
REVA UNIVERSITY
Bengaluru, India

# SCHOOL OF MECHANICAL ENGINEERING

## B.Tech

## in

## Mechatronics Engineering

## HAND BOOK

## 2020-24

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

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Bengaluru, India

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## B. Tech. in Mechatronics Engineering

**2020-2024**

## Approved by

BOS/ME/BMT/2018-19/01/13-04-2019
BOS/ME/BMT/2019-20/02/20.06.2020

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Rukmini Educational
Charitable Trust

**www.reva.edu.in**

# Chancellor's Message

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

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

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

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

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

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

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

# Vice-Chancellor's Message

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

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

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

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

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

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

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

Welcome to the portals of REVA University!

**Dr. M. Dhanamjaya**
Vice-Chancellor, REVA University

## Director'sMessage

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 Master'sProgram leading to M. Tech. Degree in Machine Design. More than 1500 students representing various parts of India as well a few students from overseas study 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. Our students are very successful in developing and demonstrating technologically advanced projects during their final year.

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 PhD 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

**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), REVAIndependentPU 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 ofDr. 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 27$^{th}$February, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

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

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

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

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance.

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

REVA University recognizing the fact that research, development and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology and other areas of study. The interdisciplinary-multidisciplinary research is given the top most priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano- Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nana Tribology, 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 suchcultural events the students are given opportunities to unfold their hidden talents andmotivate 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 distributingawardsandprizes. The foundershave 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 leadershipqualities, ethical andmoral 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,**<br>Associate Professor,<br>Department of Metallurgy & Materials Engineering, IIT Madras, Chennai. |
| 2 | **Mr. K. N. Narsimha Murthy**<br>Chairman, Fluid Air Systems, Bengaluru.<br>Hon. Treasurer, Karnataka Small Scale Industries Association (KSSIA) |
| 3 | **Prof. M. V. Krishna Murthy**<br>FormerProfessor, Dept.MechanicalEngineering,IITMadras, Chennai,<br>Former Director, VIT,Vellore. |
| 4 | **Mr. Praveen KumarJinde,**<br>Scientist, NAL, Bengaluru. |
| 5 | **Dr. K Ramachandra**<br>Former Director, GTRE, Bangalore<br>CEO, NP-MICAV's National Design Research Forum The Institute of Engineers, Bengaluru. |
| 6 | **Prof. E. Abhilash**<br>Dept. Mechanical Engineering,<br>King Khalid University Abha, Kingdom of Saudi Arabia. |

# 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)

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.


# REVA University Academic Regulations

## B. Tech., (4 years) Degree Programs

## (Applicable for the programs offered from 2020-21)

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

**1. Title and Commencement:**

1.1 These Regulations shall be called **"REVA University Academic Regulations – B. Tech., Degree Program 2020-21 Batch subject to amendments from time to time by the Academic Council on recommendation of respective Board of Studies and approval of Board of Management**

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

**2. The Programs:**

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

**B Tech in:**

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

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

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

**3.2** The medium of instruction shall be English.

**4. Definitions:**

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

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

| | |
|---|---|
| **L** | **Lecture** |
| **T** | **Tutorial** |
| **P** | **Practice** |

Where:

**L** stands for **Lecture** session consisting of classroom instruction.
**T** stands for **Tutorial** session consisting participatory discussion / self-study/ desk work/ brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes.
**P** stands for **Practice** session and it consists of Hands on Experience / Laboratory Experiments / Field Studies / Case Studies / Project Based Learning or Course end Project/Self Study/ Online courses from listed portals that equip students to acquire the much required skill component.

**4.2 Classification of Courses**

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

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

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

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

**4.2.4** **Soft Core Course (SC) (also known as Professional Elective Course)**
A Core course may be a **Soft Core** if there is a choice or an option for the candidate to choose a course from a pool of courses from the main branch of study or from a sister/related branch of study which supports the main branch of study

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

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

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

## 5. Eligibility for Admission:

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

| Sl. No. | Program | Duration | Eligibility |
|---|---|---|---|
| 1 | Bachelor of Technology (B Tech) | 4 Years (8 Semesters) | Passed 10+2 examination with Physics and Mathematics as compulsory subjects, along with any one of the following subjects, namely, Chemistry, Bio-Technology, Computer Science, Biology, Electronics and Technical Vocational subject Obtained at least 45% marks (40% in case of candidate belonging to SC/ST category) in the above subjects taken together. |
| 2 | Bachelor of Technology (B Tech) | Lateral entry to second year | A. Passed Diploma examination from an AICTE approved Institution with at least 45% marks (40% in case of candidates belonging to SC/ST category) in appropriate branch of Engineering / Technology.<br><br>B. Passed B. Sc Degree from a recognized University as defined by UGC, with at least 45% marks (40% in case of candidates belonging to SC/ST category) and passed XII standard with mathematics as a subject.<br><br>C. Provided that in case of students belonging to B. Sc. Stream, shall clear the subjects of Engineering Graphics / Engineering Drawing and Engineering Mechanics of the first year Engineering program along with the second year subjects.<br><br>D. Provided further that, the students belonging to B. Sc. Stream shall be considered only after filling the seats in this category with students belonging to the Diploma stream.<br><br>E. Provided further that student, who have passed Diploma in Engineering & Technology from an AICTE approved Institution or B. Sc., Degree from a recognized University as defined by UGC, shall also be eligible for admission to the first year Engineering Degree courses subject to vacancies in the first year class in case the vacancies at lateral entry are |

| Sl. No. | Program | Duration | Eligibility |
|---|---|---|---|
| | | | exhausted. However the admissions shall be based strictly on the eligibility criteria as mentioned in A, B, D, and E above. |
| | Bachelor of Technology (B Tech) | Lateral entry to fourth year (final year) | Any candidate with genuine reason from any University / Institution in the country upon credit transfer could be considered for lateral admission to the respective semester in the concerned branch of study, provided he/she fulfils the University requirements. |
| 4 | B. Tech. in Bioelectronics | | Pass in PUC / 10+2 examination with Physics and Mathematics as compulsory subjects along with one of the Chemistry / Biotechnology / Biology / Computer Science / Electronics / Technical Vocational subjects and obtained minimum 45% marks (40% in case of candidates belonging to SC / ST category) in the above subjects taken together of any board recognized by the respective State Government / Central Government / Union Territories or any other qualification recognized as equivalent there to. |

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

## 6. Courses of Study and Credits

**6.1** Each course of study is assigned with certain credit value

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

**6.3** The credit hours defined as below:

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

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

**The total duration of a semester is 20 weeks inclusive of semester-end examination.**
The following table describes credit pattern

| Table -2: Credit Pattern | | | | | |
|---|---|---|---|---|---|
| **Lectures (L)** | **Tutorials (T)** | **Practice (P)** | **Credits (L:T:P)** | **Total Credits** | **Total Contact Hours** |
| 4 | 2 | 0 | 4:1:0 | 5 | 6 |
| 3 | 2 | 0 | 3:1:0 | 4 | 5 |
| 3 | 0 | 2 | 3:0:1 | 4 | 5 |
| 2 | 2 | 2 | 2:1:1 | 4 | 6 |
| 0 | 0 | 6 | 0:0:3 | 3 | 6 |
| 4 | 0 | 0 | 4:0:0 | 4 | 4 |
| 2 | 0 | 0 | 2:0:0 | 2 | 2 |

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

**7.** Different C**ourses of Study**:
Different C**ourses of Study** are labeled as follows:

a. Core Course (CC)
b. Foundation Course (FC)

c. Hard Core Course (HC)

d. Soft Core Course (SC)
e. Open Elective Course (OE)

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

These are defined under Section 4 of these regulations.

**8. Credits and Credit Distribution**

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

| **Course Type** | **Credits (Range)**<br>**For B Tech Degree (8 Semesters)** |
|---|---|
| Foundation Core Course | A minimum of 06 but not exceeding 12 |
| Hard Core Course | A minimum of 118 but not exceeding 121 |
| Soft Core Course | A minimum of 15 but not exceeding 21 |

| | |
|---|---|
| Open Elective | A minimum of 04 but not exceeding 12 |

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

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

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

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

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

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

**8.7 Add- on Proficiency Certification:**

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

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

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

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

## 9 Assessment and Evaluation

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

i. Internal Assessment (IA); and

ii. Semester End Examination (SEE)

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

**9.3** The 50 marks of internal assessment shall comprise of:

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

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

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

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

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

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

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

**9.8** A test paper is set for a maximum of 30 marks to be answered in 1 hour duration. A test paper can have 4 main questions. Each main question is set for 10 marks. The main question can have 2-3 sub questions all totalling 10 marks. Students are required to answer any three main questions. Each question is set using Bloom's verbs. The questions must be set to assess the course outcomes described in the course document even with the choice is given in question

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

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

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

individual exercise. This should encourage collaborative learning and team learning and also self-study.

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

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

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

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

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

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

**9.18** There shall also be an **Program Assessment Committee (PAC)** comprising at-least 3 faculty members having subject expertise who shall after completion of examination process and declaration of results review the results sheets, assess the performance level of the students, measure the attainment of course outcomes, program outcomes and assess whether the program educational objectives are achieved and report to the Director of the School. The Examination Review Committee shall also review the question papers of both Internal Tests as well Semester End Examinations and submit reports to the Director of the respective School about the scope of the curriculum covered and quality of the questions.

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

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

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

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

**9.23** Online courses may be offered as per UGC norms.

For online course assessment guidelines would be as follows:

1. If the assessment is done by the course provider, then the School can accept the marks awarded by the course provider and assign the grade as per REVA University norms.

