REVA UNIVERSITY
Bengaluru, India

SCHOOL OF MECHANICAL ENGINEERING

B.Tech

in

Mechatronics Engineering

HAND BOOK

2019-23

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

School of Mechanical Engineering

HANDBOOK

B.Tech. in Mechatronics Engineering

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Approvedby

BOS/ME/BMT/2018-19/01/13-04-2019

Rukmini Knowledge Park,
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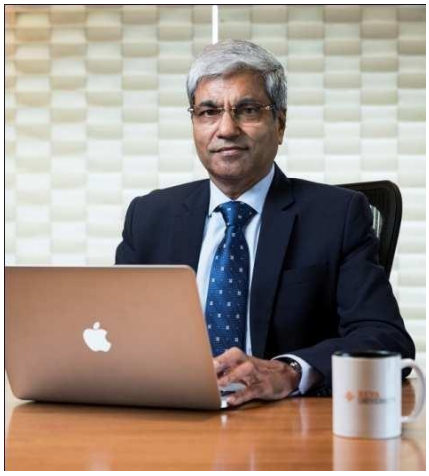
Chancellor's Message

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



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

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

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

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

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

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

Vice-Chancellor's Message

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

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

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

At REVA University, research, consultancy and innovation are regarded as our pillars of success. Most of the faculty members of the University are involved in research by attracting funded projects from various research level organizations like DST, VGST, DBT, DRDO, AICTE and industries. The outcome of the research is passed on to students through live projects from industries. The entrepreneurial zeal of the students is encouraged and nurtured through EDPs and EACs.

REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have

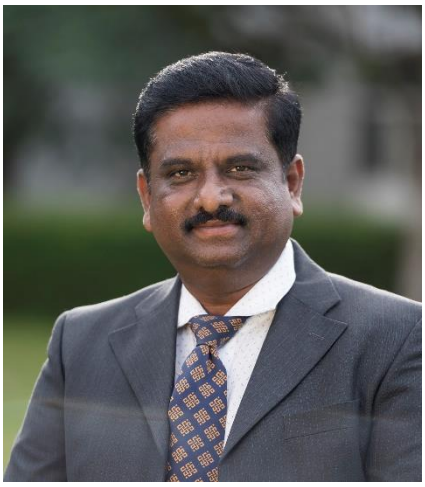
helped our students become skilled with relevant to industry requirements. Structured training programs on soft-skills and preparatory training for competitive exams are offered here to make students more employable. 100% placement of eligible students speaks the effectiveness of these programs. The entrepreneurship developmentactivities and establishment of “Technology Incubation Centers” in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise.

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

Welcome to the portals of REVA University!

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

Director's Message



With great pleasure, I welcome you to the School of Mechanical Engineering at REVA University. The School offers Undergraduate programs in Mechanical Engineering and Mechatronics Engineering leading to B. Tech., Degree, in addition to Masters Program leading to M. Tech., degree in Machine Design. More than 1500 students representing various parts of India as well a few students from overseas are studying at our School. The School has more than 60 well qualified and experienced faculty members. The School has modern teaching, learning, innovation and research facilities, in addition to excellent facilities for recreation and sports. Students are encouraged to live on campus to have better campus experience and our hostel facilities are second to none.

We understand that the students come to university for learning and the School focuses on enhancing the efficiency of learning of students and also achieving the learning outcomes to pursue careers in modern day industries. To improve efficiency of learning the School has successfully adopted modern day pedagogical methods like project based learning, problem based learning, blended learning, flipped class rooms, experiential learning and created digital resources for students to access and experience. The faculty members of the School continuously upgrade their pedagogical methods and knowledge to be in par with the best in the Country.

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

Our masters and Ph.D Scholars work on scientifically and technologically advanced topics in mechanical design, engineering analysis, manufacturing of mechanical and mechatronic systems and publish their research findings in international journals of repute.

The School has created an excellent ambience conducive for innovation, creativity and interaction. Faculty mentors and senior students instill confidence in the junior students and motivate them to achieve higher goals. The students are given support for their industry internship, placements, study abroad, industry projects and interaction with industry mentors.

I welcome you to our School and I am sure your learning experience at our school will be an enjoying and memorable one.

Dr. K.S. Narayanaswamy

Director-School of Mechanical Engineering

CONTENTS

RUKMINI EDUCATIONAL CHARITABLE TRUST

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

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

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

ABOUT REVA UNIVERSITY

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

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

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

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

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed universities / institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The 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, Fluid Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

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

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

Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana. The Centre conducts several add-on courses in challenging areas of development. It is always active in facilitating student's variety of Skill Development Training programs.

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

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

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

REVA organizes various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVOTSAVA conducted every year. The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions and variety of cultural events. Another important

event is Shubha Vidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also recognized by distributing awards and prizes. The founders have also instituted medals and prizes for sports achievers every year. The physical education department conducts regular yoga class's every day to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

Vision

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

Mechanical Engineering is one of the oldest and classical branches of engineering which drives the development and economy of the country .The school of Mechanical Engineering in REVA University has a rich blend of experienced, energetic and dedicated faculty with highest qualification in the specialization of thermal, design, manufacturing and management streams. The school is having well-furnished class rooms and well equipped laboratories with modern software tools to meet academic and industry requirements. The research Centre with modern equipment's and testing facility is also available to cater research activities in the field of materials and bio-fuels. The school is conducting extracurricular and co-curricular activities to develop additional skills, knowledge and confidence through University Industry Interaction Cell and various student clubs and student chapters with the support of industries. Industry persons are invited to give technical talks on latest technologies and students are deputed for internship in industries and universities in India and Abroad. The school is having MOU with reputed industries and universities in India and abroad for internship, research and twinning program or higher studies which will give more exposure of our students to outside world. Many students have done internship in reputed institutions like IISc, ISRO, DRDO, HAL, Rail Wheel factory, Volvo and many more. Every semester school is organizing industry visits to reputed institutions to learn various aspects of industry. The school is having clubs and chapters which are MARS, ISHRAE Student Chapter, Foundry man Society, Fluid Power Society, Solar Society, Tribology society, Robotics club, SAE club and Aryan Racing Team through which cultural events, training programs, invited talks, industry visits and placement activities are conducting. School is encouraging the students to participate in national and international level competitions like solar car design, Electric vehicle design, Formula car design, ATV design, Go-Cart design and quiz competition through this student can learn additional skills like design, team management, time management and financial aspects. Additional training programs are conducting in the field of automobile, robotics, and manufacturing to impart skills with industry relevant. The School is organizing workshops, seminars, conferences and competitions in national and international level for the students, faculty and research scholars to enhance their skills and research trends. The school offers B.Tech in Mechanical Engineering, B.Tech in Mechatronics Engineering, M.Tech in Machine design and PhD program. The curriculum of both UG and PG is designed to meet the needs of the society and industry for present and future. It also meets the requirements of higher studies in India and abroad and also for the requirement of competitive exams. In overall, school will support and make our students more disciplined, good human being and more responsible persons of the society.

Vision

"Aspires to be recognized globally for outstanding value based education in mechanical and allied areas and research leading to well-qualified engineers, who are innovative, entrepreneurial, successful in their career and committed to the development of the country."

Mission

- To impart quality education to the students and enhance their skills to make them globally competitive engineers in mechanical and allied areas.
- To promote multidisciplinary study, cutting edge research and expand the frontiers of engineers' profession in mechanical and allied areas.
- To create state-of-art facilities with advanced technology for providing students and faculty with opportunities for innovation, application and dissemination of knowledge.
- To prepare for critical uncertainties ahead for mechanical engineering and allied areas and to face the challenges through clean, green and healthy solution.
- To collaborate with industries, institutions and such other agencies nationally and internationally to undertake exchange programs, research, consultancy and to facilitate students and faculty with greater opportunities for individual and societal growth.

ADVISORY BOARD

Sl. No.	Details of Members
1	**Dr. N. V. Ravikumar,** Associate Professor, Department of Metallurgy & Materials Engineering, IIT Madras, Chennai.
2	**Mr. K. N. Narsimha Murthy** Chairman, Fluid Air Systems, Bangalore. Hon. Treasurer, Karnataka Small Scale Industries Association (KSSIA)
3	**Prof. M. V. Krishna Murthy** FormerProfessor, Dept.MechanicalEngineering,IITMadras, Chennai, Former Director, VIT,Vellore.
4	**Mr. Praveen Kumar Jinde,** Scientist, NAL, Bangalore.
5	**Dr. K Ramachandra** Former Director, GTRE, Bangalore CEO, NP-MICAV's National Design Research Forum The Institute of Engineers, Bangalore.
6	**Prof. E. Abhilash** Dept. Mechanical Engineering, King Khalid University Abha, Kingdom of Saudi Arabia.

Board of Studies (BoS) Members

Sl. No.	Name, Designation & Affiliation	Status	Correspondence Address
1	**Dr. K S Narayanaswamy**Director, School of ME, REVA University	Chair Person	Dr. K S Narayanaswamy, Director, School of ME, REVA University, Rukmini Knowledge Park, Yelahanka, Bengaluru - 560 064
2	**Dr. R C Biradar** Professor & Director REVA University	Member	Dr. R C Biradar Professor & Director, School of ECE REVA University, Bangaluru-560064
3	**Mr. S Sendilkumar** Manager FESTO India Pvt Ltd	Member	Mr. S Sendilkumar Manager- Training FESTO India Pvt Ltd, Bengaluru
4	**Mr. Raghavendra A S** Assistant Manager TENOVA India Pvt Ltd	Member	Mr. Raghavendra A S Assistant Manager, TENOVA India Pvt Ltd Bengaluru,
5	**Mr. Chandru Nadig H V** Technical Lead Robert-Bosch Engineering Solutions Ltd	Member	Mr. Chandru Nadig H V Technical Lead, EBB Dept., Robert-Bosch Engineering Solutions Ltd, Bengaluru
6	**Dr. A R K Swamy** Professor and former HOD Acharya Institute of Technology	Member	Dr. A R K Swamy Professor and former HOD Dept. of Mechatronics, Acharya Institute of Technology Bengaluru
7	**Dr. Riyaz Ahemed** Associate Professor REVA University	Member	Dr. Riyaz Ahemed Associate Professor, School of ECE REVA University.
8	**Dr. Raju B. S** Professor REVA University	Member (Internal)	Dr. Raju B. S Professor, School of Mechanical Engineering REVA University, Bengaluru 560064
9	**Dr. N Jagadeeswaran** Professor REVA University	Member (Internal)	Dr. N Jagadeeswaran Professor, School of Mechanical Engineering REVA University, Bengaluru 560064
10	**Mr. L R Jagadeesh** Associate Professor REVA University	Member (Internal)	Mr. L R Jagadeesh Associate Professor, School of Mechanical Engineering REVA University, Bengaluru 560064
11	**Dr. Mahesh L** Associate Professor REVA University	Member (Internal)	Dr. Mahesh L Associate Professor, School of Mechanical Engineering REVA University, Bengaluru 560064
12	**Mr. R Vidyasagar** Engineer Merceedz benz	Member Alumni	Mr. R Vidyasagar, Engineer Mercedes Benz Research and Development India Pvt. Ltd, Bengaluru

Programme Overview

Mechatronics Engineering is a multidisciplinary branch of engineering that focuses on mechanical, electronics and electrical systems and also includes a combination of robotics, computer, telecommunication and product engineering.

There is an immense scope for mechatronics engineering in the present scenario due to fast growth in automation and advancement in technology. The main advantage after the completion of this programme is that one can not only work in the field of mechatronics, but has equal opportunities in the other stream of engineering such as mechanical, electronics, electrical, computer and information technology. Mechatronics engineering has application in areas like Transportation and Vehicle Systems, Telecommunication and Data Communication Networks, Power Devices, Medical/Bio medical systems, Heavy Engineering and Manufacturing Systems, Energy Devices, Consumer Products, Computer Techniques in Medical, Bio imaging and Technology Systems and Computer Integrated Manufacturing Devices and Systems.

This program is developed in direct response to industrial demand for engineers with multi-disciplinary skills. The program allows engineers to design, construct and run factory production lines and automated processes, where they use acquired knowledge in computers and programming, micro-controllers, programmable logic controllers, industrial sensors, hydraulic system, pneumatic system and electric drives.

The School of Mechanical Engineering at REVA University offers B. Tech program in Mechatronics Engineering to prepare innovative, creative and thinking graduates to fill the roles of mechatronics engineers who can conceptualize, modelling and develop mechanical and electrical systems to meet the modern day requirements.

The curriculum of this program is outcome based and it comprises theoretical concepts and practical skills in the domain. In addition, students are trained in interdisciplinary topics and attitudinal skills to enhance their scope. Along with above mentioned features, the advanced teaching and learning resources, and experienced faculty members with their strong connections with manufacturing sector makes this program unique.

The curriculum covers major topics such as robotics and vision systems, data acquisition systems, sensors and transducers, rapid prototyping, computer integrated manufacturing, industrial robotics, internet of things (IoT), managerial and economical aspects. This curriculum meets requirement of industry, research and development and competitive exams like GATE, IAS and IES etc. By studying the mechatronics programme the students have the opportunity to appear for GATE in the stream of Electronics Engineering or Mechanical Engineering.

Our strongest conviction is that *'Interdisciplinary courses of Mechanical domain and Electronicsdomain are the hardcore of this program* to create Industry ready and skill-oriented living engineers.

Program Educational Objectives (PEO's)

The After few years of graduation, the graduates of B.Tech Mechatronics Engineering will:

- **PEO 1:** Work as an Engineer in mechanical and electronics sectors in multidisciplinary role
- **PEO 2:** Act as an administrator in public, private and government organisations or start own business with further training and education.
- **PEO 3:** Pursue higher education to work in colleges, universities as professors or as scientists in research establishments.
- **PEO 4:**Adopt lifelong learning philosophy for continuous improvement in working environment either as a member of team or lead the team.

Program Outcomes (POs)

On successful completion of the program, the graduates of B.Tech Mechatronics Engineering will be able to:

- **PO 1: Engineering Knowledge:**Apply the knowledge of mathematics, science, engineering fundamentals, to solve problems in mechatronics engineering.

- **PO 2: Problem Analysis:**Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

- **PO 3: Design/Development of Solutions:**Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

- **PO 4: Conduct Investigations of Complex Problems:**Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems

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

- **PO 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.

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

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

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

- **PO 10: Communication:**Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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

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

Program Specific Outcomes (PSOs)

On successful completion of the program, the graduates of B.Tech Mechatronics Engineering will be able to:

- **PSO 1:** Apply mechatronics engineering knowledge and skills in Design, Manufacturing, Automation and Electronics to obtain realistic outcomes.
- **PSO 2:** Identify, formulate, analyze and solve problems in mechatronics engineering and allied domains.
- **PSO 3:** Conduct investigations in Mechanical and Electronics Engineering and allied areas to provide optimal and sustainable solutions

Academic Regulations

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

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

Studying under CBCS has following advantages:

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

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

1. **Teaching and Learning Process:**
   The teaching &Learning process under CBCS – CAGP of education in each course of study will have four components, namely**:**:

   (i) L= Lecture (ii) T= Tutorial (iii) P=Practice, (iv) D=Dissertation / Project; 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.

   D stands for Dissertation / Project to be carried out as a part of the course work.

2. **Courses of Study and Credits**
   a. The study of various subjects in B Tech degree program are grouped under various courses. Each of these course carries credits which are based on the number of hours of teaching and learning.
   b. In terms of credits, every **one hour session of L amounts to 1 credit per Semester.** In terms of credits, every **one hour session of L amounts to 1 credit per Semester** and a minimum of **two hour session of T or P amounts to 1 credit per Semester or a three hour session of T / P / D amounts to 2 credits** over a period of one Semester of 16 weeks for teaching-learning process.
   c. **The total duration of a semester is 20 weeks inclusive of semester-end examination.**
   d. **A course shall have either or all the four components.** That means a course may have only lecture component, or only practical component or combination of any two or all the three components.
   e. The total credits earned by a student at the end of the semester upon successfully completing the course are L + T + P + D. **The credit pattern of the course is indicated as L: T: P:D.**

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

a. **Core Course:**

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

b. **Foundation Course (FC):**

The foundation Course is a core course which should be completed successfully as a part of graduate degree program irrespective of the branch of study.

c. **Hard Core Course (HC):**

The **Hard Core Course** is a Core Course in the main branch of study and related branch(es) of study, if any that the candidates have to complete compulsorily.

d. **Soft Core Course (SC):**

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

e. O**pen Elective Course:**

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

f. **Project Work / Dissertation:**

Project work is a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A project work carrying **FOUR or SIX** credits is called **Minor Project** work / **Dissertation.** A project work of **EIGHT, TEN, TWELVE or SIXTEEN** credits is called **Major Project** work / **Dissertation**. **A Minor Project work may be a hard core or a Soft Core as decided by the BoS / concerned. But the Major Project shall be Hard Core.**

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

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.

2. The medium of instruction shall be English

4. **Minimum Credits to be Earned**

4.1 **A candidate has to earn 192 credits for successful completion of B Tech degree** with the distribution of credits for different courses as prescribed by the university. A candidate can enroll for a maximum of 30 credits and a minimum of 20 credits per Semester. However he / she may not successfully earn a maximum of 30 credits per semester. This maximum of 30 credits does not include the credits of courses carried forward by a candidate.

4.2 **Only such full time candidates who register for a minimum prescribed number of credits in each semester from I semester to VIII semester and complete successfully 192 credits in 8 successive semesters shall be considered for declaration of Ranks, Medals, Prizes and are eligible to apply for Student Fellowship, Scholarship, Free ships, and such other rewards / advantages which could be applicable for all full time students and for hostel facilities**.

4.3 **Add- on Proficiency Certification:**

To acquire **Add on Proficiency Certification** a candidate can opt to complete a minimum of 4 extra credits either in the same discipline /subject or in different discipline / subject in excess to 192 credits for the B Tech Degree program.

4.3.1. Add on Proficiency Diploma:

To acquire **Add on Proficiency Diploma,** a candidate can opt to complete a minimum of 18 extra credits either in the same discipline /subject or in different discipline / subject in excess to 192 credits for the B Tech Degree program.

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

5. Continuous Assessment, Earning of Credits and Award of Grades.

5.1. The assessment and evaluation process happen in a continuous mode. However, for reporting purpose, **a semester is divided into 3 components as C1, C2, and C3.**

5.2. The performance of a candidate in a course will be assessed for a maximum of 100 marks as explained below.

a) Continuous assessment (C1 and C2) = 50 marks
b) Semester end (C3) examination = 50 marks

5.2.1 **(i) Component C1:**

The first Component (C1), of assessment is for 25 marks. This will be based on test, assignment / seminar. During the first half of the semester (i.e. by 8th week), the first 50% of the syllabus (Unit 1&2) will be completed. This shall be consolidated during the first three days of 8th week of the semester. A review test based on C1 will be conducted and completed in the beginning of the 9th week. In case of courses where test cannot be conducted, the form of assessment will be decided by the concerned school and such formalities of assessment will be completed in the beginning of the 9th week. The academic sessions will continue for C2 immediately after completion of process of C1.

The finer split - up for the award of marks in C1 is as follows:

Assignment / Seminar/Quiz …….. 10 marks

Review Test (Mid-Term) ……15 marks

Total ……..25 marks

5.2.2 **(ii) Component C2:**

The second component (C2), of assessment is for 25 marks. This will be based on test, assignment /seminar. The continuous assessment and scores of second half of the semester (9th to 16th week) will be consolidated during 16th week of the semester. During the second half of the semester the remaining units in the course will be completed. A review test based on C2 will be conducted and completed during 16th week of the semester. In case of courses where test cannot be conducted, the form of assessment will be decided by the concerned school and such formalities of assessment will be completed during 16th week.

The 17th week will be for revision of syllabus and preparation for the semester - end examination.

The finer split - up for the award of marks in C2 is as follows:

Assignment / Seminar/Quiz …….. 10 marks

Review Test (Mid-Term) ……15 marks

Total ……..25 marks

5.2.3 The outline for continuous assessment activities for Component-I (C1) and Component-II (C2) will be proposed by the teacher(s) concerned before the commencement of the semester and will be discussed and decided in the respective School Board. The students should be informed about the modalities well in advance. **The evaluated courses/assignments during Component I (C1) and Component II (C2) of assessment are immediately returned to the candidates after**

obtaining acknowledgement in the register maintained by the concerned teacher for this purpose.

5.2.4 **(iii) Component C3:**

The end semester examination of 3 hours duration for each course shall be conducted during the 18th & 19th week. **This forms the third / final component of assessment (C3) and the maximum marks for the final component will be 50.**

Valuation will be undertaken concurrently and results are announced latest by the end of 20th week. This practice will be followed both in odd semester and even semester.

5.3. Evaluation of Practical Courses

5.3.1 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.

5.3.2. 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 assessment (C1 and C2) = 50 marks
b. Semester end (C3) practical examination = 50 marks

The 50 marks meant for continuous assessment shall further be allocated as under:

i	Conduction of regular practical throughout the semester	10 marks
ii	Maintenance of lab records	10 marks
iii	Performance of mid-term test	30 marks
	Total	**50 marks**

The 50 marks meant for Semester End (C3) Examination, shall be allocated as under:

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

5.3.3 The C3 examination for Practical work will be conducted jointly by internal and external examiners. However, if external examiner does not turn up, then both the examiners will be internal examiners.

In case a course is partly P type i.e, (L=3): (T=0) (P=1), then the examination for C3 component will be as decided by the BoS concerned.

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

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

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

Component – I	(C1)	Periodic Progress and Progress Reports (25%)
Component – II	(C2)	Results of Work and Draft Report (25%)
Component– III	(C3)	Final Evaluation and Viva-Voce (50%). Evaluation of the report is for 30% and the Viva-Voce examination is for 20%

Eligibility to Appear C3 (Semester - end) Examination

Only those students who fulfill a minimum of 75% attendance in aggregate of all the courses including practical courses / field visits etc, as part of the course(s), as provided in the succeeding sections, shall be eligible to appear for C3 examination.

6. Requirements to Pass the Semester and Provision for Make-up Examination and to Carry Forward the Failed Subjects / Courses:

6.1 Requirements to Pass a Course

A candidate's performance from all 3 components will be in terms of scores, and the sum of all three scores will be for a maximum of 100 marks (25 + 25 + 50; i .e, C1 + C2 + C3) and

have to secure a minimum of 40% to declare pass in the course. However, a candidate has to secure a minimum of 25% (13 marks) in C3 which is compulsory.

6.2. Provision for Make- up Examination:

a) For those students who have secured less than 40% marks in C1, C2 and C3 (end semester examination) together; the university shall conduct a make-up C3 examination of both odd semester and even semester together, after the end of even semester and before the commencement of next odd semester.

b) There is no make-up examination for C1 and C2.

c) A student who is absent to End Semester Examination (C3) due to medical emergencies or such other exigencies and fulfills the minimum attendance is also eligible to appear for make-up examination.

6.3 Provision to Carry Forward the Failed Subjects / Courses:

The student who has failed in a maximum of 4 courses in odd and even semesters together shall move to next semester of immediate succeeding year of study. And he / she shall appear for C3 examination of failed courses of previous semesters concurrently with odd semester end examinations (C3) and / or even semester end examinations (C3) of current year of study. However, he / she shall have to clear all courses of both odd and even semesters of preceding year to register for next succeeding semester.

Examples:-

a. Student "A" has failed in 1 Course in First Semester and 3 Courses in Second Semester. He / she is eligible to seek admission for Third Semester and appear for C3 examination of 1 failed Course of First Semester concurrently with Third Semester C3 examination. Likewise, he / she is eligible to appear for C3 examination of 3 failed Courses of Second Semester concurrently with Fourth Semester C3 examination. However, he / she has to clear all the failed Courses of First and Second Semesters before seeking admission to Fifth Semester.
b. Student "B" has failed in 2 Courses in Third Semester and 2 Courses in Fourth Semester and

has passed in all Courses of First and Second Semesters. He / she is eligible to seek admission to Fifth Semester and appear for C3 examination of 2 failed Courses of Third Semester concurrently with Fifth Semester C3 examination. Likewise he / she is eligible to appear for C3 examination of 2 failed Courses of Fourth Semester concurrently with Sixth Semester C3 examination. However, he / she is not eligible to seek admission to Seventh Semester unless he / she passes in all the failed courses of Third and Fourth Semesters.

c. Student "C" has failed in 4 Courses in Fifth Semester but has cleared all the courses in Sixth Semester. He / She has also passed all the courses of First to Fourth Semesters. Student "C" is eligible to seek admission for Seventh Semester and appear for C3 examination of 4 failed Courses of Fifth Semester concurrently with Seventh Semester C3 examination. However, he / she has to pass all the failed courses of Fifth Semester along with Seventh and Eighth Semesters courses to earn B Tech Degree.

d. Student "D" passed in 1to 4 semesters, but failed in 3 courses of 5th Semester and in 1 course of 6th Semester. He / She has also passed all the courses of First to Fourth Semesters. Student "D" is also eligible to seek admission for 7th Semester and appear for C3 examination of 3 failed courses of 5th Semester concurrently with 7th Semester C3 examination and one failed course of 6th Semester concurrently with 8th Semester C3 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.

6.4 Re-Registration and Re-Admission:

a) In case a candidate's class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University, such a candidate is considered as dropped the semester and is not allowed to appear for end semester examination (C3) and he / she shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

b) In case a candidate fails in more than 4 courses in odd and even semesters together in a given academic year (and is detained from moving to higher semester) he / she may opt to re-register either for the entire semester(s) or for such courses wherein, he / she has failed and repeat the semester(s) / courses. (However, such a candidate may also opt to re-appear during subsequent semester / year within a stipulated period, for C3 (semester end) examination to such of those courses that he /she has failed without re-registering).

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

7. Attendance Requirement:

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

7.2 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.

7.3 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 (C3) examination and such student shall seek re-admission as provided in 7.8.4.

7.4 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 C3, and subsequently a notification pertaining to the above will be brought out by the Director of the School before the commencement of C3 examination. A copy of this notification shall also be sent to the office of the Registrar & Registrar (Evaluation).

8 **Absence during Mid Semester Examination:**

In case a student has been absent from a mid semester (C1 and C2) examination due to the illness or other contingencies he / she may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Head of the School, for make-up examination. The Head of the School may consider such request depending on the merit of the case and after consultation with course instructor and class teacher, and permit such student to appear for make-up mid semester (C1 and C2) examination.

8.1 Absence during End Semester Examination:

In case a student is absent for end semester examination on medical grounds or such other exigencies and has fulfilled the minimum 75% attendance requirement, he / she is permitted to appear for make-up examination.

9 **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.

10 Grade Card and Grade Point

10.1 **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).

10.2 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).

10.3 **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)+M] secured by a candidate in a course which is **rounded to nearest integer**. V is the credit value of course. G is the grade and GP is the grade point.

10.3.1 Computation of SGPA and CGPA

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

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

Illustration for Computation of SGPA and CGPA

Illustration No. 1

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

Thus, **SGPA = 188 ÷ 24 = 7.83**

Illustration No. 2

Course	**Credit**	**Grade letter**	**Grade Point**	**Credit Point (Credit x Grade point)**
Course 1	**4**	**A**	**8**	**4X8=32**
Course 2	**4**	**B+**	**7**	**4X7=28**
Course 3	**3**	**A+**	**9**	**3X9=27**

Course 4	**3**	**B+**	**7**	**3X7=21**
Course 5	**3**	**B**	**6**	**3X6=18**
Course 6	**3**	**P**	**5**	**3X5=15**
Course 7	**2**	**B+**	**7**	**2X7=21**
Course 8	**2**	**O**	**10**	**2X10=20**
	24			**175**

Thus, **SGPA = 175 ÷ 24 = 7.29**

Illustration No.3

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

Thus**, SGPA = 199 ÷ 24 = 8.29**

10.4 Cumulative Grade Point Average (CGPA):

10.4.1 Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (192) for B. Tech degree in Engineering & Technology is calculated taking into account all the courses undergone by a student over all the semesters of a program, i. e : **CGPA = ∑(Ci x Si) / ∑Ci**

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

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

Illustration:

CGPA after Final Semester

Semester (ith)	**No. of Credits (Ci)**	**SGPA (Si)**	**Credits x SGPA (Ci X Si)**
1	24	6.83	24 x 6.83 = 163.92
2	24	7.29	24 x 7.29 = 174.96
3	24	8.11	24 x 8.11 = 192.64
4	26	7.40	26 x 7.40 = 192.4
5	26	8.29	26 x 8.29 = 215.54
6	24	8.58	24 x 8.58 = 205.92
7	24	9.12	24 x 9.12 = 218.88
8	24	9.25	24 x 9.25 =222
Cumulative	196		1588.26

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

10.4.2 CONVERSION OF GRADES INTO PERCENTAGE:

Conversion formula for the conversion of CGPA into Percentage is:

Percentage of marks scored = CGPA Earned x 10

Illustration : CGPA Earned 8.10 x 10=81.0

10.5 Classification of Results

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

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

Overall percentage=10*CGPA

11 Provision for Appeal

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

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

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

List of Codes for Programs and Disciplines / Branch of Study

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

B.Tech. in Mechatronics Engineering
Scheme of Instructions and Detailed Syllabus

I SEMESTER (CHEMISTRY CYCLE)

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching school
					L	T	P	J	Total		
1	B19MT1010	Calculus	HC	---	2	1	0	0	3	4	Physical Sciences
2	B19MT1020	Applied Chemistry	HC	---	2	1	0	0	3	4	Physical Sciences
3	B19MT1030	Basic Electrical and Electronics Engineering	HC	---	2	0	1	0	3	5	EEE
4	B19MT1040	Computer Aided Engineering Drawing	HC	---	1	0	2	0	3	7	ME
5	B19MT1050	Environmental Studies	FC	---	2	0	0	0	2	2	Physical Sciences
6	B19MT1060	Technical English-I	FC	---	0	0	2	0	2	4	Humanity Science
7	B19MT1070	Workshop Practice	HC		0	0	2	0	2	3	ME
8	B19MT1080	Applied Chemistry Lab	HC	---	0	0	2	0	2	3	Physical Sciences
TOTAL CREDITS & CONTACT HOURS									20	32	

II SEMESTER (PHYSICS CYCLE)

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	B19MT2010	Linear Algebra and Laplace Transform	HC	---	2	1	0	0	3	4	Physical Sciences
2	B19MT2020	Applied Physics	HC	---	2	1	0	0	3	4	Physical Sciences
3	B19MT2030	C Programming	HC	---	3	0	0	0	3	3	C&IT
4	B19MT2040	Engineering Mechanics	HC		2	1	0	0	3	4	CE
5	B19MT2050	Constitution of India and Professional Ethics	FC	---	2	0	0	0	2	2	Legal Studies
6	B19MT2060	Technical English-II	FC	B19MT1	0	0	2	0	2	4	Humanity

				060							Science
7	B19MT2070	Manufacturing Technology	HC	---	3	0	0	0	3	3	ME
8	B19MT2080	Applied Physics Lab	HC		0	0	2	0	2	3	Physical Sciences
9	B19MT2090	C Programming Lab	HC		0	0	2	0	2	3	C&IT
10	B19MT2X10	Sports/Yoga/Music/Dance/Theatre	RULO		0	0	0	2	2	2	Sports/Arts
TOTAL CREDITS & CONTACT HOURS									25	32	
TOTAL CREDITS OF I SEMESTER TO II SEMESTER									45		

III SEMESTER

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	B19MT3010	Numerical Methods and Probability	HC	B19MT1010/2010	2	1	0	0	3	4	Physical Sciences
2	B19MT3020	Thermal Engineering	HC		4	0	0	0	4	4	ME
3	B19MT3030	Mechanics of Materials	HC	B19MT2040	3	0	1	0	4	4	ME
4	B19MT3040	Mechanical Measurements and Instrumentation	HC	B19MT2020	2	0	1	0	3	4	ME
5	B19MT3050	Analog and Digital Circuits	HC	B19MT1030	2	1	0	0	3	4	ECE
6	B19MT3060	Signals and Networks	HC		2	1	0	0	3	4	ECE
7	B19MT3070	Computer Graphics and Modelling Lab	HC	B19MT2040 / 70	0	0	2	0	2	3	ME
8	B19MT3080	Analog Devices and Digital Lab	HC	B19MT1030	0	0	2	0	2	3	ECE
9	B19MT3090	Placement Training-1	RULO		0	0	2	0	2	3	Placement
TOTAL CREDITS & CONTACT HOURS									26	33	
TOTAL CREDITS OF I SEMESTER TO III SEMESTER									71		

Note: 1. Mechanics of Materials integrated with MAT Lab for practice session

IV SEMESTER

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	B19MT4010	Applied Mathematics	HC	B19MT1010 /2010/3010	2	1	0	0	3	4	Physical Sciences
2	B19MT4020	Fluid Mechanics and Machinery	HC	B19MT2020	3	0	1	0	4	5	ME
3	B19MT4030	Kinematics of Machines	HC		4	0	0	0	4	4	ME
4	B19MT4040	Electrical Machines and drives	HC	B19MT1030	2	1	0	0	3	4	EEE
5	B19MT4050	Microcontrollers and Applications	HC		3	0	0	0	3	3	ECE
6	B19MT4060	Hydraulics and Pneumatics	HC		3	0	0	0	3	3	ME
7	B19MT4070	Manufacturing and Testing Lab	HC	B19MT1040	0	0	2	0	2	3	ME
8	B19MT4080	Microcontrollers Lab	HC		0	0	2	0	2	3	ECE
9	B19MT4090	Placement Training-2	RULO		0	0	2	0	2	3	Placement
TOTAL CREDITS & CONTACT HOURS									26	32	
TOTAL CREDITS OF I SEMESTER TO IV SEMESTER									97		

Note: Experiment on Losses in pipes and flow measurement is integrated with Fluid Mechanics and Machinery course, it should be done during practice session.

