory planning & Robot **sensors [14Hrs]**

Trajectory planning, definition, steps in trajectory planning, joint space techniques, use of a p-degree polynomial as interpolation function, cubic polynomial trajectories, linear function with parabolic blends, joint space verses Cartesian space trajectory planning, simple numerical problems on joint space trajectory planning. Classification of robot sensors and their functions, touch sensor, tactile sensor, binary sensor, analog sensor, proximity sensor, range sensor, force and torque sensor.

Unit -4: Robot sensors and Machine Vision & Robot programming [14 Hrs]

Machine vision, functions of machine vision system, sensing and digitizing, imaging devices, analog to digital signal conversion, quantization and encoding, simple numerical problems, image storage, image processing and analysis, image data reduction, segmentation, feature extraction, object recognition, robotic machine vision applications, inspection, identification, visual servoing and navigation.

Introduction to robot programming, robot cell layout, work cell control and interlocks, manual programming, lead through and walkthrough programming, off-line programming, VAL programming language, example, AML and VAL-II robot programming languages, examples, Programming with graphics, example.

Text Books:

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey: Industrial Robotics, McGraw-Hill Publications, International Edition, 2008.

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2. James G. Keramas: Robot Technology Fundamentals, Cengage Learning, International Edition 1999

Reference Books:

1. Fu K. S., Gonzelez R. C., Lee C. S. G: Robotics: Control, Sensing, Vision, IntelligenceMcGraw Hill Book Co., International edition, 2008.
2. Yorem Koren,: Robotics for Engineers, McGraw-Hill Publication, International edition, 1987
3. Craig, J. J: Introduction to Robotics: Mechanics and Control, Pearson Prentice-Hall Publications, 3rd edition, 2005.
4. Schilling R. J: Fundamentals of Robotics, Analysis and Control, Prentice-Hall Publications, Eastern Economy edition, 2007
5. Appu Kuttan K. K: Robotics, International Publications, First Edition, 2007
6. R. K. Mittal, I. J. Nagrath: Robotics and Control Tata-McGraw-Hill Publications, 2007.

B19EM7053	Internet of Things & Cyber physical system	L	T	P	C
Duration:14 Wks		4	0	0	4

Prerequisites:

Embedded systems, Computer concept networking

Course Objectives:

The objectives of this course are:

1. Provide knowledge about the basics of Internet of Things ,embedded systems design and prototyping
2. Describe Internet-of-Things and Communication protocols
3. Explain the ease of security and privacy features importance in IoT
4. Gain expertise in integrating sensing, actuation and software

Course Outcomes:

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

1. Understand basics of IoT system architecture and system design embedded through embedded prototyping (a,b)
2. Analyzing, designing, and developing prototypes of Internet-connected products using appropriate tools. (a,b,c,d)
3. Identifying, classifying and describing different kinds of Internet-connected product concepts Describe different network protocols (a,c,d)
4. Analyzing the challenges and applying adequate patterns for user-interaction with connected-objects. (a,b,c,d)
5. Analyzing and Understanding the challenges with respect to Security and Privacy through Cyber physical systems(a,b,c,d)

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Course Contents:

Unit -1: Introduction to IoT and Embedded prototyping [14Hrs]

Introduction to IOT, Wireless sensor networks, Applications of WSN, Roles in WSN, Calm and Ambient technology; Embedded prototyping: Embedded systems, Processor embedded in to system, Embedded hardware units and software system, Examples of embedded system, System on Chip, Complex system design and processors, Design process and examples in Embedded systems, Classifications of embedded systems, Skills required for embedded system designer.

Unit -2: Internet communications [14 Hrs]

Internet Communications: An Overview ,IP ,TCP ,The IP Protocol Suite (TCP/IP) ,UDP ;IP Addresses :DNS ,Static IP Address Assignment ,Dynamic IP Address Assignment ,IPv6,MAC Addresses ;TCP and UDP Ports :An Example: HTTP Ports ,Other Common Ports ;Application Layer Protocols :HTTP , HTTPS; Encrypted HTTP, Performance, ,Libraries, Debugging.

Unit -3: Overview of Security and Privacy in Cyber physical systems [14 Hrs]

Defining security and Privacy, Defining Cyber physical systems, Examples of security and privacy in action, Approaches to secure cyber physical systems, ongoing security and privacy challenges for cyber physical systems; Local network security for Cyber physical systems, Internet wide secure communication, Security and privacy for cloud interconnected Cyber physical systems.

Unit 4: **Data Security and Privacy Challenges in IoT and Distributed systems [14 Hrs]**

Context awareness for adaptive access control management in IoT Environments:

Introduction, Security challenges in IoT environment, Surveying access control models and solutions for IoT; Data privacy issues in distributed security monitoring systems: Information security in distributed data collection systems, Technical approaches for assuring information security, Approaches for building trust in data collection systems.

Case studies

a. Current challenges in IOT.
b. Battery life for IOT devices.
c. Memory management for IOT devices.

Text Books:

1. Raj Kamal 'Embedded systems, 2nd edition, McGraw-Hill, 2008.
2. IoT in 5 days Antonio Liñán Colina, Alvaro Vives, Antoine Bagula, Marco Zennaro and Ermanno PietroSemesteroli Revision 1.0 March 2015.
3. Adrian McEwen, Hakim Cassimally, 'Designing the Internet of Things', Wiley, 2014.
4. Cyber-Physical Systems: Foundations, Principles and Applications IEEE,Wiley.

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