2. If the assessment is not done by the course provider then the assessment is organized by the concerned school and the procedure explained in the regulation will apply
3. In case a student fails in an online course, s/he may be allowed to repeat the course and earn the required credits

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

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

**9.25** Utilization of one or two credit online courses would be:
4 week online course – 1 credit
8 week online course / MOOC – 2 credits
12 week online course / MOOC – 3 credits

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

**Summary of Internal Assessment and Evaluation Schedule**

| **Sl. No.** | **Type of Assessment** | **when** | **Syllabus Covered** | **Max Marks** | **Reduced to** | **Date by which the process must be completed** |
|---|---|---|---|---|---|---|
| 1 | Test-1 | During 6th week | First 40% | 30 | 15 | 7th week |
| 2 | Test -2 | During 12th Week | Second 40% | 30 | 15 | 13th Week |
| 3 | Assignment / Quiz | 15th Week | Last 20% | 20 | 20 | 16th Week |
| 4 | SEE | 18/19th Week | 100% | 100 | 50 | 20th Week |

## 10 Assessment of Students Performance in Practical Courses

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

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

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

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

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

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

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

**For > 3 credit courses**

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

**For 1 & 2 credit courses**

| | | |
|---|---|---|
| i | IA | 25 marks |
| ii | Semester end examination by the concern school board (demo, test, viva voice etc.) | 25 marks |
| | **Total** | **50 marks** |

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

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

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

**12. Requirements to Pass a Course:**

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

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

| **Marks, P** | **Grade, G** | **Grade Point (GP=V x G)** | **Letter Grade** |
|---|---|---|---|
| 90-100 | 10 | v*10 | O |

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

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

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

**a. Computation of SGPA and CGPA**

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

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

**Illustration for Computation of SGPA and CGPA**

**Illustration No. 1**

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

Thus, **SGPA = 159 ÷ 19 = 8.37**

**Illustration No. 2**

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

| | | | | |
|---|---|---|---|---|
| Course 8 | 2 | O | 10 | 2X10=20 |
| | 24 | | | 175 |

Thus, SGPA = 175 ÷ 24 = 7.29

**Illustration No.3**

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

Thus**, SGPA = 199 ÷ 24 = 8.29**

**b. Cumulative Grade Point Average (CGPA):**

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

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

**Illustration:**

**CGPA after Final Semester**

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

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

**c. Conversion of grades into percentage:**

Conversion formula for the conversion of CGPA into Percentage is:
Percentage of marks scored = CGPA Earned x 10
**Illustration: CGPA Earned 8.05 x 10=80.5**

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

**13. Classification of Results**

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

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

**Overall percentage=10*CGPA**

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

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

**14. Attendance Requirement:**

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

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

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

**15. Re-Registration and Re-Admission:**

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

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

**16. Absence during Internal Test:**

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

**17. Provision for Appeal**

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

**18. Grievance Committee:**

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

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

- The Controller of Examinations - Ex-officio Chairman / Convener
- One Senior Faculty Member (other than those concerned with the evaluation of the course concerned) drawn from the 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.

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

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

**20. Provision for Supplementary Examination**

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

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

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

**Case 1:** A student who has failed in a maximum of 4 courses in 1$^{st}$ and 2$^{nd}$ semester together shall move to the 3$^{rd}$ semester of the succeeding year.
**Case 2:** A student who has failed in a maximum of 4 courses from semester 1 to 4 together shall move to the 5$^{th}$ semester of the succeeding year.
**Case 3:**A students who has failed in a maximum of 4 courses from semester 1 to 6 together shall move to the 7$^{th}$ semester of the succeeding year.

**22. Challenge Valuation:**

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

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

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

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

# B.Tech. in Mechatronics Engineering

**Curriculum Structure for B.Tech. Mechatronics Engineering Program**

**SEMESTER-1 (Cycle-1)**

| Sl. No | Course Code | Title of the Course | HC/FC/ SC / OE | Pre requisite | Credit Pattern & Credit Value | | | | Contact Hours / Week |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | Total | |
| 1 | B20AS0103 | Differential Equations and Linear Algebra | FC | PUC/ Equivalent | 3 | 0 | 0 | 3 | 3 |
| 2 | B20AS0107 | Physics for Engineers | FC | PUC/ Equivalent | 3 | 0 | 1 | 4 | 5 |
| 3 | B20CS0101 | Introduction to Data Science | HC | PUC/ Equivalent | 2 | 0 | 1 | 3 | 4 |
| 4 | B20ER0101 | Introduction to Engineering Mechanics | HC | PUC/ Equivalent | 3 | 0 | 0 | 3 | 3 |
| | **Practical /Term Work / Practice Sessions/Online /MOOC** | | | | | | | | |
| 5 | B20ME0104 | Entrepreneurship | HC | PUC/ Equivalent | 1 | 0 | 0 | 1 | 1 |
| 6 | B20EC0101 | IoT and Applications | HC | PUC/ Equivalent | 1 | 0 | 1 | 2 | 3 |
| 7 | B20ME0101 | Computer Aided Engineering Drawing | HC | PUC/ Equivalent | 2 | 0 | 1 | 3 | 4 |
| | | | | TOTAL | 15 | 0 | 4 | 6 | 23 |
| | | | | TOTAL SEMESTER CREDITS | | | | 19 | |
| | | | | TOTAL CUMULATIVE CREDITS | | | | 19 | |
| | | | | TOTAL CONTACT HOURS | | | | 23 | |

**SEMESTER-2 (Cycle-2)**

| Sl. No | Course Code | Title of the Course | HC/FC/SC/ OE | Pre requisite | Credit Pattern & Credit Value | | | | Contact Hours/ Week |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | Total | |
| 1 | B20AS0205 | Vector Calculus and Partial Differential Equations | FC | B20AS0103 | 3 | 1 | 0 | 4 | 4 |
| 2 | B20AS0201 | Applied Chemistry | FC | - | 3 | 0 | 0 | 3 | 3 |
| 3 | B20CI0101 | Introduction to Python programming | HC | - | 2 | 0 | 1 | 3 | 4 |
| 4 | B20EE0101 | Basic Electrical and Electronics Engineering | HC | - | 3 | 0 | 1 | 4 | 5 |
| 5 | B20ER0201 | Elements of Mechanical Engineering | HC | - | 3 | 0 | 1 | 4 | 5 |
| | **Practical /Term Work / Practice Sessions/Online /MOOC** | | | | | | | | |
| 6 | B20AS0109 | Biology for Engineers | FC | - | 1 | 0 | 0 | 1 | 1 |
| 7 | B20ME0102 | Design Thinking | HC | - | 1 | 0 | 1 | 2 | 3 |
| | | | | TOTAL | 16 | 0 | 5 | 21 | 25 |
| | | | | TOTAL SEMESTER CREDITS | | | | 21 | |
| | | | | TOTAL CUMULATIVE CREDITS | | | | 40 | |

| | |
|---|---|
| TOTAL CONTACT HOURS | 25 |

**SEMESTER-3**

| Sl. No | Course Code | Title of the Course | HC/FC/ SC/OE | Pre requisite | Credit Pattern & Credit Value | | | | Contact Hours/ Week |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | Total | |
| 1 | B20AS0304 | Laplace Transforms and Fourier Series | HC | B20AS0205 | 3 | 0 | 0 | 3 | 3 |
| 2 | B20ES0301 | Thermal Engineering | HC | | 3 | 1 | 0 | 4 | 4 |
| 3 | B20ES0302 | Signals and Networks | HC | | 3 | 0 | 0 | 3 | 3 |
| 4 | B20ES0303 | Analog and Digital Circuits | HC | | 3 | 0 | 1 | 4 | 5 |
| 5 | B20ER0304 | Mechanics of Materials | HC | | 3 | 0 | 1 | 4 | 5 |
| **Practical /Term Work / Practice Sessions/Online /MOOC** | | | | | | | | | |
| 6 | B20AH0301 | Communication Skills | FC | | 2 | 0 | 0 | 2 | 2 |
| 7 | B20LS0301 | Indian constitution and Professional Ethics | FC | | 2 | 0 | 0 | 2 | 2 |
| 8 | B20AHM301 | Advanced Kannada | MC | | 0 | 0 | 0 | 0 | 2 |
| | B20AHM302 | Basics of Kannada | MC | | 0 | 0 | 0 | 0 | 2 |
| **TOTAL** | | | | | **19** | **1** | **2** | **22** | **27** |
| **TOTAL SEMESTER CREDITS** | | | | | | | | **22** | |
| **TOTAL CUMULATIVE CREDITS** | | | | | | | | **62** | |
| **TOTAL CONTACT HOURS** | | | | | | | | **27** | |

**SEMESTER-4**

| Sl. No | Course Code | Title of the Course | HC/FC/ SC/ OE | Pre requisite | Credit Pattern & Credit Value | | | | Contact Hours/ Week |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | Total | |
| 1 | B20AS0403 | Probability and Sampling Theory | HC | B20AS0304 | 3 | 0 | 0 | 3 | 3 |
| 2 | B20ER0401 | Mechanical Measurements and Metrology. | HC | | 2 | 0 | 1 | 3 | 4 |
| 3 | B20ER0403 | Kinematics and Dynamics of Machines | HC | | 3 | 0 | 1 | 4 | 5 |
| 4 | B20ES0401 | Microcontrollers and Applications | HC | | 3 | 0 | 1 | 4 | 5 |
| 5 | B20ES0402 | Sensors and Actuators | HC | | 3 | 0 | 0 | 3 | 3 |
| Practical /Term Work / Practice Sessions/Online /MOOC | | | | | | | | | |
| 6 | B20ES0403 | MATLAB | HC | | 0 | 0 | 1 | 1 | 2 |
| 7 | B20MG0301 | Management Science | HC | | 2 | 0 | 0 | 2 | 2 |
| 8 | B20AS0303 | Environmental Science | FC | | 2 | 0 | 0 | 2 | 2 |
| 9 | B20AHM401 | Universal Human Values | FC | | 0 | 0 | 0 | 0 | 2 |
| **TOTAL** | | | | | **18** | **0** | **4** | **22** | **28** |
| **TOTAL SEMESTER CREDITS** | | | | | | | | **22** | |