V SEMESTER

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	B19MT5010	CNC Technology	HC	B19MT1040	3	0	0	0	3	3	ME
2	B19MT5020	Communication Systems	HC		4	0	0	0	4	4	ECE
3	B19MT5030	Data Acquisition Systems	HC		4	0	0	0	4	4	ECE
4	B19MT5040	Robotics and Vision System	HC		4	0	0	0	4	4	ECE
5	Soft Core -1										
	B19MT5051	Automotive Engineering			3	0	0	0	3	3	ME
	B19MT5052	Tribology and Bearing Design		B19MT3030	3	0	0	0	3	3	ME
	B19MT5053	Theory of Metal Cutting and			2	0	1	0	3	4	ME

		Machine Tools	SC								
	B19MT5054	Material Science and Technology			2	0	1	0	3	4	ME
	B19MT5055	Data Structure			2	0	1	0	3	4	C&IT
6	Soft Core -2										
	B19MT5061	Elements of Avionics	SC	B19MT1030	3	0	0	0	3	3	ECE
	B19MT5062	Python Programming		B19MT2030	3	0	0	0	3	3	C&IT/ ECE
	B19MT5063	Data Communication Networking			3	0	0	0	3	3	ECE
	B19MT5064	Mobile Application Development			3	0	0	0	3	3	ECE
	B19MT5065	Sensors and Actuators			3	0	0	0	3	3	ECE/ME
7	B19MT5070	CNC Lab	HC		0	0	2	0	2	3	ME
8	B19MT5080	Data Acquisition System Lab	HC	----	0	0	2	0	2	3	ECE
9	B19MT5090	Placement Training-3	RULO	----	0	0	2	0	2	3	Placement
TOTAL CREDITS & CONTACT HOURS									27	31	
TOTAL CREDITS OF I SEMESTER TO V SEMESTER									124		

VI SEMESTER

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	B19MT6010	Process Automation	HC	B19MT4060	3	0	0	0	3	3	ME
2	B19MT6020	Design of Machine Elements	HC	B19MT3030	4	0	0	0	4	4	ME
3	B19MT6030	Digital Signal Processing	HC	B19MT3060	3	1	0	0	4	5	ECE
4	Soft Core -3										
	B19MT6041	Refrigeration and Air Conditioning	SC	B19MT3020	3	0	0	0	3	3	ME
	B19MT6042	Composite Materials		B19MT5054	3	0	0	0	3	3	ME
	B19MT6043	Rapid Prototyping		B19MT5054	3	0	0	0	3	3	ME
	B19MT6044	Nonconventional Machining Processes			3	0	0	0	3	3	ME
	B19MT6045	Machine Learning Using Python Programming		B19MT5062	2	0	1	0	3	4	C&IT
5	Soft Core -4										
	B19MT6051	Artificial Intelligence for Mechatronics Systems	SC		3	0	0	0	3	3	ECE
	B19MT6052	PLC and SCADA		----	3	0	0	0	3	3	ECE
	B19MT6053	Underwater Robotics		B19MT5040	3	0	0	0	3	3	ECE
	B19MT6054	Wireless Sensor Networks		----	3	0	0	0	3	3	ECE
	B19MT6055	System Modelling and Simulation		----	3	0	0	0	3	3	ECE/ME
6	Soft Core -5										
	B19MT6061	Heat Transfer		B19MT3020	2	1	0	0	3	4	ME
	B19MT6062	Operation Research		B19MT3010	2	1	0	0	3	4	ME

	B19MT6063	Finite Element Methods	SC		2	0	1	0	3	4	ME
	B19MT6064	Theory of Machines		B19MT4030	2	1	0	0	3	4	ME
	B19MT6065	Machine Tool Design		B19MT5053	2	1	0	0	3	4	ME
7	B19MT6070	Automation Lab	HC		0	0	2	0	2	3	ME
8	B19MT6080	Digital Signal Processing Lab	HC	----	0	0	2	0	2	3	ECE
9	B19MT6090	Placement Training-4	RULO		0	0	2	0	2	3	Placement
TOTAL CREDITS & CONTACT HOURS									26	32	
TOTAL CREDITS OF I SEMESTER TO VI SEMESTER									150		

VII SEMESTER

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	B19MT7010	Engineering Economics and Financial Management	HC		2	1	0	0	3	4	ME
2	B19MT7020	Control Systems	HC		3	1	0	0	4	5	ME/ECE
3	B19MT7030	Embedded Systems	HC	----	4	0	0	0	4	4	ECE
4	Soft Core – 6										
	B19MT7041	MEMS	SC		3	0	0	0	3	3	ME
	B19MT7042	Product Design and Development			3	0	0	0	3	3	ME
	B19MT7043	Industrial Engineering		----	3	0	0	0	3	3	ME
	B19MT7044	Non Destructive Testing Methods		----	3	0	0	0	3	3	ME
	B19MT7045	Safety Engineering		----	3	0	0	0	3	3	ME
5	Soft Core – 7										
	B19MT7051	Biomedical Signal Processing	SC	B19MT6030	2	1	0	0	3	4	ECE
	B19MT7052	Real Time Operating Systems			2	1	0	0	3	4	ECE
	B19MT7053	Autotronics			2	1	0	0	3	4	ECE
	B19MT7054	Nano Technology		B19MT3040	2	1	0	0	3	4	ECE

	B19MT7055	IoT and Cyber Physical Systems			2	1	0	0	3	4	ECE
6	Open Elective*		OE	----	4	0	0	0	4	4	---
7	B19MT7070	Embedded System Lab	HC	----	0	0	2	0	2	3	ECE
8	B19MT7080	Communication Systems Lab	HC	B19MT5020	0	0	2	0	2	3	ECE
TOTAL CREDITS & CONTACT HOURS									25	30	
TOTAL CREDITS OF I SEMESTER TO VII SEMESTER									175		

Note: 1. Open Elective must be on line course from NPTEL/SWAYAM/COURSERA or any other platform specified by the University

VIII SEMESTER

Sl. No	Course Code	Title of the Course	Type of Course	Pre requisite	Credit Pattern & Credit Value					Contact Hours	Teaching School
					L	T	P	J	Total		
1	Soft Core – 8										
	B19MT8011	Industrial Robotics	SC	B19MT5040	3	0	0	0	3	3	ME
	B19MT8012	Hybrid-Electric Vehicles		B19M1030/4040	3	0	0	0	3	3	ME/EEE
	B19MT8013	Safety and Security of Automotive Systems		B19MT7053	3	0	0	0	3	3	ME/ECE
	B19MT8014	Power Electronics		----	3	0	0	0	3	3	ECE
	B19MT8015	Project Management		----	3	0	0	0	3	3	ME
2	B19MT8030	Project Work	HC	---	0	0	0	12	12	----	ME/ECE
3	B19MT8040	MOOC/Swayam/NPTEL/ Internship *	SC	---	2	0	0	0	2	----	---
TOTAL CREDITS & CONTACT HOURS									17	06	
TOTAL CREDITS OF I SEMESTER TO VIII SEMESTER									192		

***Student should do 21 days one internship or 15 days each 2 internship or they have to undergo Certification Programme through MOOC from NPTEL/SWAYAM/COURSERA or any other platform specified by the University.**

Detailed Syllabus for 2019 Admitted Batch

First Semester

B19ME1010	Calculus	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	4

Prerequisites:

Knowledge on differentiation, integration, matrices, determinants, and geometry.

Course Objectives:

1. Study the concept of polar coordinate system and its application to engineering problems.
2. To discover the concepts of differential calculus and its application.
3. To review partial differentiation and its application in various field.
4. Describe to solve analytically the first order first degree differential equation.
5. Study the concept of integration of functions of two/three variables over a region.
6. Defend to integrate improper integrals using Beta and Gamma function

Course Outcomes:

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

1. Estimate the angle between polar curves, express the polar curve in terms of pedal form.
2. Determine radius of curvature and able to determine limits of indeterminate function applicable to already word problems and engineering problems.
3. Interpret partial differentiation to find the derivatives of implicit and composite functions.
4. Compute functional dependence using Jacobians. Learn to expand any functions of two variables in ascending power and to find the extreme value of a given function related to engineering problems and gain knowledge to solve differential equation arising in different engineering branch
5. Determine and solve first order ordinary differential equation
6. Elaborate the evaluation policy of some special functions like beta and gamma functions and their relation which is helpful to evaluate some definite integral arising in various branch of engineering.

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
B19ME 1010	CO1	3	2	1	1	3	1							3	3	3
	CO2	3	2	1	1	2	1							3	3	3
	CO3	3	2	2	1	2	1							3	3	3
	CO4	3	2	2	1	2	1							3	3	3

Course Contents:

UNIT-I: Calculus-I[12 Hrs]

Successive differentiation-nth derivatives (no proof and simple problems), Leibnitz Theorem (without proof) and problems, Taylor's series and Maclaurins series expansion for one variable (only problems), Polar curves- Angle between the radius vector tangent, angle between two curves, Pedal equation for polar curves.

UNIT-II: Calculus-II[12 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-III: Calculus-III [12 Hrs]

Jacobians-definition and problems (only find *J* and *reference- one example on JJ'=1). 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*).

UNIT-IV: Integral Calculus[12 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 and triple integrals. Beta and Gamma functions (definition), (properties and duplication formula -without proof), 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, 9th edition,2013.

Reference Books:

3. B.V. Ramana, "**Higher Engineering Mathematics**", Tata McGraw Hill Publications, 19th Reprint edition, 2013.R.K.Jain and S.R.K.Iyengar, "**Advanced Engineering Mathematics**", Narosa Publishing House, 4th edition, 2016.

B19MT1020	Applied Chemistry	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	4

Prerequisites:

10+2 Chemistry

Course Objectives:

1. To develop the interest among the students regarding chemistry and their applications in engineering.
2. The student should understand the concepts of chemistry to lay the groundwork for subsequent studies in the fields of mechanical engineering.
3. To train the students to effectively use the knowledge of electrochemistry, battery technology, corrosion science, metal finishing, fuel cells, nano chemistry in the practice of engineering.
4. To Acquire knowledge on industrially significant advanced engineering materials.

Course Outcomes:

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

1. Explain the concepts of Classical to quantum mechanical transition along with energy quantization concepts.
2. Identify and compare the materials best suited materials for construction of Battery, fuel cells and Photovoltaic Cell.
3. Demonstrate the knowledge of Science of Corrosion for futuristic engineering applications.
4. Explore the knowledge of basic concepts of Lubricants, Polymer composites and nanotechnology.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS / COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	P O 10	P O 11	P O 12	PSO 1	PSO 2	PSO 3
B19MT1020	CO1	1												2	2	2
	CO2	1	2					1						3	3	2
	CO3	2	2					2						2	3	3
	CO4	1	2					1						3	3	3

Course Contents:

UNIT-I: Mechanics in Atoms and Molecules [12 Hrs]

Classical to quantum mechanical transition, Origin of quantum mechanics, dual nature of light and matter, concept of quantization – Max Planck, Einstein, de Broglie concepts, Schrödinger wave equation and wave functions, particle in a box (1D) - Energy solutions, quantum states of electron, quantum numbers, Orbital degeneracy, magnetic behaviour of matter, wave functions in bonding in molecules (H_2).

UNIT-II: Energy Storage and Conversion Devices [12 Hrs]

Battery: Introduction to electrochemistry, Basic concepts of Cells and Battery, Battery characteristics. Primary and secondary Batteries: Working, reactions, applications, advantages, and limitations of Zn-MnO_2, Lead Acid, Lithium, Lithium-ion batteries, Super capacitor.

Fuel Cells-Types of fuel cells: Construction working, applications, advantages & limitations of Alkaline Fuel Cell, Phosphoric acid and Solid oxide fuel cells.

Photovoltaic Cell- Construction and working of photovoltaic cells and its applications and advantages using elemental Si and semiconductors, antireflective coatings. Production of single crystal Si by Crystal pulling technique, zone refining of Si.

UNIT-III: Corrosion and its Control [12 Hrs]

Electrochemical theory of corrosion, Types of Corrosion- Differential metal corrosion, Pitting corrosion, Boiler corrosion, Factors affecting rate of corrosion-Primary, secondary, Pourbiax diagram (Al and Fe system) under different potential and pH conditions.

Corrosion Control: Galvanizing, tinning, organic, inorganic coatings, cathodic protection and anodic Protection.

Metal Finishing- Theory of electroplating, Effect of plating variables on the nature of electrodeposit- electroplating and electro less plating process, electroplating of gold acid bath process and Electro less plating of Copper**.**

UNIT-IV: Engineering Materials and their applications [12 Hrs]

Lubricants-Introduction, Classification of lubricants. Lubricants for extreme ambient conditions and for special applications. Physical Properties and selection of lubricants.

Nano Materials-Introduction – Definition, classification based on dimensionality (1D, 2D and 3D), quantum confinement. Size dependent properties- surface area, magnetic properties and thermal properties.

Polymers-Synthesis, advantages and applications of Polymer composites (carbon fiber and Kevlar). Conducting polymers: Synthesis, mechanism and applications of polyacetylene.

Text books:

1. SS Dhara, **Engineering Chemistry** S. Chand Publications, New Delhi
2. R.V.Gadagand Nithyanandashetty, "**Engineering Chemistry**", IK International Publishing house.

Reference Books:

1. Charles P. Poole Jr., Frank J. Owens I**ntroduction to Nanotechnology** Wiley India Publishers.
2. Mars.G. Fontana, "**Corrosion Engineering**" Tata McGraw hill publishing pvt. Ltd.

3. Jain and Jain Engineering Chemistry, Dhanapathi Rai Publications, New Delhi

B19MT1030	Basic Electrical and Electronics Engineering	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	5

Prerequisites:

Nil

Course Objectives:

1. Explain concept of various types of generation of electricity.
2. Demonstrate basic representation of electrical quantities and relationship among them.
3. Infer an overview of various types of electrical apparatus.
4. Interpret the concept of domestic wiring and importance of safety and sensing devices.

Course Outcomes:

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

1. Understand the ohms Law,Kirchoffs Law and single phase series and parallel circuits and power calculations.
2. Describe the principle of operation of electrical equipment's like DC,AC Machines and motors
3. Describe the basic Principle of indicating instruments and different sensors.
4. Understand the application of Semiconductor diodes and Digital Electronics.

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
B19MT1030	CO1	1	2	1	2								2	1	1	1
	CO2	1	1	1	1								1	1	1	1
	CO3	1	2	2	2								1	1	1	1
	CO4	1	2	2	2								1	1	1	1

Course Contents:

UNIT-I: Electrical Circuits

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

UNIT-II: Machines

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

UNIT-III: Instruments

Basic Principle of indicating instruments –PMMC & MI instruments. TARIFF, PROTECTIVE DEVICES AND SENSORS: Tariff schemes, basic concepts of domestic wiring and types, Earthing, protective fuses, MCB, sensors: pressure sensors, strain gage, proximity sensors, displacement sensors, rotary encoder and ultrasonic sensors and civil engineering applications.

UNIT-IV: Semiconductor Diodes

Introduction, Physical operation of p-n junction diodes, Characteristics of p-n junction diodes, Zener diode, Rectifier circuits (half-wave, full-wave, bridge and peak rectifiers), Light emitting diodes. DIGITAL **Electronic Principles:** Introduction, Binary digits, Logic levels and Digital waveforms, Introduction to basic logic operation, Number system, Decimal numbers, Binary numbers, Decimal-to-Binary conversion, Simple binary arithmetic.

Labs sessions for 2 hours/week

Electrical tool introduction

(i) Electrical Tools (ii)Measuring Instruments like Ammeter, Voltmeter, Multimeter, Clamp on meter, Energy meter, Watt meter (UPF & LPF)

2. Home electrical wiring demonstration:

(i) Tube light wiring

(ii) Fan wiring

(iii) Two way control

(iv) Socket to switch connection.

(v) Electrical wiring materials & accessories

3. Study of mutual induction effect.

4. Electrical safety training:

(i) Electrical activities to avoid shocks and importance of earthing

(ii)Working of MCB, ELCB

(iii) Role of fuse.

5. Home electrical wiring demonstration: short circuit, series and parallel operation of load.

6. Single phase transformer: polarity tests.

7. Diode rectifier applications: Half wave and Full wave rectifier, ripple factor calculations.

8. Sensor experiments: Pressure sensor, light sensor and temperature sensor.

Text books:

1. David V. Kerns, JR. J. David Irwin **Essentials of Electrical and Computer Engineering** Pearson.
2. V.K.Mehta **Principles of Electrical and Electronics Engineering**, S. Chand& Co. 48
3. Robert L. Boylestad and Louis Nashelsky, **Electronic Devices and Circuit Theory** (Ninth Edition), Pearson Education, 482 FIE, Patparganj, Delhi – 110 092.
4. Thomas L. Floyd and R.P. Jain **Digital Fundamentals** (Eighth Edition), Pearson Education

Reference Books:

1. M.S Naidu and S. Kamakshaiah Introduction **to Electrical Engineering** –, TMH Publ.
2. Kothari and Nagarath Basic **Electrical Engineering**, TMH Publications, 2nd Edition.
3. Theodore Wildi, "**Electrical Machines, Drives, and Power Systems**", Pearson Education, 5th Edition, 2007

B19MT1040	Computer Aided Engineering Drawing	HC	L	T	P	C	Hrs /week
Duration:14 Wks			1	2	0	3	7

Prerequisites:

Basic Knowledge on geometry and their construction

Course Objectives:

1. To introduce lettering, sketching, scaling and dimensioning practices
2. To introduce orthographic projection of points, lines, planes and solids
3. To teach sections of solids and their projections
4. To introduce the development of lateral surfaces of solids
5. To teach Isometric views

Course Outcomes:

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

1. Draw orthographic projections of Points, lines, planes and solids
2. Draw regular and sectional views of various types of solids and also development of lateral surfaces of solids
3. Draw isometric projections of solids

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT1040	CO1	3	2			3				3	3			3	2	
	CO2	3	3	2		3				3	3			3	2	
	CO3	3	3	2		3				3	3			3	2	

Course Contents:

UNIT-I: Introduction to Drawing and Orthographic projection of Points, Lines and Plane Surface. [12 Hrs]

Introduction to 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 Plane Surface: Types of Planes, Projection of Planes, perpendicular to VP and inclined to HP – Inclined to both the planes.

UNIT-II: Projection of Solids [12Hrs]Square, pentagonal and hexagonal prisms and pyramids, cone and cylinder, Solids in simple position, Axis of the solid parallel to one plane and inclined to other plane, axis of the solid inclined to both the plane. Use change of position method and auxiliary plane method.

UNIT-III: Section of Solids and Developments of Lateral Surfaces of Solids [12Hrs]

Section Planes, Sections ,True Shape of Section, Sections of Prisms, Sections of Pyramids, Sections of Cylinders, Section of Cones.

Developments of Lateral Surfaces of Solids: Prisms and Pyramids, Cone, Cylinder, Frustum of cone and pyramids, truncated cone and pyramids

UNIT-IV: Isometric Projection [12 Hrs]

Isometric axes, Lines and Planes, Isometric Scale, Isometric Projection of Planes, Cube, Prisms, Pyramids, Cylinders, Cone and Sphere, Combination of Solids.

Text books:

1. Dr.K S Narayanaswamy and Dr.Mahesh L **Text Book on Engineering Drawing,** WILEY Publishers 2017, ISBN: 978-81-265-7004-1.
2. N.D.Bhatt and V.M. Panchal **Engineering Drawing**, 48th Edition, 2005 – Charotar Publishing House, Gujarat.
3. K.R. Gopalakrishna, **Engineering Graphics** - 32nd Edition, 2005 – Subhas Publishers, Bangalore.

Reference Books:

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

B19MT1050	Environmental Studies	FC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	0	2	2

Prerequisites:

Chemistry

Course Objectives:

1. Graduates will be familiar with current and emerging environmental engineering and global issues, and explore ethical and social responsibilities.
2. Graduates will ascertain 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. Explore knowledge with respect to biodiversity, threats, conservation and appreciate the concept of ecosystem.
5. Examine 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. Analyze the environmental conditions and protect it.
2. Will interpret the role of individual, government and NGO in environmental protection.
3. Examine 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	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT1050	CO1	1			2	1	3	3			1	1	1			
	CO2						3	3		1		1	1			
	CO3		1			2	3	3			1		2			
	CO4	1					3	3		1			1			

Course Contents:

UNIT-I: Multidisciplinary Nature of Environmental Studies [06 Hrs]

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, Initiative and Role of Non-government organizations in India and world.
Self-study**:** Need for public awareness on the environment, Gaia Hypothesis.

UNIT-II: Environmental Pollution, Degradation and Waste Management [06 Hrs]Environmental Pollution – Definition, sources and types, Pollutant-Definition & classification, Concepts of air pollution, water pollution, Soil pollution, Automobile pollution-Causes, Effects & control measures.

Self-study**:** Case studies of London smog, Bhopal gas tragedy, marine pollutions and study of different waste water treatment processes.

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**:** Disaster management, early warning systems-bio indicators for Tsunami and other natural disasters.

UNIT-III: Energy and Natural Resources [06 Hrs]

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

UNIT-IV: Ecology and Ecosystem [06 Hrs]

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. R.J. Ranjit Daniels and Jagadish Krishnaswamy **"Environmental Studies**",, (2017), Wiley India Private Ltd., New Delhi, Co-authored &Customized by Dr.MS Reddy &Chandrasekhar, REVA University.
2. R.J. Ranjit Daniels and Jagadish Krishnaswamy "**Environmental Studies**", (2009), Wiley India Private Ltd., New Delhi.
3. Benny Joseph, "**Environmental Studies**" Tata McGraw – Hill Publishing Company Limited.
4. Dr.S.M.Prakash, **Environmental Studies** by Elite Publishers Mangalore, 2007

Reference Books:

1. Rajagopalan R. 2005,"**Environmental Studies – from Crisis to cure**", Oxford University
2. Arvindwalia, Kalyani Environmental **Science** Publications, 2009.
3. Anilkumar Dey and Arnabkumar Dey **Environmental Studies**.

B19MT1060	Technical English-I	FC	L	T	P	C	Hrs /week
Duration:14 Wks			0	0	2	2	4

Prerequisites:

Basic English

Course Objectives:

1. Building on the knowledge of basic communication skills in English for the learners of Engineering and Technology.
2. Comprehending on listening, Speaking, reading and writing skills among learners of Engineering and Technology.
3. Exploring to usethe electronic media such as internet and supplement the learning materials used in the classroom

Course Outcomes:

After successful completion of the course, the students 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. Review the use of reading different genres of texts adopting various reading strategies (Reading Skills).
4. Determine 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT1060	CO1						3	2		3			3	1	1	1
	CO2						3	3		3	3		3	1	1	1
	CO3						3	2		3	2		3	1	1	1
	CO4						3	3		3	3		3	1	1	1

Course Contents:

UNIT-I: Functional English [12 Hrs]

Speaking: Debating Skills, **Reading:** Skimming a reading passage, Scanning for specific information, **Writing:** Email communication.

UNIT-II: Interpersonal Skills [

12Hrs]Grammar: Tenses, Wh-questions, **And 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-III: Multitasking Skills [12 Hrs]

Grammar: Direct and indirect speech,

Listening & Speaking: Watching videos /documentaries and responding to questions based on them, Role plays,

Reading: Making inference from the reading passage, predicting the content of a reading passage.

Writing: Interpreting visual materials (line graphs, pie charts etc.), Different types of Essay Writing

UNIT-IV: Communication Skills [12 Hrs]

Grammar: Direct and indirect speech,

Listening & Speaking: Watching videos /documentaries and responding to questions based on them, Role plays,

Reading: Making inference from the reading passage, predicting the content of a reading passage.

Writing: Interpreting visual materials (line graphs, pie charts etc.), Different types of Essay Writing

Text books:

1. Murphy, Raymond. **Murphy's English Grammar with CD**. Cambridge University Press, 2004.
2. Rizvi, M. Ashraf. **Effective Technical Communication**. New Delhi: Tata McGraw-Hill, 2005
3. Riordan, Daniel. **Technical Communication**. New Delhi: Cengage Publications, 2011.

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. Sen et al. **Communication and Language Skills**. Cambridge University Press, 2015.

B19MT1070	Workshop Practice	HC	L	T	P	C	Hrs /week
Duration:14 Wks			0	0	2	2	3

Prerequisites:

Nil

Course Objectives:

1. To elaborate knowledge and skill to use tools, machines, equipment, and measuring instruments.
2. To demonstrate safe handling of machines and tools.
3. To gain the knowledge of automobile parts

Course Outcomes:

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

1. Identify the various fitting tools
2. Demonstrate and produce different types of fitting models.
3. Make simple sheet metal models and apply the skill in real.

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
B19MT1070	CO1	3		2				1		3				3	1	1
	CO2	3		3				1		3				3	3	1
	CO3	3		3				1		2				3	3	3

Course Contents:

1. Use of Hand Tools: V-block, Marking Gauge, Files, Hack Saw, Drills, Taps and Minimum 3 models involving Dove tail joint, Triangular joint and Semicircular joint.
2. Sheet Metal & Soldering Work: Development & Soldering of the models: Tray, Frustum of cone, Prism(Hexagon & Pentagon),Truncated Square Pyramid, Funnel
3. Welding: Study of electric arc welding tools &equipment's, Demonstration of Welding.
4. Study the assembly and disassembly of the Toyota Innova Car engine parts.

B19MT1080	Applied Chemistry Lab	HC	L	T	P	C	Hrs /week
Duration:14 Wks			0	0	2	2	3

Prerequisites:

10+2 Chemistry knowledge

Course Objectives:

1. Explore practical aspects of the redox reaction.
2. Explain the function of fuel cells, batteries and extend the knowledge to the processes of corrosion and its prevention.
3. Interpret preparation and properties of synthetic polymers and other material that would provide sufficient impetus to engineer these to suit diverse applications.
4. Examine the hygiene aspects of water and design methods to produce potable water using modern technology.

Course Outcomes:

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

1. Demonstrate the use of different types of instruments for analysis of materials for better accuracy and precision
2. No techniques for the analysis of mechanical parameters such as density, viscosity etc
3. Apply Stoichiometric principles to prepare solution for quantitative estimation of materials
4. Differentiate between volumetric and instrumentation technique.

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
B19MT1080	CO1	1												1	1	1
	CO2	2	1		2			1						1	1	1
	CO3	1													2	
	CO4	1												1		

Course Contents:

List of Experiments:

1. Potentiometric estimation of FAS using standard $K_2Cr_2O_7$
2. Conductometric estimation of an acid mixture using standard NaOH solution
3. Determination of pKa of a weak acid using pH meter

4. Determination of molecular weight of given polymer sample using Ostwald's Viscometer
5. Determination of COD of the given industrial waste water sample
6. Determination of total and temporary hardness of water using disodium salt of EDTA
7. Estimation of alkalinity of given water sample using standard HCl solution.
8. Determination of calcium oxide in the given sample of cement by rapid EDTA method
9. Determination of flash and fire point of petroleum products by Cleveland (open cup) apparatus.
10. Determination of flash point of oils by Pensky Martins flash point apparatus.
11. Determination of viscosity of the given oil using Redwood Viscometer at different temperatures.
12. Determination of viscosity of the given oil using Say Bolt Viscometer at different temperatures.
13. Determination of viscosity of the given oil using Torsion Viscometer at different temperatures.
14. Determination of the calorific value of gaseous fuel by Boy's gas calorimeter

Second Semester

B19MT2010	Linear Algebra and Laplace Transform	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	4

Prerequisites:

Knowledge of basics of derivatives, vectors, complex numbers

Course Objectives:

1. Explore the concepts of Linear algebra and its applications in various fields of engineering and Technology.
2. Explain the concepts of Integral calculus and its applications.
3. Interpret partial differential equations, and its applications to standard problems like Heat, Wave and Laplace.
4. Infer the Knowledge of Laplace transforms and its applications in the field of engineering.

Course Outcomes:

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

1. Interpret the knowledge of Linear Algebra in Image processing and digital signal processing.
2. Explain analytical techniques to compute solutions of first and higher order ordinary differential equations.
3. Examine the knowledge of partial differential equations in the field of signals and systems, control systems, magnetic wave theory.
4. Customize the knowledge of Laplace transformation from the time domain to the frequency domain, which transforms differential equations into algebraic equations and convolution into multiplication.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B1ME 2010	CO1	3	3	1	2	1								3	3	2
	CO2	3	1	1	2	2								2	3	3
	CO3	3	2	1	2	2								3	3	3
	CO4	2	3	2	1	1								2	1	2

Course Contents:

UNIT-I: Linear Algebra [12 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. LU decomposition, Linear and Inverse transformation. Diagosnalisation of a matrix.

UNIT-II: Differential Equations [12 Hrs]

Differential Equations of Ist order and Ist degree: 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).

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 Lagranges linear PDE.

UNIT-III: Laplace Transforms [12 Hrs]

Laplace transforms of elementary functions, properties of Laplace Transforms, Laplace Transforms of derivatives and integrals, problems. Transforms of periodic functions, Unit step functions and unit impulse functions.

UNIT-IV: Inverse Laplace Transforms [12 Hrs]Inverse Laplace transform of standard functions, different methods of solving inverse Laplace transforms convolution theorem, verification and 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, 9th edition, 2013.

Reference Books:

1 B.V. Ramana, "**Higher Engineering Mathematics**", Tata McGraw Hill Publications, 19th Reprint edition, 2013.

5. R.K.Jain and S.R.K.Iyengar, "**Advanced Engineering Mathematics"**, Narosa Publishing House, 4th edition, 2014.

B19MT2020	Applied Physics	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	4

Prerequisites:

10+2 Physics

Course Objectives:

1. To introduce the basic concepts and principles of Physics to analyze practical engineering problems and apply its solutions effectively and efficiently.
2. To be acquainted with the basic concepts of properties of fluids, pressure and its measurements
3. To impart the different physical phenomena in fluid mechanics and materials science.
4. To develop design, practical oriented skills and problem solving challenges.
5. To incorporate the knowledge in various class of materials and their applications

Course Outcomes:

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

1. Apply the knowledge of fluid mechanics and its applications in real life problems.
2. Demonstrate different applications of pressure measuring gauges
3. Analyze the material selection for different applications.
4. Recognize the need for measurement and calibration

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
B19MT2020	CO1	3	3		1									1	3	3
	CO2	3	3		1									1	3	3
	CO3	3	3		2									1	3	3
	CO4	3	3		3									1	3	3

Course Contents:

UNIT-I: Hydrostatics-I [12 Hrs]

Properties of Fluids: Physical properties of fluids like Density, Specific Weight, Specific Gravity, Specific Volume, Surface Tension, Capillarity, Viscosity, Compressibility and Bulk Modulus, Classifications of Fluids.

Pressure and its measurements: Pressure, Pascal's law, pressure at a point, hydrostatic Law, atmospheric pressure, absolute pressure, gauge pressure and Vacuum pressure and Manometers.

UNIT-II: Hydrostatics-II [12 Hrs]

Hydrostatics Forces on plane submerged surfaces, Forces on Horizontal surfaces, on Vertical Surfaces, on Inclined Surfaces, on Curved Surfaces. Buoyancy and Flotation, Archimedes' Principle, Stability of Immersed and floating bodies, determination of metacentric height.

UNIT-III: Smart and Nano Materials [12 Hrs]

Materials exhibiting ferroelectric, piezoelectric, Optoelectric and semiconducting properties. Photo conductivity and super conductivity behavior (Examples with applications). Introduction to bio materials, super alloys and shape memory alloys.

Nano materials: Introduction to Nano science, Nano materials. Synthesis of nanomaterial's using bottom up method (Arc Method), Top Down method (ball milling method), properties and applications of carbon Nano tubes.

UNIT-IV: Measurement and Measurement Systems [12 Hrs]

Introduction, Definition, Requirement of measurements, significance of measurement system, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-times delay. Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers. Mechanical members: Bourdon tube, Diaphragm, Bellows. Electrical members: Resistive, capacitive, piezoelectric transducers.

Intermediate Modifying and Terminating Devices: Introduction, Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers-CE Transistor amplifier and telemetry. Introduction to Terminating devices, Meter indicators, CRO, Measurement of frequency.

Text Books:

1. Dr.R. K. Bansal **A Textbook of Fluid Mechanics and Hydraulic Machines** , Laxmi Publications ,New Delhi
2. Shackleford, & M. K Muralidhara, **Material science**, Pearson Publications, 2007.
3. Anand.K.Bewoor and VinayA Kulkarni **Mechanical Measurements and Metrology**, McGraw-Hill Science.

Reference Books:

1. Dr. P. N. Modi & Dr.S.M.Seth, **Hydraulics and Fluid Mechanics**, Standard Book House.
2. Beckwith Marangoni and Lienhard, **Mechanical Measurements**, Pearson Education, 6th Ed., 2006.
3. R.K. Jain **Mechanical Measurements**, Khanna Publishers, 1994.

B19MT2030	C Programming	HC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Basic Knowledge of computer

Course Objectives:

1. Discuss the fundamentals of Unix operating system and C programming concept
2. Illustrate the usage of control statements for solving the real world applications.
3. Demonstrate the use of arrays, functions and looping statements for solving the real world problems
4. Explain strings, pointers and fundamental concept of computer graphics.

Course Outcomes:

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

1. Demonstrate the usage of Unix commands and basic constructs of C programming
2. Design programs involving operators, decision structures, loops and functions.
3. Apply the basic concepts of C programming for solving the real world problems.
4. Interpret, compile and debug programs in C language;

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
B19MT2030	CO1	3	2	2	2	1								2	3	3
	CO2	3	2	2	3	2								2	3	3
	CO3	3	1	2	3	1								3	3	3
	CO4	3	1	2	3	2								2	3	3

Course Contents:

UNIT-I: Basic Commands in UNIX, Fundamentals of C Language [09 Hrs]

Basic Commands in UNIX: Introduction to basic command format, using the text editor, Basic Unix commands, types of computer networks.

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

UNIT-II: Operator, Expressions & statements, Unconditional statements [09 Hrs]

Operator: (unary operator, assignment operator, arithmetic operator, relational operator, logical operator, logical operator, bitwise types of operator's operator, conditional operator, increment and decrement operator, special operator).

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

Unconditional statements: break and continue statement, go to statement, return statement

UNIT-III: Iterative statements, **Arrays, Functions [09 Hrs]**

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

Arrays: one dimensional array, two dimensional array, searching techniques (binary search), sorting (bubble sort)

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

UNIT-IV: Strings, Pointers, Fundamentals of computer graphics [09 Hrs]

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

Pointers: Introduction to pointers.

Fundamentals of computer graphics: Output primitives – Line, Circle and Ellipse. Drawing algorithms – Attributes of output primitives, Two Dimensional Geometric transformation

Text books:

1. Sumitabha das, **UNIX concepts and applications**, 4th edition; TataMcgraw hill.
2. E. Balaguruswamy, **Programming in ANSI C**, 4th edition, TATA MCGRAW Hill, 2008
3. Edward Angel, **Interactive Computer Graphics**, 6th Edition, Pearson.

Reference Books:

1. Herbert Schildt, C: **The Complete Reference**, 4th edition, TATA MCGRAW Hill.
2. Nanjesh Bennur, Dr. C.K.Subbaraya, **Programming in C**, excellent publishing house, 2015.
3. Donald Hearn, Pauline Baker, **Computer Graphics C Version**, second edition, Pearson

B19MT2040	Engineering Mechanics	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	4

Prerequisites:

Basic Physics

Course Objectives:

1. Detail problems involving Forces, loads and Moments and know their applications in allied subjects.
2. Interpret the concepts in courses like Strength of materials, Design of Machine Elements, Kinematics and Dynamics of Machines.

Course Outcomes:

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

1. Comprehend the action of Forces, Moments and other loads on systems of rigid bodies.
2. Compute the reactive forces and the effects that develop as a result of the external loads.
3. Locate the Centroid and compute the Moment of Inertia of regular cross sections.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT2040	CO1	3	3	2	1		2	1				1	3	2	1	1
	CO2	3	3	3	1		1					1	2	2	1	1
	CO3	3	3	1	1		2	1				1	3	2	1	1

Course Contents:

UNIT-I: Introduction to Engineering Mechanics [12 Hrs]

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

UNIT-II:Analysis of Force Systems [12 Hrs]

Analysis of Force Systems: Composition of forces - Definition of Resultant, Composition of coplanar - concurrent force system, Parallelogram Law of forces, Principle of resolved parts, Numerical problems on composition of coplanar concurrent force systems, Composition of coplanar - non-concurrent force system, Varignon's principle of moments, Numerical problems on composition of coplanar concurrent force systems.

UNIT-III: I Equilibrium of Coplanar Forces [12 Hrs]

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

UNIT-IV: Centroid and Moment of Inertia [12 Hrs]

Introduction, Centroid of plane figures, locating the centroid of triangle, semicircle, quadrant of a circle and sector of a circle using method of integration, Centroid of composite sections, Numerical problems. Moment of Inertia: Introduction to the concept, Rectangular and polar moment of inertia, Radius of gyration, Perpendicular axis theorem and Parallel axis theorem, Moment of Inertia of rectangle, circle, semi-circle, quarter circle and triangle from method of integration, Moment of inertia of composite areas, Numerical.

Text books:

1. A. Nelson, "**Engineering Mechanics-Statics and Dynamics**", Tata McGraw-Hill Education Private Ltd, New Delhi, 2009
2. S. S. Bhavikatti, "**Elements of Civil Engineering**", New Age International Publisher, New Delhi, 3rd edition 2009.
3. Beer FP and Johnston ER, "**Mechanics for Engineers- Dynamics and Statics**", 3rd SI Metric edition, Tata McGraw Hill. - 2008 3. Shames IH, "**Engineering Mechanics–Statics & Dynamics**", PHI–2009.

Reference Books:

1. S. Timoshenko, D.H. Young and J.V.Rao, "**Engineering Mechanics**", TATA McGraw-Hill Book Company, New Delhi
2. M. N. Shesha Prakash and Ganesh B. Mogaveer, "**Elements of Civil Engineering and Engineering Mechanics**", PHI Learning, 3rd Revised edition.

B19MT2050	Constitution of Indian and Professional Ethics	FC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	0	2	2

Prerequisites:

Nil

Course Objectives:

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

Course Outcomes:

After successful completion of the course, the students 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 Duties.
3. 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.
4. Get exposed about Professional ethics and know about etiquettes about it and know about ethical Standard of different Companies which will increase their Professional ability.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT2050	CO1						1	2	2		2		1			
	CO2						2	2	2		2		2			
	CO3						2	2	3		2		2			
	CO4						3	3	3		2		2			

Course Contents:

UNIT-I: Constitution of India [06 Hrs]

Definition, Making of Indian Constitution, Preamble to the Constitution of India, Fundamental Rights under Part III, Rights to Equality, Right to Freedom, Right against Exploitation, Rights to Freedom of Religion, Cultural and Educational Rights, Constitutional Remedies. Fundamental Duties of the

Citizen, Significance and Characteristics. Elements of National Significance, National Flag, National Anthem, National Emblem.

UNIT-II::Union and State **[06 Hrs]**

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

UNIT-III:Ethics **[06 Hrs]**

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

UNIT-IV:Engineering Ethics **[06 Hrs]**Definition Scope and needs, Ethics in Consumer Protection, Due Care theory, Environmental Ethics, Ethical Code of Conduct in ethics. Best Ethical Companiesin India and Abroad, Corporate Social Responsibilities, Code of Conduct and Ethical Excellence.

Text books:

1. M V Pylee, **INDIA'S Constitution**, S. Chand Publishing, 2016
2. M Govindarajan, S Natarajan, V S Senthil Kumar, **Engineering Ethics: Includes Human Values**, PHI Learning, 2004

B19MT2060	Technical English - II	FC	L	T	P	C	Hrs /week
Duration:14 Wks			0	0	2	2	4

Prerequisites:

Technical English - I

Course Objectives:

1. Demonstrate the ability of using language skills effectively in real-life scenarios.
2. To develop the learners competence in employability skills.
3. To elaborate 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 of Engineering and Technology.