| | |
|---|---|
| **TOTAL CUMULATIVE CREDITS** | **84** |
| **TOTAL CONTACT HOURS** | **28** |

**SEMESTER-5**

| Sl. No | Course Code | Title of the Course | HC/FC/SC/ OE | Pre requisite | Credit Pattern & Credit Value | | | | Contact Hours/ Week |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | Total | |
| 1 | B20ES0501 | Electrical Machines and Drives | HC | B20EE0101 | 3 | 0 | 0 | 3 | 3 |
| 2 | B20ER0302 | Material Science | HC | | 3 | 0 | 0 | 3 | 3 |
| 3 | B20ES0502 | Control Systems | HC | | 3 | 0 | 0 | 3 | 3 |
| 4 | B20ES0503 | Robotics | HC | | 4 | 0 | 0 | 4 | 4 |
| **Professional Elective-1** | | | | | | | | | |
| 5 | B20ESS511 | CNC Machines | SC | B20ER0201 | 3 | 0 | 0 | 3 | 3 |
| | B20ESS512 | Conventional and Electrical Vehicles | SC | | 3 | 0 | 0 | 3 | 3 |
| | B20ESS513 | Product Design and Development | SC | | 3 | 0 | 0 | 3 | 3 |
| | B20ESS514 | Data Structures | SC | | 2 | 0 | 1 | 3 | 4 |
| **Open Elective-1 for other school students** | | | | | | | | | |
| 6 | B20MEO501 | Smart Materials | OE | | 3 | 0 | 0 | 3 | 3 |
| **Practical /Term Work / Practice Sessions/Online /MOOC** | | | | | | | | | |
| 7 | B20ES0504 | Control Systems Lab | HC | | 0 | 0 | 1 | 1 | 2 |
| 8 | B20ES0505 | Robotics Lab | HC | | 0 | 0 | 1 | 1 | 2 |
| 9 | B20PA0501 | Indian Tradition and Culture | FC | | 1 | 0 | 0 | 1 | 1 |
| **TOTAL** | | | | | **20** | **0** | **2** | **22** | **24** |
| **TOTAL SEMESTER CREDITS** | | | | | | | | **22** | |
| **TOTAL CUMULATIVE CREDITS** | | | | | | | | **106** | |
| **TOTAL CONTACT HOURS** | | | | | | | | **24** | |

**SEMESTER-6**

| Sl. No | Course Code | Title of the Course | HC/FC/SC/ OE | Pre requisite | Credit Pattern & Credit Value | | | | Contact Hours/ Week |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | Total | |
| 1 | B20ES0601 | Automation in Production | HC | | 3 | 0 | 0 | 3 | 3 |
| 2 | B20ES0602 | Introduction to Finite Element Methods | HC | B20ER0304 | 3 | 1 | 0 | 4 | 5 |
| 3 | B20ES0603 | Optimization Methods | HC | | 3 | 0 | 0 | 3 | 3 |
| **Professional Elective-2** | | | | | | | | | |
| 4 | B20ESS611 | Robotic Dynamics and Control | SC | B20ES0503 | 3 | 0 | 0 | 3 | 3 |
| | B20ESS612 | Hybrid Vehicles | SC | | 3 | 0 | 0 | 3 | 3 |
| | B20ESS613 | Digital Manufacturing systems | SC | B20EC0101 | 3 | 0 | 0 | 3 | 3 |
| | B20ESS614 | Computer Vision | SC | | 3 | 0 | 0 | 3 | 3 |
| **Professional Elective-3** | | | | | | | | | |
| 5 | B20ESS621 | Autotronics and Vehicle Automation | SC | | 3 | 0 | 0 | 3 | 3 |
| | B20ESS622 | Aircraft Flight and Control System | SC | | 3 | 0 | 0 | 3 | 3 |
| | B20ESS623 | Operation Management | SC | | 3 | 0 | 0 | 3 | 3 |
| | B20ESS624 | Machine Learning with Python | SC | | 2 | 0 | 1 | 3 | 4 |
| **Open Elective-2 for other school students** | | | | | | | | | |
| 6 | B20MEO601 | Energy Technology | OE | | 3 | 0 | 0 | 3 | 3 |
| **Practical /Term Work / Practice Sessions/Online /MOOC** | | | | | | | | | |
| 7 | B20ES0604 | Research Based Mini Project | HC | | 0 | 0 | 1 | 1 | 2 |
| 8 | B20ER0605 | Technical Documentation | FC | | 1 | 0 | 0 | 1 | 1 |
| 9 | B20ES0606 | Automation Lab | HC | | 0 | 0 | 1 | 1 | 2 |
| 10 | B20ES0607 | Computer Aided Engineering Lab | HC | | 0 | 0 | 1 | 1 | 2 |
| | | | | **TOTAL** | **19** | **1** | **3** | **23** | **27** |
| | | | | **TOTAL SEMESTER CREDITS** | | | | **23** | |
| | | | | **TOTAL CUMULATIVE CREDITS** | | | | **129** | |
| | | | | **TOTAL CONTACT HOURS** | | | | **27** | |

**SEMESTER-7**

| Sl. No | Course Code | Title of the Course | HC/FC/SC/ OE | Pre requisite | Credit Pattern & Credit Value | | | | Contact Hours/ Week |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | Total | |
| 1 | B20ES0701 | Design of Machine Elements | HC | B20ER0304 | 3 | 1 | 0 | 4 | 4 |
| 2 | B20ES0702 | Introduction to Hydraulics and Pneumatics | HC | | 3 | 0 | 0 | 3 | 3 |
| 3 | B20ES0703 | Digital Signal Processing | HC | | 3 | 0 | 0 | 3 | 3 |
| **Professional Elective-4** | | | | | | | | | |
| 4 | B20ESS711 | Additive Manufacturing | SC | | 3 | 0 | 0 | 3 | 3 |
| | B20ESS712 | Smart Materials | SC | B20ER0302 | 3 | 0 | 0 | 3 | 3 |
| | B20ESS713 | Engineering Economics and Financial Management | SC | | 3 | 0 | 0 | 3 | 3 |
| | B20ESS714 | Internship | SC | | 0 | 0 | 3 | 3 | 6 |
| **Professional Elective-5** | | | | | | | | | |
| 5 | B20ESS721 | IoT and Cyber Physical Systems | SC | B20EC0101 | 3 | 0 | 0 | 3 | 3 |
| | B20ESS722 | Agriculture Automation and Smart Farming | SC | | 3 | 0 | 0 | 3 | 3 |
| | B20ESS723 | Micro and Nano Mechatronics Systems | SC | | 3 | 0 | 0 | 3 | 3 |
| | B20ESS724 | Artificial Intelligence | SC | | 3 | 0 | 0 | 3 | 3 |
| **Open Elective-3 for other school students** | | | | | | | | | |
| 6 | B20MEO701 | Electric And Hybrid Vehicles | OE | | 3 | 0 | 0 | 3 | 3 |
| **Practical /Term Work / Practice Sessions/Online /MOOC** | | | | | | | | | |
| 7 | B20ES0704 | Hydraulics and Pneumatics Lab | HC | | 0 | 0 | 1 | 1 | 2 |
| 8 | B20ES0705 | Digital Signal Processing Lab | HC | | 0 | 0 | 1 | 1 | 2 |
| | | | | **TOTAL** | **18** | **1** | **2** | **21** | **23** |
| | | | | | | | | **TOTAL SEMESTER CREDITS** | **21** |
| | | | | | | | | **TOTAL CUMULATIVE CREDITS** | **150** |
| | | | | | | | | **TOTAL CONTACT HOURS** | **23** |

**SEMESTER-8**

| Sl. No | Course Code | Title of the Course | HC/FC/SC/ OE | Pre requisite | Credit Pattern & Credit Value | | | | Contact Hours/ Week |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | Total | |
| **Open Elective-4 for other school students** | | | | | | | | | |
| 1 | B20MEO801 | Total Quality Management And Six Sigma | OE | | 3 | 0 | 0 | 3 | 3 |
| **Practical /Term Work / Practice Sessions/Online /MOOC** | | | | | | | | | |
| 2 | B20ES0801 | Major Project | HC | | 0 | 0 | 7 | 7 | 21 |
| | | | | **TOTAL** | **3** | **0** | **7** | **10** | **24** |
| | | | | | | | | **TOTAL SEMESTER CREDITS** | **10** |
| | | | | | | | | **TOTAL CUMULATIVE CREDITS** | **160** |

| | | |
|---|---|---|
| | **TOTAL CONTACT HOURS** | **24** |

## List of Professional Electives:

| Sl.No | Course Code | Title of the Course |
|---|---|---|
| 1 | B20ESS511 | CNC Machines |
| 2 | B20ESS512 | Conventional and Electrical Vehicles |
| 3 | B20ESS513 | Product Design and Development |
| 4 | B20ESS514 | Data Structures |
| 5 | B20ESS611 | Robotics Dynamics and Control |
| 6 | B20ESS612 | Hybrid Vehicles |
| 7 | B20ESS613 | Digital Manufacturing systems |
| 8 | B20ESS614 | Computer Vision |
| 9 | B20ESS621 | Autotronics and Vehicle Automation |
| 10 | B20ESS622 | Aircraft Flight and Control System |
| 11 | B20ESS623 | Operation Management |
| 12 | B20ESS624 | Machine Learning with Python |
| 13 | B20ESS711 | Additive Manufacturing |
| 14 | B20ESS712 | Smart Materials |
| 15 | B20ESS713 | Engineering Economics and Financial Management |
| 16 | B20ESS714 | Internship |
| 17 | B20ESS721 | IoT and Cyber Physical Systems |
| 18 | B20ESS722 | Agriculture Automation and Smart Farming |
| 19 | B20ESS723 | Micro and Nano Mechatronics Systems |
| 20 | B20ESS724 | Artificial Intelligence |

**List of Open Elective Courses**

| Sl.No | Course Code | Semester | Open Elective Course Name | Offered by | Offered to School |
|---|---|---|---|---|---|
| 1 | B20CEO501 | 5 | BUILDING MATERIALS AND CONSTRUCTION | CE | All Engineering |
| 2 | B20CEO601 | 6 | BUILDING PLANNING AND BYE LAWS | CE | All Engineering |
| 3 | B20CEO701 | 7 | DISASTER PREPAREDNESS, PLANNING AND MANAGEMENT | CE | All Engineering |
| 4 | B20CEO801 | 8 | ROAD SAFETY AND MANAGEMENT | CE | All Engineering |
| 5 | B20CIO501 | 5 | INTRODUCTION TO AI | CI | Mech, Civil, ECE,EEE |
| 6 | B20CIO502 | 5 | OOPS WITH C++ | CI | Mech, Civil, ECE,EEE |
| 7 | B20CIO503 | 5 | WEB TECHNOLOGY | CI | Mech, Civil, ECE,EEE |
| 8 | B20CIO601 | 6 | DATA MINING | CI | Mech, Civil, ECE,EEE |
| 9 | B20CIO602 | 6 | MACHINE LEARNING | CI | Mech, Civil, ECE,EEE |
| 10 | B20CIO603 | 6 | NEURAL NETWORKS | CI | Mech, Civil, ECE,EEE |
| 11 | B20CIO701 | 7 | DEEP LEARNING | CI | Mech, Civil, ECE,EEE |
| 12 | B20CIO702 | 7 | PYTHON FOR DATA SCIENCE | CI | Mech, Civil, ECE,EEE |
| 13 | B20CIO801 | 8 | IOT PROGRAMMING | CI | Mech, Civil, ECE,EEE |
| 14 | B20CIO802 | 8 | REINFORCEMENT LEARNING | CI | Mech, Civil, ECE,EEE |
| 15 | B20CSO501 | 5 | DATABASE MANAGEMENT SYSTEMS | CS | All Engineering |
| 16 | B20CSO601 | 6 | DATA STRUCTURES | CS | All Engineering |
| 17 | B20CSO701 | 7 | JAVA PROGRAMMING | CS | All Engineering |
| 18 | B20CSO801 | 8 | R PROGRAMMING LANGUAGE | CS | All Engineering |
| 19 | B20ECO501 | 5 | SENSORS AND INSTRUMENTATION | EC | All Engineering |
| 20 | B20ECO601 | 6 | MICROPROCESSORS AND MICROCONTROLLERS | EC | All Engineering |
| 21 | B20ECO801 | 7 | AUTOMOTIVE ELECTRONICS | EC | All Engineering |
| 22 | B20ECO802 | 8 | ROBOTICS AND AUTOMATION | EC | All Engineering |
| 23 | B20EEO501 | 5 | ENERGY CONSERVATION | EE | All Engineering |
| 24 | B20EEO601 | 6 | ELECTRICAL SAFETY AND REGULATIONS | EE | All Engineering |
| 25 | B20EEO801 | 7 | RENEWABLE ENERGY SYSTEM | EE | All Engineering |
| 26 | B20EEO802 | 8 | TROUBLE SHOOTING OF COMMON ELECTRICAL APPLIANCES | EE | All Engineering |
| 27 | B20MDO501 | 5 | BIOPYTHON | MD | All Engineering |
| 28 | B20MDO601 | 6 | BIOSENSORS AND BIOELECTRONICS | MD | All Engineering |
| 29 | B20MDO701 | 7 | COGNITIVE NEUROSCIENCE | MD | All Engineering |
| 30 | B20MDO801 | 8 | CYBER SECURITY AND FORENSICS | MD | All Engineering |
| 31 | B20MEO501 | 5 | SMART MATERIALS | ME | All Engineering |
| 32 | B20MEO601 | 6 | ENERGY TECHNOLOGY | ME | All Engineering |
| 33 | B20MEO701 | 7 | ELECTRIC AND HYBRID VEHICLES | ME | All Engineering |
| 34 | B20MEO801 | 8 | TOTAL QUALITY MANAGEMENT AND SIX SIGMA | ME | All Engineering |

# Detailed Syllabus
## Semester - 1

| CourseTitle | Differential Equations and Linear Algebra | | | | CourseType | | FC | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20AS0103 | Credits | 3 | | Class | | I Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | TotalNumber of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50%** | **50%** |

**COURSE OVERVIEW**

This course is introduction to applied mathematics, which is useful for Mechanical engineering students. This course covers identifying and methods of solving differential equation of first and higher order along with applications to engineering problems. Most importantly learn linear algebra topics like linear transformation, solving linear system of equations and determining Eigen values and Eigen vectors.

**COURSE OBJECTIVES**

1. To impart the Knowledge of first order ordinary differential equations and its applications in the field of engineering.
2. To impart the Knowledge of higher order linear differential equations and its applications in the field of engineering.
3. To study different methods to solve consistent system of algebraic equations.
4. To study Eigen values and Eigen vectors using numerical method, diagonalization and canonical forms.

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Solve first order ordinary differential equations and its application using different methods. | 1,2 | 1 |
| CO2 | Solve Non-Homogeneous Linear Differential Equations with constant coefficients using direct method and the method of variation of parameters | 1,2 | 1 |
| CO3 | Solve Non-Homogeneous Linear Differential Equations with variable coefficients | 1,2 | 1 |
| CO4 | Compute the solution of system of equations by various methods | 1,2 | 1 |
| CO5 | Compute the Eigen values and Eigen vectors of square matrix and to diagonalize the square matrices. | 1,2 | 1 |
| CO6 | Apply the linear transformation and canonical form of matrix in Mechanical Engineering | 1,2 | 1 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | | | | | | | | | | | 3 | | |
| CO2 | 3 | 1 | | | | | | | | | | | 3 | | |
| CO3 | 3 | 1 | | | | | | | | | | | 3 | | |
| C04 | 3 | 2 | | | | | | | | | | | 2 | | |
| CO5 | 3 | 2 | | | | | | | | | | | 2 | | |
| C06 | 3 | 2 | | | | | | | | | | | 3 | | |
| **Average** | **3.0** | **1.5** | | | | | | | | | | | **2.7** | | |

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

**COURSE CONTENT**

**Unit – 1**

**Differential equations of First order and first degree:**

(Recap: Variable separable, Homogenous and Linear equations) Bernoulli's equation, Exact Differential Equations, Equation reducible to exact [IF for the case of $\frac{1}{M}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$ ***and*** $\frac{1}{N}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$ ***only*** ].Orthogonal trajectories (both Cartesian and polar form), Engineering applications.

**Unit – 2**

**Linear differential equations:**

Linear differential equations with constant coefficients: inverse differential operator method and method of variation of parameters. Linear differential equations with variable coefficients: Solution of Cauchy's and Legendre's linear differential equations, engineering applications.

**Unit – 3**

**Linear Algebra:**

Rank of Matrix by elementary transformations, Linear System of Equations, Conditions of Existence and Uniqueness of Solutions. Solution of linear system ofequations by Gauss Elimination, Gauss –Jordan and Gauss-Seidel method, Engineering applications.

**Unit – 4**

**Matrix theory:**

Eigen Values and Eigen Vectors, Rayleigh's power method to find the largest Eigen value and the corresponding Eigen vector.Linear transformation, diagonalization of a square matrix. Reduction of Quadratic form to Canonical form, engineering applications.

**TEXTBOOKS**

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 19thReprint edition, 2013
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43nd edition, 2015

**REFERENCE BOOKS**

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 9th edition, 2013
2. P.V. O'Neil, "Advanced Engineering Mathematics", Thomson Mathematical Methods by Potter & Goldberg; Publisher: PHI.

**JOURNALS/MAGAZINES**

1. https://www.journals.elsevier.com/journal-of-differential-equations
2. https://www.journals.elsevier.com/linear-algebra-and-its-applications

**SWAYAM/NPTEL/MOOCs**

1. https://nptel.ac.in/courses/111/106/111106051/
2. https://nptel.ac.in/courses/111/104/111104031/
3. https://www.coursera.org/learn/differential-equations-engineers

| CourseTitle | Physics for Engineers | | | | CourseType | | FC | |
|---|---|---|---|---|---|---|---|---|
| CourseCode | B20AS0107 | Credits | 4 | | Class | | I Semester | |
| CourseStructure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 1 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **4** | **5** | **5** | **40** | **26** | **50%** | **50%** |

**COURSE OVERVIEW**

Fundamental Physics is very important and necessary basic subject for all branches of engineering students. It provides the fundamental knowledge of basic principles of Physics which is required for basic foundation in engineering education irrespective of branch. This course introduces the basic concepts of Physics and its applications to Mechanical Engineering courses by emphasizing the concepts underlying four units .1 Lasers and optical fibers , 2.Quantum effects like blackbody radiations ,photoelectric effect , electromagnetic radiations 3.Quantum mechanics and its applications ,4.Theories of solids to explain electrical properties of materials(Conductors, semiconductors, insulators and superconductors) etc.. This subject has basic laws expressions and theories which helps to increase the scientific knowledge to analyze upcoming technologies. The course also consists of real time and numerical examples which makes subject interesting and attractive.

**COURSE OBJECTIVES**

This course enables graduating students

1. To understand the basic concepts and principles of Physics to analyze practical engineering problems and apply its solutions effectively and efficiently.
2. To gain the knowledge of different physical phenomena, quantum/wave mechanics and materials science.
3. To understand design issues, practical oriented skills and problem solving challenges.

**COURSEOUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Explain the working, principle and applications $CO_2$ and semiconductor lasers and characteristics of lasers | 1, 9, 10 | 2,3 |
| CO2 | Summarize principles and distinguish different types of optical fibers | 1, 2, 9, 10 | 2,3 |
| CO3 | Analyze quantum effects like blackbody radiations , photoelectric effect , and polarization of electromagnetic radiations | 1, 2, 9, 10 | 2, 3 |
| C04 | Interpret laws of quantum mechanics and applications of schrodinger wave equations | 1, 2 | 2, 3 |
| CO5 | Compare theories of solids to apply Conductors, semiconductors and dielectrics in the varies fields | 1, 2, 9, 10 | 2, 3 |
| C06 | Demonstrate the experiments to characterize the semiconductor, laser, optical fiber, transistors, photodiode and capacitor. | 1, 2, 9, 10 | 2, 3 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

| CO | Bloom's Level | | | | | |
|---|---|---|---|---|---|---|
| | Remember (L1) | Understand (L2) | Apply (L3) | Analyze (L4) | Evaluate (L5) | Create (L6) |
| CO1 | ✓ | ✓ | ✓ | ✓ | | |
| CO2 | ✓ | ✓ | ✓ | ✓ | | |
| CO3 | ✓ | ✓ | ✓ | ✓ | | |
| C04 | ✓ | ✓ | ✓ | ✓ | | |
| CO5 | | | ✓ | ✓ | | |
| C06 | ✓ | ✓ | | | | |

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | 3 | 3 | | | | 1 | 1 |
| CO2 | 3 | 2 | | | | | | | 3 | 3 | | | | 1 | 1 |
| CO3 | 3 | 2 | | | | | | | 3 | 3 | | | | 1 | 1 |
| C04 | 3 | 2 | | | | | | | | | | | | 1 | 1 |
| CO5 | 3 | 1 | | | | | | | 3 | 3 | | | | 1 | 1 |
| C06 | 3 | 1 | | | | | | | 3 | 3 | | | | 1 | 1 |
| **Average** | **3.0** | **1.6** | | | | | | | **3.0** | **3.0** | | | | **1.0** | **1.0** |

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

**COURSE CONTENT**

**THEORY**

**Unit-1**

**Lasers:** Lasers Interaction between radiation and matter, Expression for energy density at thermal equilibrium in terms of Einstein's coefficients. Characteristics of laser light, Conditions for laser operation, Requisites of laser system, Construction and working of Carbon Dioxide ($CO_2$) laser, semiconductor laser and Applications of laser.