Course Outcomes:

After successful completion of the course, the students 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 and Develop accurate writing skills using different components of academic writing.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT2060	CO1						3	3		3	3		3			
	CO2						3	3		3	3		3			
	CO3												3			
	CO4						3	3		3	3		3			

Course Contents:

UNIT-I: Language Acquisition [12 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-II::Persuasive Skills [12 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-III: Cognitive Skills [12 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-IV: Employability skills [12 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 advertisements and the profile of the company concerned, **Writing:** Applying for a job, writing a cover letter with résumé / CV

Text Books:

1. Green, David. **Contemporary English Grammar Structures and Composition**. New Delhi: MacMillan Publishers, 2010.
2. Thorpe, Edgar and Showick Thorpe. **Basic Vocabulary**. Pearson Education India, 2012.
3. Leech, Geoffrey and Jan Svartvik. **A Communicative Grammar of English**. Longman, 2003.
4. Murphy, Raymond. Murphy's **English Grammar with CD**. Cambridge University Press, 2004.

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.

B19MT2070	Manufacturing Technology	HC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Nil

Course Objectives:

1. To develop the basic knowledge of working of various metal casting process
2. To acquire knowledge in casting defects and melting practices in foundry.
3. Explain the concepts of metal joining process and their applications
4. Interpret appropriate production process for a specific application.
5. Develop the knowledge of special welding process and inspection methods.

Course Outcomes:

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

1. Explain the concepts of working principle of metal joining process.
2. Identify the inspection methods based on the defects.
3. Describe the various casting process and can build his career in foundry.
4. Demonstrate the principles associated with special casting process.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT2070	CO1	3	1	2							3			3	1	1
	CO2	2	2	1							3			3	1	1
	CO3	3	1	1							3			3	1	1
	CO4	3	1	1							3			3	1	1

Course Contents:

UNIT-I:Introduction to Foundry [09 Hrs]

Introduction to Foundry – Concept of manufacturing process, classification of manufacturing process, Casting process and Steps involved in casting, advantages, limitations and applications of casting process.

Pattern: Definition, different types of pattern, materials used for pattern, allowances for pattern and their importance.

Sand Moulding: Types of Base sand, Requirements of base sand, Binder and additives used in moulding sand, Moulding sand mixture ingredients for different sand mixtures. **Cores**: Definition, Need and Types of cores. Concept of Gating and risers, Fettling and cleaning of castings, casting defects.

UNIT-II:Special Moulding Process [09 Hrs]

Study of special Moulding Processes: CO_2mould, shell mould, investment mould.

Metal Moulds: Metallic moulds, Types of metallic mould castings: Gravity die castings, pressure die castings, Centrifugal castings, Slush castings, Squeeze castings, Thixo casting.

Melting Furnaces: Classification, constructional features and working principle of coke fired and Gas fired pit furnace, Resistance furnace, Electric arc furnace, Cupola furnace.

UNIT-III:Metal Joining Processes [09 Hrs]

Welding Process: Definition, Principles, Classification, Application, Advantages & limitations of welding. Gas welding Principle, Oxy – Acetylene welding, Types of flame and Flame characteristics.

Electric Arc Welding: Introduction to Arc welding, Classification of Arc welding, FSMAW, TIG, MIG, Arc welding current and voltage, Arc welding equipment's, Safety Precautions

Soldering and Brazing: Principles of soldering & brazing, Distinguish between soldering and brazing.

UNIT-IV: Advanced Welding Process and Inspection [09 Hrs]

Special Welding: Resistance welding - principles, Seam welding, Butt welding, Spot welding and projection welding. Friction welding-Explosive welding, Thermit welding, Laser welding and Electron beam welding.

Inspection Methods – Methods used for Inspection of casting and welding-Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography, Eddy current, Holography methods of Inspection.

Text books:

1. S. Kalpakjian and S.R. Schmid, "**Manufacturing Engineering and Technology**", 7th Edition, Prentice-Hall, 2013
2. P.C. Sharma Production Technology (Manufacturing Processes), S. Chand.
3. O.P Khanna **"Production Technology (Manufacturing Processes-Vol-1**)" by, Dhanpat Rai Publications.
4. Dr.K.Radhakrishna "**Manufacturing Process-I**", Sapna Book House, 5thRevised Edition 2009.
5. P.N.Rao "**Manufacturing Technology: Foundry Forming and Welding**", 3rd Ed., Tata McGraw Hill, 2003.

Reference Books:

1. S.K. Hajra Choudhury (2001), **Elements of Workshop Technology, Vol-I**, Media Promoters Pvt Ltd., Mumbai.

2. P.N. Rao (1998), **Manufacturing Technology – Foundry, Forging and Welding**, Tata McGraw-Hill Publishing Co., New Delhi.
3. Roy A. Lindberg (2004), **Processes and Materials of Manufacture**, 4th Edition, Prentice-Hall of India, New Delhi.
4. Banga T.R, and Agrawal R.L, "**Foundry Engineering**", Khanna Publishers, 1992.
5. Serope Kalpakjian, Steuen. R. Sechmid "**Manufacturing Technology**", Pearson Education Asia, 5th Ed. 2006

B19MT2080	Applied Physics Lab	HC	L	T	P	C	Hrs /week
Duration:14 Wks			0	0	2	2	3

Prerequisites:

10+2 Physics

Course Objectives:

1. Expose practical knowledge of Physics to correlate with the theoretical studies.
2. Acquire perfectness in experimental skills relevance to the existing applications to improve confidence and ability to bring in advancement in fabricating new equipment's.
3. Demonstrate different measurement systems and on common types of errors.
4. Ascertain material characterization through standard techniques.

Course Outcomes:

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

1. Extend skills to apply practical knowledge of Physics in real time solution.
2. Interpret the most appropriate measuring instruments for evaluation of various parameters.
3. Apply laws of hydrostatics in co relevance to practical considerations.
4. Determine various properties of different materials to authenticate the accuracy of evaluation technique.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT2080	CO1	3	3			3					3			3	3	3
	CO2	3	3			3					3			3	3	3
	CO3	3	3			3					3			3	3	3
	CO4	3	3			3					3			3	3	3

Course Contents:

List of Experiments

1. Determination of acceleration due to gravity by Bar Pendulum.
2. Determination of Young's Modulus by single cantilever method/Uniform bending method.
3. Determination of Moment of Inertia and Rigidity Modulus by Static Torsion Method.
4. Determination of Tensile strength of mild steel.
5. Determination of viscosity of liquid by Poiseuille method.
6. Determination of Metacentric height of a floating body.
7. Determination Viscosity of given liquid using falling ball method.
8. Determination of surface tension of water by capillary rise method.
9. Study of characteristics of CE mode Transistor Amplifier
10. Calibration of pressure gauges.
11. Determination of modulus of elasticity of a mild steel specimen using strain gauges.
12. Study of photodiode characteristics/LVDT

B19MT2090	C Programming Lab	HC	L	T	P	C	Hrs /week
Duration:14 Wks			0	0	2	2	3

Prerequisites:

Concepts of computer and basic programming skill.

Course Objectives:

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

Course Outcomes:

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

1. Distinguish working of different operating systems like widows and Linux
2. Analyze, Integrate, apply and demonstrate Software Development Tools, like Algorithms, Pseudo Codes and Programming Structures.
3. Determine engineering solutions to simple (moderate) mathematical and logical problems using 'C' programming language;

4. Analyze, Integrate, Classify, Compare and Apply simple Data Structures, Pointers, to solve real world problems

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT2090	CO1	2	3	2	3	2								2	3	
	CO2	3	3	2	3	2								2	3	
	CO3	3	3	2	3	2								2	3	
	CO4	3	3	3	3	2								2	3	

Course Contents:

List of Programs

1 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.

2 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.

3 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 Addition of two numbers, Subtraction of two numbers Multiplication of two numbers, Division of two numbers, Wrong choice

4 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.

5 Read your ATM Pin Number. Write a program to identify your Pin Number is palindrome or not**.**

6 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.

7 You have joined a startup company of N employees, Write a program is to sort all employee id.

8 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.

9 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.

10 Read your first and last name in two different strings, Write a program to combine these two strings into third string.

11 Write a C program to create a line of given length or co-ordinates, and to perform 2D transformations such as translation, scaling and rotation on a line.

12 Write a C program to create a circle of given diameter and center co-ordinates and to perform 2D transformations such as translation and scaling on a circle.

13 Write a C program to create an ellipse of given major diameter, minor diameter and center co-ordinates and to perform 2D transformations such as translation, scaling, and rotation on an ellipse.

14 Write a C program to create a rectangle of given dimensions and to perform 2D transformations such as translation, scaling, and rotation on a rectangle.

THIRD SEMESTER

Course Code	Numerical Methods and Probability	Course Type	L	T	P	C	Hrs./ Wk.
B19MT3010		HC	2	1	0	3	4

Prerequisites:

Calculus and Linear Algebra

Course Objectives:

1. Learn to solve algebraic, transcendental equations and finite difference, interpolation and its application.
2. Learn to solve ordinary differential equations numerically using different methods.
3. Learn the concept of Random variables and probability distributions.
4. Construct the various tests essentially needed for the testing of small samples for the testing of hypothesis.

Course Outcomes:

By the end of the course student shall be able to

1. Apply the basics of numerical methods and their applications, Analyse the problems of algebraic, transcendental equation and use a given data for equal and unequal intervals to find a polynomial function for estimation.
2. Apply Interpolation technique to approximate the value of the integral for the functions.
3. Analyse the problems of ordinary differential equations using various methods.
4. Apply the concepts of probability distribution to solve the engineering problems.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT3010	CO1	3	2	1	2	1	1							3	3	3
	CO2	3	2	1	1	2	1							3	3	3
	CO3	3	2	2	1	2	1							3	3	3
	CO4	3	2	2	2	2	1							3	3	3

Course Content:

UNIT-I: Numerical Analysis [12 Hrs]

Solution of algebraic and transcendental equation- Regula- falsi method, Newton-Raphson method.

Finite differences and Interpolation:-Forward and Backward differences, Newton's forward and Backward interpolation formulae. Divided differences-Newton's divided difference formula. Lagrange's Interpolation formula and Inverse Interpolation formula and Problems (formulae without proof).

UNIT -II: Numerical Differentiation and Integration [12 Hrs]Numerical Differentiation: Derivatives using Newton's forward and backward difference formula. **Numerical Integration:** Trapezoidal Rule, Simpson's $1/3^{rd}$, $3/8^{th}$ Rule, Weddle's formula and Problems.

Numerical solutions to ODE: First order and first degree, Picards Method , Taylor's series method , Modified Euler's method , Runge-Kutta method of fourth order, Milne's and Adam's-Bashforth Predictor-corrector method and Problems.

UNIT-III: Probability Distributions and Sampling Theory [12 Hrs]

Random variables (discrete and continuous), Probability density function, probability distribution – binomial and Poisson's distributions, exponential and normal distributions.

Sampling, Sampling distributions, standard error, test of hypothesis for means and confidence limits, Student's t-distribution and Chi-square distributions.

UNIT-IV: Joint Distribution and Markov's Chain [12 Hrs]Joint Probability Distribution:-Concept of joint probability, joint distributions –discrete random variables, independent random variables, problems on expectation and variance.

Markov's Chains: Probability vectors, stochastic matrices, fixed points and regular stochastic matrices, higher transition Probability, stationary distribution of regular Markov's Chains absorbing states.

Text books:

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

Reference Books:

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

Course Code	Thermal Engineering	Course Type	L	T	P	C	Hrs./ Wk.
B19MT3020		HC	4	0	0	4	4

Prerequisites:
Applied Chemistry

Course Objectives:

1. The course aims at to cover the basic principles of thermodynamics, to give students a feel for how thermodynamics is applied in engineering practice.
2. To develop an intuitive understanding of laws of thermodynamics by emphasizing the physics and physical arguments.
3. To present a wealth of real world engineering examples to give students a feel for how thermodynamics is applied in engineering practice.
4. Introduce the basic principles and laws governing the heat transfer.
5. Identify and compare the various modes of heat transfer, combined heat transfer processes and special heat transfer processes.
6. Use mathematical skills to solve engineering thermodynamic and heat transfer problems using suitable data hand book

Course Outcomes:

By the end of the course student shall be able to

1. Describe the fundamental concepts of thermodynamic systems and various processes of heat and work interactions
2. Apply laws of thermodynamics to understand and enhance the performance of different thermodynamic system.
3. Define heat transfer and compare the three modes of heat transfer.
4. Discuss and analyze the application to implement governing laws pertaining to the mode of heat transfer.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT 3020	CO1	3	3	3	1									3	3	3
	CO2	3	3	3										3	3	3
	CO3	3	2	3	1									3	2	1
	CO4	3	3	2	1	1								3	3	3

Course Content:

UNIT- 1: Introduction, Work and Heat [12 Hrs]

Introduction: Types of thermodynamics System, Microscopic and Macroscopic approaches, Thermodynamic properties, definition and units, Thermodynamic state process and cycle, path and point function, quasi-static process, Reversible and Irreversible processes, cyclic and non-cyclic processes, Thermodynamic equilibrium, Zeroth law of thermodynamics, Temperature concepts.

Work and Heat: Definition of Work and limitations, Thermodynamic definition of work, sign convention, Displacement work, expressions for displacement work in various processes through p-v diagrams, , Heat: definitions, units, sign convention, work and heat as a path function. Comparison between work and heat. Simple numerical.

UNIT -2: First Law of Thermodynamics, Second Law of Thermodynamics [12 Hrs]

First Law of Thermodynamics: Joule's experiments, First law for a closed system undergoing a cycle, First law for a closed system undergoing a change of state, Energy – A property of a system, Energy balance for closed system, Enthalpy, Specific heat at constant volume, and constant pressure, PMM1, Steady flow energy equation (SFEE) and its applications, Numerical.

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Thermal energy reservoirs, Direct and reversed heat engines, thermal efficiency and COP, Kelvin-Plank statement and Clausius statement of second law of Thermodynamics, Equivalence of both statements, PMM II. Numerical. Discussion on Reversibility, Irreversibility and Entropy concept.

UNIT-3: Conduction and Natural convection Heat Transfer [12 Hrs]

Heat Transfer: Introductory Concepts and Definitions: Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity; convective heat transfer coefficient; radiation heat transfer; combined heat transfer mechanics. Boundary conditions of 1st, 2nd and 3rd Kind, simple problems, Discussion on theory of fins.

Natural Convections: Applications of dimensional analysis for natural convection. Physical significance of Grashoff, Prandtl, Nusselt, Simple problems.

UNIT-4: Forced Convection and Radiation heat transfer [12 Hrs]

Forced Convections: Applications of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt, Simple problems.

Radiation Heat Transfer: Thermal radiation; definitions of various terms used in radiation heat transfer, Stefan-Boltzman law, Kircoff's law. Planck's law and Wein's displacement law. Radiation heat exchange between two parallel infinite black surface, between two parallel infinite gray surfaces; effect of radiation shield, Simple problems.

Self-Study: Types of heat exchangers and its analysis with LMTD and effectiveness or NTU methods.

Text Books:

1. Tirumaleshwar, **Heat & Mass transfer**, Pearson education 2006
2. Ozisik, **Heat transfer-A basic approach**, Tata McGraw Hill 2002.
3. Nag P.K. **Basic & Applied Thermodynamics**. Tata McGraw Hill Pub. Co. 2002.
4. Rajput R.K, **Thermal Engineering**. Lakshmi publications.

Reference Books:

1. Yunus A-Cengel, **Heat transfer-A practical approach,** Tata McGraw hill.
2. Mahesh M Rathore, **Heat and mass transfer,** Laxmi publications.
3. Kreith **Principles of Heat transfer,** Thomas Learning 2001
4. Frenk P.Incropera and DavidP.Dewitt, **Fundamentals of heat and mass transfer**,John Wiley and son's.
5. R K Rajput ,**Heat and Mass transfer,** S Chand Publications**.**

6. Yunus A. Cenegal and Michael A. Boles, **"Thermodynamics -An Engineering Approach**", TataMcGraw-Hill.2002.
7. Mahesh M Rathore, **"Thermal Engineering**", Tata McGraw-Hill, Prentice-hall of India Pvt. Ltd.
8. G J Van Wylen and R E Sonntag, **"Fundamental of Classical Thermodynamics**", Wiley Eastern.1st edition,2002

Course Code	Mechanics of Materials	Course Type	L	T	P	C	Hrs./ Wk.
B19MT3030		HC	3	0	1	4	4

Prerequisites:

Engineering Mechanics

Course Objectives:

1. To teach the students'knowledge of simple stresses, strains and deformations components due to external loads and study on the behavior of ductile and brittle materials.
2. To enable to assess stresses and deformations of Compound stresses, Thin pressure vessels and Torsion
3. To teach the students'knowledge of Shear Force, Bending Moment Diagram and Bending stress
4. To teach the students'knowledge of beams, Columns & Struts
5. To Provide the Basic knowledge for use in the design courses.

Course Outcomes:

By the end of the course the student shall be able to

1. Describe the basic meaning of stress-strain diagrams for engineering materials.
2. Compute stress distribution in thin pressure vessels, identify the stresses in torsional members and determine principal stresses in two dimensional systems.
3. Construct the shear force and bending moments for the beam.
4. Determine the Deflections in beams, Columns & Struts.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT 3030	CO1	3	3	1	1									3	3	3
	CO2	3	3	2	1		1							3	3	3
	CO3	3	3	1	1									3	3	3
	CO4	3	3	2	1		1							3	3	3

CourseContent:

UNIT-I: Simple Stresses, Strains and Elastic Constants [12 Hrs]

General meaning of stress, types of simple stresses and strains. Stress- strain diagrams for Engineering materials, Hooke's law, Extension/shortening of bars, Principles of super positions, compound bars.

Lateral strain, Poisson's ratio, volumetric strain, Bulk modulus, Shear modulus, Young's modulus and their relations. Temperature stresses in compound bars.

UNIT-II: Compound stresses, Thin Pressure Vessels and Torsion [12 Hrs]

Stresses in two dimensional system, plane Stress transformation, Principal planes, principal stress and principal strain, Maximum shear stress Analytical and Graphical approach.

Stresses in thin pressure vessels, Pure Torsion, Torsion equations and applications, simple numerical

UNIT-III: Shear Force, Bending Moment Diagram and Bending Stress [12 Hrs]

Introduction, relationship between shear force and bending moments, shear force and bending moment diagrams for different beams subjected to various loads.

Theory of Simple Bending (Bending equation/ Flexural Formula), Section Modulus, Applications of Bending Equation, Beams of uniform strength.

UNIT-IV: Deflections in Beams, Columns and Struts [12 Hrs]

Beam Deflection, Relation between Slope, Deflection and Radius of Curvature, Slope and Deflection at a Section using Double Integration Method and Macaulay's method for simply supported, cantilever beams. Columns, concept of buckling, application of Euler's formulae, Rankin formula to columns under various end conditions.

List of problems to be solved during practice session using MATLAB

1. Write a MATLAB program to generate set of elongation, strain and stress developed in a circular bar of length 2.5 m and diameter 20 mm subjected a load of 3000 N to 30 kN in a step of 3000 N. Display the results under the following title: Assume Modulus of Elasticity as 200 GPa.
2. Write a MATLAB program to generate set of elongation and stress developed in a circular uniformly tapering bar of length 2.5 m and diameter tapering from 25 mm to 15 mm over the given length is subjected to a load of 3000 N to 30 KN in a step of 3000 N. Also calculate the percentage error if average area is considered instead of tapering cross-section for calculating extension. Assume Modulus of Elasticity as 200 GPa
3. A cantilever circular steel bar of diameter 50 mm and 0.5 m long is subjected to a point load varying from 200 N to 4 KN in a step of 200 N at the free end. Determine the Bending moment, maximum deflection and bending stress induced in the bar using MATLAB.
4. A simply supported beam 0f 10 m long, 150 mm breadth and 100 mm thickness is subjected to a mid-point load from 0 to 20 KN with an increment step of 1kN. Generate a table displaying maximum deflection, maximum bending moment and maximum bending stress induced against each load steps. Take E = 2.1 x 105 N/mm2
5. A steel circular shaft of 50 mm diameter and 5 m long is transmitting turning moment from 0 to 2 kNm with an increment step of 200 Nm, with a constant speed of 200 rpm. Generate a table displaying angular deformation both in radians and degrees, maximum torsional shear stress induced and power transmitted in kW against each turning moment steps. Take G = 79.3 x 103 N/mm2

Text Books:

1. Beer & Russell Johnston "**Mechanics of Materials**", in S.I. Units, Ferdinand TATA Mc GrawHill-2003.

2. S.S.Bhavikatti,"**Strength of Materials**", Vikas publications House -1 Pvt. Ltd., 2nd Ed., 2006.
3. R K Bansal "**Engineering Mechanics and Strength of Materials**", Laxmi Publications-New Delhi (2004)

Reference Books:

1. R.C.Hibbeler,"**Mechanics of Materials**", Printice Hall. Pearson Edu., 2005
2. S Ramamrutham, R Narayana, "**Strength of Materials**", Dhanphatrai publishing Co.Ltd.2003
3. Timoshenko.S.P "**Strength of Materials**", Part1,D.Van Nostrand company, Inc.Newyork

Course Code	Mechanical Measurements and Instrumentation	Course Type	L	T	P	C	Hrs./ Wk.
B19MT3040		HC	2	0	1	3	4

Prerequisites:

Applied Physics

Course Objectives:

1. To impart the knowledge of importance of standards & conversion, concepts involving linear and angular measurement.
2. To introduce the need of limit systems, tolerance and fits in an assembly system, concepts involving comparators.
3. To explore the various aspects regarding the temperature and strain measurement
4. To elaborate the fundamental methods of force, torque and pressure measurement and advances in Modern metrology.

Course Outcomes:

By the end of the course students shall be able to

1. Explain the need, history for the development of standards & conversion and concepts of linear and angular measurement.
2. Demonstrate the fundamentals of Limit systems, tolerances, fits in an assembly system and the need of comparators.
3. Apply the skills in measuring strain and temperature measurement
4. Explain the concepts of Force, torque and pressure measurement and advances in metrology.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT 3040	CO1	2	2	2	2	2						3		3	2	2
	CO2	3	3	2	1	2						2		3	1	2
	CO3	2	1	3	2	3						2		2	2	3
	CO4	3	3	3	2	2						1		1	3	2

Course Content:

UNIT-I: Basic of Metrology, Linear and Angular Measurement [12 Hrs]

Objectives of metrology, role of standards, standards of length- International prototype meter, Imperial standard yard, wave length standard, subdivision of standards, line & end standard, calibration of end bars (numerical), Slip gauges, Wringing phenomenon, Numerical problems on building of slip gauges, Vernier bevel protractor, Angle gauges, Sine principle, Sine bar & Sine Centre.

UNIT-II: System of limits, Fits, Tolerance, Gauging and Comparators [12 Hrs]

Need of limit system, Tolerance, Specification of tolerance in assembly, Accumulation tolerance & compound tolerance, principle of interchangeability & selective assembly, concept of limit of size & tolerance, Concept of fits, types of fits, shaft basis & hole basis system, geometric tolerance, tolerance grade, Numerical problem on limits and fits. Taylor's principle, introduction to comparators, need, characteristics, classification of comparators, Johanson Mikrokator, Zeisss ultra optimeter, Solex, LVDT.

UNIT-III: Temperature and Strain Measurement [12 Hrs]

Introduction, Classification, working principle, construction, advantages, limitations and applications of temperature measuring devices: Mercury in glass thermometer, bimetallic thermometer, resistance thermometer, thermistor, thermocouple, radiation pyrometer, optical pyrometer, radiation pyrometer,

Strain measurement, strain gauge, preparation & mounting of strain gauges, electrical strain gauge, backing & bonding materials.

UNIT-IV: Force, Torque and Pressure measurement and Modern Metrology [12 Hrs]

Introduction, Direct method: Analytical balance, unequal arm balance, proving ring. Torque measurement: Mechanical, hydraulic dynamometer, Pressure measurements, principle, Bridgeman gauge, McLeod gauge, Pirani gauge.

Introduction to advancement in metrology, lasers in metrology, advantages of lasers, laser scan micrometer applications- straightness, alignment, ball bar test, Machine vision, basic concept of machine vision system, elements, applications.

List of Experiments

1. Measurement of angle using sine center / sine bar / bevel protractor/roller set.
2. Measurement of alignment/flatness using Autocollimator

3. Measurements of Surface roughness using surface roughness tester(Tally Surf)
4. To inspect the height of given specimens using mechanical comparator.
4. Measurement of effective diameter of screw thread using two wire or Three-wire method.
5. Measurement of gear tooth thickness using gear tooth vernier caliper.
6. Calibration of Micrometer using slip gauges
7. Measurement surface flatness using optical flats
8. Measurement of cutting tool forces using Lathe Tool Dynamometer
9. Measurement of cutting tool forces using Drill Tool Dynamometer.

Text Books:

1. Beckwith Marangoni and Lienhard, **Mechanical Measurements**, Pearson Education, 6th Ed., 2006.
2. R.K. Jain, **Engineering Metrology**, Khanna Publishers, 1994.
3. B.C Nakra **Instrumentation, Measurement & Analysis**, K K Choudhary, 4th Edition, McGraw-Hill.
4. I.C.Gupta, **Engineering Metrology** Dhanpat rai publications.

Reference Books:

1. Bently, **Engineering Metrology and Measurements**, Pearson Education.
2. Anand K. Bewoor & Vinay A. Kulkarni **Metrology & Measurement**, Tata McGraw.
3. N.V Raghavendra & L. Krishnamurthy, **Engineering Metrology and Measurements,** Oxford University Press.
4. Gupta I.C, **Engineering Metrology,** Dhanpat Rai Publications, Delhi.
5. R.K Jain **Mechanical Measurement**, Khanna Publishers. 1994

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B19MT3050	**Analog and Digital Circuits**	HC	2	1	0	3	4

Prerequisites:

Number System, Semiconductor Basics.

Course Objectives:

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. Perform a load-line analysis of the most common BJT configurations.
5. Become acquainted with the design process for BJT biasing.
6. Analyze the concepts of Oscillator circuits.

Course Outcomes:

By the end of the course the student shall be able to

1. Understand the basics of Combinational Circuit design and various optimization techniques.
2. Analyze the working of sequential circuit.
3. Demonstrate the working of Transistor and various biasing techniques.
4. Understand the fundamentals of Operational Amplifier and their characteristics.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT 3050	CO1	2	2	2	3								2	2	2	2
	CO2	1	2	2	3								2	2	2	2
	CO3	1	2	2	2								2	2	2	2
	CO4	1	2	2	2								2	2	2	2

Course Content:

UNIT-I: Combinational Circuits: [12 Hrs]

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. Analysis and design of Adder/Subtractor, Carry Look Ahead adder, BCD adder. Principle of Encoder and Decoder

UNIT-II: Introduction to Sequential circuits [12 Hrs] 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.

UNIT-III: Transistor and its Biasing Techniques [12 Hrs]

Construction and Operation of a Transistor, characteristics (CB and CE), Operating Point, Fixed Bias, Voltage-Divider Bias Configurations, Emitter-Follower, Bias Stabilization, Problems linked to above topics.

UNIT-IV: Introduction to Operational Amplifiers: [12 Hrs]

Basic Operational Amplifier Circuit, The 741 IC Op-Amp, Voltage Follower, Non-inverting and Inverting Amplifiers, Summing Amplifiers, Difference Amplifier, Problems linked to above topics.

Text Books:

1. John M Yarbrough, "**Digital Logic Applications and Design**", Thomson Learning, 1st Edition, 2001.
2. Donald D Givone, "**Digital Principles and Design**", Tata McGraw-Hill 1st Edition, 2002.

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

Reference Books:

1. Floyd, "**Electronic Devices**", 6th Edition, Prentice Hall of India, Pearson Education.2010.
2. Moshe Morris Mano, "**Digital Design**" Prentice Hall, 3rd Edition, 2008.

Course Code	Signals and Networks	Course Type	L	T	P	C	Hrs./ Wk.
B19MT3060		HC	2	1	0	3	4

Prerequisites:

Basic Electrical and Electronics

Course Objectives:

1. To provide insight into fundamentals of Continuous and Discrete-time signals and systems, their properties and representations.
2. To provide understanding of signal representation in Fourier domain such as Fourier series, Fourier transform, discrete time Fourier transform.
3. Introduce the fundamental concepts of electrical circuit analysis with active and passive energy sources,
4. Study and analyze circuit using network theorems, transforms, and circuit resonance,
5. Select an analysis strategy to determine a response

Course Outcomes:

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

1. Illustrate the operations on Signals and summarize the properties of Systems.
2. Represent continuous time periodic signals in frequency domain using Fourier technique.
3. Analyse the concepts of super mesh, super node and network theorems.
4. Analyse transient behaviour of electrical circuit by applying Laplace Transforms.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT 3060	CO1	3	2	1	1										2	3
	CO2	3	2	1	1											3
	CO3	3	3	3						3	1			1	1	2
	CO4	3	3	3						3	1	1		1	1	2

Course Content:

UNIT-I: Introduction to Signals and Systems [12 Hrs]

Definitions of a signal and system, Elementary signals, Basic operations on signals, Classification of signals, Properties of systems.

UNIT-II: Fourier Representation for Aperiodic signals [12 Hrs]

FT representation of aperiodic CT signals - FT, definition, FT of standard CT signals, Properties and their significance, Inverse Fourier Transform.

FT representation of aperiodic discrete signals-DTFT, definition, DTFT of standard discrete signals.

UNIT-III: Circuit Analysis Techniques [12 Hrs]

Practical sources, Source transformations, Concepts of super node and super mesh, Network Theorems: Superposition theorem, Thevenin's & Norton's theorem, Maximum power transfer theorem.

UNIT-IV: Applications of LT technique in circuit analysis [12 Hrs]

A procedure for evaluating initial conditions, Initial & Final State of a network element. Time-domain to s-domain transformation of R-L-C circuits, step response of series R-L & series R-C circuit, impulse response of series R-L & series R-C network.

Text Books:

1. Simon Haykins, "**Signals and Systems**", John Wiley, India Pvt Ltd, Second Edition, 2008
2. W H Hayt, J E Kemmerly, S M Durbin, "**Engineering Circuit Analysis**", 6th Edition, Tata McGraw-Hill Publication.

Reference Books:

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, "**Signals and Systems**", Pearson Education, Second Edition, 1997.
2. Nahvi and Edminister, "**Electric Circuits**" Schaum's Outline Series, McGraw Hill, 2003.
3. J. David Irwin and R. Mark Nelms, "**Basic Engineering Circuit Analysis**", 8th Edition, John Wiley, 2006.

Course Code	Computer Graphics and Modeling Lab	Course Type	L	T	P	C	Hrs./ Wk.

B19MT3070		HC	0	0	2	2	3

Prerequisites:

C Programming and CAED

Course Objectives:

1 To introduce the use of the components of a graphics system and become familiar with building approach of graphics system components
2 To learn the basic principles of 3- dimensional computer graphics.
3 Provide an understanding of how to create the basic geometrical primitives and how to transform the shapes to fit them as per the picture definition.
4 Develop primary knowledge of working drawing and draw orthographic drawing of different machine parts.
5 Develop skill to produce 3D and assembly drawings of machine components.

Course Outcomes:

After completion of the course the student will be able to

1. Describe the basic concepts used in computer graphics
2. Create the basic geometrical primitives and perform transformations, Area filling, clipping.
3. Describe the importance of viewing and projections.
4. Draw detailed schematic and simplified drawings in sections and elevation using ANSI standards
5. Apply this knowledge to generating new and innovative design

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT 3070	CO1	3		3		3					2			3		
	CO2	3		3		3					2			3		
	CO3	3		3		3					2			3		
	CO4	3		3		3					2			3		

Course Content:

PART-A: Computer Graphics

1 Write a C program to create a line of given length or co-ordinates, and to perform 2D transformations such as translation, scaling and rotation on a line.
2 Write a C program to create a circle of given diameter and center co-ordinates and to perform 2D transformations such as translation and scaling on a circle.
3 Write a C program to create an ellipse of given major diameter, minor diameter and center co-ordinates and to perform 2D transformations such as translation, scaling, and rotation on an ellipse.

4 Write a C program to create a rectangle of given dimensions and to perform 2D transformations such as translation, scaling, and rotation on a rectangle
5 Write a C program to create orthographic views of a given machine component.

PART-B: Modeling

1 Orthographic projection of Hexagonal headed and square headed bolt and nut.
2 Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings).
3 3D modelling and assembly of following Machine components
a. Cotter joint (socket and spigot)
b. Knuckle joint (pin joint)
c. Split Muff coupling,
d. Protected type flanged coupling
e. Screw jack
f. Plumber Block

Course Code	Analog Devices and Digital Lab	Course Type	L	T	P	C	Hrs./ Wk.
B19MT3080		HC	0	0	2	2	3

Prerequisites:

Analog and Digital circuits

Course Objectives:

1. Design, realization and verification of Boolean Theorems, logic expressions
2. Realize various arithmetic, data path modules, memory modules
3. Demonstrate the designing and testing of (a) BJT R-C Phase shift Oscillator for $f_0 \leq 10$ KHz, (b) BJT Hartley and Colpitts's Oscillators $f_0 \geq 100$KHz (c) BJT Crystal Oscillator.
4. Understand the transfer characteristics Operational Amplifiers.

Course Outcomes:

By the end of the course the student shell be able to
1. Verify the truth table for given Boolean function and theorem.
2. Realize basic combinational and sequential circuits.
3. Describe and Design low frequency and high frequency oscillators like RC-phase shift, LC and crystal oscillators.
4. Demonstrate Characteristics of Op Amp, and applications of Op-Amp.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT 3080	CO1	3	2	1	1									1	2	2
	CO2	2	2	1	1									2	2	2
	CO3	2	3	3	2									1	1	2
	CO4	2	2	2	2									1	1	2

List of 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. Design a Single stage BJT RC Coupled Amplifier and obtain frequency response curve and find Bandwidth, Input & Output Impedances.
7. Design a Two stage voltage series BJT Amplifier and Obtain frequency response curve, also find Bandwidth, Input & Output Impedances
8. Rig-up an R-C Phase Shift oscillator for $f_o \leq 10$ KHz & Crystal oscillators for $f_o > 1$MHz.
9. Design a BJT Hartley &Colpitts's Oscillators for frequency ≥100kHz & simulate the circuit in Multisim.
10. Design an OPAMP Inverting & Non-Inverting Amplifier.

Fourth Semester

B19MT4010	Applied Mathematics	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	4

Prerequisites:

Calculus, Linear Algebra and Laplace Transform& Numerical Methods

Course Objectives:

1. Formulate, solve and analyze engineering problems.
2. Understand the fundamental concepts of Complex Analysis such as analytic functions, complex integrals and a range of skills which will allow students to work effectively with the concepts.
3. To study and understand the application approach of the concepts of Fourier series.
4. To study and understand the application approach of the concepts of Fourier transforms.
5. Apply numerical methods to solve differential equations.

Course Outcomes:

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

1. Apply appropriate numerical methods to solve first, second order ode and partial differential equations.
2. Apply Cauchy's integral theorem and formula to compute line integrals.
3. Apply techniques of Fourier series to solve problems of mechanical engineering.
4. Apply techniques of Fourier transform to solve problems of mechanical engineering.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3
B19MT 4010	CO1	3	2	2	2	3	1							3	3	3
	CO2	3	2	2	2	3	1							3	3	3
	CO3	3	2	2	2	3	1							3	3	3
	CO4	3	2	2	2	2	1							3	3	3

Course Contents:

UNIT-I: Complex Analysis [12 Hrs]

Function of a complex variable, Analytic functions-Cauchy-Riemann equations in Cartesian and polar forms (No proof C-R equations). Properties of analytic functions. Complex line integrals-Cauchy's theorem, Cauchy's integral formula and problems. Poles and residues. Cauchy's residue theorem (without proof) - problems

UNIT-II: Fourier Series [12 Hrs]

Periodic functions, Dirichlet's condition, Fourier series of periodic functions with period 2π and with arbitrary period $2l$. Fourier series of even and odd functions. Half range Fourier series, practical harmonic analysis-Illustrative examples from mechanical engineering field.

UNIT-III: Fourier Transforms [12 Hrs]

Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Applications to mechanical engineering problems.

UNIT-IV: Numerical Solution of Differential Equations [12 Hrs]

Numerical solution of simultaneous first order ODE -Picard's and Runge-Kutta method of fourth order. Numerical solution of second order ordinary ODE - Picards method, Runge-Kutta method and Milne's method. Numerical solutions of PDE- Finite difference approximations to derivatives, Numerical solution of two –dimensional Laplace equation, one-dimensional Heat and Wave Equations.