Optical fibers: Construction and light propagation mechanism in optical fibers, Acceptance angle, Numerical Aperture (NA), Expression for numerical aperture in terms of core and cladding refractive indices, Types of optical fibers, Attenuation and reasons for attenuation, optical fiber communication using block diagram, Advantages and limitations. Working of LED and Photodiode.

**Unit-2**

**Electromagnetic Waves:** Wave equation in differential form in free space. Plane electromagnetic waves in vacuum, their transverse nature. Polarization of electromagnetic waves (qualitatively)

Quantum Physics: Black body radiation spectrum, Stefan's law of radiation, Plank's quantum theory of radiation, verification of Weins law and Rayleigh Jeans law, using planks law. Wave Particle dualism, deBroglie hypothesis, Matter waves, Photoelectric effect, Compton Effect (qualitative).

**Unit-3**

**Quantum Mechanics:** Heisenberg's uncertainty principle, and its applications (nonexistence of electron inside the nucleus). Wave function, properties of wave function and physical significance. Probability density and Normalization of wave function, Schrodinger time independent wave equation, Eigen values and Eigen functions. Applications of Schrödinger wave equation - Particle in one dimensional infinite potential well with numerical examples.

**Unit-4**

**Electron Theory of Metals:** Classical free electron theory and its failures. Quantum Free electron theory and its success, density of states, Fermi-Dirac statistics (qualitative), Fermi factor, Fermi level, Fermi energy.

Physics of Semiconductor: Band structure – types of semiconductors-mention the expression for concentration of electrons and Holes in intrinsic semiconductors, Expression for electrical Conductivity of semiconductors in terms of energy gap and temperature. (Derivation)

Dielectric materials: polar and non-polar dielectrics, types of polarizations. Internal fields in a one dimensional solid dielectric (Derivation), Applications and Numerical problems.

Superconductivity and properties of superconductors.

**PRACTICE:**

| Sl. No. | Titleof theExperiment |
|---|---|
| 1. | Variation of Resistivityof intrinsic Semi-conductor crystal using four probe method |
| 2. | Determination Value of Planck's constant by using light emitting diode |
| 3. | Attenuation and propagation characteristics of optical fiber cable. |
| 4. | Determination of numerical aperture of a given optical fiber. |
| 5. | To find the laser parameters–wavelength and divergence of laser light by diffraction method. |
| 6. | Photo Diode Characteristics (Study of I–V characteristics in reverse bias and variation of photocurrent as a function of reverse voltage and intensity |
| 7. | Dielectric constant of a capacitor by charging and discharging of a capacitor |
| 8. | Determination of particle size using laser. |
| 9. | Band gap of intrinsic Semi-conductor |
| 10. | Verification of Stefan's law of radiation by electrical method |

**TEXT BOOKS**

1. M.N. Avadhanulu and P.G. Kshirsagar , "A Text book of Engineering Physics", S. Chand & Company Ltd, New Delhi, 10th revised Ed,., 2018.
2. Gaur and Gupta, "Engineering Physics", Dhanpat Rai Publications, 2017.

**REFERENCE BOOKS**

1. Arthur Beiser, "Concepts of Modern Physics", Tata McGraw Hill Edu Pvt Ltd- New Delhi, 6thEdition, 2006
2. M K Verma, "Introduction to Mechanics", University Press (India) Pvt Ltd, Hyderabad, 2nd Edition, 2009.
3. B laud, "Lasers and Non Linear Optics", New Age International Publishers, 3rd Edition, 2011
4. S O Pillai, "Solid State Physics", New Age International Publishers, 8th Edition, 2018.

| **Course Title** | **Introduction to Data Science** | | | | **Course Type** | | **Hard Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20CS0101** | **Credits** | **3** | | **Class** | | **I Semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | WorkLoad | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 2 | 2 | 2 | | | | |
| | Practice | 1 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | **0** | **0** | | | | |
| | **Total** | **3** | **4** | **4** | **26** | **26** | **50 %** | **50 %** |

**COURSE OVERVIEW**

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

**COURSE OBJECTIVES**

The objectives of this course are to:

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

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Make use of the basic concepts of Data Science in developing the real world applications. | 1 to 5, 8 to 10 | 1, 2, 3 |
| CO2 | Apply the SQL commands in developing the real-worldapplications. | 1 to 5, 8 to 10 | 1, 2, 3 |
| CO3 | Build the data analytics solutions for real world problems, perform analysis, interpretation and reporting of data. | 1 to 5, 8 to 10 | 1, 2, 3 |
| CO4 | Create the real world AI based solutions using different machine learning algorithms. | 1 to 5, 8 to 10 | 1, 2, 3 |
| CO5 | Illustrate modeling Error in Linear Regression | 1 to 5, 8 to 10 | 1, 2, 3 |
| C06 | Demonstrate applications of data science. | 1 to 5, 8 to 10 | 1, 2, 3 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

| CO | Bloom's Level | | | | | |
|---|---|---|---|---|---|---|
| | Remember(L1) | Understand(L2) | Apply(L3) | Analyze(L4) | Evaluate(L5) | Create(L6) |
| CO1 | | | ✓ | | | |
| CO2 | | | ✓ | | | |
| CO3 | | | ✓ | ✓ | | |
| CO4 | | | ✓ | ✓ | ✓ | ✓ |
| CO5 | | ✓ | | | | |
| C06 | | | √ | | | |

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | | | 1 | 3 | 3 | | | 3 | 3 | 3 |
| CO2 | 2 | 2 | 2 | 2 | 2 | | | 1 | 3 | 3 | | | 3 | 3 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 2 | | | 1 | 3 | 3 | | | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 2 | | | 1 | 3 | 3 | | | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 2 | 2 | | | 1 | 3 | 3 | | | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | 2 | 2 | | | 1 | 3 | 3 | | | 3 | 3 | 3 |
| **Average** | **2.8** | **2.8** | **2.5** | **2.0** | **2.0** | | | **1.0** | **3.0** | **3.0** | | | **3.0** | **3.0** | **3.0** |

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

**COURSE CONTENT**

**THEORY:**

**UNIT – 1**

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

**UNIT – 2**

**Introduction to Data Science:** What is Data Science? Probability theory, bayes theorem, bayes probability; Cartesian plane, equations oflines, graphs; exponents**.**

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

**UNIT – 3**

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

**UNIT – 4**

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

**PRACTICE:**

<table>
<tr><th>Sl.No</th><th>Title of the Experiment</th><th>Tools and Techniques</th><th>Expected Skill/Ability</th></tr>
<tr><td>1</td><td>The height (in cm) of a group of fathers and sons are given below, Find the lines of regression and estimate the height of son when the height of father is 164 cm.<br><br>
<table>
<tr><td>Plot the graph. Hgt of Fathers</td><td>158</td><td>166</td><td>163</td><td>165</td><td>167</td><td>170</td><td>167</td><td>172</td><td>177</td><td>181</td></tr>
<tr><td>Hgt of Sons</td><td>163</td><td>158</td><td>167</td><td>170</td><td>160</td><td>180</td><td>170</td><td>175</td><td>172</td><td>175</td></tr>
</table>
</td><td>MS Excel</td><td>Create and perform operations on Excel data set by applying Linear regression</td></tr>
<tr><td>2</td><td>Using the data file DISPOSABLE INCOME AND VEHICLE SALES, perform the following:<br>i) Plot a scatter diagram.<br>ii) Determine the regression equation.<br>iii) Plot the regression line (hint: use MS Excel's Add Trend line feature).<br>iv) Compute the predicted vehicle sales for disposable income of $16,500 and of $17,900.<br>v) Compute the coefficient of determination and the coefficient of correlation</td><td>MS Excel</td><td>Perform prediction and visualization of data</td></tr>
</table>

<table>
<tr>
<td>3.</td>
<td>Managers model costs in order to make predictions. The cost data in the data file INDIRECT COSTS AND MACHINE HOURS show the indirect manufacturing costs of an ice-skate manufacturer. Indirect manufacturing costs include maintenance costs and setup costs. Indirect manufacturing costs depend on the number of hours the machines are used, called machine hours. Based on the data for January to December, perform the following operations.<br><br>Plot a scatter diagram.<br>Determine the regression equation (hint: use MS Excel's Add Trend line feature).<br>Compute the predicted indirect manufacturing costs for 300 machine hours and for 430 machine hours.<br>Compute the coefficient of determination and the coefficient of correlation</td>
<td>MS Excel</td>
<td>Perform prediction and visualization of data</td>
</tr>
<tr>
<td>4.</td>
<td>Apply multiple linear regression to predict the stock index price which is a dependent variable of a fictitious economy based on two independent / input variables interest rate and unemployment rate.<br><br>
<table>
<tr><th>year</th><th>month</th><th>interest rate</th><th>unemployment rate</th><th>stock index price</th></tr>
<tr><td>2020</td><td>10</td><td>2.75</td><td>5.3</td><td>1464</td></tr>
</table>
</td>
<td>MS Excel</td>
<td>Perform prediction and visualization of data</td>
</tr>
<tr>
<td>5.</td>
<td>Calculate the total interest paid on a car loan which has been availed from HDFC bank. For example, Rs.10, 00,000 has been borrowed from a bank with annual interest rate of 5.2% and the customer needs to pay every month as shown in table below. Calculate the total interest rate paid for a loan availed of Rs.10, 00,000 during 3 years.<br><br>
<table>
<tr><th>Sl No.</th><th>A</th><th>B</th></tr>
<tr><td>1</td><td>Principal</td><td>Rs.10,00,000</td></tr>
<tr><td>2</td><td>Annual interest rate</td><td>5.20%</td></tr>
<tr><td>3</td><td>Year of the loan</td><td>3</td></tr>
<tr><td>4</td><td>Starting payment number</td><td>1</td></tr>
<tr><td>5</td><td>Ending payment number</td><td>36</td></tr>
<tr><td>6</td><td>Total interest paid during period</td><td>?</td></tr>
</table>
</td>
<td>MS Excel</td>
<td>Create Excel data and perform EMI estimator</td>
</tr>
<tr>
<td>6.</td>
<td>Create a supplier database of 10 records with SUPPLIER_ID as primary key, SUPPLIER_NAME, PRODUCTS, QUANTITY, ADDRESS, CITY, PHONE_NO and PINCODE, Where SUPPLIER_NAME, PRODUCTS, QUANTITY and PHONE_NO, should not be NULL.</td>
<td>SQL</td>
<td>Creating Tables</td>
</tr>
</table>

<table>
<tr><td>7.</td><td>Create the customer database of a big Market with CUSTOMER_ID as primary key, CUSTOMER_NAME, PHONE_NO, EMAIL_ID, ADDRESS, CITY and PIN_CODE. Store at least twenty customer's details where CUSTOMER_NAME and PHONE_NO are mandatory and display the customer data in alphabetical order.</td><td>SQL</td><td>Creating and retrieving Tables</td></tr>
<tr><td>8.</td><td>Apply linear regression to find the weather (temperature) of a city with the amount of rain in centimeters. Create your own database with following details.<table><tr><th>CITY</th><th>Temperature in Centigrade</th><th>Rain in Centimeters</th></tr><tr><td></td><td></td><td></td></tr></table></td><td>MS Excel</td><td>Apply Linear regression</td></tr>
<tr><td>9.</td><td>Use the linear regression technique to compare the age of humans with the amount of sleep in hours.<table><tr><th>Name</th><th>Age in Years</th><th>Sleep in hours</th></tr></table>Create your own database with above details.</td><td>MS Excel</td><td>Apply Linear regression</td></tr>
<tr><td>10.</td><td>Apply the linear regression, compare the average salaries of batsman depending on the run rate scored/ recorded in the matches. Assume your own database.</td><td>MS Excel</td><td>Apply Linear regression</td></tr>
<tr><td>11.</td><td>Design the ER diagram and create schema of the REVA library management system.</td><td>Entity Relatio</td><td>Entity Relationship</td></tr>
<tr><td>12.</td><td>Design the ER diagram and create schema for Hospital Management system.</td><td>Entity Relatio</td><td>Schema design</td></tr>
</table>

**TEXT BOOKS**


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


**REFERENCE BOOKS**


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


**JOURNALS/MAGAZINES**

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

**SWAYAM/NPTEL/MOOCs**

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

**SELF-LEARNINGEXERCISES**

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

| Course Title | Introduction to Engineering Mechanics | | | | Course Type | | Hard Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ER0101 | Credits | 3 | | Class | | I semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

The primary purpose of the study of Introduction to Engineering Mechanics is to develop the capacity to predict the effects of force and motion while carrying out the creative design functions of engineering. This capacity requires more than a mere knowledge of the physical and mathematical principles of mechanics; also required is the ability to visualize physical configurations in terms of real materials, actual constraints ,and the practical limitations which govern the behavior of machines and structures. One of the primary objectives in a mechanics course is to help the student develop this ability to visualize, which is so vital to problem formulation.

**COURSE OBJECTIVES**

This course enables graduating students to identify, analyze, formulate, and solve engineering problems by applying principles of engineering, Mathematics and Physics.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Determine the Resultant force and moment for a given system of forces. | 1 | 1 |
| CO2 | Analyses and apply the knowledge of centroid, and moment of inertia for composite plane figures. | 1,2 | 1,2 |
| CO3 | Apply knowledge of support reaction to find reaction forces and equilibrium condition for different beams. | 1,2 | 1.2 |
| CO4 | Analyze planer and spatial to determine the forces in the member of trusses. | 1,2 | 1.2 |
| CO5 | Evaluate the friction forces required to hold a system in static equilibrium | 1,2 | 1,2 |
| CO6 | Determine the properties of a system or its loads for which a system will be in a condition of impending motion. | 1,2 | 1.2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | | | | | | | | | | | 1 | | |
| CO2 | 3 | 3 | | | | | | | | | | | 1 | 3 | |
| CO3 | 3 | 3 | | | | | | | | | | | 1 | 3 | |
| CO4 | 3 | 1 | | | | | | | | | | | 1 | 3 | |
| CO5 | 3 | 3 | | | | | | | | | | | 1 | 3 | |
| CO6 | 3 | 1 | | | | | | | | | | | 1 | 3 | |
| **Average** | **3.0** | **2.2** | | | | | | | | | | | **1.0** | **3.0** | **2.3** |

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

**COURSE CONTENT**

**Unit-1**

**Introduction:**Engineering Mechanics, Idealization of bodies, Basics concepts, fundamental principles, system of units.

**Concurrent forces in a plane:** Concept of force, vector, Parallelogram law of forces, Moment of force, Moment of couple, simple problems on force and couple, Composition of forces by method of resolution, Numerical Problems

**Unit-2**

**Non-Concurrent forces in a plane:** Varignon's principle moments, resultants of non-concurrent force system, Numerical problems, Equilibrium of Concurrent forces in a plane Types of forces acing on the body, free body diagram, Equation of Equilibrium, Lami's theorem, equilibrium of connected bodies, Numerical problems.**Equilibrium of Non-Concurrent forces in a plane:** Equilibrium equation and Numerical Problems.

**Unit-3**

**Centroid:** Centre of gravity, center of gravity of a body, concept of centroid, centroid of two dimensional body, Determination of centroid or center of Gravity – integration method. Centroid of a composite plane figure.
Moment of Inertia: Moment of inertia of plane figure, polar moment of Inertia, radius of gyration, theorems of moment of Inertia, finding moment of inertia for standard sections.

**Unit-4**

**Supporting Reaction:** Types of support, Types of Beams, Types of loading, finding support reactions.

**Introduction to Simples trusses:**Types of Frames and its applications, Assumptions, Nature of forces in members. Numerical on pin joint stresses only

**Friction:** Introduction, law of friction, block resting on horizontal and inclined plane, Application of wedge and ladder, Rope and pulley systems.

**TEXT BOOK**

1. Ferdinand P. Beer, E. Russell Johnston, Jr. David F. Mazurek, Phillip J. Cornwell, with the collaboration of Brian P. Self,"Vector Mechanics for Engineers static and Dynamics", Tata McGraw Hill, 12th Edition.

**REFERENCE BOOKS**

1. Shames. I. H, and Krishna Mohana Rao.G, "Engineering Mechanics (Statics and Dynamics)", Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2006.
2. Hibbeler. R.C., "Engineering Mechanics: Statics & Dynamics", Pearson Education (US), 14thEdition, 2015.

**JOURNALS/MAGAZINES**

1. https://ascelibrary.org/journal/jenmdt
2. https://www.scimagojr.com/journalsearch.php?q=22062&tip=sid

**SWAYAM/NPTEL/MOOCs**

1. https://swayam.gov.in/explorer?searchText=Engineering%20mechanics
2. https://nptel.ac.in/downloads/111104026/
3. https://www.coursera.org/learn/engineering-mechanic

| CourseTitle | Entrepreneurship | | | | CourseType | | Hard Core | |
|---|---|---|---|---|---|---|---|---|
| CourseCode | B20ME0104 | Credits | 3 | | Class | | I semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 1 | 1 | 1 | | | | |
| | Practice | - | - | - | Theory | Practical | IA | SEE |
| | Tutorial | - | - | - | | | | |
| | **Total** | **1** | **1** | **1** | **13** | **0** | **50%** | **50%** |

**COURSE OVERVIEW**

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

**COURSEOBJECTIVES**

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

**COURSEOUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Define the keywords and concepts used in entrepreneurship development | 1 | |
| CO2 | Describe the characteristics and types of an entrepreneur | 1,6 | |
| CO3 | Explain the new generations of an entrepreneurship and skills of an entrepreneur | 1,2,6,7,10,12 | 1,3 |
| CO4 | Differentiate between the industrial park and special economic zone | 1,2,7 | 1,3 |
| CO5 | Classify the tender process and exemptions from income tax. | 1,2,5,8,10-12 | 1,3 |
| CO6 | Choose the suitable government agencies to support his/her idea to become an entrepreneur | 1-4,6-12 | 1,3 |

**BLOOM'SLEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | | | | | | | | | | | | | | |
| CO2 | 1 | | | | | 1 | | | | | | | 2 | | 2 |
| CO3 | 1 | 1 | | | | 2 | 1 | | | 1 | | 2 | 2 | | 2 |
| CO4 | 1 | 1 | | | | | 2 | | | | | | 2 | | 2 |
| CO5 | 2 | 2 | | | 1 | | | 3 | | 3 | 3 | 1 | 2 | | 2 |
| CO6 | 1 | 3 | 3 | 1 | | 3 | 3 | 3 | 1 | 3 | 3 | 2 | 2 | | 2 |
| **Average** | **1.2** | **1.8** | **3.0** | **1.0** | **1.0** | **2.0** | **2.0** | **3.0** | **1.0** | **2.3** | **3.0** | **1.7** | **2.0** | | **2.0** |