Text Books:

1. B.S. Grewal, "**Higher Engineering Mathematics**", Khanna Publishers, 43nd edition, 2015.
2. Erwin Kreyszig, "**Advanced Engineering Mathematics**", Wiley Publications, 9th edition, 2013.

Reference Books:

2. B.V. Ramana, "**Higher Engineering Mathematics**", Tata McGraw Hill Publications, 19th Reprint edition, 2013.
3. R.K.Jain and S.R.K.Iyengar, "**Advanced Engineering Mathematics**", Narosa Publishing House, 4th edition, 2016.

B18ME4020	Fluid Mechanics and Machinery	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	1	3	4

Prerequisites:

Applied Physics

Course Objectives:

1. To identify the flow characteristics and dynamics of flow field for various Engineering Applications.
2. To describe the importance of major and minor losses of fluid flows through pipes.
3. To discuss the main properties of viscous flow and flow over the immersed bodies.
4. To analyze the velocity components and energy transfers in fluid machines

Course Outcomes:

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

1. Apply the principles of fluid kinematics, fluid dynamics and dimensional analysis.

2. Apply the concept of fluid flow through pipe to find frictional losses and flow around immersion bodies to determine lift and drag forces.
3. Analyze the basic concept of Impact of jets and its applications.
4. Evaluate the main and operating characteristics of hydraulic turbines and pumps.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B18ME4020	**CO1**	**3**	**3**	**3**	**3**	**1**								**3**	**3**	**3**
	CO2	**3**	**3**	**3**	**3**	**3**								**3**	**3**	**3**
	CO3	**3**	**3**	**3**	**3**	**3**								**3**	**3**	**3**
	CO4	**3**	**3**	**3**	**3**	**2**								**3**	**3**	**3**

Course Contents:

UNIT-I: Fluid Kinematics, Dynamics and Dimensional Analysis[12 Hrs]

Fluid Kinematics: Stream lines, path lines, streak lines Types of Flow, velocity components, Discussion on convective and local acceleration, velocity potential, stream function,3-dimensional Continuity equation in Cartesian co-ordinates.

Fluid Dynamics: Euler's equation of motion along stream line, Bernoulli's equation and its limitations, Applications of Bernoulli's theorem such as venturi meter **(Derivation),** working principle of orifice meter, Pitot tube, Rectangular and triangular notch,. Numerical

Dimensional Analysis: Dimensions and units, Dimensional Homogeneity methods of dimensional analysis, Rayleigh's method, Buckingham π theorem, Discussion on Dimensionless numbers, Numerical.

UNIT -II: Flow through Pipes, Viscous Flow, Flow around Bodies[12 Hrs]

Energy consideration in pipe flow, Loss of Pressure Head due to Fluid Friction- Darcy Weisbach equation & Chezy's formula and related numerical**.,** Discussion on minor losses in pipes, HGL and TEL.

Laminar and turbulent flow: Reynolds Number, fully developed laminar flow in circular pipes, Hagen – Poiseuille equation, Laminar flow between parallel plates(no derivation), numerical.

Basic concept of Lift and Drag: Types of drag, Co-efficient of drag and lift, streamline body and bluff body, Discussion on flow around circular bodies and aero foils, Numerical on streamline body and bluff body, Discussion on flow around circular bodies and aero foils, Numerical.

UNIT -III: Impact of Jets and Centrifugal Pumps [12 Hrs]

Force exerted by the jet on a stationary and moving vertical plate, unsymmetrical curved vane at the center and tangentially at one of the tip. Force exerted by a jet of water on series of plate ,numericals. Generalized fluid flow through fluid machines and the velocity components, Euler turbine equation.

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, minimum speed for starting the pump, net positive suction head, cavitation, need for priming, pumps in series and parallel, numerical.

UNIT -4: Hydraulic Turbines[12 Hrs]

Classification, efficiencies of hydraulic turbines. Pelton turbine – velocity triangles, design parameters, Maximum efficiency,Francis turbine - velocity triangles, design parameters, Kaplan and Propeller turbines – velocity triangles, design parameters. Draft tubes- Types and functions, Micro turbines, Numerical.

Text Books:

1. Dr. Bansal, **Fluid Mechanics and Machinery**, R.K.Lakshmi Publications, 2004.
2. Jagadish Lal **Fluid Mechnaics and Hydraulic** , Metropolitan Book Company

Reference Books:

1. Yunus A. Cengel John M.Cimbala, **Fluid Mechanics** (SI Units), 3rd Ed., TataMcGraw Hill, 2014.
2. Pijush.K.Kundu, **Fluid Mechanics**, IRAM COCHEN, ELSEVIER, 3rd Ed. 2005

Lab Exercises

1. Determination of C_d of Notches.
2. Determination of C_d of Orifice, Venturimeter and Nozzle
3. Determination of Co-efficient of impact of jet on vanes.

B19MT4030	Kinematics of Machines	HC	L	T	P	C	Hrs /week
Duration:14 Wks			4	0	0	4	4

Prerequisites:

Engineering Mechanics.

Course Objectives:

1. To teach the students to gain the Knowledge of Mechanisms, and their mobility.
2. To analyze velocity and acceleration for different mechanisms
3. To understand the fundamentals of gear teeth, types of gear, gear mesh and its arrangements.
4. To teach the kinematic analysis of cam- follower motion

Course Outcomes:

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

1 Differentiate between a machine and mechanism, its degrees of freedom, possible inversions and classify mechanism with lower pair based on applications.
2 Determine the velocity and acceleration of simple mechanisms.
3 Analyze various types of gears and gear arrangements
4 Draw various types of cams and follower based on motion.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT4030	CO1	3	2	1										3	3	
	CO2	3	3	2	1						2			3	3	2
	CO3	3	3	2	1									3	3	2
	CO4	3	3	3							2			3	3	2

Course Contents:

UNIT-I: Simple Mechanisms [12 Hrs]

Introduction: Links-types, Kinematics pairs-classification, Constraints-types, Degrees of freedom of planar mechanism, Grubler's equation, linkage mechanisms, inversions of four bar chain, slider crank chain and double slider crank chain.

Mechanisms with Lower Pairs: Pantograph, Exact straight line motion mechanisms-Peaucellier's, Hart and Scott Russell mechanisms, Approximate straight line motion mechanisms–Grass-Hopper, Hooke's joint, Davis gear mechanism. Analysis of Ackermann steering gear mechanisms.

UNIT-II: Velocity and Acceleration in Mechanisms [12 Hrs]

Velocity in Mechanisms: Velocity of point in mechanism, Velocities in four bar mechanism and slider crank mechanism, relative velocity method, Instantaneous center method, Types & location of instantaneous centers, Kennedy's theorem, Velocities of slider crank mechanism.

Acceleration in Mechanisms: Introduction to Acceleration of a point on a link, Acceleration diagram for four bar and single slider mechanism, concept of corriolis component of acceleration , Crank and slotted lever mechanism, Klein's construction for Slider Crank mechanism.

UNIT-III: Gears and Gear Trains [12 Hrs]

Gears : Classification & terminology, law of gearing, tooth forms & comparisons, Systems of gear teeth, Analysis of spur gears, Length of path of contact, contact ratio, interference & under cutting in involute gear teeth, minimum number of teeth on gear and pinion to avoid interference, Numericals

Gear Trains: Simple, compound, reverted and Epicyclic gear train, Numericals

UNIT-IV: Cams [12 Hrs]

Cams and Followers - Classification & terminology, Cam profile by graphical methods with knife edge and roller follower for uniform velocity, uniform acceleration and retardation, simple harmonic motion.

Text books:

1. Thomas Bevan **Theory of Machines**, 3rd Edition, CBS publications.
2. Shigley, **Theory of Machines and Mechanisms**- 3rd edition Mc Graw Hill Book company
3. R S Khurmi & J K Gupta, **Theory of Machines** ,5th edition, S. Chand publications
4. R. K. Bansal , **Theory of Machines** –6th edition, Laxmi Publications

Reference Books:

1. Ghosh & Mallik **Theory of Machines and Mechanisms**- 3rdedition, East west press
2. S.S. Rattan, **Theory of Machines**- 3rd edition, 2013,TMH publications
2. Dr. Sadhu Singh **Kinematics of Machines**-, 2nd edition, Pearson Publication.

B19MT4040	Electrical Machines and Drives	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	4

Prerequisites:

Basic Electrical and Electronics Engineering.

Course Objectives:

1. To study the basic concept of D.C. and A.C. circuits and to learn the concept of transformers and do simple problems.
2. To study the performance characteristics of D.C. motors, three phase induction motor and single phase induction motor.
3. To study the methods of speed control of D.C. and A.C. motors and methods of starting of D.C. and A.C. motors.
4. To study the basic of selection of drive for a given application.
5. To study the concept of controlling the speed of D.C. and A.C. motors using solid state devices.

Course Outcomes:

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

1. Explain the concept of transformers.
2. Explain the working of power electronic converters and inverters
3. Analyze and compare the performance of DC and AC machines in various drive applications
4. Design controllers for electric drives which achieve the regulation of torque, speed, or position in the above machines.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT4040	CO1	3			1									3		
	CO2	3			1									3		
	CO3	3	3	1	2	2								3	3	2
	CO4	3	3	3	1	3								3	2	2

Course Contents:

UNIT-I: Circuit and Transformers [9 Hrs]

Sinusoidal waves, phasor representation, power factor, complex power, basic idea of transformers, simple problems.

UNIT-II: Electrical Motors [9 Hrs]

Constructional details, principle of operation and performance characteristics of D.C. motors, single phase induction motor, three phase induction motor, synchronous motors, universal motors, stepper motors, servo motors and reluctance motor.

UNIT-III: Speed Control and Starting [9 Hrs]

Speed control of D.C. motors – three phase induction motors – starting methods of D.C. motor and three phase induction motor – electrical braking, Liquid résistance Starters – simple problems.

UNIT-IV: Electrical Drives and Solid State Drives [9 Hrs]

Type of Electrical Drives, Selection & factors influencing the selection, heating and cooling curves, loading condition and classes of duty, determination of power rating, simple problems.

Advantages of solid state drives, D.C. motor control using rectifiers and choppers, control of induction motor by V, V/f and slip power recovery scheme using inverters and A.C. power regulators, Variable Frequency Drives

Text Books:

1. I.J.Nagrath, T.P. Kothari., **Basic Engineering**, McGraw – Hill Publishing company Ltd., Second edition, 2002.
2. S.K. Bhattacharya, **Electrical Machines**, second edition 1999, Tata McGraw – Hill Pvt.Company Ltd., Second edition, 1999.
3. G.K. Dubey, **Fundamental Electrical Drives**, second edition 2002, Narosa Publications, Second edition, 2002.
4. Pillai, S.K., A Seish **course on Electrical Drives**, Wilay Eastern Ltd., New Delhi, 1982.

Reference Books:

1. Hughes, A. and Drury, B., **Electric Motors and Drives: Fundamentals, Types and Applications**, Newnes, 4th Ed., 2014.
2. Sharkawi, Mohammed.A.El, **Fundamentals of Electric Drives**, PWS- Brooks/Cole Pub. Company, 2000.

B19MT4050	Microcontrollers and Applications	HC	L	T	P	C	Hrs /week
Duration: 14 Wks			3	0	0	3	3

Prerequisites:

Digital Circuits.

Course Objectives:

1. To introduce the microcontroller systems and learn the assembly level programming language.
2. To understand the architecture of 8051 microcontroller
3. To familiarize with the 8051-microcontroller instruction set, registers.
4. To familiarize with 8051 microcontroller subsystems, such as timer modules.
5. To interface a microcontroller with common peripheral devices, such as switches, visual displays, digital-to-analog converters, analog-to-digital converters, and memory to produce a system to accomplish a specified task.

Course Outcomes:

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

1. Understand the architecture and addressing modes of 8051 microcontroller.
2. Analyze the usage different instructions,Timers and Counters.
3. Demonstrate the different modes of Timers/Counters, Interrupts and Serial Communication**.**
4. Illustrate the different Interfacing techniques and Applications.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT4050	CO1	1	2	1	2								1	1	2	2
	CO2	1	2	1	1								1	2	2	2
	CO3	1	3	3	2								1	1	1	2
	CO4	1	2	2	2								1	1	1	2

Course Contents:

UNIT-I: 8051 Architecture, Addressing Modes [9 Hrs]

Introduction to Microprocessors and Microcontrollers, Microprocessor 8085 architecture, Microprocessor 8086 architecture, The 8051 Architecture, Memory organization, Addressing Modes..

UNIT-II: Instruction Set, Introduction to Timers/Counters [9 Hrs]

Data transfer Instructions, Stack, Assembly language programs. Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instruction, Instruction delay calculations, Assembly language programs. Introduction to Timers and Counters.

UNIT-III: Modes of Timers/Counters, Interrupts and Serial Communication[9 Hrs]

Time delay calculations, Basics of interrupts, 8051 interrupt structure, Serial Communication: Data communication, connections to RS-232. Timers/counters, Interrupts and Serial communication programming in Assembly and C.

UNIT-IV: Interfacing and Applications [9 Hrs]

8051 Memory Interfacing, Interfacing 8051 to LCD, parallel and serial ADC0804, DAC, Stepper motor and DC Motor, Interfacing Programming in C. Add on: Overview of microcontroller families and their applications.

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.

Reference Books:

1 Y Uday Kumar and Mallikarjuna swamy, "**The 8051 Miroprocessor**", Tata McGraw Hill Publications, 2009.

2 Rajkamal, "**Microtrollers Architecture, Programming, Interfacing and System Design**", Pearson Education, 2005

B19MT4060	Hydraulics and Pneumatics	SC	L	T	P	C	Hrs /week

Duration:14 Wks			**3**	**0**	**0**	**3**	**3**

Prerequisites:

Fluid Mechanics.

Course Objectives:

1. To acquire the knowledge of hydraulic and pneumatic systems.
2. Analyze the energy transfer in hydraulic actuators and motors and solve the Problems.
3. To impart the knowledge on controlling components of hydraulics and pneumatics systems.
4. Analyze the hydraulic and pneumatic circuits and interpret their applications

Course Outcomes:

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

1. Identify and select the hydraulic and pneumatic systems based on requirement.
2. Explain the controlling components of hydraulic and pneumatic systems.
3. Compile the design of hydraulic and pneumatic circuit systems and analyze them.
4. Exposure to do the project

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 4060	CO1	2	2	2	2								1	3	3	2
	CO2	2	2	2	2								1	3	3	2
	CO3	3	3	3	3								1	3	3	2
	CO4	3	3	3	3								1	3	3	2

Course Contents:

UNIT-I: Introduction to Fluid Power [9 Hrs]

Fluid Power System: Advantages of fluid power, Application of fluid power system. Basics of Hydraulics-Applications of Pascal's Law, Structure of Hydraulic System- Numerical on Pascal's law.

Hydraulic Pumps: Pumping theory – Gear pump, Vane Pump, Piston pump, construction and working of pumps – pump performance-Factors for selection of pumps–Numerical on hydraulic pumps.

UNIT-II: Hydraulic Actuators and Control Valves [9 Hrs]

Hydraulic Motors and Control Valves: Gear motor, Vane motor, Piston motor, construction and working of motors– motor performance- Control Valves-DCV: check valve,3/2, 4/3, 5/2 PRV: Pressure reducing valve, FCV: needle valve. Fluid power symbols, Numerical on hydraulic motors.

Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting, Special types of cylinders, Loading Mechanism, Cylinder Mounting- Cylinder load,

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

UNIT-III: Hydraulic Circuits and Maintenance [9 Hrs]

Hydraulic Circuits: Single acting, Double acting, Regenerative, Double pump, Sequencing, Cylinder locking, Synchronizing, pump unloading circuit, counter balance circuit, Meter-in, Meter-out, Accumulators and Accumulator using circuits.

Maintenance of hydraulic Systems: Hydraulic oils – Desirable properties, Sealing Devices, Reservoirs System, Filters and strainers, Problem caused by Gases in Hydraulic Fluids, Wear of moving parts to solid particle contamination, Temperature control, Trouble shooting.

UNIT-IV: Pneumatic and Servo Systems [9 Hrs]

Pneumatic Systems and Components: Pneumatic Components: Properties of air – Compressors – Filter, Regulator, and Lubricator Unit – Air control valves, Quick exhaust valves, and pneumatic actuators.

Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics – Introduction to fluidic devices, simple circuits, Introduction to PLC. Pneumatic logic circuits byusing OR & AND Gate

Text Books:

1. Anthony Esposito, **Fluid Power with Applications**, Pearson Education 2000.
2. Majumdar S.R., **Oil Hydraulics**, Tata McGraw-Hill, New Delhi 2009.

Reference Books:

1. Majumdar S.R., **Pneumatic systems – Principles and Maintenance**, Tata McGraw Hill, New Delhi 2005.
2. Anthony Lal, **Oil hydraulics in the service of industry**, Allied publishers, 1982.

B19MT4070	Manufacturing and Testing Lab	HC	L	T	P	C	Hrs

							/week
Duration:14 Wks		**0**	**0**	**2**	**2**	**3**	

Prerequisites:

Manufacturing Technology.

Course Objectives:

1. To introduce desirable properties of molding sand and establish its relevance in preparing the sand mold.
2. To introduce the experimental procedure in determining the GFN, Permeability, Strength of mold, moisture & clay content in sand sample & mold hardness.
3. To give students hands on practice in preparing the sand molds (Cope & Drag box) using single piece, split pattern and without using pattern.
4. Introduce the destructive and nondestructive method for determining the material properties and defects.

Course Outcomes:

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

1. Describe general properties of molding sand.
2. Illustrate the influence of Grain fineness of sand, content of clay and moisture on properties of molding sand.
3. Identify the different tools used in foundry practice with their uses
4. List the different stages involved in preparing the sand mold box.
5. Create the sand mold cavity using cope & drag box with pattern or without pattern
6. Find out tensile, compressive, torsional and bending properties of the given material using UTM.
7. Find hardness and impact strength of the given material
8. Introduce non-destructive testing methods.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT4070	**CO1**	**2**	**1**	**2**	**1**									**1**		
	CO2	**3**	**2**	**2**	**3**					**1**	**1**			**3**	**3**	**3**
	CO3	**1**	**2**		**1**					**1**				**2**	**1**	
	CO4	**2**	**2**	**2**	**1**					**2**	**2**			**3**	**3**	**3**
	CO5	**2**	**2**	**2**	**1**					**2**	**2**			**3**	**3**	**3**
	CO6	**3**	**2**	**2**	**2**					**3**				**3**	**3**	**3**
	CO7	**3**	**2**	**2**	**2**					**3**				**3**	**3**	**3**
	CO8	**2**	**2**	**2**	**1**	**2**				**3**				**3**	**3**	**3**

Course Contents:

PART-A: Manufacturing

1. Determination of Compression and Shear strength of molding sand using Universal Sand Testing Machine.
2. Determination of Permeability of molding sand
3. Determination of mold hardness.
4. Sieve Analysis to find Grain Fineness number of Base Sand
5. Moisture and Clay content determination in Base Sand
6. Preparation of molds using two molding boxes using patterns or without patterns.
7. Introduction to Lathe and Preparation of model using lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Eccentric turning

PART-B: Testing

1. Study the defects in Cast and Welded specimens using Non-destructive test experiments like: Ultrasonic flaw detection, Magnetic crack detection and Dye penetration method.
2. Tensile, shear and compression tests of metallic and nonmetallic specimens using Universal Testing Machine
3. Torsion Test
4. Bending Test on metallic and nonmetallic specimens.
5. Izod and Charpy Tests on M.S, C.I Specimen.
6. Brinell, Rockwell and Vickers's Hardness test.

B19MT4080	Microcontrollers Lab	HC	L	T	P	C	Hrs /week
Duration:14 Wks			0	0	2	2	3

Prerequisites:

Microcontrollers and Applications.

Course Objectives:

1. To introduce the microcontroller systems and learn the assembly level programming language.
2. To understand the architecture of 8051 microcontroller
3. To familiarize with the 8051-microcontroller instruction set, registers.
4. To familiarize with 8051 microcontroller subsystems, such as timer modules.
5. To interface a microcontroller with common peripheral devices, such as switches, visual displays, digital-to-analog converters, analog-to-digital converters, and memory to produce a system to accomplish a specified task.

Course Outcomes:

After successful completion of the course, the students 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.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT4080	CO1	1	2	1	2								2	2	2	2
	CO2	1	1	1	1								2	2	2	2
	CO3	1	3	3	2								2	1	1	2
	CO4	1	2	2	2								1	1	1	2
	CO5	1	2	2	2								1	1	1	2

List of Experiments:

Section-A (Assembly Language Programming)

1. Data Transfer Instructions: Data Transfer between internal and external RAM with and without overlap, Sorting, largest and smallest number in an array and exchange.
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. Exchange 2 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)

6. Serial Reception and Display the ASCII value of Key pressed on LCD.
7. Count the incoming pulses using counters.
8. DC Motor speed control using external interrupt.
9. Stepper motor interfacing by controlling the steps and direction.
10. Interfacing DAC to generate various waveforms with output voltage varying between -12V to 12V with Amplitude and Frequency control.
11. Keyboard Interfacing.

Fifth Semester

B19MT5010	CNC Technology	HC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Knowledge of Basic Electrical & Electronics.

Course Objectives:

1. Develop skills required for programming and tooling for CNC machine.
2. Introduce how to interface the mechanical system with electronics
3. Learn maintenance practices of CNC machines.
4. Mechatronics Engineers to master CNC technology.

Course Outcomes:

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

1. Explain the working and use of various components of CNC machines
2. Identify the sequence of codes to process a job
3. Create CNC program for turning and milling operations & Interface software application for auto part programming
4. Apply maintenance practices for CNC machines.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 5010	CO1	2	1	1										2	2	1
	CO2	2	1	1										2	2	1
	CO3	2	1	1										2	2	1
	CO4	2	1	1										2	2	1

Course Contents:

UNIT-I: Fundamentals of Process Planning and CNC systems. [9 Hrs]
Process planning, Structure of process plan, factors influencing process plan, Sequence of operation of process, CAM, NC, CNC and DNC, selection criteria for CNC machines, adaptive control.

UNIT-II: Constructional Features of CNC machines [9 Hrs]Classifications of CNC Machine, modes of operation of CNC, working of: Machine Structure, Slide ways, Spindle drive, Axis drive, Recirculating ball screw Feedback devices (transducers, encoders),

Automatic tool changer (ATC), Automatic pallet changer (APC), SMED Technique, CNC axis and motion nomenclature, CNC tooling – tool pre-setting, qualified tool, tool holders and inserts.

UNIT-III: CNC Part Programming [9Hrs]

Axis Identification in CNC turning and machining centers, machine zero, home position, work piece zero, NC Programming format, types and methods of part programme, ISO G and M codes for turning and milling-meaning and applications of important codes. Tool length compensation, pitch error compensation, Tool radius compensation, simple part programming for turning and milling (minimum four to five operations).

UNIT-IV: Maintenance of CNC Machine [9Hrs]

Types of machine tools maintenance, systems and sub systems of CNC machines, CNC Maintenance practice: Tools required, daily checklist, problems related to mechanical systems, backlash, causes and precautions of electronics system.

Text books:

1. Pabla, B.S., Adithan M, **CNC Machines**, New Age International, New Delhi, 2014
2. Quesada, Robert, **Computer Numerical Control- turning and machining centers**, PHI Learning, New Delhi, 2004
3. Sareen, Kuldeep, **CAD/CAM**, S.Chand, New Delhi, 2007
4. Vishal, S., **Introduction to NC/CNC Machines**, S.K.Kataria & Sons., New Delhi,2009
5. Rao,P N, Tiwari, N K, Kundra, T, **Computer Aided Manufacturing**, Tata McGraw Hill, NewDelhi,2014
6. Khanna, O.P., **Industrial Engineering**, Dhanpat rai, New Delhi, 2012

Reference Books:

1. M. P. Groover, **Automation, Production Systems and Computer Integrated Manufacturing**, Pearson education. Third Edition, 2008.
2. Vajpayee **Principles of CIM**, PHI.
3. Amber G.H & P. S. Amber, **Anatomy of Automation**, Prentice Hall.

B19MT5020	Communication Systems	HC	L	T	P	C	Hrs /week

Duration:14 Wks			**4**	**0**	**0**	**4**	**4**

Prerequisites:

Analog and Digital Circuits

Course Objectives:

1. To Introduce Electronic Communication, The Significance of Human Communication, the Different Types of Electronic Communications, Multiplexing, Modulation and Communication systems.
2. To describe the various analog modulation & demodulation techniques.
3. To tackle concepts like Transmission Lines, Communication Tests and Measurements, Internet Technologies, Telecommunication Systems, Microwave Communication, Satellite Communication, and Optical Communication.
4. To elucidate on Cell phone and Wireless technologies, Radio Transmitters, FM Circuits, the Transmission of the Binary Data in Communication Systems and Communication Receivers, Antennas and Wave Propagation.

Course Outcomes:

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

1. Differentiate different analog and digital communication systems.
2. Construct simple communication systems employing AM or FM
3. Use various modes of communication for mechatronic applications.
4. Exploit the internet and wireless medium for industrial electronic communication

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 5020	**CO1**	**1**	**2**	**2**	**2**								**2**	**2**	**2**	**2**
	CO2	**1**	**1**	**1**	**2**								**2**	**2**	**2**	**2**
	CO3	**1**	**3**	**3**	**2**								**2**	**1**	**1**	**2**
	CO4	**1**	**2**	**2**	**2**								**1**	**1**	**1**	**2**

Course Contents:

UNIT-I: Overview of Communication Systems [12 Hrs]

General representation of a communication system, Brief description of fundamental elements in the system, Introduction to electronic communications, The fundamentals of electronics- a review, Baseband and Broadband signals.

UNIT-II: Analog and Digital signals in communication [12Hrs]

Amplitude modulation fundamentals, Amplitude modulator and demodulator circuits, Fundamentals of frequency modulation, FM Circuits, Digital Communication techniques, Radio transmitters, Communication receivers, Multiplexing and demultiplexing. The transmission of binary data in communication systems, Introduction to networking and local area networks.

UNIT-III: Communication in Mechatronics [12 Hrs]

System buses, Serial and Parallel data transmission, Synchronous vs. Asynchronous, Network topologies (hierarchy, network access), Device interfaces (serial and parallel interfaces), Wireless protocols (wi-fi, Bluetooth, xbee), USB.

UNIT-IV: Domains of Communication [12 Hrs]

Transmission lines, Antennas and wave propagation, Internet technologies, Microwave communication, Satellite communication, Telecommunication systems, Optical communication, Cell phone technologies, Wireless technologies.

Text Books:

1. Frenzel, Louis. **Principles of electronic communication systems**. McGraw-Hill, Inc., 2007.
2. John. G. Proakis, Masoud Salehi, "**Fundamentals of Communications Systems**", 2005.

Reference Books:

1. W.Bolton,"**MECHATRONICS Electronic Control Systems in Mechanical and Electrical Engineering**", 2011
2. Sam Shanmugam, "**An introduction to analog and digital Communication system**", John Wiley publication, 3rd edition, 2008.
3. Simon Haykins, "**Communication Systems**", John Willey, 3rd Edition, 1996.

B19MT5030	Data Acquisition Systems	HC	L	T	P	C	Hrs /week
Duration:14 Wks			4	0	0	4	4

Prerequisites:

Analog and Digital circuits

Course Objectives:

1. To introduce the need of data acquisition and requirement.
2. To study the selection sensors, signal conditioning, and data acquisition hardware.
3. To introduce the procedure of testing of sensors, signal conditioning and data acquisition hardware.
4. To study the software solution for data acquisition.

Course Outcomes:

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

1. Identifying and defining requirements and specifying data acquisition tasks to be performed.
2. Selecting appropriate sensors, signal conditioning, and data acquisition hardware.
3. Setting up and testing of sensors, signal conditioning and data acquisition hardware.
4. Developing a software solution to implement specified data acquisition tasks.
5. Documenting and presenting an appropriate solution.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 5030	CO1	1	2	1	2								2	2	2	2
	CO2	1	1	1	1								1	2	2	2
	CO3	1	3	3	2								1	1	1	2
	CO4	1	2	2	2								1	1	1	2

Course Contents:

UNIT-I: Data Acquisition Techniques [12 Hrs]

Analog and digital data acquisition, Sensor/Transducer interfacing, unipolar and bipolar transducers, Sample and hold circuits, Interference, Grounding and Shielding.

UNIT-II: System Control [12 Hrs]

Data Acquisition with Op-Amps: Operational Amplifiers, CMRR, Slew Rate, Gain, Bandwidth. Zero crossing detector, Peak detector, Window detector. Difference Amplifier, Instrumentation Amplifier AD 620, Interfacing of IA with sensors and transducer, Basic Bridge amplifier and its use with strain gauge and temperature sensors, Filters in instrumentation circuits.

UNIT-III: Guidance and Navigation [12 Hrs]

Data Transfer Techniques: Serial data transmission methods and standards RS 232-C: specifications connection and timing, 4-20 mA current loop, GPIB/IEEE-488, LAN, Universal serial bus, HART protocol, Foundation Fieldbus, Modbus, Zigbee and Bluetooth.

UNIT-IV: Data Acquisition System (DAS) [12 Hrs]

Single channel and multichannel, Graphical Interface (GUI) Software for DAS, RTUs, PC-Based data acquisition system.

Text Books:

1. Coughlin, R.F., **Operational Amplifiers and Linear Integrated Circuits**, Pearson Education (2006).
2. Kalsi, H.S., **Electronic Instrumentation**, Tata McGraw Hill (2002).
3. Gayakwad, R.A., **Op-Amp and Linear Integrated Circuits**, Pearson Education (2002).

4. Mathivanan, N., **Microprocessor PC Hardware and Interfacing**, Prentice Hall of India Private Limited (2007).

Reference Books:

1. Ananad, M.M.S., **Electronic Instruments and Instrumentation Technology**, Prentice Hall of India Private Limited (2004).
2. Murthy, D.V.S., **Transducers and Instrumentation**, Prentice Hall of India Private Limited (2006).

B19MT5040	Robotics and Vision System	HC	L	T	P	C	Hrs /week
Duration:14 Wks			4	0	0	4	4

Prerequisites:

Microcontrollers, Control System

Course Objectives:

1. To introduce the applications of robots in industry.
2. To study the robot motion analysis.
3. To introduce the mathematical modelling and trajectory concept.
4. To introduce the concept of programming of robots.

Course Outcomes:

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

1. Summarize the anatomy of robot and their classification and specification
2. Analyze the Robot Motion Analysis and its control
3. Relate mathematical modelling and trajectory planning scheme in robots.
4. Understand the robot programs and upgrade knowledge on different types of cell layouts applicable in robotics.

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
B19MT5040	CO1	3	3	1	2								2	2	2	2
	CO2	2	1	2	1								2	2	2	2
	CO3	2	3	3	2								2	1	2	2
	CO4	2	2	2	2								2	1	1	2

Course Contents:

UNIT-I: Introduction to Robotics [12 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-II: Robot Motion Analysis and Robot Control [12 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-III: Robot Trajectory Planning and Robot Sensors [12 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.

UNIT-IV: Machine Vision and Robot Programming [12 Hrs]

Machine vision, functions of machine vision system, sensing and digitizing, imaging devices, 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, Intelligence,** McGraw 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.

B19MT5051	Automotive Engineering	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Applied Thermodynamics

Course Objectives:

1. To make the student understand about the various components of petrol engine and diesel engine.
2. To make the student understand about the various electrical components of an automobile necessary for Ignition system of an automobile.
3. To make the students understand the importance of emission control, alternate fuels and modifying the engine suitably.
4. To make students to recognize the need for safety and comfort that need to be invoked in the system.

Course Outcomes:

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

1. Describe various aspects of automobile components and system which include engine components, fuel and ignition systems, transmission systems.
2. Demonstrate the knowledge on suspension and braking systems used in automobiles
3. Describe the environmental implications of automobile emissions
4. Illustrate the principle of steering system and steering mechanism

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 5051	CO1	2	3	2	3	1								3	3	3
	CO2	3	3	3	2	1								3	3	3
	CO3	3	3	3	2	2								3	2	3
	CO4	3	3	3	3	3								3	3	3

Course Contents:

UNIT-I: Engine Components, Cooling and Lubrication [9 Hrs]

Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relative merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve-Timing diagram, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, thermostat valves.

Self-study: different lubrication arrangements.

UNIT-II: Fuel Supply and Emission Control System [9 Hrs]

Fuel Supply System: Fuel supply in SI engines- Fuel mixture requirements for SI engines, Working principle of simple carburetors, Injection systems -Single-point body injection, multipoint fuel injection, Inline distributor pump, Individual control pump, Common rail, Unit injection fuel transfer pumps, Fuel filters, fuel injection pumps and injectors.

Engine Emissions And Control Systems: Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Air-injection system, Air-aspirator system, Catalytic converter, low temperature combustion (LTC), homogeneous charge compression ignition (HCCI).

Self-study: Emission standards, premixed charge compression ignition (PCCI).

UNIT-III: Ignition System and Transmission System [9 Hrs]

Ignition System, Superchargers And Turbochargers: Introduction, objectives, Ignition System Types, Comparison between Battery and Magneto Ignition System, Drawbacks (Disadvantages) of Conventional Ignition Systems, Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger and comparisons.

Transmission System: General arrangement of clutch, Principle of friction clutches, Torque transmitted, Fluid flywheel, Single plate, multi-plate and centrifugal clutches. Gear box: Necessity for gear ratios in transmission. synchromesh gear boxes, automatic transmission system.

UNIT-IV: Suspension, Braking and Steering System [9 Hrs]

Suspension, Springs and Brakes: Requirements, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system. Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock

Steering System: Steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer and neutral steer.

Text Books:

1. Kirpal Singh,**Automobile Engineering**, Volume 1&2, Standard Publications.
2. R. B. Guptha**Automobile Engineering,** Satya Prakashan, New Delhi

Reference Books:

1. William.H.Crouse, (2006),**Automotive Mechanics**, 10th Edition, McGraw-Hill.
2. Mathur and Sharma**Internal Combustion Engines**Dhanpat Rai & sons- India.
3. V Ganesan (2006), **Internal Combustion Engines**, 12th Edition, McGraw-Hill.

19MT5052	Tribology and Bearing Design	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Mechanics of Materials, Fluid Mechanics

Course Objectives:

1. To understand the principles of lubrication& regimes of lubrication.
2. To understand the genesis of friction, laws of sliding and rolling friction
3. To learn about consequences of wear, wear mechanisms, wear theories.
4. To impart a knowledge of theories of hydrodynamic, Elasto-hydrodynamic and mixed/ boundary lubrication.
5. To learn about tribological testing and experimental techniques in tribology in order to learn about the tribology of different machine elements.

Course Outcomes:

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

1. Apply the knowledge of theory of friction to solve engineering problems.
2. Derive the equation for Idealized Journal Bearing and Slider / Pad Bearing with A Fixed and Pivoted Shoe.
3. Derive the Oil Flow and Thermal Equilibrium equations of Journal Bearing and Hydrostatic Lubrication.
4. Analyze the Behavior of Tribological Components.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 5052	CO1	3	3	1										3	3	1
	CO2	3	3	1										3	3	1
	CO3	3	3	1										3	3	1
	CO4	3	3	1										3	3	1

Course Contents:

UNIT-I: Introduction to Tribology and Hydrodynamic Lubrication [9 Hrs]

Introduction to Tribology: Properties of oils and equation of flow: Viscosity, Newton's Law of viscosity, Hagen-Poiseuille Law, Flow between parallel stationary planes, viscosity measuring apparatus regimes of lubrication classification of lubricants.

Hydrodynamic Lubrication: Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, mechanism of pressure development in an oil film, Reynolds's investigation and Reynolds's equation in 2D.

UNIT-II: Performance of Bearings [9 Hrs]

Idealized Journal Bearing: Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld's numbers and significance of it, Partial bearings, end leakages in journal bearing, numerical.

Slider / Pad Bearing with A Fixed and Pivoted Shoe: Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, numerical.

UNIT-III: Thermal Equilibrium of Journal Bearing [9 Hrs]

Oil Flow and Thermal Equilibrium of Journal Bearing: Oil flow through bearings, self-contained journal bearings, bearings lubricated under pressure, thermal equilibrium of journal bearings.

Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing.

UNIT-IV: Bearing Materials and Tribological Components [9 Hrs]

Bearing Materials: Commonly used bearings materials, properties of typical bearing materials. Advantages and disadvantages of bearing materials.

Behavior of Tribological Components: Selection, friction, Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure. Tribological measures, Material selection, improved design, surface engineering.

Text Books:

1. B.C. Majumdar, **Introduction to Tribology Bearings**, Wheelers and company pvt. Ltd., 2011-12. ISBN:81-219-29870
2. Basu S K., Sengupta A N., Ahuja B. B.,**Fundamentals of Tribology** , PHI 2006

Reference Books:

1. Fuller, D.,**Theory and Practice of Lubrication for Engineers,** New York Company 1998
2. Moore,**Principles and Applications of Tribology,** Pergamaon press 1998
3. Srivastava S.,**Tribology in Industries,** S Chand and Company limited, Delhi 2002
4. Redzimovskay E I., **Lubrication of bearings – Theoretical Principles and Design,** Oxford Press company 2000.

B19MT5053	Theory of Metal Cutting and Machine Tools	SC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	1	3	4

Prerequisites:

Manufacturing Technology

Course Objectives:

1. To familiarize the student with tool nomenclature and cutting forces.
2. To impart knowledge of mathematics on machining parameters for different machining processes, tool life and tool wear.
3. To acquire the knowledge about various machining processes for production of complex shaped components.
4. To predict a suitable super finishing process to produce the intricate components.

Course Outcomes:

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

1. Analyze forces acting on the cutting tool in orthogonal and oblique cutting and various process parameters to improve the cutting tool life.
2. Describe various machining process used for machining of components.
3. Explain various machines used for manufacturing of metal components.
4. Identify the cutting tools required for different machining processes.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 5053	CO1	3	2	1	3									2	2	2
	CO2	3		1										1	1	1
	CO3	3	3											1	1	1
	CO4	3	2											2	2	2

Course Contents:

UNIT-I: Theory of Metal Cutting [9 Hrs]

Introduction -Geometry of a single point cutting tool - Chip formation and types of chips–Orthogonal and oblique cutting – Merchant circle diagram for cutting forces - Shear angle in terms of chip thickness ratio and rake angle –Problems on shear angle- Machining variables – Factors affecting cutting tool life – Types of tool wear – Taylor's tool life equation – Problems on Taylor's tool life equation. Cutting tool materials of common use and their characteristics – Functions of cutting fluids – Types of cutting fluids – Heat generation in metal cutting and factors affecting heat generation – Measurement of tool tip temperature using tool work thermocouple technique.

UNIT -II: Lathe, Drilling and Shaping Machine [9 Hrs]

Lathe: Working principle and specifications of lathe, Description of main components and lathe operations, Work holding devices. Constructional features of turret and capstan lathe. Automatic Lathe, Introduction to CNCturning center

Drilling Machine-Principle of working, Classification, construction and working of Bench and Radial drilling machines, drilling operations, drill bit nomenclature, simple problems,

Shaping Machine: Introduction, types, construction and operations of horizontal shaper.

UNIT -III: Milling and Grinding Machine [9 Hrs]

Milling: Principle of working, Classification of Milling machines, construction and working of Horizontal and vertical milling machines. Milling operations, methods of indexing simple and compound-problems on simple indexing, Introduction to CNCmilling center

Grinding: Working principle, constructional features of Cylindrical, Centerless and Surface grinding machines, Types of abrasives, grinding operations- dressing, truing.

UNIT -IV: Lapping, Honing and Broaching Machines [9 Hrs]

Lapping – Principle of Lapping – Lapping methods – Advantages and limitations of lapping

Honing – principle of honing – Types of honing machines – Advantages, limitations and applications of honing.

Broaching – Principle of working – Details of a commonly used broach – construction and working of a horizontal broaching machine – Advantages, limitations and applications.

List of Models/Work

1. Preparation of two models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.
2. Cutting of V Groove/ dovetail/Rectangular groove using a shaper.
3. Cutting of Gear Teeth Using Milling Machine

Text Books:

1. Hajra choudhury, **Workshop Technology Vol-II**, Media Promoters & Publishers Pvt. Ltd. 2004
2. R.K Jain, **Production Technology**, Khanna Publications, 2003.
3. HMT, **Production Technology**, Tata McGraw Hill, 2001.
4. O.P Khanna,**Production Technology Vol-1**, Dhanpat Rai publications
5. Rajput,**Manufacturing Technology**Second edition, Laxmi Publications

Reference Books:

1. Amitabh Ghosh and Mallik**Manufacturing Science**, affiliated East West Press, 2003
2. G. Boothroyd, **Fundamental of Metal Machining and Machine Tools**, McGraw-Hill, 2000.
3. G.C Sen & Bhattacharya**Principle of Machine Tools**, Tata Mcgraw hill, New Delhi
4. Kalpakjian, serope**Manufacturing Engineering and Technology**, Addison –wesley publishing co., New york
5. P.C Pandey & H.S Shan**Modern Machining Processes**:, T.M.H Company, New Delhi

B19MT5054	Material Science and Technology	SC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	1	3	4

Prerequisites:

Applied Chemistry

Course Objectives:

To gain an understanding of the relationships between the structures, properties, processing and applications of various engineering materials.

Course Outcomes:

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

1. Describe the necessity of engineering materials and its applications in various fields.
2. Identify possible cause of failure due to fatigue and Creep.
3. Demonstrate the knowledge of nucleation, Crystal growth, Solid solution and Phase diagrams.
4. Explain the significance and applications of various heat treatment processes.
5. Explain significance and fabrication processes of composite materials.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 5054	CO1	1	2	3										3	3	1
	CO2	1	1	2										3	2	1
	CO3	2	1	2										3	2	1
	CO4	3	2	2										3	2	1

Course Contents:

UNIT -I: Mechanical Behavior and Fracture [9 Hrs]

Mechanical Behavior: Stress- Strain diagram showing ductile and brittle behavior of materials, Linear and non-linear elastic behavior and properties, mechanical Properties in plastic range, Yield strength offset yield strength, ductility, ultimate tensile strength, toughness plastic deformation of single crystal by slip and twinning. Atomic diffusion, flick's laws of Diffusion, Factors attaching the Diffusion

Fracture: Types, creep: Description of the phenomenon with examples, 3 stages of creep properties, stress relaxation fatigue: types of fatigue lauding with examples, Mechanism of fatigue, Fatigue properties, Fatigue testing and S-N diagram.

UNIT -II: Heat Treating & Materials [9 Hrs]

Heat Treating of metals: TTT curves, Continuous cooling curves, Annealing and its types, Normalizing, Hardening, Tempering, Martempering, Austemparing, hardenability, Surface hardening

methods like Carburizing, Cyaniding, Nitriding, flame hardening and induction hardening, age hardening of aluminium and copper alloys.

Ferrous and Non-Ferrous Materials: Properties composition and use of grey cast iron, malleable iron, SG iron and steel. Copper alloys- brasses and bronzes, aluminium alloys Al-Cu, Al-Si, Al-Zn alloys.

UNIT -III: Solidification and phase diagram [9 Hrs]

Mechanism of solidification, Homogenous and Heterogeneous nucleation. Cristal Growth, Cast metal strictures, Phase diagram. Solid solutions, Substitution and Interstitial solid solution, Hume rothary rule, Intermediate phase, construction of equilibrium diagram involving complete and partial solubility, lever rule, Gibb's phase rule. Introduction to Iron carbon diagram.

UNIT -IV: Composite Materials [9 Hrs]

Definition, classification, type of matrix materials and reinforcements, advantages and application of composites.

Processing of FRP Composites: Layup and curing, fabricating process, open and closed mould process, hand layup technique, structural laminate bag molding, production procedures for bag molding, filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding.

Metal Matrix Composites: Reinforcement materials, types, characteristics and selection, base metals selection. Need for MMC's and its application.

List of Experiments:

1. Preparation of specimen for metallographic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.
2. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.
3. Fatigue Test.

Text Books:

1. James F Shackleford& Madanapalli K Muralidhara,**Material science for Engineers,**Sixth edition, Pearson Publications - 2007
2. Smith,**Foundations of Materials Science and Engineering,**4th Edition McGraw Hill, 2009.

Reference Books:

1. Alan Cottrell,**An Introduction to Metallurgy,**Universities Press India Oriental Longman Pvt. Ltd 1974.
2. W.C.Richards**Engineering Materials Science**, PHI, 1965
3. V.Raghavan**Materials Science and Engineering**, ,PHI, 2002
4. William D. Callister Jr., **Materials Science and Engineering**, John Wiley & Sons.Inc, 5th Edition, 2001.
5. Traugott Fischer, **Materials Science for Engineering Studies,**2009. Elsevier Inc

B19MT5055	Data Structures	SC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	1	3	4

C Programming

Prerequisites:

1. To impart the basic concepts of data structures and algorithms
2. To understand concepts about searching and sorting techniques
3. To Understand basic concepts about stacks, queues, lists, trees and graphs
4. To understanding about writing algorithms and step by step approach in solving problems with the help of fundamental data structures

Course Outcomes:

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

1. Explain different types of data structures, operations and algorithms
2. Apply searching and sorting operations on files
3. Make use of stack, Queue, Lists, Trees and Graphs in problem solving.
4. Develop all data structures in a high-level language for problem solving.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 5055	CO1	3		1										1	3	
	CO2	3	3	2	3	3								3	3	2
	CO3	3	2	2	1	3								2	2	1
	CO4	3	2	3	3	3								3	3	2

Course Contents:

UNIT -I: Introduction, Array Operations and Strings [12Hrs]Introduction: Data Structures, Classifications (Primitive & Non Primitive), Data structure Operations, Review of Arrays, Structures, Self-Referential Structures, and Unions. Pointers and Dynamic Memory Allocation Functions. Representation of Linear Arrays in Memory, Dynamically allocated arrays.

Array Operations: Traversing, inserting, deleting, searching, and sorting. Multidimensional Arrays, Polynomials and Sparse Matrices.

Strings: Basic Terminology, Storing, Operations and Pattern Matching algorithms. Programming Examples.

UNIT -II: Stacks and Queues [12 Hrs]

Stacks: Definition, Stack Operations, Array Representation of Stacks, Stacks using Dynamic Arrays, Stack Applications: Polish notation, Infix to postfix conversion, evaluation of postfix expression, Recursion - Factorial, GCD, Fibonacci Sequence, Tower of Hanoi, Ackerman's function.
Queues: Definition, Array Representation, Queue Operations, Circular Queues, Circular queues using Dynamic arrays, Dequeues, Priority Queues, A Mazing Problem. Multiple Stacks and Queues. Programming Examples.

UNIT -III: Linked Lists and Trees [12 Hrs]
Linked Lists: Definition, Representation of linked lists in Memory, Memory allocation, Garbage Collection. Linked list operations: Traversing, Searching, Insertion, and Deletion. Doubly Linked lists, Circular linked lists, and header linked lists. Linked Stacks and Queues. Applications of Linked lists – Polynomials, Sparse matrix representation. Programming Examples
Trees: Terminology, Binary Trees, Properties of Binary trees, Array and linked Representation of Binary Trees, Binary Tree Traversals - Inorder, postorder, preorder, Additional Binary tree operations. Threaded binary trees, Binary Search Trees – Definition, Insertion, Deletion, Traversal, Searching, Application of Trees-Evaluation of Expression, Programming Examples

UNIT -IV: Graphs, Sorting and Searching, Hashing and Files and Their Organization[12 Hrs]
Graphs: Definitions, Terminologies, Matrix and Adjacency List Representation of Graphs, Elementary Graph operations, Traversal methods: Breadth First Search and Depth First Search.
Sorting and Searching: Insertion Sort, Radix sort, Address Calculation Sort.
Hashing: Hash Table organizations, Hashing Functions, Static and Dynamic Hashing.
Files and Their Organization: Data Hierarchy, File Attributes, Text Files and Binary Files, Basic File Operations, File Organizations and Indexing.

Text Books:
1. Ellis Horowitz and Sartaj Sahni**, Fundamentals of Data Structures in C**, 2nd edition, Universities Press, 2014
2. Seymour Lipschutz, Schaum's Outlines, **Data Structures** -, Revised 1st edition, McGraw Hill, 2014

Reference Books:
1. Gilberg & Forouzan, **Data Structures: A Pseudo-code approach with C**, 2nd edition, Cengage Learning, 2014
2. Reema Thareja,**Data Structures using C,**3rd edition Oxford press, 2012
3. Jean-Paul Tremblay & Paul G. Sorenson,**An Introduction to Data Structures with Applications,**2ndEdition, McGraw Hill, 2013
4. A M Tenenbaum, **Data Structures using C,**PHI, 1989

B19MT5061	Elements of Avionics	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Basic Electrical and Electronics

Course Objectives:

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:

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

1. Describe various avionics items.
2. Identify different aircraft cockpit instruments and displays.
3. Illustrate the avionics systems.
4. Explain surveillance system in aircraft

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 5061	CO1	1	1	1	2								2	1	1	2
	CO2	1	1	1	1								2	1`	1	2
	CO3	1	3	3	2								1	1	1	2
	CO4	1	2	2	2								1	1	1	2

Course Contents:

UNIT-I: Design Considerations and Display Systems [9 Hrs]

Importance and role of avionics, avionic environment, Regulatory and advisory agencies -Displays and man-machine interaction: Head -glass cockpit- Cathode Ray Tube (CRT), 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-II: Aircraft Instruments [9 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, Weather Radar, RADOME.

UNIT-III: Navigation Systems and Flight Control [9 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-IV: Surveillance and Communications Systems [9 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**, 3rd Edition, CRC Press LLC, 2006.
2. Collinson, R.P.G, **Introduction to Avionics**, 3rd Edition, springer, 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**, 3rdEdition, John Wiley & Sons, Ltd 2008
2. Cary R.Spitzer,**Digital Avionics Handbook**, 2nd Edition, CRC Press LLC 2007.
3. Brain Kendal, **"Manual of Avionics**", The English Book House, 3rd Edition, New Delhi, 1993.
4. Collinson RPG, **Introduction to Avionics**, Second Edition, Kluwer Academic Publishers, Chapman & Hall, 2003.
5. Don Middleton., **Avionic Systems**(Longman Aviation Technology Series), Longman, 1989

B19MT5062	Python Programming	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

C Programming

Course Objectives:

1. To understand why Python is a useful scripting language for developers.
2. To learn how to design and program Python applications.
3. To learn how to use lists, tuples, and dictionaries in Python programs.
4. To learn how to identify Python object types.

Course Outcomes:

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

1. Implement a given algorithm as a computer program (in Python).
2. Adapt and combine standard algorithms to solve a given problem (includes numerical as well as non-numerical algorithms).
3. Adequately use standard programming constructs: repetition, selection, functions, composition, modules, aggregated data (arrays, lists, etc.)
4. Use library software for (e.g.) building a graphical user interface, web application, or mathematical software

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 5062	CO1	3	2	3	3	3	1				3	1	3	3	1	
	CO2	3	3	3	3	3	1				3	1	3	3	2	1
	CO3	3	3	3	3	3	1				3	1	3	3	2	1
	CO4	2	3	3	3	3	1				3	1	3	3	3	3

Course Contents:

UNIT -I: Introduction and Function [9 Hrs]

Statements, expressions, variables, understand the structure of this class, explore Python as a calculator.

Functions, logic, conditionals, learn the basic constructs of Python programming, create a program that plays a variant of Rock –Paper-Scissors

UNIT -II: Programming [9 Hrs]

Event –Driven programming, Local/global variables, Learn the basics of event driven programming, understand difference Local and global variables, create an interactive program that plays a simple guessing game.

UNIT -III: Canvas [9 Hrs]

Canvas, drawing, timers, Create a canvas in Python, learn how to draw on the canvas, create a digital stopwatch.

UNIT -IV: Modelling [9 Hrs]

Lists, keyboard input, the basics of modelling motion, Learn the basics of lists in python, model moving objects in python ,recreate the classic arcade game" Pong".

Text Books:

1. Allen B. Downey, **Think Python**, second edition, O'Reilly, Sebastopol, California. *Online Version:www.greenteapress.com/thinkpython2.pdf.*
2. Brad Miller and David Ranum, How **to think like a computer Scientist**, *Online Version:www.interactivepython.org/runstone/static/thinkscpy/index.html.*

B19MT5063	Data Communication Networking	SC	L	T	P	C	Hrs /week

Duration:14 Wks			**3**	**0**	**0**	**3**	**3**

Prerequisites:

Course Objectives:

1. Build an understanding of the fundamental concepts and the underlying basic principles of computer communication networks through the discussion on existing protocols and standards.
2. Familiarize the student with the basic taxonomy and terminology of the computer networking.
3. To understand OSI and TCP/IP layered models with Internet perspective.
4. Learn about data link layer protocols, Network layer addressing formats, transport layer and application layer protocols

Course Outcomes:

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

1. Understand the fundamentals of data communication and communication networks in terms of OSI and TCP/IP perspective.
2. Differentiate noisy channel protocols at the Data link protocol and Study of different media access protocols.
3. Discuss IPv4 and IPv6 addresses.
4. Appreciate and interpret various protocols in transport layer and application layer.

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
B19MT 5063	**CO1**	**1**	**2**	**1**	**2**								**2**	**2**	**2**	**2**
	CO2	**1**	**1**	**2**	**1**								**2**	**2**	**2**	**2**
	CO3	**1**	**2**	**3**	**2**								**2**	**1**	**2**	**2**
	CO4	**2**	**2**	**2**	**2**								**2**	**1**	**1**	**2**

Course Contents:

Unit-I: Introduction to Data Communication and Networking [9 Hrs]

Introduction: Data Communications, Networks, The Internet, Protocols and Standards, Layered tasks, OSI Model, Layers in the OSI Model, TCP/IP protocol Suite, Addressing.

UNIT-II: Noisy Channel Protocols and Multiple Access. [9 Hrs]

Noisy Channels Protocols: Stop and Wait Automatic Repeat Request, Go-Back-N Automatic Repeat Request, And Selective Repeat Automatic Repeat Request. (Only Block diagram and flow diagram approach). Multiple Access: Random access, Controlled access, Channelization.

UNIT -III: Network Layer. [9 Hrs]

Network Layer: Logical addressing, Ipv4 addresses, Ipv6 addresses, Internetworking, Ipv4 Header Format, IPv6 Header Format, and Transition from Ipv4 to Ipv6.

UNIT-IV: Transport Layer and Application Layer [9 Hrs]

Process to Process Delivery, UDP, TCP, Remote Logging, Electronic Mail and File Transfer.

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.

B19MT5064	Mobile Application Development	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Fundamentals of Programming

Course Objectives:

1. Learn to setup Android application development environment
2. Illustrate user interfaces for interacting with apps and triggering actions
3. Interpret tasks used in handling multiple activities
4. Identify options to save persistent application data
5. Appraise the role of security and performance in Android applications

Course Outcomes:

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

1. Create, test and debug Android application by setting up Android development environment

2. Describe user experiences and Background Tasks.
3. Demonstrate methods in storing, sharing and retrieving data in Android applications
4. Analyze performance of android applications and understand the role of permissions and security

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 5064	CO1	1	1	2	2								2	1	1	1
	CO2	1	1	2	1								2	2	2	2
	CO3	1	2	2	2								2	1	2	2
	CO4	2	2	2	2								2	1	1	2

Course Contents:

UNIT -I: Introduction and factors in Developing Mobile Applications [9 Hrs]

Introduction to Mobile Computing, Introduction to Android Development Environment, Get started, build your first app, Activities, Testing, debugging and using support libraries. Mobile Software Engineering, Frameworks and Tools, Generic UI Development, Android User, User Interaction, Delightful user experience, Testing your UI.

UNIT-II: User experience and Background Tasks [9 Hrs]

More on UIs: VUIs and Mobile Apps, Text-to-Speech Techniques, Designing the Right UI Multichannel and Multimodal UIs.

Working in the background: Background Tasks, Triggering, scheduling and optimizing background tasks

UNIT-III: All about data and Communication [9 Hrs]

Preferences and Settings, storing data using SQLite, sharing data with content providers, loading data using Loaders

Communications Via Network and the Web and Multimedia: State Machine, Correct Communications Model, Android Networking and Web, Multimedia, Mobile Agents and Peer-to-Peer Architecture, Android Multimedia

UNIT-IV: What's Next? [9 Hrs]Putting It All Together, Packaging and Deploying, Performance Best Practices, Android Field Service App, Permissions, Performance and Security, Active Transactions, More on Security, Hacking Android, Firebase and AdMob, Publish, Platforms and Additional Issues, Development Process, Architecture, Design, Technology Selection, Mobile App Development Hurdles, Testing.

TEXT BOOKS:

1. Google Developer Training, "**Android Developer Fundamentals Course – Concept Reference",** Google Developer Training Team, 2017.https://www.gitbook.com/book/google-developer-training/android-developerfundamentals-course-concepts/details (Download pdf file from the above link)

REFERENCES:

1. Erik Hellman, **"Android Programming – Pushing the Limits",** 1st Edition, Wiley India, Pvt Ltd, 2014.
2. Dawn Griffiths and David Griffiths, **"Head First Android Development",** 1st Edition, O'Reilly SPD Publishers, 2015.
3. J F DiMarzio, **"Beginning Android Programming with Android Studio",** 4th Edition, Wiley India Pvt Ltd, 2016. ISBN-13: 978-8126565580
4. Anubhav Pradhan, Anil V Deshpande, **"Composing Mobile Apps"** using Android, Wiley 2014, ISBN: 978-81-265-4660-2

B19MT5065	Sensors and Actuators	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Applied Physics, Basic Electrical and Electronics Engineering

Course Objectives:

1. Understanding basic laws and phenomena on which operation of sensors and actuators-transformation of energy is based.
2. Introduce sensors (analog and digital) for measuring of position, force, displacement and other mechanical entities and temperature.

Course Outcomes:

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

1. Elucidate working principles and architecture of a large number of sensors and their elements.
2. Chose and use sensors and equipment for measuring mechanical quantities and temperature.
3. Demonstrate the knowledge about the architecture and working principles of the most common electrical motor types.
4. Chose and use electrical drives and actuators.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT	CO1	3	1											3		

5065	**CO2**	**3**	**2**	**2**	**3**	**2**								3	3	3
	CO3	**3**	**3**	**3**	**3**	**2**								3	3	3
	CO4	**3**	**1**	**2**	**2**	**2**								3	2	2

Course Contents:

Unit-I: Sensors [9 Hrs]

Introduction and Displacement Measurement: Sensors - Basic requirements of a sensors- Classification of sensors- Static and Dynamic characteristics of sensors- Displacement Sensors- Linear and Rotary displacement sensors-Potentiometer, Capacitive and Inductive type displacement sensor- position sensors- Optical encoder, Photoelectric sensor, Hall Effect Sensor.

Measurement of Proximity, Force and Pressure:

Eddy current proximity sensor- Inductive Proximity sensor- Capacitive Proximity sensor -Pneumatic Proximity sensors- Proximity Switches- Contact and Noncontact type – Strain Gauge – Diaphragm Pressure Sensor- Capsule Pressure sensors- Bellows Pressure Sensor- Bourdon tube pressure sensor- Piezoelectric Sensor- Tactile sensor.

Unit-II: Sensors (continued) [9 Hrs]

Measurement of Velocity, Flow and Level: Tachogenerator - Pyroelectric sensors - Ultrasonic sensor – Resistive sensor- Pitot tube – Orifice plate - flow nozzle- Venturi tubes – Rotameter- Electromagnetic flow meter. Float level sensor- Pressure level sensor- Variable capacitance sensor.

Measurement of Temperature, Motion and Light Sensors: Thermocouples- Thermistors - Thermodiodes - Thermo transistors- Bimetallic Strip- Resistance Temperature Detector- Infrared Thermography. Vibrometer and accelerometer- seismic accelerometer. Photo resistors -Photodiodes - Phototransistors- Photoconductors.

Unit-III: Actuators [9 Hrs]

Actuators in motor vehicles, power switches, electrical rotary and linear actuators. Electro-pneumatic and electro-hydraulic actuators for motor vehicles, pumps and valves. Reliability of actuators used in motor vehicles, identification of actuator faults.

Unit-IV: Micro Sensors and Actuators [9 Hrs]

Micro Sensors: Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors.

Micro Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezo effect, other principles.

Text Books:

1. De Silva, Clarence W. **Sensors and actuators**: Engineering system instrumentation. CRC Press, 2015.

Reference Books:

1. Kaltenbacher, Manfred. **Numerical simulation of mechatronic sensors and actuator**s. Vol. 2. Berlin: Springer, 2007.
2. Ida, N. "**Sensor, Actuators and their Interfaces: A Multidisciplinary Introductions**. (1st eds)." SciTech, Edison, NJ (2014).

B19MT5070	CNC Lab	HC	L	T	P	C	Hrs /week
Duration:14 Wks			0	0	2	2	3

Prerequisites:

CAED, Computer Graphics, Machine Tools

Course Objectives:

1. Understand the concept of CNC machines
2. Understand and analyse the CNC part programming on Lathe and Milling operations.

Course Outcomes:

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

1. Understand the concept CNC Machines.
2. Understand, remember and practice CNC Simulation Software.
3. Understand and practice of CNC Turning center and milling center basic operations.
4. Prepare and apply the concept of CNC turning and milling operations on production models.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 5070	CO1	3	3	3		2			3	3	3			3	1	
	CO2	2	1	1							3			3	1	1

	CO3	**2**	**2**	**1**		**2**					**3**			**3**	**1**	
	CO4	**2**	**3**	**1**		**2**					**3**			**3**	**1**	

Course Contents:

CNC, Part Programming using CAM packages, simulation of Turning, Drilling and milling operations. Simulations to be carried out using simulation packages like Master CAM, Edge CAM, Cadem , MTAB or any equivalent software.

1. Develop a part programme for Plain turning, Step turning, Facing, Drilling, Grooving, Taper turning, Thread cutting, Boring, Tapping and simulate.
2. Develop a part programme for combined turning centre operations and simulate (combined operation models)
3. Develop a part programme on milling centre for Square slot, triangular slot and rectangle slot cutting and simulate.
4. Develop a part programme on milling centre for contouring operations and simulate.
5. Develop a part programme on milling centre for drilling on component by using canned cycles and simulate
6. DEMO of Flexible Manufacturing System

B19MT5080	**Data Acquisition System Lab**	**HC**	**L**	**T**	**P**	**C**	**Hrs /week**
Duration:14 Wks			**0**	**0**	**2**	**2**	**3**

Prerequisites:

Analog and Digital circuits

Course Objectives:

1. To collect the data of system and analysis of data collected
2. Introduce the process of making measurement of physical event and storing them in some logical fashion.
3. To learn how to implement the system with hardware and software components.

Course Outcomes:

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

1. Understand concepts of data acquisition system.
2. Create virtual instruments using LabVIEW

3. Use data acquisition systems to measure physical quantities.
4. Gain good understanding of General Purpose Interface Bus (GPIB) communication devices and drivers.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 5080	CO1	1	1	1	2								2	2	2	2
	CO2	1	1	2	1								2	2	2	2
	CO3	1	2	3	2								2	1	2	2
	CO4	2	2	2	2								2	1	1	2

Course Contents:

The following topics are covered during the semester:

1. Introduction to LabVIEW
2. LabVIEW programming
3. Building an application
4. Instrument drivers
5. Writing a DAQ program
6. Process control application
7. Physical application

The following are the laboratory projects that students perform during the semester:

1. Creating a virtual instrument (VI) and sub VI.
2. Use While, For Loops, and a waveform chart for acquiring data in real time.
3. Create a VI that takes a number representing degree Celsius and convert it to a number representing degree Fahrenheit. Also, use thermocouple to monitor the real time temperature.
4. Build a VI that uses the formula node to evaluate a complex mathematical expression and graph the results.
5. Build a VI that illustrated the concept of case structure.

Sixth Semester

B19MT6010	Process Automation	HC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Knowledge of Basic Electrical & Electronics.

Course Objectives:

1. Explore the concept of automation in uplifting of Industries.
2. Imparting the importance of PLC, SCADA and robots in automation.
3. Introduce different industrial automation techniques.

Course Outcomes:

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

1. Draw block diagram of industrial automation and control system.
2. Explain architecture of industrial automation system.
3. Use programmable logic controllers for industrial automation.
4. Draw block diagram of supervisory control and data acquisition (SCADA).
5. Use Internet of Things for industrial automation.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 6010	CO1	2	2	2	2									2	3	2
	CO2	3	2	3	2									2	3	2
	CO3	3	2	2	3	3								3	2	2
	CO4	3	2	3	2									2	3	3

Course Contents:

UNIT -I: Introduction and Automation Components [9 Hrs]

Introduction: Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems: modbus & profibus.

Automation Components: Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

UNIT-II: Computer Aided Measurement and Control Systems [9 Hrs]

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software and Computer based data acquisition system, Internet of things (IoT) for plant automation.

UNIT -III: Programmable Logic Controllers [9 Hrs]

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

UNIT -IV: Distributed Control System with industrial Robots [9 Hrs]

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

Overview of Industrial automation using robots: Basic construction and configuration of robot**,** Pick and place robot, Welding robot.

Text Books:

1. M. P. Groover, **Automation, Production Systems and Computer Integrated Manufacturing,** Pearson education. Third Edition, 2008
2. Vajpayee **Principles of CIM,** PHI.

Reference Books:

1. Amber G.H & P. S. Amber, **Anatomy of Automation**, Prentice Hall.
2. Viswanandham, **Performance Modeling of Automated Manufacturing Systems,** PHI.
3. Krishna Kant, **Computer Based Industrial Control**, EEE-PHI
4. S.K. Singh**, Industrial Instrumentation and Control**, The McGraw Hill Companies
5. . C.D. Johnson, **Process Control Instrumentation Technology**, PHI
6. Parr, Newnem ,**Industrial control handbook**.

B19MT6020	Design of Machine Elements	HC	L	T	P	C	Hrs /week
Duration:14 Wks			4	0	0	4	4

Prerequisites:

Mechanics of Materials, Kinematics of Machines, Modelling Lab

Course Objectives:

1. To gain knowledge of theories of failures, stress concentration and machine elements.
2. To understand the techniques in machine elements.
3. To determine the parameters of machine elements subjected to various load condition.
4. To design of various machine elements

Course Outcomes:

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

1. Describe of theories of failures, stress concentration, power screws, shafts, keys, couplings, gears, and springs.
2. Select the mechanical joints for an application.
3. Calculate the stresses, parameters of machine elements subjected to various loads also make proper assumptions with respect to material, FOS for various machine components.
4. Design machine elements like power screws, shafts, keys, couplings, gears, and springs

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 6020	CO1	3	3	2	1		1							3	3	3
	CO2	3	3	1	1		1							3	3	3
	CO3	3	3	2	1		1							3	3	3
	CO4	3	3	2	1		1							3	3	3

Course Contents:

UNIT -I: Introduction and Theories of failure [9 Hrs]

Introduction: Machine design, classification of machine design, design consideration, Tri axial stresses, Stress Tensor. Codes and Standards. Factor of Safety, design procedure for simple and combined stresses (No Numerical), Introduction to Stress Concentration, Stress concentration Factor and its effects, (Simple problems).

Introduction to Theories of failure: Maximum Normal Stress Theory, Maximums shear Stress Theory, Distortion Energy Theory (Simple Problems)

UNIT-II: Design of Keys, Couplings and Joints and **Power Screws [9 Hrs]**

Design of Keys, Couplings and Joints: Keys: Types of keys, Design of keys, Design of Couplings: Flange coupling, Design of cotter and knuckle joint.

Power Screws: Stresses in Power Screws, Efficiency and Self-locking, Design of Power Screw, Design of Screw Jack.

UNIT -III: Design of Shafts and springs [9 Hrs]

Design of Shafts: Design for strength and Rigidity with Steady loading, ASME & BIS codes for Power Transmission shafting, Simple Numerical

Design of springs: Types of springs - stresses in Helical coil springs of circular cross sections. Tension and compression springs only.

UNIT -IV: Design of Gears **[9 Hrs]**

Design of Spur Gears: Beam strength of spur gear, Stresses in gear teeth (Lewis equation), dynamic tooth load, and design for wear.

Design of Helical Gears: Beam strength of helical gear, Stresses in gear teeth (Lewis equation), dynamic tooth load, and design for wear.

Text Books:

1. Joseph E Shigley and Charles R. Mischke, **Mechanical Engineering Design**, McGraw Hill International edition, 6thEdition 2009.
2. V.B. Bhandari, **Design of Machine Elements**, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 3rdEdition 2010.
3. Dr. P C Sharma and Dr. D K Aggarwal, **Machine Design**, S. K. Kataria& Sons, 11th Edition 2009.

Reference Books:

1. Robert L. Norton, **Machine Design,** Pearson Education Asia, 2001.
2. M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V.Venkatesh, **Design of Machine Elements**, Pearson Education, 2006.
3. Hall, Holowenko, Laughlin (Schaum's Outlines series),**Machine Design**, Adapted by S.K. Somani, TataMcGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.

B19MT6030	Digital Signal Processing	HC	L	T	P	C	Hrs /week
Duration:14 Wks			3	1	0	4	5

Prerequisites:

Signals and Networks

Course Objectives:

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. Describe the concept of linear filtering Technique.
5. Demonstrate FIR & IIR filters for digital filter structures.

Course Outcomes:

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

1. Apply the DFT for the analysis of digital signals
2. Explain the different properties of DFT and Compute DFT using FFT algorithms

3. Design and analyze DSP systems like IIR and FIR filters
4. Appraise the concepts of hardware interface.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 6030	CO1	3	2	1	1										2	3
	CO2	3	3	2	1										2	
	CO3	3	2	1	1											3
	CO4	1	2					3		1	2	3	3	3		

Course Contents:

UNIT -1: Discrete Fourier Transforms and its Properties [12 Hrs]

The Discrete Fourier Transform (DFT), The Properties of the DFT: Periodicity, Linearity, and Symmetry Properties, Multiplication of two DFTs and Circular Convolution, Additional DFT Properties.

UNIT-2: Design of IIR Filters [12 Hrs]

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-3: Design of Fir Filters and Digital Filter Structures [12 Hrs] 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.

UNIT-4: DSP Architectures [12 Hrs]

Introduction, DSP System Architectures, Standard DSP Architectures, Ideal DSP Architectures, Multiprocessors and Multicomputer, Systolic Arrays, Wave Front Arrays, Shared-Memory Architectures.

Text Books:

1. Proakis & Monalakis, **Digital signal processing – Principles Algorithms & Applications**, PHI, 4th Edition, New Delhi, 2007.
2. Lars Wanhammar "**DSP Integrated circuits**", Academic Press, San Diego, Second Edition, 1999.

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.

B19MT6041	Refrigeration and Air Conditioning	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Thermal Engineering

Course Objectives:

1. To enable the students to gain knowledge of refrigeration and air conditioning.
2. To acquire the concept of refrigerants and their effects
3. To teach students the principles of psychrometry
4. To teach the students compute the cooling load for different applications of Refrigeration and Air-conditioning
5. To develop the knowledge of students in selecting the right equipment for a particular application of Refrigeration and Air-conditioning.
6. To expose the students to field of refrigeration and air conditioning, so that they can get an opportunity to work in R&AC industries.

Course Outcomes:

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

1. Apply the concept of various types of refrigeration and air conditioning systems
2. Choose suitable refrigerants and equipment's for a particular application
3. Evaluate the amount of heat load and cooling requirement for general and simple application.
4. Demonstrate the knowledge on general and commercial devices like water coolers, refrigerator, simple air conditioners and centralized system.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3

B19MT 6041	**CO1**	**3**	**3**	**2**			**2**	**2**					**1**	**3**		
	CO2	**2**	**3**				**2**	**2**	**2**					**3**	**2**	**2**
	CO3	**3**	**3**						**3**					**3**	**3**	
	CO4	**2**	**3**					**2**	**1**					**2**	**1**	

Course Contents:

UNIT -1: Refrigeration Cycles and System [9 Hrs]

Methods of refrigeration, Brief discussion about Vapour compression refrigeration cycles and actual vapour compression cycle (detail discussion) Air refrigeration cycles (In brief)-Aircraft refrigeration system- various types- numerical on aircraft refrigeration system. Vapour absorption systems-COP of the system-Lithium bromide, three fluid vapour absorption systems, and simple numerical.

UNIT-2: Refrigerants and Refrigeration Components [9 Hrs]

Refrigerant classification–primary and secondary refrigerants. Designation—Detail discussion about selection of refrigerants, CFC'S, HCFC's and HFC's. Alternate refrigerants, Refrigerant absorbent combinations for vapor absorption system, Refrigerant compressors, Reciprocating, Rotary type, Condensers, Evaporators, Expansion devices, Low side-high side float, low pressure and high pressure cut outs, solenoid valves.

Self-Study: Global warming and Ozone depleting aspects.

UNIT -3: Psychrometry and Load Estimation [9 Hrs]

Review of Moist air properties-various psychrometric process, Load estimation-comfort chart-SHF-GRSHF-ERSHF, cooling load estimate, heating load estimate, solar heat gain, infiltration, internal heat gain, Numerical on load estimation.