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

**COURSECONTENT**

**Unit-1**

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

**Unit-2**

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

**TEXTBOOKS**

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

**REFERENCE BOOKS**

1. Baringer and Ireland, "Entrepreneurship", Pearson,11th Edition, 2020.
2. P. Narayana Reddy, "Entrepreneurship – Text and Cases, Cengage Learning India", 1st Edition,2010
3. Corporate Entrepreneurship: Building the Entrepreneurial Organization" byPaul Burns published by PalgraveMacmillan.
4. Drucker F Peter: "Innovation and Entrepreneurship", 1985.Heinemann,London.
5. Doanld F Kuratko &Richard M Hodgeth, "Entrepreneurship in the New Millennium", India Edition - South-Western, CengageLearning

**JOURNALS/MAGAZINES**

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

**SWAYAM/NPTEL/MOOCs**

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

| **CourseTitle** | **IoT and Applications** | | | | **CourseType** | | **Hard Core** | |
|---|---|---|---|---|---|---|---|---|
| **CourseCode** | **B20EC0101** | **Credits** | **2** | | **Class** | | **ISemester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | TotalNumber of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 1 | 1 | 1 | | | | |
| | Practice | 1 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **2** | **3** | **3** | **13** | **26** | **50 %** | **50 %** |

**COURSE OVERVIEW:**

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

**COURSE OBJECTIVES**

The objectives of this course are to:

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

**COURSE OUTCOMES (COs)**

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

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

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | | 3 | 3 | |
| CO2 | 3 | | | | | | | | | | | | 3 | 3 | |
| CO3 | 3 | | | | 3 | | | | | | | 3 | 2 | 2 | |
| CO4 | 3 | | | | 3 | | | | | | | 3 | 1 | 1 | |
| CO5 | 3 | | | | 3 | | | | 2 | | | 3 | 3 | 3 | |
| CO6 | 3 | | | | 3 | | | | 2 | 2 | 2 | 3 | | | |
| **Average** | **3.0** | | | | **3.0** | | | | **2.0** | **2.0** | **2.0** | **3.0** | **2.4** | **2.4** | **2.5** |

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

**COURSE CONTENT**

**THEORY**

**Unit – 1**

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

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

**Unit – 2**

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

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

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

**PRACTICE:**

| Sl. No. | Titleof theExperiment | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| | | **Part-A** | |
| 1. | Introduction to IoT Board<br>a. Arduino UNO<br>b. Arduino Nano<br>c. Node MCU<br>d. Ethernet Shield | Hardware | • Identifications of various parts of Arduino and Node MCU boards<br>• Study of Ethernet shield and connection to the board |
| 2. | Working with Arduino IDE (Integrated Development Environment) | Open source Arduino IDE | • Download specified software<br>• Modify code as per the application |
| 3. | a) Demonstration of Multimeter usage<br>b) Demonstration of Breadboard connection for Voltage, Ground, series and parallel connections<br>c) Exercise to read the value of resistor using Colour code chart | Multimeter<br>Breadboard<br>Resistor packs | • Measurement of voltage at various points in IoT boards<br>• Choose the value of Resistor for an application |
| 4. | Reading photo resistor sensor value connected to Arduino Board | Arduino UNO<br>Arduino IDE<br>LDR , Multimeter, Resistor | • Interface of photo sensor to IoT board for light measurement applications |
| 5. | Reading temperature sensor value connected to Arduino Board | Arduino UNO , Arduino IDE, Temperature sensor, Multimeter | • Interface of Temperature sensor to IoT board for temperature measurement application |
| 6. | Reading motion detector sensor value connected to IoT board | Arduino UNO , Arduino IDE, pyro-dielectric sensor, Multimeter | • Interface of Motion detector sensor to IoT board for motion detection. |
| 7 | Reading distance measurement using Ultrasonic sensor Connected to IoT board | Arduino UNO, Arduino IDE, Ultrasonic sensor, Multimeter. | • Interface of Motion detector sensor to IoT board for motion detection |
| 8 | Interface relay to IoT board | Arduino UNO , Arduino IDE, relay Multimeter | Interface relay to IoT board for Switching applications |
| 9 | Connect Wifi-ESP8266 to Arduino UNO board, Send and receive data through smart phone. | Arduino UNO<br>ESP8266, Arduino IDE<br>Smart phone | Connect IoT board to Wifi network |
| | | **Part-B (Case Study projects)** | |
| Automated lighting system<br>IoT and Cloud Server Based Wearable Health Sensor's Monitoring System intelligent Traffic system<br><br>Motor Controlling with Android App<br><br>A Smart System connecting E-Health Sensor's and the Cloud | | **S**mart Parking Smart healthcare<br>IoT - Industrial Internet of Things<br>Monitoring Of Sensor's Data on Android App<br><br>Integrated Smart Health Care Monitoring System | Smart water management<br>IoT for smart cities<br>Remote Patient Monitoring ,E Agriculture Monitoring on Webpage<br><br>Air Pollution & Water Quality Monitoring System<br><br>An IoT Based PatientMonitoring | |

| Sl. No. | Titleof theExperiment | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| IoT based Garbage Management System ,<br><br>IoT based submersible motor pumps on/off<br><br>IoT Based Electronic Door Opener,<br><br>IoT Based Garbage Monitoring<br><br>Building Automation System Using GRPS IoT,<br><br>Implementation of Industrial Data Acquisition, management and Guiding using IoT<br><br>Distance based Accident Avoidance System using CAN protocol & Tracking through IoT ,<br><br>Swachh Bharat Waste Collection Management System using IOT | | Smart E-Agriculture Monitoring Using Internet Of Things<br><br>Smart Home Automation using IOT<br><br>Monitoring of Highway Hybrid Parameter & Controlling Highway Light Through IoT<br><br>IoT Based Smart Agriculture Monitoring System<br><br>IoT Based Agriculture Crop - Field Monitoring System and Irrigation Automation<br><br>Multiple Garbage Box Monitoring & Collection system<br><br>IoT Based Garbage Monitoring System | System using RaspberryPi ,Underground Cable Fault Detection Over Internet Of Things (Iot) Google Map<br><br>IoT Air & Water Quality Monitoring System,IoT Based Automatic Vehicle Accident Detection and Rescue System<br><br>Patient Health Status Observing Based On IoT and Email Alert<br><br>IoT Based Vehicle Accident Detection and Tracking System on google map webpage<br><br>Data Logger System for weather monitoring using WSN ,Smart intelligent security system for women |
| **PART C (Mini Project)** | | | |
| **1** | Arduino Controlled Light intensity: design and build a simple , effective circuit called Auto Intensity Control of Street Lights using Arduino | ArduinoUNO,DS3231 RTC Module, LDR 16×2 LCD Display ,LED,10KΩ Potentiometer,10KΩ Resistor, Push Button, Connecting Wires, Breadboard | Design and Implementation of IoT project to solve Engineering Problems. |
| **2** | Thermometer: build an LCD thermometer with an Arduino UNO and a LM35/36 analog temperature sensor. | Arduino Uno, Temperature Sensor, LCD display, Breadboard and Connecting wires | Design and Implementation of IoT project for Engineering applications. |
| **3** | Motion activated light lamp: build an automated project that It switches on and off when there's motion. | Arduino Uno, PIR Motion sensor, breadboard, connecting wires, LED generic. | Design and Implementation of IoT project for Engineering applications |
| **4** | Touchless motion sensor trash can: build touchless motion sensor trash can | Arduino UNO, Ultra sonic sensor, Micro servo motor, Breadboard, Connecting wires | Design and Implementation of IoT project for Engineering applications |

**TEXTBOOKS:**

1. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-On- Approach " Second edition 2014, ISBN: 978 0996025515.

**REFERENCE BOOKS:**

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

**SWAYAM/NPTEL/MOOCs**

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

**SELF-LEARNINGEXERCISES:**

1. Create Arduino project hub

| **Course Title** | **Computer Aided Engineering Drawing** | | | | **Course Type** | | **Hard Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ME0101** | **Credits** | **3** | | **Class** | | **I Semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 2 | 2 | 2 | | | | |
| | Practice | 1 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | - | - | | | | |
| | **Total** | **3** | **4** | **4** | **26** | **26** | **50 %** | **50 %** |

**COURSE OVERVIEW**

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

**COURSE OBJECTIVES**

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

**COURSE OUTCOMES (COs)**

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

| **CO** | **Course Outcomes** | **POs** | **PSOs** |
|---|---|---|---|
| CO1 | Draw orthographic projection of point, linemanually and also by using CAD software. | 1,2,5,10 | 1 |
| CO2 | Draw orthographic projection of plane surfaces manually and also by using CAD software. | 1,2,5, 10 | 1 |
| CO3 | Draw orthographic projection of simple solidsmanually and also by using CAD software. | 1,2,5, 10 | 1 |
| CO4 | Draw sectional views of prisms, pyramids, cone and cylindermanually and also by using CAD software. | 1,2,5, 10 | 1 |
| CO5 | Draw the development of lateral surfaces of the solidsmanually and also by using CAD software. | 1,2, 3,5,10 | 1 |
| CO6 | Create isometric view of the solidsmanually and also by using CAD software. | 1,2,3,5,10 | 1 |

**BLOOM'S LEVELOF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | | | 2 | | | | | 3 | | | 3 | | |
| CO2 | 3 | 2 | | | 2 | | | | | 3 | | | 3 | | |
| CO3 | 3 | 2 | | | 2 | | | | | 3 | | | 3 | | |
| CO4 | 3 | 2 | | | 2 | | | | | 3 | | | 3 | | |
| CO5 | 3 | 2 | 2 | | 2 | | | | | 3 | | | 3 | | |
| CO6 | 3 | 1 | 2 | | 2 | | | | | 3 | | | 3 | | |
| **Average** | **3** | **1.6** | **2** | | **2** | | | | | **3** | | | **3** | | |

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

**COURSE CONTENT**
**THEORY**

**Unit-1**

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

**Unit-2**

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

**Unit-3**

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

**Unit-4**

Isometric projections of simple and combined solids.