UNIT -4:Air-conditioning Equipment'sand Application of R and AC [9 Hrs]

Package unit, central unit. Air distribution system- principles- air handling system, ducts and its arrangements, filters, fans, room air distribution- supply air outlets.

Food preservation-necessary-food freezing- various types, cold storage plants, Domestic refrigerator-construction and working and maintenance, Water coolers-storage type and pressure type, Dessert cooler, Window air conditioners, split air conditioners.

Self-Study: Design and installation of Centralized air conditioning system for Hospital/Hotel/commercial complex/Software Company etc.

Text Books:

1. S. C. Arora and Dumkundwar, , **Refrigeration and Air-Conditioning**, Dhanpathrai Publishers (1996)
2. R K Rajput "**Refrigeration and Air conditioning**" second edition, S K kataria and sons

Reference Books:

1. Manohar Prasad, **Refrigeration and Air conditioning**, Wiley Eastern Ltd. (1998)
2. Arora, C. P., **Refrigeration and Air Conditioning**, Tata McGraw-Hill Publishing Company Ltd. (2007)
3. W. F. Stocker and J. W. Jones, **Refrigeration and Air conditioning**, McGraw Hill. (2002)

B19MT6042	Composite Materials	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Material Science and Technology

Course Objectives:

1. To classify the composite materials, highlight their applications in key areas
2. To provide a detailed understanding of metal matrix composites including types, application, fabrication and properties.
3. To provide thorough knowledge on ceramic matrix composites including, types, application, fabrication and properties
4. To provide a detailed understanding of polymer matrix composites including types, application, fabrication and properties.

Course Outcomes:

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

1. Classify the composites based on applications.
2. Describe the types and characteristics of Metal Matrix Composites
3. Describe the types and characteristics of Ceramic matrix composites.
4. Describe the types and characteristics of Polymer Matrix Composite.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3

B19MT 6042	**CO1**	**2**	**2**	**1**										**3**	**3**	**3**
	CO2	**2**	**2**	**3**	**3**	**1**	**1**							**3**	**3**	**3**
	CO3	**2**	**2**	**3**	**3**	**1**								**3**	**3**	**3**
	CO4	**2**	**2**	**3**	**3**	**1**								**3**	**3**	**3**

Course Contents:

UNIT–I: Composite Materials [9 Hrs]

Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites, particulate composites. Advantages, dis-advantages and Application of Composites in Automobile, Aircrafts. Missiles. Space hardware, Electrical and electronics, Marine, and sports equipment, future potential of composites.

UNIT–II: Metal Matrix Composites [9 Hrs]

Metal Matrix Composites: Reinforcement materials, types, characteristics and selection base metals. Need for production MMC's and its properties.

Fabrication Process For MMC's: Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques.

UNIT-III: Ceramic Matrix Composites [9 Hrs]

Ceramic Matrix Composites: Reinforcement materials, types, characteristics and selection base materials. Need for production CMC's and its properties.

Fabrication Process For CMC's: hot pressing-reaction bonding process-infiltration technique, direct oxidation- interfaces.

UNIT–IV: Polymer Matrix Composites [9 Hrs]

Polymer Matrix Composites: Reinforcement materials, types, characteristics and selection base material, Need for production of PMC's and its properties.

Fabrication Process of PMC's: Hand lay-up, spray technique, filament winding, Pultrusion, Resin Transfer Molding (RTM)-, bag molding, injection molding, Sandwich Mould Composites (SMC).

Text Books:

1. K. K. Chawla **Composite Science and Engineering**, Springer Verlag 1998.
2. Autar K. Kaw **Mechanics of composite materials**, CRC Press New York.

Reference Books:

1. P. K. Mallick, **Fiber Reinforced Composites**, Marcel Dekker,Inc
2. Robert M. Jones, **Mechanics of Composite Materials,** McGraw Hill Kogakusha Ltd.1998
3. Meing Schwaitz," **Composite Materials Hand Book**, McGraw Hill book company.1984
4. Ronald F. Gibron. **Principles of Composite Material Mechanics**, McGraw Hill international, 1994.

5. Madhujit Mukhopadhyay, **Mechanics of Composite Materials and Structures,** Universities Press 2009

B19MT6043	Rapid Prototyping	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

None

Course Objectives:

1. To learn the fundamentals of Rapid prototyping and related concepts to understand the various materials used in the techniques.
2. To minimize sustaining engineering changes
3. To extent product life time by adding necessary features and eliminating redundant features early in the design.
4. To have a hands on experience on various tools used for modeling and manufacturing aspects of RP
5. To understand the role of rapid prototyping and rapid tooling.
6. To study about the programming aspects by using machine code languages for various operations using sophisticated software's (Manual and computer aided part programming)

Course Outcomes:

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

1. Justify the needs of additive manufacturing technology and differentiate b/w conventional approach.
3. Explain the concept of data processing for additive manufacturing technology for development, tooling and production.
4. Illustrate the process of concept modeler - three dimensional printing.

Mapping of Course Outcomes with Programme Outcomes

Course	POS/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO	PO	PO	PSO	PSO	PSO

Code	COs										10	11	12	1	2	3
B19MT 6043	CO1	2	1	1										3	1	1
	CO2	2	1	1										3	1	1
	CO3	2	1	1										3	1	1
	CO4	2	1	1										3	1	1

Course Contents:

UNIT- I: Introduction and SLA [9 Hrs]

Definition of RP, Prototypes, Types of prototypes, roles of prototypes, Need for the compression in product development, Impact of Rapid prototyping in product development, history of RP systems, Survey of applications,industryandclassificationofRPsystems,Basicmethodologyof RP, Benefits and limitations.

Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data filesand machine details, Application.

UNIT -II: Techniques of RP [9 Hrs]

Solid Ground Curing: Principle of operation, Machine details, Applications

Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications.

Fusion Deposition Modeling: Principle, Process parameter, Path generation, Applications.

Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.

UNIT -III: Concept Modelers and Rapid Tooling [9 Hrs]

Concepts Modelers: Principle, Thermal jet printer, Sander's model maker, 3-Dprinter, object Quadra systems.

Rapid Tooling: Indirect Rapid tooling, Silicon rubber tooling, Aluminium filled epoxy tooling,Spray metal tooling, 3D keltool etc. Direct Rapid Tooling, Quick cast process, Copper polyamide, Rapid Tool, DMILS, , Sand casting tooling, Laminate tooling soft Toolings .hard tooling.

Software for RP: STL files, Overview of Solid view, magic's, Mimics, magic communicator etc. Internet based manufacturing

UNIT -IV: Process Optimization and Reverse Engineering [9 Hrs]

Process Optimization: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.

Reverse Engineering: surface digitizing, Surface generation from point cloud data, surface modification–data transfer to solid models. Detail application with respect to Aerospace, medical, and automobile industry.

Text Books:

1. Paul F. Jacobs **Stereo Lithography and other RP & M Technologies**, SME, NY 1996.
2. Pham D.T & Dimov, S.S Verlog **Rapid Manufacturing**, S.SVerlog London 2001

Reference Books:

1. Terry Wohlers **Rapid Prototyping**, Wohler's Report 2000" Wohler's Association 2000.
2. Gurumurthi, **Rapid Prototyping Materials**, IISc Bangalore
3. Lament wood. **Rapid Automated**, Indus press New York

B19MT6044	Nonconventional Machining Processes	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Manufacturing Process

Course Objectives:

1. To describe the principles of material removal mechanism of advanced machining processes such as mechanical, electro-chemical and thermal.
2. To explore in-depth knowledge in selection of advanced machining process to fabricate intricate and complex shapes in difficult to machine material.
3. To develop awareness of advanced finishing processes to achieve submicron/nano surface finish.
4. To acquire the knowledge of the applications of Radiant energy processes in various fields.

Course Outcomes:

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

1. Identify and suggest the suitable manufacturing process for advanced materials and critical finishing.
2. Customize the machining parameters for components used in aircraft applications
3. Apply the knowledge of various factors influencing the processes and their applications.
4. Examine the sophisticated and advanced equipment such as LBM, EBM for its operation.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3

B19MT 6044	**CO1**	**2**	**3**	**1**		**2**								**2**	**2**	
	CO2	**3**	**2**	**1**		**2**								**3**	**2**	
	CO3	**2**	**1**			**3**								**2**	**2**	
	CO4	**2**	**2**			**2**								**2**	**1**	

Course Contents:

UNIT– I: Ultrasonic Machining [9 Hrs]

Importance of NTM, History, Classification, Need and comparison between conventional and Non-conventional machining process.

Ultrasonic Machining: equipment, tool materials & tool size, abrasive slurry, Effect of process parameters: Effect of amplitude and frequency and vibration, Effect of abrasive grain diameter, effect of applied static load, effect of slurry, tool & work material. Applications, Advantages & Disadvantages of USM.

Water Jet Machining: Principal, Equipment, Operation, Application, Advantages and limitations of water Jet machinery

UNIT– II: Abrasive Jet Machining and Electrochemical Machining Process [9 Hrs]

Abrasive Jet Machining: Equipment, Variables in AJM: Carrier Gas, Type of abrasive, size of abrasive grain, velocity of the abrasive jet, mean number, abrasive particles per unit volume of the carrier gas, work material, standoff distance (SOD), nozzle design, shape of cut. Applications, advantages & Disadvantages of AJM.

Electro Chemical Machining: study of ECM machine, elements of ECM process. Cathode tool, Anode work piece, source of DC power, Electrolyte, chemistry of the process, ECM Tooling, Electrolyte flow arrangement, Advantages and Limitations.

UNIT–III: Chemical Machining Process and Electric Discharge Machining [9 Hrs]

Chemical Machining –Steps in CHM, process characteristics of CHM: material removal rate, accuracy, surface finish, Hydrogen embrittlement, advantages & application of CHM.

Electric Discharge Machining: Principle, Construction and Mechanism of metal removal, Electrode feed mechanism, Dielectric fluid, Tool materials in EDM, EDM process characteristics: metal removal rate, accuracy, surface finish, Applications, advantages & Disadvantages of EDM.

UNIT– IV: Plasma Arc Machining, LBM and EBM Processes [9 Hrs]

Plasma Arc Machining: Introduction, equipment, non-thermal generation of plasma, selection of gas, Mechanism of metal removal, PAM parameters, process characteristics. Safety precautions, Applications, Advantages and limitations.

Laser Beam Machining: Introduction, equipment of LBM mechanism of metal removal, LBM parameters, Process characteristics, Applications, Advantages & limitations.

Electron Beam Machining: Principles, equipment, operations, applications, advantages and limitation of EBM

Text Books:

1. Pandey and Shan, **Modern Machining Process**, Tata McGraw Hill 2000
2. Bhattacharya **New Technology**, 2000

Reference Books:

1. HMT Production **Technology**, Tata McGraw Hill. 2001
2. Aditya, **Modern Machining Process** 2002
3. P.K.Mishra, **Non-Conventional Machining**, The Institution of Engineers (India) Test book series, Narosa Publishing House –2005.
4. Joseph R. Davis (Editor), **Metals Handbook: Machining Volume 16**, American Society of Metals (ASM).

B19MT6045	Machine Learning Using Python Programming	SC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	1	3	4

Prerequisites:

Python Programming

Course Objectives:

1. To Describe the basic concepts of Python
2. To Identify the fundamental problems of machine learning
3. To Collect basic knowledge of the key algorithms and theory that form the foundation of machine learning
4. To Describe the techniques, mathematical concepts, and algorithms used in machine learning to facilitate further study in this area
5. To examine the limitations of various machine learning algorithms and the way to evaluate performance of machine learning algorithms.

Course Outcomes:

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

1. Describe the basic concepts of Python and ML
2. Differentiate between different types of supervised learning.
3. Describe unsupervised learning.
4. Apply Reinforcement Learning to case studies.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3

B19MT 6045	**CO1**	**3**	**3**	**2**	**2**							**3**	**2**	**2**	**3**
	CO2	**3**	**3**	**2**	**1**							**3**	**2**	**2**	**2**
	CO3	**3**	**2**	**1**	**1**							**3**	**1**	**2**	**3**
	CO4	**1**	**2**	**3**	**3**							**3**	**3**	**2**	**2**

Course Contents:

UNIT –I: Python and Overview of ML [12 Hrs]

Python: Origin, Programming Basics, data types and Operators, Program Files, Directories, Changing Data Through Names, Copying Data, Accessing a Tuple through another Tuple, packages and libraries.

Overview of ML, broad categories of Machine learning- Supervised, Unsupervised, Semi-supervised, and Reinforcement Learning, Applications areas of Machine Learning. Examples and Case studies

UNIT –II: Supervised Learning [12 Hrs]

Introduction, Classification and Linear Regression, k-Nearest Neighbor, Linear models, Decision Trees, Naive Bayes Classifiers, Kernelized Support Vector Machine (SVM) Algorithm. Neural Networks (deep learning), Comparison of different algorithms, discussions on case studies.

UNIT –III: Unsupervised Learning [12 Hrs]

Introduction, types and challenges, preprocessing and scaling of datasets, Dimensionality reduction, feature extraction. Principal Component Analysis (PCA), k-means, agglomerative, and DBSCAN clustering algorithms. Comparison of different cluster algorithms, discussions on Case studies.

UNIT –IV: Reinforcement Learning [12 Hrs]

Introduction, the learning task, Q learning –function, convergence, & updating sequence, rewards and actions, relationship to dynamic programming, discussions on Case studies.

Text Books:

1. Andreas C Muller & Sarah Guidp **Introduction of Machine Learning with Python** –O'Reilly & Shroff publishers
2. **Introducing Python**, Oriely Publications (chapters 1-6)
3. Tom M Mitchell **Machine Learning** – McGraw Hill Education publication – 2013

Reference Books:

1. Peter Flach **Machine Learning: The Art and Science of algorithms** –– Cambridge University Press
2. Ethem Alpaydin **Machine Learning** – PHI learning private limited
3. David barber **Bayesian Reasoning and Machine Learning** - Cambridge University Press
4. Christopher Bishop, **Pattern Recognition and Machine Learning**, Springer, 2006
5. Olivier Chapelle, Bernhard Sch¨olkopf, and Alexander Zien **Semi-Supervised Learning**- The MIT Press Cambridge

6. Trevor Hastie, Robert Tibshirani and Jerome Friedman **The Elements of Statistical Learning** – Springer 2017 publication
7. Michael Dawson **Python Programming for absolute beginners**-3rd Edition
8. IEEE Transactions on **Artificial Intelligence & Machine Learning**
9. Journal of Machine Learning Research.

B19MT6051	Artificial Intelligence for Mechatronics Systems	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Fundamentals of Mechanical Engineering, MATLAB and Simulink

Course Objectives:

1. Be familiar with the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, machine learning, knowledge acquisition and learning methods in solving particular engineering problems.
2. Identify real world problems of AI domain.
3. Write algorithms for searching techniques.
4. Describe real world problem in symbolic form.
5. Develop an expert system.

Course Outcomes:

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

1. Learn the basics and applications of artificial intelligence and categorize various problem domains, basic knowledge representation and reasoning methods.
2. Knowledge Representation and Reasoning with Uncertain Knowledge.
3. Understand the planning and Decision Making
4. Acquire knowledge about the architecture of an expert system and design new expert systems for real life applications

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 6051	CO1	3	3	2	2								2	2	2	3
	CO2	3	3	2	2								2	2	2	2
	CO3	2	2	2	2								2	1	2	3
	CO4	2	2	3	3								2	3	2	2

Course Contents:

UNIT-I: Introduction to AI and Problem solving through Search [09Hrs]

AI task domain, problem representation in AI, Problem characteristics. Game playing using AI.**Searching Strategies:** forward and backward, state-space, blind, heuristic, problem reduction, A, A*, AO*, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, sample applications.

UNIT-II: Knowledge Representation and Reasoning [09 Hrs]Ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications.

Representing and Reasoning with Uncertain Knowledge: probability, connection to logic, independence, Bayes rule, Bayesian networks, probabilistic inference, sample applications.

UNIT-III: Planning and Decision Making [09 Hrs]

Planning: planning as search, partial order planning, construction and use of planning graphs

Decision-Making: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications.

Case study: **Design and Deploy Control Algorithm for Mechatronic System**

- Modelling & Simulation of Multi-domain systems (Mechanical & Electrical)
- Predict and optimize system performance
- Design and tuning of Control System
- Verify and test mechatronic systems such as motor control, battery management using fewer hardware prototypes.
- Eliminate manual coding errors by automatically generating code from the simulation model

UNIT-IV: AI Tools [09 Hrs]

Expert System Shells, Explanation, and Knowledge Acquisition. Human expert behaviour, Expert system components, structure of expert system, the production system, how expert system work and Expert system development for particular application.

Natural language processing: Introduction, Syntactic Processing, Semantic Analysis, Discourse and Pragmatic Processing. Architectures and functions in ANN, various learning rules. Building an ANN. Building an Expert System.

Case study: Architecture of an expert system, existing expert systems like MYCIN, RI, Expert system shells.

Text Books:

1. Rich E., **Artificial Intelligence**, Tata McGraw Hills (2009).
2. George F. Luger, **Artificial Intelligence: Structures and Strategies for Complex Problem Solving**, Pearson Education Asia (2009).

Reference Books:

1. Patterson D.W, **Introduction to AI and Expert Systems**, Mc GrawHill (1998).
2. Shivani Goel, **Express Learning- Artificial Intelligence**, Pearson Education India (2013).
3. MATLABworkshop:https://in.mathworks.com/company/events/seminars/artificial-intelligence-and-mechantronics-using-matlab-and-simulink-2679389.html

B19MT6052	PLC and SCADA	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Microcontrollers

Course Objectives:

1. Gain the Knowledge of various skills necessary for Industrial applications of PLC.
2. Understand the basic programming concepts and various logical Instructions used in PLC.
3. Solve the problems related to I/O module, Data Acquisition System and Communication Networks using Standard Devices.
4. Design and analysis of general structure of an automated process for real time applications using PLC and SCADA

Course Outcomes:

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

1. Have knowledge of Programmable Logic Controller domain on various Logical Operation and Various Advanced Logical Instruction, I/O Module, Sensor, Actuator, Communication and Measurement System.
2. Understand the basic programming concepts and various logical Instructions used in PLC.
3. Compute the extent and nature of electronic circuitry in PLC and SCADA including monitoring and control circuits for Communication and Interfacing.
4. Design and analyze the general structure of an automated process for real time industrial applications

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3

B19MT 6052	**CO1**	**1**	**3**	**2**	**2**							**2**	**2**	**2**	**3**
	CO2	**2**	**3**	**2**	**2**							**2**	**2**	**2**	**2**
	CO3	**2**	**2**	**2**	**2**							**2**	**1**	**2**	**3**
	CO4	**2**	**2**	**3**	**3**							**2**	**3**	**2**	**2**

Course Contents:

UNIT-I: Introduction of PLC [09 Hrs]

Definition of PLC, advantages, characteristics functions of a PLC, Chronological Evolution of PLC, Types of PLC, Unitary PLC, Modular PLC, Small PLC, Medium PLC, Large PLC, Block Diagram of PLC: Input/output (I/O) section, Processor Section, Power supply, Memory central Processing Unit: Processor Software / Executive Software, Multi asking, Languages, Ladder Language.

UNIT-II: PLC with logic gates [09 Hrs]

Bit Logic Instructions: introduction: Input and Output contact program symbols, Numbering system of inputs and outputs, Program format, introduction to logic: Equivalent Ladder diagram of AND gate, Equivalent ladder diagram of or Gate, equivalents Ladder Diagram of NOT gate, equivalent ladder diagram of XOR gate, equivalent ladder diagram of NAND gate, equivalent ladder diagram of NOR gate, equivalent ladder diagram to demonstrate De Morgan theorem. Ladder design.
Examples: Training Stopping, Multiplexer, DE multiplexers

UNIT-III: PLC Timers and Counters [09 Hrs]

On Delay and OFF delay timers, Timer-on Delay, Timer off delay, Retentive and non-retentive timers. Format of a timer instruction. PLC Counter: Operation of PLC Counter, Counter Parameters, Counters Instructions Overview Count up (CTU) Countdown (CTD).
Advanced instructions: Introduction: Comparison instructions, discussions on comparison instructions, “EQUAL” or “EQU” instruction, “NOT EQUAL” or“NEQ” instruction, “LESS THAN” or “LESS” instruction, “LESS THANOR EQUAL’or “LEQ” instruction, GREATER THAN” OR “GRT” instruction, “GREATER THANOR EQUAL TO” or “GRO” instruction, “MASKED COMPARISON FOR EQUAL” or“MEQ” instruction, “LIMIT TEST” or “LIM” instruction.

UNIT-IV: SCADA Systems [09 Hrs]

Introduction, definition and history of Supervisory Control and Data Acquisition, typical SCADA System Architecture, Communication Requirements, Desirable properties of SCADA system, Features, advantages, disadvantages and applications of SCADA. SCADA Architecture(First generation-Monolithic, Second Generation-Distributed, Third generation-Networked Architecture), SCADA systems in operation and control of interconnected power system, Power System Automation, Petroleum Refining Process, Water Purification System, Chemical Plant.

Text Books:

1. Madhuchandan Gupta and Samarjit Sen Gupta, "**PLC and Industrial application**", pernram international pub. (Indian) Pvt. Ltd., 2011.
2. Ronald L Krutz, "**Securing SCADA System**", Wiley Publication

Reference Books:

1. Gary Dunning, **"Introduction to Programmable Logic Controllers**", Thomson, 2nd Edition.
2. John W Webb, Ronald A Reis,"**Programmable Logic Controllers: Principles and Application**", PHI Learning,Newdelhi, 5th Edition
3. Stuart A Boyer, "**SCADA Supervisory Control and Data Acquisition",** ISA, 4th Revised edition

B19MT6053	Underwater Robotics	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Robotics and Vision System

Course Objectives:

1. Introduce the types, operation and application of robotic system
2. Demonstrate the maritime robotics system architecture
3. Learn the analysis of navigation and signal processing and data techniques
4. Introduce the ethical and practical considerations when deploying maritime robotic systems.

Course Outcomes:

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

1. Identify and describe the types and applications of maritime robotic systems.
2. Calculate and explain operational requirements, vehicle parameters and performance metrics used to design maritime robotics systems.
3. Summaries typical maritime robotics system architectures and demonstrate (low level) control system design.
4. Formulate and model maritime robotic system dynamics, control and multiple vehicular operations.
5. Design implement and analyses guidance, navigation and control systems for maritime robotic systems.
6. Evaluate and use typical maritime robotic system sensors, signal processing and data analysis techniques.
7. Explain the legal, ethical and practical considerations when deploying maritime robotic systems.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3

B19MT 6053	**CO1**	**1**	**3**	**2**	**2**								**2**	**2**	**2**	**3**
	CO2	**2**	**3**	**2**	**2**								**2**	**2**	**2**	**2**
	CO3	**2**	**2**	**3**	**3**								**2**	**1**	**2**	**3**
	CO4	**2**	**2**	**3**	**3**								**3**	**3**	**2**	**2**

Course Contents:

UNIT-I: System Types and Applications [09 Hrs]

An introduction to the types and applications of Maritime Robotic Systems including AUVs, ASVs, ROVs, underwater gliders and Argo floats.

System Design: Design of system architectures, calculation of operational requirements, vehicle parameters and performance metrics used in the design maritime robotics systems including vehicle power, speed, range, and cost of transport (COT).

UNIT-II: System Control [09 Hrs]

Vehicle and actuator dynamics, control objectives, controller design including brushed and brushless DC motors, pulse width modulation (PWM), hall sensors, encoders and PID controllers.

UNIT-III: Guidance and Navigation [09 Hrs]

System Guidance: Path planning algorithms and line of sight guidance strategies including artificial potential field methods, Dijkstra's and A* star algorithms.

System Navigation: Navigation strategies and sensors for maritime robotic systems including SLAM.

UNIT-IV: System Operation [09 Hrs]

Multiple vehicle operation, legal, ethical and practical considerations of maritime robotic deployment including launch and recovery of maritime robotic systems

Text Books:

1. Steven W. Moore, Harry Bohm, and Vickie Jensen. **Underwater robotics: science, design & fabrication.** Marine Advanced Technology Education (MATE) Center. 2010.
2. Wadoo, Sabiha, and Pushkin Kachroo. **Autonomous underwater vehicles: modeling, control design and simulation**. CRC Press, 2016.

Reference Books:

1. Roberts, Geoff N., and Robert Sutton, eds. **Advances in unmanned marine vehicles**. Vol. 69. Iet, 2006.
2. Antonelli, Gianluca, and G. Antonelli. **Underwater robots.** Vol. 3. Switzerland: Springer International Publishing, 2014.

B19MT6054	**Wireless Sensor Networks**	**SC**	**L**	**T**	**P**	**C**	**Hrs /week**
Duration:14 Wks			**3**	**0**	**0**	**3**	**3**

Prerequisites:

Data Communication and Networking

Course Objectives:

1. To introduce the characteristics, basic concepts and systems issues in Wireless sensor
2. networks
3. To illustrate architecture and protocols in wireless sensor networks
4. To identify the trends and latest development of the technologies in the area
5. To provide a broad coverage of challenges and latest research results related to the design
6. and management of wireless sensor networks

Course Outcomes:

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

1. Architect sensor networks for various application setups.
2. Explore the design space and conduct trade-off analysis between performance and resources.
3. Determine suitable medium access protocols and radio hardware
4. Understand the Operating Systems, Platforms and Tools for WSNs

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 6054	CO1	1	3	2	2								2	2	2	3
	CO2	2	3	2	2								2	2	2	2
	CO3	2	2	3	3								2	1	1	3
	CO4	2	2	3	3								3	3	1	2

Course Contents:

UNIT-I: Introduction to Wireless Transmission and Sensor Networks [09 Hrs]

Introduction to Wireless Sensor Networks: Introduction, Applications of Wireless Sensor Networks, WSN Standards, IEEE 802.15.4, Zigbee. Network Architectures and Protocol Stack – Network architectures for WSN, classification of WSN, protocol stack for WSN.

Wireless Transmission Technology and Systems: Radio Technology, Available Wireless Technologies Wireless Sensor Technology Sensor Node Technology, Hardware and Software, Sensor Taxonomy, WN Operating Environment

UNIT-II: MAC Protocols for Wireless Sensor Networks [09 Hrs]

Fundamentals of MAC Protocols, MAC Protocols for WSNs, Contention-Based protocols: Power Aware Multi-Access with Signaling - Data-Gathering MAC, Contention-Free Protocols: Low Energy Adaptive Clustering Hierarchy, B-MAC, S-MAC. Dissemination Protocol for Large Sensor Network.

Energy Efficiency and Power control: Need for energy efficiency and power control in WSN, passive power conservation mechanisms, active power conservation mechanisms

UNIT-III: Deployment and Configuration [09 Hrs]

Target tracking, Localization and Positioning, Coverage and Connectivity, Single-hop and Multihop Localization, Self-Configuring Localization Systems. Routing Challenges and Design Issues in Wireless Sensor Networks, Routing Strategies in Wireless Sensor Networks, Routing protocols: data centric, hierarchical, location-based energy efficient routing etc. Querying, Data Dissemination and Gathering.

UNIT-IV: Operating Systems, Platforms and Tools for WSNs [09 Hrs]

Operating System Design Issues, TinyOS, Contiki – Task management, Proto threads, Memory and IO management. Sensor Node Hardware – Tmote, Micaz, Programming Challenges, Node-level Software Platforms, Node-level Simulators, State-centric Programming.

Case study: Application of WSNs in

- Habitat Monitoring,
- Tracking Chemical Plumes,
- Smart transportation,
- Collaborative Processing

Text Books:

1. Kazem Sohraby, Daniel Minoli, Taieb Znati, **"Wireless Sensor Networks, Technology, Protocols and Applications**", Wiley, 2007
2. Feng Zhao, Leonidas. J.Guibas, **Wireless Sensor Networks**, Morgan Kaufamann Publishers 2000

Reference Books:

1. Holger Karl, Andreas Willig, **"Protocols and Architectures for Wireless Sensor Networks**", John Wiley, 2005
2. Jun Zheng, Abbas Jamalipour, **"Wireless Sensor Networks: A Networking Perspective**", Wiley, 2009.

3. Ian F. Akyildiz, Mehmet Can Vuran, "**Wireless Sensor Networks**", Wiley, 2010
4. Ibrahiem M. M. El Emary, S. Ramakrishnan, "**Wireless Sensor Networks: From Theory to Applications**", CRC Press Taylor & Francis Group, 2013
5. William Stallings, **"Wireless Communications and Networks**", Prentice Hall, 2000.

B19MT6055	System Modeling and Simulation	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Fundamentals of Mechanical Engineering, MATLAB and Simulink

Course Objectives:

1. To present several modelling methodologies that can be used for mechatronics systems.
2. To cover mathematical and graph models.
3. Software tools, such as MATLAB/Simulink and/or LABVIEW, will be used to simulate the systems and analyze the responses.
4. To introduce system identification

Course Outcomes:

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

1. Recognize modelling and identification concepts as related to mechatronics systems
2. Understand simulation tools and result analysis
3. Recognize patterns among different systems and comprehend complex models
4. Simulate industrial systems using software packages and apply modelling and simulation techniques to engineering system design
5. Identify dynamic physical systems and optimize system performance

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 6055	CO1	3	2	3	1									3	2	1
	CO2	3	3	2	1	2								3	2	1
	CO3	3	2	3	1									3	2	1
	CO4	3	2	2		3								3	2	1
	CO5	3	2	1	1									3	2	1

Course Contents:

UNIT-I: Physical Modelling [09 Hrs]

Mechanical and electrical systems, physical laws, continuity equations, compatibility equations, system engineering concept, system modelling with structured analysis, modelling paradigms for mechatronic system, block diagrams.

UNIT-II: Mathematical Models [09 Hrs]

Systems of differential-algebraic equations, response analysis of electrical systems, thermal systems, fluid systems, mechanical rotational system, electrical-mechanical coupling.

UNIT-III: Simulation Techniques [09 Hrs]

Solution of model equations and their interpretation, zeroth, first and second order system, solution of 2nd order electro-mechanical equation by finite element method, transfer function and frequency response, non-parametric methods, transient, correlation, frequency, Fourier and spectra analysis, design of identification experiments, choice of model structure, scaling, numeric methods, validation.

UNIT-IV: Modelling of Sensors and Actuators [09 Hrs]

Methods of lumped element simulation, modelling of sensors and actuators, hardware in the loop simulation (HIL), rapid controller prototyping, coupling of simulation tools, simulation of systems in software (MATLAB, LabVIEW) environment.

Modeling and Simulation of Practical Problems:

- Pure mechanical models
- Models for electromagnetic actuators including the electrical drivers
- Models for DC-engines with different closed loop controllers using operational amplifiers
- Models for transistor amplifiers
- Models for vehicle system

Text Books:

1. L. Ljung, T. Glad, "**Modeling of Dynamical Systems**", Prentice Hall Inc. (1994).
2. D.C. Karnopp, D.L. Margolis and R.C. Rosenberg, "**System Dynamics: A Unified Approach**", 2nd Edition, Wiley-Interscience (1990).

Reference Books:

1. G. Gordon, "**System Simulation**", 2nd Edition, PHI Learning (2009).
2. V. Giurgiutiu and S. E. Lyshevski, "**Micromechatronics, Modeling, Analysis, and Design with MATLAB**", 2nd Edition, CRC Press (2009).
3. George Pelz, **Mechatronic Systems: Modeling and Simulation with HDL: Principles of Modeling and Simulation; Modeling and Simulation of Mixed Systems**, John Wiley,2003, ISBN: 978-0-470-84979-8;
4. Bolton, W. **Mechatronics**. London: Addison Wesley Longman ltd, 1999.

B19MT6061	Heat Transfer	SC	L	T	P	C	Hrs

							/week
Duration:14 Wks		**2**	**1**	**0**	**3**		**4**

Prerequisites:

Thermal Engineering

Course Objectives:

1. To introduce the basic modes of heat transfer and their governing equations.
2. To identify the various modes of heat transfer and combined heat transfer processes.
3. To analyze conduction, convention and radiation problems.
4. To design heat exchangers and analyze boiling and condensation process.

Course Outcomes:

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

1. Apply the concept of steady and unsteady state heat transfer to analyze the systems
2. Analyze the convective heat transfer systems under free and forced convection
3. Evaluate the performance of heat exchangers and phase change devices
4. Illustrate the thermal management system in electronic devices

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT	**CO1**	**3**	**3**	**3**	**3**	**1**								**3**	**3**	**3**
6061	**CO2**	**3**	**2**	**3**	**3**	**1**								**3**	**3**	**3**
	CO3	**3**	**2**	**3**	**3**	**3**								**3**	**3**	**3**
	CO4	**2**	**2**	**2**	**2**	**2**								**3**	**2**	**1**

Course Contents:

UNIT -I: Introduction and Conductive Heat Transfer [12 Hrs]

Introduction to Heat transfer: Modes of heat transfer, basic laws of heat transfer, Initial conditions and boundary conditions, Overall heat transfer coefficient, 3-D heat conduction equation in Cartesian co-ordinates, Discussion on 1-D steady state heat conduction without heat generation (plane wall, cylinders & spheres), Heat transfer through composite wall and numerical.

1-D Transient Conduction: Lumped system Analysis, Use of Heisler's charts for transient conduction in plane slab, long cylinder and sphere. Numerical.

UNIT -II Convective Heat Transfer I[12 Hrs]

Concepts and basic relations in boundary layers: Hydrodynamic and thermal boundary layer over a flat plate, critical Reynolds number, Local heat transfer coefficient, average heat transfer coefficient, Numerical on flow over plates and cylinder.

Free or Natural Convection: physical significance of Grashoff number, Use of correlations for free convection of plates, cylinders, spheres, Numerical.

UNIT -III: Convective Heat Transfer II and Heat Exchangers [12 Hrs]

Convective Heat transfer II: Forced Convection-physical significance of Reynolds, Prandtl, Stanton, Nusselt numbers, Use of correlations for hydro dynamically and thermally developed flows in case of internal and external flows, laminar and turbulent flow solutions.

Heat Exchangers: Classification, Overall heat transfer coefficient, fouling and fouling factors, LMTD (With Derivation), Discussion on effectiveness-NTU methods (Without Derivation) of analysis of heat exchangers, Numerical.

UNIT -IV: Phase Change Convective Process and Thermal management of Electronic System [12 Hrs]

Phase Change Convective Process: Condensation and its types, Discussion of condensation with Nusselt theory (No Derivation), Use of condensation correlations for flat vertical plate, horizontal tube and **bank of tubes,** Reynolds number for condensate flow.

Boiling-types of boiling, Regimes of pool boiling, Pool boiling correlations, Numerical.

Thermal Management of Electronics:Introduction to thermal management, Overview of Temperature Measurement, Heat generation, Heat sink selection, Thermal Interface Materials, Liquid cooling of electronics, Jedec Standards, Heat pipes, Thermoelectric coolers, Nano scale heat transfer.

Text books:

1. Tirumaleshwar, **Heat & Mass transfer**, Pearson education 2006
2. Ozisik, **Heat transfer-A basic approach**, Tata McGraw Hill 2002.

Reference books:

1. Yunus A-Cengel, **Heat transfer-A practical approach,** Tata McGraw hill.
2. Mahesh M Rathore, **Heat and mass transfer,** Laxmi publications.
3. Kreith **Principles of Heat transfer,** Thomas Learning 2001
4. Frenk P.Incropera and DavidP.Dewitt, **Fundamentals of heat and mass transfer**, John Wiley and son's.
5. R K Rajput, **Heat and Mass transfer,** S Chand Publication.

B19MT6062	Operation Research	SC	L	T	P	C	Hrs /week

Duration:14 Wks			2	1	0	3	4

Prerequisites:

Numerical Methods and Probability

Course Objectives:

1. To learn Fundamentals of OR, Formulation of an LPP. And determine the optimal solution for a LPP Problem
2. To learn applications of LPP such as transportation problem , Assignment problem , travelling salesman problem
3. To analyze the waiting line model for real world applications.
4. To determine the project completion time by using PERT and CPM.
5. To know the scheduling of machines in the shop floor by using Johnson's algorithm.
6. To know the conflict between the two players in a game and determine the best strategy for the play.

Course Outcomes:

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

1. Develop Mathematical Model for LPP and solve graphically for the optimal product mix and also with iterative method
2. Formulate the problem in to standard transportation and assignment problem and obtain the optimal solution
3. Analyze network technique i.e, PERT/CPM and to determine optimal project duration and its cost
4. Discuss and solve the various waiting line problems & identify the importance of sequencing, determine total elapse time & idle time.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 6062	CO1	3	3	3										3	3	3
	CO2	3	3	3	1									3	3	3
	CO3	3	2	3	1									3	3	3
	CO4	3	3	3										3	3	3

Course Contents:

UNIT -I: Introduction to OR and Solution of LPP [12 Hrs]

Introduction to Operation Research: Definition, Scope of OR, OR Models, Characteristics and phases of OR. Advantages and limitation of OR. Mathematical formulation of LPP, Assumptions in LPP. Graphical solutions of LPP, Convex and non-convex sets.

Linear Programming Problem: Slack, surplus and artificial variables, Simplex method & BIG-M, Concept of duality, Special cases such as unbounded solution, multiple optimal solution, infeasible solution & degeneracy.

UNIT–II: Transportation Model and Application [12 Hrs]

Formulation of transportation model, Determination of IBFS using different methods & optimality by modi (V-V) method. Balanced and unbalanced transportation Problem, Degeneracy in transportation problems and resolving degeneracy, maximization of transportation problem. Application of Transportation Problem: Assignment model – Hungarian Method, Formulation of the assignment model (Minimization and Maximization), Balanced and unbalanced model, travelling salesman problem.

UNIT -III: Network analysis and Waiting Line Model [12 Hrs]

Network analysis – PERT & CPM Techniques. Project scheduling, Basic terminology used in project network, network construction, time estimates, determination of critical path and its durations, Floats , Variance under probabilistic models, prediction of project completion date.

Waiting Line model: Queue system and characteristics of queuing models, Kendall's notation, classification of the queue. The M/m/1 :∞/FCFS queuing system, Numerical.

UNIT -IV: Game Theory and Sequencing [12 Hrs]

Game theory: Introduction, Definition, strategy, Formulation of games, pay off matrix, Maximin and minimax criteria, Saddle point, Types of games. Solution of game with and without saddle point, Graphical solution of 2 X n game & M X 2 game. Dominance property for rectangular game i.e., Mx N game.

Sequencing: Johnson's algorithm, Assumptions in sequencing, n jobs to 2 machines, n jobs on 3 machines, n jobs on m machines, 2 jobs on n machines, graphical solution priority rules, processing of n jobs through m machines.

Text Books:

1. Prem kumar gupta and D.S.Hira, **Operations Research**, S.Chand Publication, New Delhi.
2. S.D.Sharma **Operations Research**, , Kedarnath ramanth & co.,

Reference Books:

1. Hiller and Liberman, **Introduction to Operation Research**, Tata McGraw hill.
2. Taha.H.A, **Operation Research and Introduction**, Pearson education edition.
3. Ravindran, **Operation Research: principles and practice**: Phillips and Solberg, Wiley India ltd, 2nd edition 2007.

B19MT6063	Finite Element Methods	SC	L	T	P	C	Hrs /week
Duration:14 Wks			2	0	1	3	4

Prerequisites:

Mechanics of Materials/Engg Mathematics

Course Objectives:

1. To enable the students to understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and heat transfer problems.
2. To provide systematic and comprehensive knowledge of basics of Finite element method as an analysis tool.
3. To teach the students the characteristics of various elements and selection of suitable elements for the problems being solved.
4. To make the students derive finite element equations for simple and complex elements.
5. To make the student solve for field variable for thermal composite wall problems.

Course Outcomes:

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

1. Describe the different types of analysis methods and various approaches in Finite Element Method
2. Analyze the Interpolation polynomials by Euler-Lagrange equations and Solution to 1-D Bars
3. Determine the stiffness matrix and unknown DOFs of Trusses and derive shape functions for Higher Order Elements
4. Derive Hermite Shape function and apply it to solve beam problems, 1D heat transfer problems and composite walls.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 6063	CO1	3	3	1	1	1								3	3	3
	CO2	2	3	1	1	1								3	3	3
	CO3	3	3	1	1									3	3	3
	CO4	3	3	1	1	1								3	3	3

Course Contents:

UNIT–1: Introduction [12 Hrs]

Introduction: Background of Various Stress analysis methods, Principle of minimum PE, Variation approach-Rayleigh Ritz method, Weighted Residual methods, Galerkin method simple problems, Comparison of FEM with classical methods. Advantages and limitations of FEM, Steps involved in FEM, Applications of FEM and FEM Packages.

Discretization: Element shapes and behavior, Choice of element types, size and number of elements, Element shape and distortion, Location of nodes, Node and Element numbering.

UNIT–2: Interpolation Models and Solution of 1-D Bars [12 Hrs]

Interpolation polynomials- Linear, quadratic and cubic. Simplex complex and multiplex elements.2D PASCAL's triangle. CST elements-Shape functions in NCS, Strain displacement matrix and Jacobian for triangular element. (No derivation)

Solution of 1-D Bars: Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach.

UNIT–3: Trusses and Higher Order Elements [12 Hrs]

Trusses: Stiffness matrix of Truss element. Numerical

Higher Order Elements: Lagrange's interpolation, higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral elements. Iso parametric, Sub parametric and super parametric elements. Numerical integration: 1 and 2 gauss point for 1D case.

UNIT –4: Beams and Heat Transfer Beams [12 Hrs]

Hermite shape functions for beam element, Derivation of stiffness matrix. (No derivation of load vectors) Numerical problems on beams carrying concentrated, UDL and linearly varying loads.

Heat Transfer: Steady state heat transfer, 1D heat conduction governing equations, Galerkin's approach for heat conduction and solution for composite walls.

List of Experiments:

Study of a FEA package and modeling stress analysis of

1 Bars of constant cross section area, tapered cross section area and stepped
2 Trusses
3 Beams – Simply supported, cantilever, beams with UDL, beams with varying load.
4 Thermal Analysis – 1D & 2D problem with conduction and convection boundary Conditions.

Text Books:

1. S.S. Bhavikatti, **Finite Element Analysis**, New Age International publishers,2006
2. T.R.Chandrapatla, A.D Belegunde, **Finite Elements in Engineering** 3rd Ed PHI.

Reference Books:

1. Daryl. L. Logon, **Finite Element Methods**, Thomson Learning 3rd edition, 2001.
2. J.N.Reddy, **Finite Element Method**, McGraw -Hill International Edition.
3. R.D. Cook D.S Maltus, M.E Plesha, R.J.Witt, **Concepts and applications of Finite Element Analysis,** Wiley 4th Ed, 2009

B19MT6064	Theory of Machines	SC	L	T	P	C	Hrs /week

Duration:14 Wks			2	1	0	3	4

Prerequisites:

Kinematics of Machines

Course Objectives:

1. To explain the equilibrium conditions, static force analysis for different mechanisms and to draw the turning moment diagram of flywheel
2. To explain the analytical approach and graphical methods (force and couple polygon) in balancing the unbalanced rotating and reciprocating engines.
3. To explain the application of governors in controlling the mean speed of an engine.
4. To introduce the concept of gyroscopic effect in analyzing the stability of disc, two wheeler, four wheeler, ships and aero planes.

Course Outcomes:

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

1. Describe the equilibrium conditions, D'Alembert's principle, Turning moment diagram, Static and dynamic balancing, Governors, Terminology of governors, Gyroscopic couple.
2. Derive the equation of principle of virtual work, Maximum fluctuation energy of flywheel, balancing condition of rotating masses and reciprocating masses, relation between speed and height of porter governor, stiffness of Hartnell Governor, Gyroscopic couple, stability condition for two wheeler and four wheeler vehicle.
3. Compute static and dynamic forces of the mechanisms, dimensions and mass of flywheel, unbalancing forces and couples in engines, centrifugal force and speed of governors, gyroscopic couple.
4. Analyze the static and dynamic forces of the mechanisms used in I C Engines and shaping machines, balancing forces and couples of engines, centrifugal force of governors, and gyroscopic effect and stability of aeroplane, ship, two wheeler and four wheeler vehicles.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 6064	CO1	3	2	2										3	3	1
	CO2	3	3	2	1		1							3	3	1
	CO3	3	3	3	1		1							3	3	2
	CO4	3	3	2	1		1							3	3	2

Course Contents:

UNIT-I: Static Force Analysis and Flywheel [12 Hrs]

Static & Dynamic Force Analysis: Introduction, Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque. Free body diagrams. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction. Principle of virtual work.
Flywheel: Turning moment diagrams and flywheels. Fluctuation of Energy. Determination of size of flywheels.

UNIT-II: Balancing of Rotating Masses and Reciprocating Masses [12 Hrs]
Balancing of Rotating Masses: Static and dynamic balancing. Balancing of several rotating masses by balancing masses in same plane and in different planes.
Balancing of Reciprocating Masses: Balancing of primary force in reciprocating engine, partial balancing of multi cylinder locomotives inline engine. Numerical.

UNIT-III: Governors [12 Hrs]
Introduction, principles, Types of governors, Terminology, force analysis of Porter and Hartnell governors, sensitivity, stability, Hunting, Isochronism, effort and power of governor, controlling force diagram. Numerical.

UNIT-IV: Gyroscopic Motion [12 Hrs]
Principles, Gyroscopic Torque, effect of gyroscopic couple on the stability of disc, aero plane, ship, two wheeler and four wheeler.

Text Books:

1. S.S. Rattan, **Theory of Machines**, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd edition, 2013.
2. R K Bansal, **Theory of Machines**- 6th edition, Laxmi Publications.
3. R S Khurmi & J K Gupta, **Theory of Machines**, 5th edition, S. Chand Publications.

Reference Books:

1. Dr. Sadhu Singh, **Kinematics of Machines**-2nd edition, Pearson publication.
2. Thomas Bevan, **Theory of Machines**- 3rd edition, CBS Publication.
3. Shigley, **Theory of Machines**- 3rd edition McGraw hill Book Company.

B19MT6065	Machine Tool Design	SC	L	T	P	C	Hrs /week

Duration:14 Wks			2	1	0	3	4

Prerequisites:

Theory of Metal Cutting and Machine Tools

Course Objectives:

1. To know the design consideration for the manufacturing and selection of tool.
2. To Know the tool life and there regulation when it is under operating condition.

Course Outcomes:

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

1. Describes the tool life and manufacturing of different tools.
2. Explains the regulation and general consideration for the selection of tool.
3. Illustrate the vibration and control system in machine tools .

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 6065	CO1	3	2											1	1	1
	CO2	3	3	2	1	1								3	2	1
	CO3	2	3	1	2	3								2	2	2

Course Contents:

UNIT – I **[12 Hrs]**

Principles of Machine Tool Design: General requirements of machine tool design – design process machine tool layout general requirements of machine tool design – design process machine tool layout.

Machine Tool Drives and Mechanisms: Working and auxiliary motion. Drives- Electric drives, Hydraulic transmission, Kinematic structure, Regulation of speed and feeds, stepped regulation, standardization of speed and feed, step less regulation of speeds and feeds.

UNIT – II **[12 Hrs]**

Cutting Force Analysis and Power Requirement: In Turning, Milling, Drilling, Shaping and Broaching operation with simple problems. General requirements of machine tools – Centre lathe, Milling machine.

Design of Machine Tool Structures: Functions-Requirements-Design criteria Material used – static and dynamic stiffness – Profile and basic design procedure for machine tool structures. Design of beds, columns, housing, bases, tables, cross-rails, arms saddle, carriages.

UNIT – III **[12 Hrs]**

Design of Guide Ways and Power Screws: Function and types of guide ways – Design and lubrication of slide ways –antifriction guide ways, protecting devices, design of power screws.

Design of Spindle And Spindle Bearings: Functions-Requirements and materials for spindle compliance and machining accuracy. Design of spindles, antifriction bearing, Hydrodynamic and Hydrostatic bearing, Air lubricated bearing.

UNIT – IV **[12 Hrs]**

Dynamics of Machine Tools: Concept of dynamic cutting process, Physical causes of chatter and vibrations, Types of Chatter. Stability chart, chatter vibration in Lathe, Drilling machine, Grinding machine and Milling machine. Different methods for avoiding machine tool chatter and vibration.

Control Systems In Machine Tools: Functions, requirements and classification. Control system for speed and feeds centralized control pre selective control, control system for forming and auxiliary motions – Mechanical control– Ergonomic consideration and compatibility – Automatic control system – Electric Hydraulic and pneumatic systems.

Text Books

1.N.K. Mehta, "**Machine Tool Design"**2nd Ed., Tata McGraw Hill 2001

2.Sen and Bhattacharaya "**Principles of Machine Tools",** Oxford IBM Publishing 2000

Reference Books

1. **Machine Tool Design Volume – II and III,** N. Acharkan MIR Publications 2000

2. **Design of Machine Tools**, S. K. Basu and D. K. Pal 2000

3. **Principles of Machine Tool Design**, Koensberger

B19MT6070	Automation Lab	HC	L	T	P	C	Hrs /week
Duration:14 Wks			0	0	2	2	3

Prerequisites:

Process Automation, H&P

Course Objectives:

1. Understand the concept of Mechatronics system.
2. Understand the basic concept of utilization of ladder diagram for real time programming by using PLC and suitable software.
3. Introduce of programming of PLC and its application in process automation

Course Outcomes:

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

1. Understand the concept of logic gates
2. Design the concepts of building a ladder diagram for different virtual models
3. Analyses the construction of ladder diagram for control devices with respect time.
4. Understand the application of PLC circuit for conveyer feed movement with emitter & receiver
5. Design the concept PLC program in real time applications.
6. Design the robot for material handling systems.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 6070	CO1	3	2	2	3									3	2	2
	CO2	3	2	2	3									3	2	3
	CO3	3	3	2	2	2								3	2	3
	CO4	3	2	2	3									3	3	3
	CO5	3	2	2	2	2								2	3	3
	CO6	3	2	2	3	2								3	2	3

Course Contents:

1. Using PLC ladder diagram realize the following logic gates: AND, OR, NOT, NAND, NOR, EX-OR.
2. Water level controller using programmable logic controller
3. Batch process reactor using programmable logic controller
4. Speed control of ac servo motor using programmable logic controller
5. Lift control system using programmable logic controller
6. Star delta starter using programmable logic controller
7. Design a PLC ladder diagram to construct an alarm system.
8. Device a circuit that can be used to start a motor and then to start a pump after delay of 50s. Then the motor is switched off 10s before the pump is switched off when the pump remains on for 50s.
9. There are 3 mixing devices on a processing line A,B,C.Afterthe process begin mixer-A is to start after 7 seconds elapse, next mixer-B is to start 3.6 second after A. Mixer-C is to start 5 seconds after B. All then remain ON until a master enable switch is turned off. Write PLC ladder diagram, timing diagram and realize the same
10. The sub conveyors feed a main conveyor. The count from feeder conveyor is fed into an input register in the PLC. Construct a PLC program to obtain the total count of parts on the main

conveyor. Use a time to update the total every 15 seconds. Design, construct, and test PLC circuits for this process.

11. Build a pneumatic circuit for Stamping operation by using single acting cylinder being controlled by 3way 2 position directional control valves
12. Build a pneumatic circuit for automatic opening and closing of a door by using double acting cylinder being controlled by 4way 2 position directional control valves.
13. Build a pneumatic circuit for forward and reverse speed control of a double acting cylinder(meter in meter out)
14. Build a pneumatic circuit of a pilot controlled double acting cylinder of being controlled by3way 2 position directional control valves and 4way 2 positions impulse valve.

Note: Above experiments can be performed by using Robotic trainer kit or by using Robotic simulating software. Mechatronics Experiments can be performed by using PLC with software.

B19MT6080	Digital Signal Processing lab	HC	L	T	P	C	Hrs /week
Duration:14 Wks			0	0	2	2	3

Prerequisites:

Analog and Digital circuits

Course Objectives:

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. Apply the concept of FFT algorithms to compute DFT.
4. Design IIR filter using impulse invariant, bilinear transform.
5. Describe the concept of linear filtering Technique.
6. Demonstrate FIR & IIR filters for digital filter structures.

Course Outcomes:

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

1. Demonstrate the concept of sampling, DFT,IDFT
2. Compute the convolution of the pair of signals in time domain.
3. Create IIR and FIR Filter.
4. Design of Butterworth and chebyshev filter for different specification.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT	CO1	2	2	2	2								2	2	2	2

6080	**CO2**	**2**	**3**	**3**	**2**							**2**	**2**	**2**	**2**
	CO3	**2**	**3**	**3**	**2**							**2**	**3**	**3**	**2**
	CO4	**2**	**2**	**2**	**2**							**2**	**2**	**3**	**2**

List of Experiments:

List of Experiments using MATLAB/Octave:

1. Perform the Linear convolution of any two given sequences in time domain.
2. Computation of N point DFT of a given sequence using the definition of DFT and plot magnitude and phase spectrum and verify using built in function (using FFT).
3. Perform the Circular convolution of two given sequences in time domain.
4. Perform Circular convolution of any two given sequences in frequency domain by using DFT and IDFT.
5. Obtain the Auto correlation and cross correlation of a given sequence and verify its properties.
6. Verification of sampling theorem.
7. Design of digital Low-pass and High-pass Butterworth IIR filter to meet the given specifications using bilinear transformations.
8. Design of digital Low-pass and High-pass Chebyshev IIR filter to meet the given specifications using bilinear transformations.
9. Design of digital Low-pass FIR filter to meet the given specifications using windowing technique.

List of Experiments using DSP Processor:

1. Linear convolution of two given sequences.
2. Circular convolution of two given sequences.
3. Computation of N-point DFT of a given sequence.
4. Solving a linear constant coefficient difference equation.
5. Audio applications such as to plot time and frequency spectrum, display of microphone output plus a cosine using DSP. Read a wav file and match with their respective spectrograms.

Seventh Semester

B19MT7010	**Engineering Economics and Financial Management**	**HC**	**L**	**T**	**P**	**C**	**Hrs /week**
Duration:14 Wks			**2**	**1**	**0**	**3**	**4**

Prerequisites:

Basics of Management

Course Objectives:

1. To Study principles and techniques of economic evaluation in different field of Engineering
2. To know the assessment procedure for the financial position of an organization.
3. To calculate interest under various conditions, know time value of the money.
4. To learn Budgeting process and its preparation and use

Course Outcomes:

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

1. Describe the economic strength of organization in the decision making process related to Engineering application
2. Estimate the Present, annual and future worth comparisons for each of the cash flows
3. Calculate the rate of return, depreciation charges and income taxes
4. Enumerate different cost entities in estimation and costing, budgeting

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 7010	CO1	3	3	3										3	3	3
	CO2	3	3	2	1									3	3	3
	CO3	3	3	3	1									3	3	3
	CO4	3	3	2	1									3	3	3

Course Contents:

UNIT-I: Introduction to Engineering Economy [12 Hrs]

Introduction to Indian Economy, Basic terminologies used in economy, Engineering Decision-Makers, Engineering and Economics, Problem solving and Decision making, Intuition and Analysis, Tactics and Strategy. Law of demand and supply, Interest and Interest factors: Interest rate, Cash – flow diagrams, Exercises and Discussion.

Present-Worth Comparisons: Conditions for present worth comparisons, Basic Present worth Comparisons, Present-worth equivalence, Net Present worth, Assets with unequal lives, infinite Lives, Future-worth comparison, Pay-back comparison, Simple Exercises.

UNIT-II: Evaluation of Projects and Depreciation [12 Hrs]

Present worth Method, Annual worth method, Future worth method, internal rate of return method Numerical covering all the above method with comparisons. Rate-of-Return Calculations, Minimum acceptable rate of Return, IRR, IRR misconceptions

Depreciation: Causes of Depreciation, Methods of depreciation. Simple Numerical, Tax- Direct and Indirect tax, GST and simple concepts of taxing.

UNIT-III: Estimation, Costing and Finance Functions [12 Hrs]

Estimation for simple components (with calculations of all types of costs involved in it).Introduction, Scope of Finance, and Finance Functions, Statements of Financial Information: Source of financial information, financial statements, Balance sheet, Profit and Loss Account, relation between Balance sheet and Profit and Loss account. Simple Numerical.

UNIT-IV: Financial Ratio Analysis and Profit Planning [12 Hrs]

Financial Ratio Analysis: Introduction, Nature of ratio analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Evaluation of a firm's earning power. Simple numerical

Financial and Profit Planning: Introduction, Financial planning, Profit planning, Objectives of Profit planning, type of budgets in Indian Economy, preparation of Budgets, advantages, problems on flexible budget, cash budget and production budget.

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Text books:

1. Riggs J.L., **Engineering Economy**, 4TH ed., McGraw Hill, 2002
2. Thuesen H.G. **Engineering Economy** PHI, 2002
3. Ramesh Singh, **Indian Economy**, 8th edition, 2018
4. Khan & Jain, **Financial Management**, Text and Problems, 5th Edition, TMH, ISBN 0-07-460208 A, 2001.

Reference Books:

1. Tarachand, **Engineering Economy,** 2000.
2. O P Khanna, **Industrial Engineering and Management**, Dhanpat Rai & Sons. 2000
3. Prasanna Chandra, **Financial Management,** 7th Ed., TMH, 2004
4. IM Pandey **Financial Management,** Vikas Pub. House, 2002

B19MT7020	Control Systems	HC	L	T	P	C	Hrs /week
Duration:14 Wks			3	1	0	4	5

Prerequisites:

Signals and Networks

Course Objectives:

1. To provide knowledge of fundamentals related to automatic control, feedback systems and their applications in real time.
2. Use of mathematical tool like Laplace transforms to analyze the system theoretically.
3. Representation of actual system in terms of physical model and mathematical model by writing mathematical equations.
4. To analyze the behavior of the system for various inputs under time domain and frequency domain.
5. To analyze the performance and stability by using plots like polar plot, bode plot and root locus techniques.

Course Outcomes:

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

1. Categorize different types of system, identifying a set of Mathematical equations in order to represent a complicated system model in a simple form.
2. Characterize any system in Laplace domain in order to illustrate different specification of a system by using the concept of transfer function.
3. Use time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions.
4. Investigate the different types of analysis in frequency domain to eniculate the system stability.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT7020	CO1	3	2	2	1									3	3	3
	CO2	3	3	3	1									3	3	3
	CO3	2	2	2	1									3	3	3
	CO4	3	3	3	1	2								3	3	3

Course Contents:

UNIT-I: Mathematical Modeling and Block Diagrams [12 Hrs]

Concepts of automatic controls, Types of control systems, open and closed loop systems with examples, feedback system. Requirement of an ideal control system. Mathematical Models: Models of mechanical systems, Transfer function, Numerical on mechanical system and transfer function, Block Diagrams: block representation of system elements, reduction of block diagrams

UNIT-II: Signal Flow Graphs and Time Response Analysis [12 Hrs]

Mason's gain formula, numerical. Time Response Analysis: Transient and Steady State Response Analysis: types of inputs, first order and second order system response to step, ramp and impulse inputs, (no derivation), time response specifications and concepts of time constant, numerical problems, System stability: Routh's-Hurwitz Criterion, numerical.

UNIT-III: Estimation, Costing and Finance Functions [12 Hrs]

Polar plots, Nyquist Stability Criterion, Stability Analysis, phase and gain margin, Stability Analysis using Bode plots, Simplified Bode Diagrams.

UNIT-IV: Root Locus Plots and Compensation Techniques [12 Hrs]

Definition of root loci, general rules for constructing root loci, Analysis using root locus plots. Types of controller & compensation techniques: proportional controller, differential controller, PI, PD & PID controllers, compensation, compensation techniques-series, parallel, lead, lag, lead & lag compensation.

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Text books:

1. K. Ogatta. **Modern Control Engineering,** Pearson education, 2003**.**
2. M.Gopal**, Control Systems principles &design** TMH, 2000

Reference Books:

1. 1. I.J.Nagarath & M.Gopal **Control Systems,** New age International Publishers

2. Schaum's series **Feedback Control Systems** 2001

B19MT7030	Embedded Systems	HC	L	T	P	C	Hrs /week
Duration:14 Wks			4	0	0	4	4

Prerequisites:

Microcontrollers, Operating Systems

Course Objectives:

1. Present brief idea about the embedded system components, memory, communication interfaces and other firmware components.
2. Prescribe the quality attributes, hardware and software co-design, computational models in embedded systems, unified modelling languages etc.
3. Present the firmware system development and firmware development languages.
4. Give a brief description of RTOS, integrated development environment, simulators and emulators.
5. Present the trends in embedded system development.

Course Outcomes:

After successful completion of the course, the students 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. Select the model, architecture, language and hardware/software partitioning in hardware/software code sign.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 7030	CO1	3	2		1	3	1				2	1	2		1	1
	CO2	3	2	2	1	3									1	1
	CO3	2					1				2	1	2			
	CO4	3	1	2	1	2								2	2	2

Course Contents:

UNIT-I: Typical Embedded System [12 Hrs]

Introduction, classification of Embedded System, Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface.

UNIT-II: Characteristics and Quality Attributes of Embedded Systems [12 Hrs]

Characteristics of Embedded Systems, Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Hardware Software trade-offs.

UNIT-III: Embedded Firmware Design and Development [12 Hrs]

Embedded Firmware Design Approaches, Embedded Firmware Development Languages.

Integration and testing of Embedded Hardware &Firmware: Integration of Embedded Hardware &Firmware, Board Power-Up.

UNIT-IV: The Embedded System Development Environment [12 Hrs]

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.

Text 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

Reference Books:

1. Rajkamal, "**Embedded Systems Architecture, Programming and Design**" , Tata McGraw Hill, 2nd Edition, 2008
2. Dr K.V.K.K. Prasad, "**Embedded/Real-Time Systems: Concepts, Design and Programming- The Ultimate Reference**", Dreamtech Press/Wiley India, 2007.

B19MT7041	MEMS	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Basic Electrical & Electronics

Course Objectives:

1. To study the fundamentals of MEMS and micro fabrication.
2. To identify the essential of MEMS material properties.
3. To distinguish various sensing and transducer techniques.
4. To select various fabrications and machining process of MEMS as per application.

Course Outcomes:

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

1. Elaborate the important concepts applicable to MEMS, their fabrication.
2. Analyze the material properties used in MEMS.
3. Apply the MEMS for different applications.
4. Explain the working principle of micro sensors and micro actuators.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 7041	CO1	2	1	1										3	2	
	CO2	2	3	2									1	3	2	
	CO3	3	3	2									1	3	2	
	CO4	2	2	1									1	3	2	

Course Contents:

UNIT-I: Applications of MEMS [09 Hrs]

Unique characteristics of MEMS, Microsystems Technology- an Overview, typical MEMS and Microsystems Products.

Applications of MEMS - Scaling effects - scaling laws in miniaturization- Application of MEMS and Microsystems- Future Directions of MEMS.

UNIT-II: Material for MEMS and Manufacturing [09 Hrs]

Structure of silicon and other materials - Silicon wafer processing - Bulk micromachining and Surface micromachining, Wafer-bonding. Thin-film deposition, Lithography, wet etching and dry etching.

UNIT-III: Micro-Fabrication Methods [09 Hrs]

LIGA and other molding techniques- Soft lithography and polymer processing- Thick-film processing, Low temperature co-fired ceramic processing-.Smart material processing.

UNIT-IV: MEMS Components-Micro Sensors and Micro-Actuators [09 Hrs]

Micro sensors - Basic principles and working of micro sensors- Acoustic wave micro sensors- Bio-medical micro sensors- Bio-sensors- Chemical micro sensors – Optical Sensors – Pressure micro sensors- Thermal micro sensors-acceleration micro sensors.

Micro actuators - Basic principles and working of micro actuators- Electrostatic micro actuators- Piezoelectric micro actuators- Thermal micro actuators- SMA micro actuators- Electromagnetic micro actuators, micro valves, micro pumps.

Text Books:

1. Tai-Ran-Hsui (2013), **MEMS & Microsystems: Design and Manufacture**, McGraw Hill, 17th Reprint.

Reference Books:

1. Nadim Maluf and Kirt Williams (2004), **An Introduction to Microelectro mechanical Systems Engineering,** Second Edition, Artech House Print on Demand, ISBN-13 978-1580535908.
2. Stephen R.Santuria (2001), **Microsystem Design,** Springer Science-Business Media Inc.
3. Minhang Bao (2005), **Analysis and Design Principles of MEMS devices**, Elsevier.
4. Marc J. Madou (2002), **Fundamentals of Micro Fabrication: The Science of Miniaturization,** Second Edition, CRC.
5. Nitaigour Premchand Mahalick (2007), **MEMS,** Tata McGraw Hill.

B19MT7042	Product Design and Development	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Course Objectives:

1. To demonstrate the awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).
2. Ability to coordinate multiple, interdisciplinary tasks in. order to achieve a common objective

Course Outcomes:

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

1. Identify and analyze the product design and development processes in manufacturing industry.
2. Define the components and their functions of product design and development processes and their relationships from concept to customer over whole product lifecycle.
3. Analyze, evaluate and apply the methodologies for product design, development and management.
4. Undertake a methodical approach to the management of product development to satisfy customer needs. Carry out cost and benefit analysis through various cost models

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT 7042	CO1	2	1	1										2		2
	CO2	2	1	1										2		2
	CO3	2	1	1										2		2
	CO4	2	1	1										2		2

Course Contents:

UNIT-I: Introduction to Product Design, &processes [09 Hrs]

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development.

Development Processes and Organizations: A generic development process, concept development: the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.

UNIT-II: Product Planning, Customer needs and Product Specification [09 Hrs]

Product Planning: The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

Product Specifications: What are specifications, when are specifications established, establishing target specifications, setting the final specifications.

UNIT-III: Concept Generation, Selection and Testing [09 Hrs]

Concept Generation: The activity of concept generation clarifies the problem, search externally, search internally, explore systematically, reflect on the results and the process.

Concept Selection: Overview of methodology, concept screening, and concept scoring,

Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.

UNIT-IV: Product design and manufacturing [09 Hrs]

Industrial Design: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design.

Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

Text Books:

1. **Product Design and Development** - Karl.T.Ulrich, Steven D Eppinger – Irwin McGrawHill – 2000.
2. Sameul Eilon – **Elements of Production Planning and Control** – McMillan and Company, 1962.
3. Jones S.W., **Product Design and Process Selection**, Butterworth Publications, 1973

Reference Books:

1. Harry Nystrom – **Creativity and Innovation**, John Wiley & Sons, 1979
2. George E. Dieter, Engineering Design – **Materials and process approach**, Tata McGraw-Hill, 3rdEdition, 2000.
3. Donald E. Carter – **Concurrent Engineering**, Addison Wesley, 1992

B19MT7043	Industrial Engineering	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	0	3

Prerequisites:

None

Course Objectives:

1. To provide knowledge of Industrial Engineering concepts, Application of Work study in the shop floor
2. To know the concepts of method study and work measurement with their relative technique.
3. To perform work sampling for a job.
4. To determine the standard time for the specified job.
5. To determine different types of depreciation cost.

Course Outcomes:

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

1. Define and apply productivity concept to engineering applications & evaluate the Location, layout of the plants
2. Describe the implementation of work and time study at a workplace
3. Perform value analysis and work sampling of a job
4. Apply the concepts of depreciation and compute the replacement policy of machines.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT7043	CO1	3	3	2										3	3	2
	CO2	3	3	2										3	3	2

	CO3	3	3	3									3	3	2
	CO4	3	3	2									3	3	2

Course Contents:

UNIT-I: Introduction and Plant **Location and Layout [09 Hrs]**

Industrial Revolution and historic development of the factory system. Concept of Productivity, Various types of productivity, causes for lack of productivity and increase of work content. Production system and its types,

Plant Location and layout Factors influencing plant location, theories of plant location, location economics, and selection of specific site, objectives of plant layout, principles of plant layout, types of plant layout, their merits and demerits, Evaluation of Layouts

UNIT-II: Work Study and Work Measurement [09 Hrs]

Work Study: Concept of work study, Basic procedure of work study. Concept of method study, Definition, selection, recording, examining, developing, installing and maintaining new method. Use of recording techniques such as outline process , flow process chart, multiple activity chart, flow diagram , String diagram, Travel chart. Principles of motion economy & Micro motion study.

Work Measurement: Common steps in work measurement, Time study method, breaking the task into work elements, types of elements, rating and different methods of rating. Allowances and its types. Calculation of basic time and standard time with numerical.

UNIT-III: Work Sampling and Material Handling [09 Hrs]

Work Sampling: Principles, Procedure, confidence limits, number of observations required, advantages and disadvantages, applications. Ergonomics: Human factors in the design of workplace, layout of equipment, design of displays and controls. Fatigue and measurement of fatigue.

Material Handling: Principles, classification, material handling equipment, selection of material handling equipment.

UNIT-IV: Equipment Replacement and Depreciation [09 Hrs]

Equipment Replacement: Nature of replacement problems, economic life of challenger and defender, Replacement of items – individual replacement and group replacement .

Depreciation – Definition, factors, Types of Depreciation with numerical.

Text Books:

1. ILO(International Labor organization) **Introduction to Work study**,
2. O.P.Khanna, **Industrial Engineering and Economy** , PHI Publisher

Reference Books:

1. Maynard **Hand book of Industrial Engineering** ,
2. Ralph. M. Barnes, **Motion and Time Study**, John wiley.
3. Marvin.E.Mundel ,**Motion and Time Study** ,

B19MT7044	Non Destructive Testing Methods	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Manufacturing Technology

Course Objectives:

1. To acquire the principle behind various NDT techniques and study about NDT equipment's and accessories
2. To study the considerations for selection of appropriate NDT technique(s) for various applications
3. To enumerate the working procedures of various NDT techniques
4. To study the common types of defects arising in different types of manufactured products to evaluate them.

Course Outcomes:

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

1. State the principles used in different types of NDT techniques
2. Compare the advantages of various NDT techniques for various applications.
3. Select the different types of NDT equipment's for real time applications
4. Identify the causes for the different types of defects that may result in castings and suitable measures to eliminate them.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 7044	CO1	2	2	1										2	1	
	CO2	2	2	1										1	1	
	CO3	2	3	2	2									3	1	
	CO4	2	3	2	2									3	1	

Course Contents:

UNIT-I: Visual Inspection and Liquid Penetrate Testing [09 Hrs]

Introduction, Visual inspection and Liquid particle testing: Introduction to various nondestructive methods- Comparison of Destructive and Nondestructive Tests, Visual Inspection, Optical aids used

for visual inspection, Applications. Basic principle, procedure for penetrant testing, Penetrant Testing materials, Penetrant testing methods-water washable, post-Emulsifiable methods, Applications.

UNIT-II: Magnetic Particle Testing and Eddy Current Testing [09 Hrs]

Magnetic Particle Testing and Eddy current testing: Principle of MPT, procedure used for testing a component, Equipment used for MPT, Applications. Principles, Instrumentation for ECT, Absolute-differential probes, Techniques-High sensitivity Techniques, Applications

UNIT-III: Acoustic Emission Testing and Ultrasonic Testing [09 Hrs]

Acoustic Emission Testing: Principle of AET, Instrumentation, Applications – testing of metal pressure vessels, Fatigue crack detection in aerospace structures. Ultrasonic Testing: Principle of Ultrasonic testing, Ultrasonic transducers ,Inspection Methods, Normal Incident Pulse – Echo Inspection, Through – transmission Testing, angle Beam Pulse- Echo testing, Techniques for Normal Beam Inspection, Ultrasonic Flaw detection Equipment, Modes of display A- scan, B-Scan, C-Scan, Applications.

UNIT-IV: Radiography Testing [09 Hrs]

Radiography, Comparison and selection of NDT methods: Basic principle, Effect of radiation on Film, Radiographic imaging, Inspection Techniques-Single wall single image, Double wall Penetration, Multiwall Penetration technique. Comparison and selection of various NDT techniques.

Text Books:

1. Baldev raj T, Jayakumar M. Thavasimuthu "**Practical Non Destructive Testing**", 3rd edition, Narosa publishing house, New Delhi
2. American Society for Metals, "**Non-Destructive Evaluation and Quality Control**": Metals Hand Book: 1992, Vol. 17, 9th Ed, Metals Park, OH.

Reference Books:

1. Krautkramer. J., **Ultra Sonic Testing of Materials**, 1st Edition, Springer Verlag Publication, New York, 1996.
2. Peter J. Shull Non Destructive Evaluation: **Theory, Techniques and Application** Marcel Dekker, Inc., New York, 2002

B19MT7045	Safety Engineering	SC	L	T	P	C	Hrs /week

Duration:14 Wks			3	0	0	3	3

Prerequisites:

None

Course Objectives:

1. To know the reasons for accidents happen in mechanical Industries
2. To understand the safety procedure to avoid accidents
3. To know the safety rules and regulations.
4. To understand the various acts of Govt of India.
5. To know the responsibility as a citizen, employer, employee and head of the family

Course Outcomes:

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

1. Evaluate workplace to determine the existence of occupational safety and health hazards, injury and illness
2. Identify relevant regulatory safety and national consensus standards along with best practices that are applicable in mechanical handling
3. Select appropriate control methodologies based on the hierarchy of controls with respect to chemical and gases
4. Describe and analyze the rules and regulations laid by Govt of India for health, safety and environment.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 7045	CO1	2	1	1			3	2	1					2		2
	CO2	2	1	1			1	1						2		2
	CO3	2	1	1			3	1						2		2
	CO4	2	1	1			1	1						2		2

Course Contents:

UNIT-I: Accidents and Safety [09 Hrs]

Definitions and theories.- Accident - Injury - Unsafe act - Unsafe condition -Dangerous occurrence - Theories and principles of accident causation - Cost of accidents - Accident reporting and investigations - Safety committees - Need - Types- Advantages. Safety education and training - Importance - Various training methods -Accident prevention - Motivating factors - Safety suggestion schemes. Safety performance - Definitions connected with measuring safety performance as per Indian and International standards.

UNIT-II: Safety in Mechanical Handling [09 Hrs]

General safety consideration in material handling - Ropes, Chains, Sling, Hoops, Clamps, arresting gears - Prime movers. Ergonomic consideration in material handling, design, installation, operation and maintenance of conveying equipment, hoisting, traveling and slewing mechanisms. Selection, operation and maintenance of industrial trucks - Mobile cranes - Tower crane.

UNIT-III: Safety in Storage and Handling of Chemicals and Gases [09 Hrs]

Safety in the design process of chemical plants - Safety in operational and maintenance - Exposure of personnel - Operational activities and hazards - Safety in storage and handling of chemicals and gases - Hazards during transportation - Pipeline transport - Safety in chemical laboratories. Specific safety consideration for cement, paper, pharmaceutical, petroleum, petro - chemical, rubber, fertilizer and distilleries.

UNIT-IV: Regulations for Health, Safety and Environment [09 Hrs]

Factories act and rules, - Indian explosive act - Gas cylinder rules – Environmental pollution act - Indian petroleum act and rules - Oil industry safety directorate (OISD) - Indian Electricity act and rules. - Mines act and rules - Indian motor vehicles act and rules.

Text Books:

1. Handlin.W**, "Industrial Hand Book",** McGraw-Hill, 2000.
2. Anton.T.J, **"Occupational safety and health management",** (2nd Edition). New York, McGraw Hill, 1989.

Reference Books:

1. Heinrich.H.W, **"Industrial Accident Prevention***"*, McGraw-Hill, 1980.
2. Rudenko.N, **"Material Handling Equipments",** Mir Publishers, Moscow, 1981.
3. Lees.F.P, **"Loss "Prevention in Process Industries",** Butterworths, New Delhi, 1986.
4 **IS CODES of Oil Industry Safety Directorate**, Govt. of India.

B19MT7051	Biomedical Signal Processing	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	4

Prerequisites:

Signals and Networks, DSP, Linear Algebra

Course Objectives:

1. Identify the application of the main signal processing tools to the analysis of biomedical signals.
2. Describe how clinically relevant information can be extracted from these signals.
3. Relate advanced signal processing for uni and multi-modal medical signals.
4. Discuss advanced signal processing for multidimensional medical signals.
5. Interpret and analyze medical signals from a set of specific medical applications.
6. Describe and apply signal processing methods for removal of artefacts in medical signals.
7. Estimate unique segments or regions in medical signals an - images using automatic signal processing methods for classification.

Course Outcomes:

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

1. Apply statistical and adaptive signal modelling for multidimensional medical signals. List the various ECG systems.
2. Define and apply signal processing methods for removal of artefacts in medical signals
3. Illustrate unique segments or regions in medical signals an - images using automatic signal processing methods for classification.
4. Explain Smear signal processing methods for characterization of physiological and pathological phenomena(g,f)

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 7051	CO1	2	2											2		
	CO2		2	2	3									2		2
	CO3		3	3	2								3	3		2
	CO4		2	3	3								3			3

Course Contents:

UNIT-I: Introduction to Biomedical Signals [12 Hrs]

Nature of Biomedical Signals, Examples of Biomedical Signals (ENG, EMG, ECG, EEG, ERP, EGG, PCG, CP, VMG, VAG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer aided Diagnosis.

UNIT-II: Electrocardiography [12 Hrs]

Basic Electrocardiography, ECG lead systems, ECG Signal characteristics, ECG QRS Detection, ECG Analysis Systems.

UNIT-III: Neurological Signal Processing [12 Hrs]

The Brain and its potentials, The Electrophysiological Origin of Brain Waves, EEG signal and its characteristics, EEG Analysis, Linear Prediction Theory, The AR method, Recursive Estimation of AR Parameters.

UNIT-IV: Sleep EEG [12 Hrs]

Data Acquisition and Classification of sleep stages, The Markov Model and Markov Chains, Dynamics of Sleep-Wake Transitions, Hypnogram Model parameters, Event History Analysis for modelling Sleep.

Text Books:

1. Rangaraj M Rangayyan, "**Biomedical Signal Analysis**" A case study approach, John Wiley publications. Second Edition 2009
2. Willis J Tompkins, ED, "**Biomedical Digital Signal Processing**", Prentice-Hall of India, 1993 First edition

Reference Book:

1. DC Reddy, "**Biomedical Signal Processing Principles and Techniques**", Tata McGraw-Hill, First Edition 2005 first edition

B19MT7052	Real Time Operating Systems	SC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	4

Prerequisites:

Microcontrollers, Operating Systems

Course Objectives:

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:

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

1. Understand the basics and importance of real-time systems.
2. Create a high-level design document based on analysis documentation
3. Create a test plan based on requirements specification
4. Create a validation plan based on all documentation
5. Understand capabilities of at least one commercial off-the-shelf R-T kernel

Mapping of Course Outcomes with Programme Outcomes

Course	POS/	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO	PO	PO	PSO	PSO	PSO

Code	Cos										10	11	12	1	2	3
B19MT 7052	CO1	3	2	2	1					3	3	2	1	3	3	3
	CO2	3	3	3	2	2				3	3	2	1	3	3	3
	CO3	3	2	3	2	2				3	3	2	3	3	3	3
	CO4	3	3	3	2	2				3	3	3	3	3	3	3
	CO5	3	2	2	1	2				3	3	2	1	3	3	3

Course Contents:

UNIT-I: Introduction [12 Hrs]

Basic Real-Time Concepts**,** Terminology, Real-Time System Design Issues, Example Real-Time Systems, Common Misconceptions, Brief History.

UNIT-II: Hardware for Real-Time Systems [12 Hrs]

Basic Processor Architecture, Memory Technologies, Architectural Advancements, Peripheral Interfacing, Microprocessor versus Microcontroller, Distributed Real-Time Architectures.

UNIT-III: Real-Time Operating Systems [12 Hrs]

Real-Time Kernels, Theoretical Foundations of Real-Time Operating Systems, Inter-task Communication and Synchronization, Memory Management.

UNIT-IV: Software System Design [12 Hrs]

Properties of Software, Basic Software Engineering Principles, The Design Activity, Procedural-Oriented Design, Object-Oriented Design.

Text Books:

1. Philip A. Laplante, "**Real Time System Design and Analysis**," Third edition, Wiley India Edition, 2004.
2. Philip A. Laplante, "**Real Time System Design and Analysis**," Fourth edition, Wiley India Edition, 2011

Reference Books:

1. Staurt Bennett, "**Real Time Computer Control**," Second Edition, Pearson, 2002
2. C.M. Krishna and Kang G. Shin, "**Real Time Systems**", MGH, 1997.
3. Raj Kamal, "**Embedded Systems Architecture, Programming and Design**," Second Edition, TMH, 2003
4. Jane W. S. Liu, "**Real Time Systems**," Pearson Education, 2000.

B19MT7053	Autotronics	HC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	4

Prerequisites:

Embedded System Design, Microcontroller & Control systems

Course Objectives:

1. Explain power train and drive train components in automotive systems.
2. Discuss the role of electronics in engine control systems.
3. Illustrate the concepts of in-vehicle networking.
4. Describe automotive safety systems & infotainment systems.
5. Analyze the status of software in the automotive industry and present the specifications elaborated within the AUTOSAR consortium in terms of standardization

Course Outcomes:

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

1. Explain power train and drive train components in automotive systems.
2. Illustrate the concepts of in-vehicle networking.
3. Describe automotive safety systems & infotainment systems.
4. Analyze the status of software in the automotive industry and present the specifications elaborated within the AUTOSAR consortium in terms of standardization

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 7053	CO1	3	2	1	1	1								2	2	2
	CO2	3	2	1	1	1								2	2	2
	CO3	3	2	2	2	1								2	2	2
	CO4	3	2	2	2	3								2	2	2

Course Contents:

UNIT-I: Automotive Systems [12 Hrs]

Introduction to Power Train System, Transmission System, Braking System, Steering System, Starting System, Charging System. Need for Electronics: Performance, Control & Legislation

UNIT-II: Architecture and Protocols [12 Hrs]

Introduction to control networking, Review of SPI, I2C, USB, CAN, Ethernet, LIN, FLEXRAY, MOST, UDS, KWP200 Protocols.

Power train & Chassis Subsystem: Electronic fuel control in ignition systems, ABS, TCS & ESP, ECUs, and Airbags.

UNIT-III: Automotive Sensors & Actuators [12 Hrs]

Engine Speed Sensor, temperature sensor, Lambda sensor, Accelerometer (knock sensors), automotive engine control actuators, Solenoid actuator, Exhaust Gas Recirculation Actuator.
Automotive Diagnostics: On-board & Off-board diagnostics.

UNIT-IV: AUTOSAR Standard [12 Hrs]

Motivation, AUTOSAR Architecture, Main Areas of AUTOSAR Standardization, AUTOSAR **Models. Infotainment & Navigation Systems**: Vehicle multimedia, Driver Assistance & Navigation.

Text Books:

1. Denton. T – **Automobile Electrical and Electronic Systems**, Edward Arnold publication, 1995.
2. William T.M – **Automotive Electronic Systems**, Heiemann Ltd., London, 1978.

References:

1. Nicholas Navet, **Automotive Embedded System Handbook**, CRC Press, 2009.
2. **BOSCH Automotive Handbook**, Wiley Publications, 8th Edition, 2011.
3. Jason.R.Andrews**, Co-Verification of hardware & software for ARM SoC Design**, Newnes Publications, 2004.
4. F. Balarin, Kluwe, **Hardware Software co-design of embedded systems**, r Academic publishers, 1987.
5. William B. Ribbens, **Understanding Automotive Electronics**, Newnes Publications, 6th Edition, 2003.

B19MT7054	Nano Technology	SC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	4

Prerequisites:

Solid State Devices

Course Objectives:

1. To inspire the students to expect to the trends in development and synthesizing of nano systems and measuring systems to nano scale.
2. To expose the students to the evolution of Nano systems, to the various fabrication techniques.
3. Also, to impart knowledge to the students about nano materials and various nano measurements techniques.

Course Outcomes:

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

1. To attain a broad range of the knowledge required to flourish in the rapidly developing field of Nanotechnology.

2. Facilitate the application of basic physical laws, chemical laws, dynamic behavior as well as steady state performance to design and synthesize MEMS and Microsystems.
3. Acquaint him / her with applications of nanotechnology to solve the problems encountered at a macro level.
4. Gain Proficiency in modeling, simulating and evaluating Nano materials.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 7054	CO1	3	3	2	2	1	1	1						3	3	3
	CO2	3	2	2	3	2								3	3	3
	CO3	3	3	2	2									3	3	3
	CO4	2	2	1	1	1								3	3	3

Course Contents:

UNIT-I: Over View of Nanotechnology [12 Hrs]

Definition, historical development, properties, design and fabrication Nano systems, working principle, applications and advantages of nano system. Nano materials, ordered oxides, Nano arrays, potential health effects. Nano defects in crystals, applications, Nuclear Track nano defects. Fabrication of nano particles, LASER ablation, sol gels, precipitation of quantum dots. Nano layers, PVD, CVD, Epitaxy andion implantation, formation of Silicon oxide- chemical composition, doping properties, optical properties.

UNIT-II: Nano Structuring [12 Hrs]

Nano photolithography, introduction, techniques, optical, electron beam, ion beam, X-ray and Synchrotron, nanolithography for microelectronic industry, nano polishing of Diamond, Etching of Nano structures, Nano imprinting technology, Focused ion beams - LASER interference Lithography Nano arrays –Near-Field Optics - case studies and Trends.

UNIT-III: Science and Synthesis of Nano Materials: [12 Hrs]

Classification of nano structures, Effects of nano scale dimensions on various properties, structural, thermal, chemical, magnetic, optical and electronic properties fluid dynamics –Effect of nano scale dimensions on mechanical properties - vibration, bending, fracture Nanoparticles, Sol-Gel Synthesis, Inert Gas Condensation, High energy Ball Milling, Plasma Synthesis, Electro deposition and other techniques. Synthesis of Carbon nanotubes, Solid carbon source-based production techniques, Gaseous carbon source-based production techniques, Diamond like carbon coating. Top down and bottom up processes.

UNIT-IV: Characterization of Nano Materials [12 Hrs]

Nano-processing systems, Nano measuring systems, characterization, analytical imaging techniques, microscopy techniques, electron microscopy scanning electron microscopy, confocal LASER scanning microscopy - transmission electron microscopy, transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, diffraction techniques, spectroscopy

techniques, Raman spectroscopy, 3D surface analysis, Mechanical, Magnetic and thermal properties, Nano positioning systems.

Case study:

Applications of Nanotechnology in Medicines: Nano biosensors, Electronic Nose, Photo Dynamic Therapy, Molecular Motors, Protein Engineering.

Text Books:

1. Tai – Ran Hsu, **MEMS and Microsystems Design and Manufacture**, Tata-McGraw Hill, New Delhi, 2002.
2. Fahrner W.R., **Nanotechnology and Nano Electronics**, Springer (India) Private Ltd., 2011.
3. Mark Madou, **Fundamentals of Micro fabrication**, CRC Press, New York, 1997.

Reference Books:

1. Norio Taniguchi, **Nano Technology**, Oxford University Press, New York, 2003
2. Mohamed Gad-el-Hak, **MEMS Handbook**, CRC press, 2006, ISBN: 8493-9138-5
3. Waqar Ahmed and Mark J. Jackson, **Emerging Nanotechnologies for Manufacturing**, ElsevierInc.,2013, ISBN: 978-93-82291-39-8
4. Sami Franssila, **Introduction to Micro fabrication**, John Wiley & sons Ltd, 2004. ISBN:470-85106-6
5. Charles P Poole, Frank J Owens, **Introduction to Nano technology**, John Wiley and Sons, 2003
6. Julian W. Hardner **Micro Sensors, Principles and Applications**, CRC Press 1993.

B19MT7055	IoT and Cyber Physical Systems	SC	L	T	P	C	Hrs /week
Duration:14 Wks			2	1	0	3	4

Prerequisites:

Embedded systems, RTOS

Course Objectives:

1. Introduce some concepts and techniques that are core to IoT and CPS.
2. Understand Internet of Things—Robustness and Reliability
3. Acquire knowledge of Modelling Dynamic Behaviors of Cyber Physical Systems.
4. Provide information of Designing of Embedded Systems

Course Outcomes:

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

1. Explain the core concepts of IoT and CPS

2. Create the mathematical relationships within and across Internet of Things architecture and Cyber physical Systems.
3. Design an Embedded System.
4. Identify a real-world problem and apply the learned techniques of CPS Modelling to solve the problem

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 7055	CO1	3	2	1			1				1	1		1	2	2
	CO2	3	2	2	2	2					1	1		2	2	2
	CO3	3	2	3	1									2	2	3
	CO4	3	3	2	1	2	1	1						2	2	3

Course Contents:

UNIT-I: IoT Ecosystem Concepts and Architectures [12 Hrs]

Internet of Things Definition Evolution, IoT Architectures, Resource Management, IoT Data Management and Analytics, Communication Protocols, Internet of Things Applications, Open IoT Architecture for IoT/Cloud Convergence, Scheduling Process and IoT Services Lifecycle,

Internet of Things—Robustness and Reliability: IoT Characteristics and Reliability Issues, Addressing Reliability, IoT Governance.

UNIT-II: IoT Enablers and Solutions [12 Hrs]

Programming Frameworks for Internet of Things: Background, Survey of IoT Programming Frameworks.

IoT Applications: Architecture Overview, Sensors, the Gateway, Data Transmission.

Internet of Vehicles: Basics of IoV, Characteristics and Challenges, Enabling Technologies, Applications

UNIT-III: Modelling Dynamic Behaviors [12 Hrs]

Continuous Dynamics -Properties of Systems, Discrete Dynamics- The Notion of State, Finite-State Machines, Behaviors and Traces, Hybrid Systems - Classes of Hybrid Systems, Composition of State Machines - Hierarchical State Machines, Concurrent Models of Computation - Synchronous-Reactive Models, Dataflow Models of Computation, Timed Models of Computation

UNIT-IV: Design of Embedded Systems [12 Hrs]

Sensors and Actuators - Models of Sensors and Actuators, Common Sensors, Actuators, Parallelism, Memory Architectures - Memory Models, Input and Output - Sequential Software in a Concurrent World, Multitasking – Threads, Scheduling - Basics of Scheduling, Scheduling and Mutual Exclusion, Multiprocessor Scheduling.

Text Books:

1. Rajkumar Buyya, Amir Vahid Dastjerdi, "**Internet of Things Principles and Paradigms**", Morgan Kaufmann- Elsevier Publisher, 2016.
2. E. A. Lee and S. A. Seshia., "**Introduction to Embedded Systems -** A Cyber-Physical Systems Approach", Second Edition, MIT Press, 2017

Reference Books:

1. Peter. Marwedel. **Embedded System Design: Embedded Systems Foundations of Cyber-physical Systems, and the... Internet of Things**. SPRINGER, 2019.
2. Gilchrist, Alasdair. **Industry 4.0: the industrial internet of things**. Apress, 2016.
3. Wolf, Marilyn. **Embedded System Interfacing: Design for the Internet-of-Things (IoT) and Cyber-Physical Systems (CPS)**. Morgan Kaufmann, 2019.

B19MT7060	Robotics and Vision System	OE	L	T	P	C	Hrs /week
Duration:14 Wks			4	0	0	4	4

Prerequisites:

Microcontrollers, Control Systems

Course Objectives:

1. To introduce the applications of robots in industry.
2. To study the robot motion analysis.
3. To introduce the mathematical modelling and trajectory concept.
4. To introduce the concept of programming of robots.

Course Outcomes:

1. Summarize the anatomy of robot and their classification and specification
2. Analyze the Robot Motion Analysis and its control
3. Relate mathematical modelling and trajectory planning scheme in robots.
4. Understand the robot programs and upgrade knowledge on different types of cell layouts applicable in robotics.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 7060	**CO1**	**3**	**3**	**1**	2								2	2	2	2
	CO2	**2**	**1**	**2**	**1**								2	2	2	2
	CO3	**2**	**3**	**3**	**2**								2	1	2	2
	CO4	**2**	**2**	**2**	**2**								2	1	1	2

Course Contents:

Unit-I: Introduction to Robotics [12 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-II: Robot Motion Analysis and Robot Control [12 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-III: Robot Trajectory Planning and Robot Sensors [12 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.

UNIT-IV: Machine Vision and Robot Programming [12 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, Intelligence,** McGraw 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.

B19MT7070	Embedded Systems Lab	HC	L	T	P	C	Hrs /week
Duration:14 Wks			0	0	2	0	3

Prerequisites:

Microcontroller and C Programming

Course Objectives:

1. To understand and implement the concepts of embedded system
2. To write the programs on threads, process individually and execute them

Course Outcomes:

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

1. Understand the firmware system development and firmware development languages.
2. Give a brief description of RTOS, Integrated Development Environment, Simulator and Emulators.
3. Understand the trends in embedded system development.
4. Elaborate the quality attributes, hardware-software co-design in embedded systems.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 7070	CO1	3	2	2	2									2	2	2
	CO2	3	2	2	1	2								2	2	2
	CO3	3	2	2	2									1	2	2
	CO4	3	2	2	1									2	2	2

List of Experiments:

1. Write a program for Thread Creation and Termination
2. Create independent threads each of which will execute some function and wait till threads are complete before main continues. Unless we waitrun the risk of executing an exit which will terminate the process and all threads before the threads have completed.
3. Create the N number of threads and find the how many threads are executed.
4. Create threads numbers 1-3 and 8-10 as permitted by functionCount1and create threads number 4-7 as permitted by functionCount2 and print final count value.
5. Design develop and execute a program using any 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 that upper limit.
6. Rewrite above program (Program 5) such that the processes instead of thread are created and the number of child processes created is fixed as two. The program should make use of kernel timer to measure and print the real time, processor time, User space time and kernel space time for each process.
7. Design, develop and 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. Design develop and execute a program to solve a system of n liner equations using successive over-relaxation method and n processes which use shared memory API
9. CHALLENGE EXPERIMENT: Implement the usage of anonymous pipe with 512 bytes for data sharing between parent and child process using handle inheritance mechanism.

B19MT7080	Communication Systems Lab	HC	L	T	P	C	Hrs

							/week
Duration:14 Wks		**0**	**0**	**2**	**0**		**3**

Prerequisites:

Analog and Digital circuits

Course Objectives:

1. To visualize the effects of sampling and TDM
2. To Implement AM & FM modulation and demodulation
3. To implement PCM & DM
4. To implement FSK, PSK and DPSK schemes
5. To implement Equalization algorithms
6. To implement Error control coding schemes

Course Outcomes:

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

1. Simulate end-to-end Communication Link
2. Demonstrate their knowledge in base band signalling schemes through implementation of FSK, PSK and DPSK
3. Apply various channel coding schemes & demonstrate their capabilities towards the improvement of the noise performance of communication system
4. Simulate & validate the various functional modules of a communication system.
5. Demonstrate a clear understanding of fundamentals of wireless and mobile communication systems and standards.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 7080	**CO1**	**3**	**2**	**2**	**2**	**2**								**2**	**2**	**2**
	CO2	**3**	**2**	**2**	**2**	**1**								**2**	**2**	**2**
	CO3	**3**	**2**	**2**	**2**	**1**								**2**	**2**	**2**
	CO4	**3**	**2**	**2**	**2**	**2**								**2**	**2**	**2**
	CO5	**3**	**2**	**2**	**2**	**1**								**2**	**2**	**2**

List of Experiments:

1. Experiment on amplitude modulation
2. Experiment on amplitude demodulation

a) Signal Sampling and reconstruction
b) Time Division Multiplexing
c) AM Modulator and Demodulator

3. Experiment on frequency modulation
4. Experiment on FM demodulation

a) FM Modulator and Demodulator

5. Experiment on digital communication

a) Pulse Code Modulation and Demodulation
b) Delta Modulation and Demodulation

6. Experiment on digital communication

a) Observation (simulation) of signal constellations of BPSK, QPSK and QAM
b) Line coding schemes
c) FSK, PSK and DPSK schemes (Simulation)
d) Error control coding schemes – Linear Block Codes (Simulation)

7. Experiment on antennas
8. Experiment on wireless networks

a) Communication link simulation 12. Equalization – Zero Forcing & LMS algorithms(simulation)

9. Experiment on mobile communication

EightSemester

B19MT8011	Industrial Robotics	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Robotics and Vision System

Course Objectives:

1. Introduce the concepts of Kinematics of Robotics.
2. Analysis of Motions, velocities and dynamic analysis of force.
3. Introduce the concepts of Motion planning, Trajectory Planning and programming of robot

Course Outcomes:

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

1. Identify the position and orientation of the object in space in a 3 dimensional space.
2. Describe the relationship between joint variables and the position and orientation of the robot end effectors
3. Elaborate the plan of trajectories for the robot end effectors to perform specific task
4. Apply the knowledge to design actual robots to perform basic operations such as pick & place line follower robots etc.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 8011	CO1	3	2	3	2								1	3	3	2
	CO2	3	3	2	2								1	3	3	2
	CO3	3	3	2	2								1	3	3	2
	CO4	3	3	3	2								1	3	3	2

Course Contents:

UNIT-I: Introduction to Industrial Robot [09 Hrs]

Fundamental laws of Robotics, Brief History of Robotics, Classification of Robots, Robot Evaluation-resolution, repeatability and accuracy of robot.

Components of Robots and Structure of Robots: Types of Joints, Representation of Joint, Degrees of Freedom and workspace

Configuration of Robots: RRR (Articulate), RRP (Spherical), RPP (Cylindrical), PPP (Cartesian)

UNIT-II: Kinematics of Robot and Transformations [09 Hrs]

Spatial Description: Description of position and orientation of a rigid body, Types of Frames, Euler angle representation for xyz, xyz frames.

Transformations: Translation, Rotation, Scaling (numerical with real applications), Homogeneous representation of Transformations, Properties of rotation matrices and combined transformations (numerical with real applications).

D-H Convention: Forward Kinematics, Implementation of D-H convention and obtaining transformation matrices for 3R Manipulator, SCARA Manipulator, PUMA 560 Manipulator. Inverse Kinematics, Inverse Kinematics of 3R Manipulator.

UNIT-III: Robot End Effectors and Applications [09 Hrs]

Robot end effectors - Types of end effectors - Mechanical gripper – types of mechanical grippers – magnetic gripper – Vacuum gripper – Adhesive gripper – other special grippers.

Robot Applications- Industrial and non-industrial application, mobile application, limitations and future application of robot.

UNIT-IV: Robot Programming [09 Hrs]

Methods of Programming, Lead through Programming Methods, Three levels of Robot Programming – Teach by Showing, Explicit Robot Programming Language, Task Level Programming Language. Requirements of Robot Programming Language – World Modelling, Motion Specifications, Flow of Execution. Programming Environment, Sensor Integration, AML and VAL. Simple example, programming with graphics,

Text Books:

1. Saeed B. Niku, **Introduction to Robotics: Analysis, Systems, Applications**, 2nd edition, Pearson Education India, PHI 2003 (ISBN 81-7808-677-8)
2. Ganesh Hegde, **Industrial Robotics** University Science Press,2014

References Books:

1. M.P. Groover, **Industrial Robotics – Technology, Programming and Applications,** McGraw-Hill, USA, 1986.
2. Ramesh Jam, Rangachari Kasturi, Brain G. Schunck, **Machine Vision**, Tata McGraw-Hill, 1991.
3. Yoremkoren, **Robotics for Engineers**, McGraw-Hill, USA, 1987.
4. P.A. Janaki Raman, **Robotics and Image Processing**, Tata McGraw-Hill, 1991.

B19MT8012	Hybrid-Electric Vehicles	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Course Objectives:

1. To present a comprehensive overview of conventional Vehicles.
2. To present a comprehensive overview of Electric and Hybrid Electric Vehicles.
3. To identify suitable communication and energy storage system for hybrid vehicles.
4. To recognize the importance of electric and hybrid electric vehicle in automobile industry.
5. To explore the future trends and applications of hybrid vehicles.

Course Outcomes:

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

1. Elaborate and describe the various systems and features adopted for electric vehicles and hybrid electric vehicles.
2. Identify a suitable drive scheme for developing an electric hybrid vehicle depending on resources.
3. Detail basic schemes of electric vehicles and hybrid electric vehicles.
4. Select proper energy storage systems for vehicle applications.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 8012	CO1	3	3	2										3	1	3
	CO2	3	3	3			1							3	1	2
	CO3	2	3	2										3	1	3
	CO4	3	3	3										2	1	2

Course Contents:

UNIT-I: Conventional and Hybrid Electric Vehicles [09 Hrs]

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristic and mathematical models to describe vehicle performance

Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies

UNIT-II: Drive-trains [09 Hrs]

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT-III: Electric Propulsion Unit and Energy Storage [09 Hrs]

Electric Propulsion unit: Electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices

UNIT-IV: Drive and Communications Systems [09 Hrs]

Drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics,

Communications, supporting subsystems: In vehicle networks- CAN, Energy Management Strategies: Energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies

Self-study: selecting the energy storage technology

Text Books:

1. Iqbal Hussein, **Electric and Hybrid Vehicles: Design Fundamentals**, CRC Press, 2003

Reference Books:

1. James Larminie, John Lowry, **Electric Vehicle Technology Explained**, Wiley, 2003
2. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, **Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design**, CRC Press, 2004.

B19MT8013	Safety and Security of Automotive Systems	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

Autotronics

Course Objectives:

1. To impart basic understanding of various types of automobiles
2. To understand electrical system & air conditioning systems of mechatronics systems
3. To explore different components of mechatronic systems
4. To acknowledge modern gadgets used to secure mechatronics systems

Course Outcomes:

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

1. Explain simple and modern fuel injection systems.
2. Analyze numerous parameters involved in assuring safety and security of mechatronics systems.
3. Explore modern gadgets involved in safety and security of mechatronics systems.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3

B19MT 8013	**CO1**	**3**			**2**									**3**	**1**	**1**
	CO2	**3**	**3**	**3**	**3**	**1**	**3**		**2**					**3**	**3**	**2**
	CO3	**3**	**2**	**2**	**2**	**3**	**3**		**2**					**3**	**2**	**3**

Course Contents:

UNIT-I: Automotive Safety and Regulations [09 Hrs]

Types of automobiles. Limiting Dimensions as per Central Motor Vehicles Rules. Engines – Classification, Construction, Materials of engine components. Prototype Testing as per Central Motor Vehicles Rules, Fuel System – Fuel tank, Fuel filter, Types of Fuel system. Carburetor – Simple and Modern, Fuel, injection System. Emission Standards as per CMV Rules.

UNIT-II: Electrical and Electronic Safety [09 Hrs]

Storage Battery Operations and Maintenance. Ignition System – Coil and Magneto Ignition System. Starting System, Lighting System, Horn System – Wind Shield.

UNIT-III: Electromechanical System Safety [09 Hrs]

Wiper Motors, Fans, Heaters, Traficators. Automobile air conditioning. Central Motor Vehicles Rules regarding Lighting, Windshields, Wipers. Transmission System – Clutches – operation and fault finding of clutches, Fluid Flywheel, Gear Box-types, Steering Systems, Chassis Springs, and Suspension

UNIT-IV: Inspection and Maintenance [09 Hrs]

Differential, Dead and Live axles, Rims, Tyre etc. Brakes – Types, construction and fault finding. CMV Rules – Brakes, Steering & Tyre. Lubrication Systems – Types, Components, Lubricating oil, cooling, system – Details of components, Study of Systems, Types

Case Study:

- Special gadgets and accessories for fire fighting vehicles. Automobile accidents.
- CMV Rules regarding Safety devices for drivers, passengers.

Text Books:

1. William H. Crouse, **"Automobile Chassis and Body Construction, Operation and Maintenance**".
2. William H. Crouse, "**Automobile Machines –Principles& Operations**".

Reference Books:

1. GBS Narang, "**Automobile Engineering".**
2. Kirpal Singh, "**Automobile Engineering".**
3. Joseph Heitner, "**Automotive Mechanics-Principles & Practices**".
4. P. L. Kohli, "**Automotive Electrical Equipments**".
5. "The Central Motor Vehicles Rules", 1989

B19MT8014	**Power Electronics**	**SC**	**L**	**T**	**P**	**C**	**Hrs /week**
Duration:14 Wks			**3**	**0**	**0**	**3**	**3**

Prerequisites:

Course Objectives:

1. Provide to the students a detailed knowledge about power semiconductors and their use as switching power devices as well as basic principles of electrical machines.
2. To analyzed in detail accounting different operating conditions of power electronics converters, used for DC or AC conversion from a DC or AC source.
3. Introduce to applications of Power Electronics converters, in particular to power train of electrical vehicles and battery chargers.

Course Outcomes:

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

1. Identify suitable semiconductor device for a given application.
2. Select suitable power electronic converters for different applications
3. Analyze and identify different types of techniques used for control and conversion of power.
4. Select suitable drives for different applications.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 8014	CO1	3	3	1	1	2								3	3	3
	CO2	3	3	2	1	2								3	3	2
	CO3	3	3	1										2	2	2
	CO4	3	3	2	1	2								1	2	2

Course Contents:

UNIT-I: Power Semi-Conductor Devices [09 Hrs]

Principle of operation – Characteristics of power diodes, SCR, TRIAC, GTO, Power BJT, Power MOSFET and IGBT – Thyristor protection circuits. Static and dynamic behavior. Thermal behavior. Conduction and switching losses. Technical specifications provided by manufacturers' datasheets. Driving circuits.

UNIT-II: Power Converters [09 Hrs]

DC-DC Converters. Buck, Boost, Buck-Boost. Switching losses reduction. Modulation techniques (PWM, PFM, PRM). Half and Full Bridge DC-DC converters.

DC-AC Converters (Inverters). Half and Full Bridge DC-AC single-phase converters based on static switches. Three-phase converters. Modulation techniques. Selective Harmonic Elimination (SHE). Sinusoidal Pulse Width Modulation (SPWM).

UNIT-III: Phase Controlled Converters [09 Hrs]

Controlled rectifiers: Single phase semi and full converters, 3 phase half converter and 3 phase full converter – Thyristor triggering circuits.

Ac Voltage Controllers: Single phase AC voltage controller – on - off control and phase control (with R-load and RL load)

UNIT-IV: Electrical Drives [09 Hrs]

DC variable speed drives: Four quadrant operation, Motor control based on the DC chopper and H-bridge converter (common hardware topology), Closed-loop transfer function and analysis, Stepper

motors and operating principle.

AC variable speed drives: Induction motor control - scalar control, open-loop flux vector control, closed-loop vector control. Permanent magnet synchronous motor control (sinusoidal MMF distribution, trapezoidal MMF distribution/BLDC) – vector control. Explanation of the motor control principles are based on the space vector representations of the three-phase electromagnetic quantities (e.g. voltage, current, flux).

Power Electronics Applications (use cases)

1. Power Converters simulation using Matlab-Simulink/Sim power system.
2. Example of Power trains for electrical vehicles. Battery chargers

Text Books:

1. Muhammad H. Rashid, **Power Electronics: Circuits, Devices & Applications**, Pearson.
2. N. Mohan, **Power Electronics**: A First Course, Wiley.

Reference Books:

1. Lander, W., **"Power Electronics"** McGraw-Hill and Company, 3rd Edition, 1993.
2. Singh, M.D., Khanchandani, K.B., **"Power Electronics",** Tata McGraw-Hill, 1998.
3. Dubey, G.K., Doradia, S.R., Joshi, A. and Singh, R.M., **"Thyristorised Power Controllers",** Wiley Eastern Limited, 1986.
4. Mohan Undeland and Robbins, **"Power Electronics",** John Wilry and Sons, New York, 1995.

B19MT8015	Project Management	SC	L	T	P	C	Hrs /week
Duration:14 Wks			3	0	0	3	3

Prerequisites:

None

Course Objectives:

1. To provide the knowledge of project management, methodology
2. To know the use of project management tools, techniques and skills.
3. To give knowledge to manage the project cost, quality and delivery.
4. To learn the skill of selection and initiation of individual projects and portfolios of projects in the enterprise.

Course Outcomes:

After successful completion of the course, the students 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.
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 by applying effective management techniques.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
B19MT 8015	CO1	2	1	1										2		1
	CO2	2	1	1										2	1	1
	CO3	3	2	1										2	1	1
	CO4	2	1	1										2		1

Course Contents:

UNIT-I: Introduction to Project Management [09 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-II: Project Planning and Estimation [09 Hrs]Feasibility study and report, phased planning, project planning steps: objectives and goals of the project, preparation of cost estimation, finalization of project implementation, and 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-III: Project Scheduling, Coordination and Control [09 Hrs]

Project implementation, scheduling-different techniques-GANTT 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-IV: Project Inventory Management [09 Hrs]

Performance indicators, performance improvement for the CM and DM companies for better project management, 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 Book:

1. Harvey Maylor **Project Management,** , 3rd edition, Pearson, 2003,

B19MT8030	Project Work	HC	L	T	P	J	C	Hrs /week
Duration:14 Wks			0	0	0	12	12	12

Prerequisites:

Mechatronics Knowledge

Course Objectives:

1. To identify the problem in real time application and find out the solution
2. To make the students to convert their ideas in to reality.
3. To develop the skill of writing, documentation and presentation.

Course Outcomes:

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

1. Identify the problems in the real time application.
2. Apply the knowledge to analyze the problem.
3. Document the progression of the work and results.
4. Design the process/ product for simple applications.

Mapping of Course Outcomes with Programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
B19MT 8030	CO1	3	3	3				3	3	3	2		2	3	3	3
	CO2	3	3	3	3	1	2	2	2	3	3	3	3	3	3	3
	CO3	2		3		3			3	3	3			3	3	3
	CO4	3	3	3	2	3	3	3	2	3	3	3	3	3	3	3

Course Contents:

The students have to make a project team of minimum two candidates to maximum of four candidates and select the problems from an industry or in the society or any innovative ideas. The project team has to work for the solution or converting their ideas into product and present the progress of the work in two phases which will be evaluated for 50 marks. At the end of the semester the students have to submit the hard copy of the report which will be prepared as per the guidelines/format of the university. Semester end evaluation will be conducted batch wise.