**PRACTICE:**

| Sl. No | Practice | Tools and Techniques | Expected Skill /Ability |
|---|---|---|---|
| 1. | Use of solid edge software and familiarization of tools | Solid Edge Software | Use of commands to draw the drawings |
| 2. | Draw the projection of point locating in first and third quadrant | Solid Edge Software | Analyzing and software skill |
| 3. | Draw the projection of lines locating in first quadrant | Solid Edge Software | Draw the views of the line and software skill |
| 4. | Draw the projection of rectangular and pentagonal lamina inclined to both HP and VP | Solid Edge Software | analyzing and software skill |

| Sl. No | Practice | Tools and Techniques | Expected Skill /Ability |
|---|---|---|---|
| 5. | Draw the projection of hexagonal and circular lamina inclined to both HP and VP | Solid Edge Software | analyzing and software skill |
| 6. | Draw the projection of prisms inclined to both HP and VP | Solid Edge Software | Interpretationand software skill |
| 7. | Draw the projection of pyramids inclined to both HP and VP | Solid Edge Software | Interpretation and software skill |
| 8. | Draw the projection of cone and cylinder inclined to both HP and VP | Solid Edge Software | Interpretation and software skill |
| 9 | Draw the projection of section of solids in simple position | Solid Edge Software | Analyzing and Software Skill |
| 10 | Develop the lateral surface of prisms and cylinder | Solid Edge Software | Creative and Software Skill |
| 11 | Develop the lateral surface of pyramids and cone | Solid Edge Software | Creative and Software Skill |
| 12 | Draw the isometric projection of simple plane surface and simple solids | Solid Edge Software | Analyzing and software skill |
| 13 | Draw the isometric projection of two co-axial solids | Solid Edge Software | Analyzing and software skill |

**TEXT BOOKS**

1. K S Narayanswamy and Mahesh L, “Engineering Drawing”, WILEY Publishers, 2017, ISBN: 978-81-265-7004-1.
2. K. R. Gopala Krishna, “Engineering Graphics”, Subhas Publications, 2012.
3. Bhatt N.D., Panchal V.M. & Ingle P.R,“Engineering Drawing”, Charotar Publishing House, 2014.

**REFERENCE BOOKS**

1. Luzadder and Duff, “Fundamental of Engineering Drawing”,Printice Hall of India Pvt. Ltd. 11th Edition, 2001.
2. Shah, M.B. and Rana B.C., “Engineering Drawing and Computer Graphics”, Pearson Education, 2008.

**SWAYAM/NPTEL/MOOCS**

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

## SEMESTER-2

| CourseTitle | Vector Calculus and Partial Differential Equations | | | | CourseType | | FC | |
|---|---|---|---|---|---|---|---|---|
| CourseCode | B20AS0205 | Credits | 4 | | Class | | II Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | TotalNumber of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 1 | 1 | 1 | | | | |
| | **Total** | **4** | **4** | **4** | **52** | **0** | **50%** | **50%** |

**COURSE OVERVIEW**

This course is an essential one for civil and mechanical engineering students. This course covers the concept of vector differentiation to understand the flow problems. Further students are able to understand identifying partial differential equations and methods of solving them.

**COURSE OBJECTIVES**

1 To impart the knowledge of partial differentiation, multiple integrals and beta gamma functions.
2. To impart the knowledge of vector calculus in the field of engineering.
3. To study about vector integration and curvilinear coordinate system.
4. To study various methods to solve partial differential equations.

**COURSE OUTCOMES (COs):**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Study the concept of partial differentiation and its application in engineering. | 1,2 | 1 |
| CO2 | Solve double and triple integrals over a region and improper integrals using Beta and Gamma function. | 1,2 | 1 |
| CO3 | Analyze vector functions and vector differential operators. | 1,2 | 1 |
| CO4 | Evaluate line integrals, surface, and volume integrals and to study curvilinear coordinate systems. | 1,2 | 1 |
| CO5 | Evaluate the solution of homogeneous and non- homogeneous partial differential equations. | 1,2 | 1 |
| CO6 | Study various methods to solve partial differential equations having one or more independent variables | 1,2 | 1 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | | | | | | | | | | | 3 | |
| CO2 | 3 | 1 | | | | | | | | | | | 3 | |
| CO3 | 3 | 1 | | | | | | | | | | | 3 | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | 3 | 2 | | | | | | | | | | 2 | |
| CO5 | 3 | 2 | | | | | | | | | | 2 | |
| CO6 | 3 | 2 | | | | | | | | | | 3 | |
| **Average** | **3.0** | **1.5** | | | | | | | | | | **2.7** | |

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

**COURSE CONTENT**

**Unit-1**

**Partial Derivatives and Multiple Integrals:**Functions of several variables – Partial derivatives, Homogeneous Functions – Euler's theorem, Jacobians. Multiple Integrals – Double integrals – Change of order and change of variables. Triple integrals Illustrative examples for change of order and change of variables. Gamma and Beta functions with simple examples. Engineering applications.

**Unit –2**

**Vector Calculus:**Differentiation of Vectors, Curves in space, Velocity and Acceleration, Tangential and normal acceleration, Relative velocity and acceleration, Scalar and vector point functions- Vector operator del. Del applied to scalar point functions – Gradient, Del applied to Vector point function – Divergence and Curl. Engineering applications.

**Unit -3**

**Vector integration:**Line integral – Circulation – work, Surface integral – Flux, Green's Theorem in the Plane, Stokes Theorem, Volume Integral, Divergence Theorem, Green's Theorem, Irrotational and Solenoidal Fields, Orthogonal Curvilinear Coordinates. Engineering Applications.

**Unit -4**

**Partial Differential Equations:** Formation of partial differential equations, solutions of non-homogeneous PDE by direct integration, Solutions of homogeneous PDE involving derivatives with respect to one independent variable, solution of Lagrange's Linear PDE, Solutions of PDE by product method, Engineering Applications.

**TEXTBOOKS**

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 19th Reprint edition, 2013.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 9th edition,2013.

**REFERENCE BOOKS**

1. P.V. O'Neil, "Advanced Engineering Mathematics", Cengage Learning, 7th Edition, 2012.
2. Potter and Goldberg, "Mathematical Methods",Printice Hall of India Pvt. Ltd.

**JOURNALS/MAGAZINES**

1. https://www.journals.elsevier.com/partial-differential-equations-in-applied-mathematics/
2. https://www.elsevier.com/books/vector-calculus/cox/978-0-08-057295-6

**SWAYAM/NPTEL/MOOCs**

1. https://www.coursera.org/learn/calculus-and-optimization-for-machine-learning
2. https://www.coursera.org/learn/vector-calculus-engineers.
3. https://www.coursera.org/learn/differential-equations-engineers

| **CourseTitle** | **Applied Chemistry** | | | | **CourseType** | | **FC** | |
|---|---|---|---|---|---|---|---|---|
| **CourseCode** | **B20AS0201** | **Credits** | **3** | | **Class** | | **II semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | TotalNumber of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50%** | **50%** |

**COURSE OVERVIEW**

Applied chemistry covers very relevant topics compatible with Civil engineering students and make them aware of importance of various aspects of basic science in engineering. The subject of applied chemistry covers area of water technology, corrosion phenomenon, which is widely an interdisciplinary subject of discussion. Further the course focus on the corrosion phenomenon, and various methods to control it. This area of science is very much interdisciplinary in its nature and gives a platform for students to strengthen their engineering knowledge of

corrosion in higher semester. The present applied chemistry course further enlightens on the energy conversion and storage devices, which have become very attractive field of research in engineering stream. The subject deals with various engineering materials, their properties and applications in the field of engineering.

**COURSE OBJECTIVES**

The Applied chemistry course is designed to fulfill the following objective;

1. To impart knowledge about the significance of water chemistry and various methods of water treatment.
2. To provide information on electrochemical concepts of corrosion science and engineering.
3. Highlights on energy storage devices and other renewable energy sources and their applications.
4. Introduction to engineering materials, properties and their applications.

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Describe the properties of water and various methods employed in water treatment. | 1 | 1 |
| CO2 | Analyse the metal stability (corrosion resistance) under different environmental conditions. | 1,2 | 1 |
| CO3 | Identify and compare the materials best suited materials for construction of Battery, fuel cells and Photovoltaic Cell. | 1,2 | 1 |
| CO4 | Demonstrate common use of metals and alloys, ceramics, polymers, their composition, properties and engineering applications. | 1,2 | 1 |
| CO5 | Explore the modern materials and their composites for technological applications | 1,2 | 1 |
| CO6 | Suggest advanced materials for electrochemical energy storage, conversion, and environmental remedies. | 1,2 | 1 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | | 1 | |
| CO2 | 2 | 1 | | | | | | | | | | | 1 | |
| CO3 | 1 | 1 | | | | | | | | | | | 1 | |
| CO4 | 2 | 1 | | | | | | | | | | | 1 | |
| CO5 | 2 | 1 | | | | | | | | | | | 1 | |
| CO6 | 1 | 1 | | | | | | | | | | | 1 | |
| **Average** | **1.8** | **1.0** | | | | | | | | | | | **1.0** | |

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

**COURSE CONTENT**

**Unit-1**

**Water Technology:**Sources of water, Impurities of water, Hardness & its determination (EDTA method), Boiler Troubles & their removal, water softening methods -Lime soda, Zeolite & Ion exchange, Desalination of water — Electro dialysis & Reverse osmosis method, Chemical analysis of water

**Unit-2**

**Corrosion:**Definition, Examples, Types, Theory of corrosion, Dry corrosion (Direct chemical Attack), Wet corrosion (electrochemical attack), Mechanism of wet corrosion, Factors affecting corrosion, Corrosion Control methods, protective coatings — Metallic & organic type.

**Unit-3**

**Energy devices:**Batteries & types, fuel cell, super capacitors, photo voltaic cell.

**Unit-4**

**Materials:**Metals & Alloys: Classification and properties of iron, Steel, Nickel, Chromium, Tungsten & alloys.
**Modern Materials:** Classification, properties, and compositions: polymers, biomaterials, glass, cement, ceramics, composite materials, Nano materials, thin films, liquid crystals.

**TEXTBOOKS**

1. R.V.Gadag and Nithyanandashetty, "Engineering Chemistry", Ik International Publishing house.
2. S.S. Dara, "Text Book of Engineering Chemistry", S. Chand & Co.

**REFERENCE BOOKS**

1. P.W. Atkins, "Physical Chemistry", Oxford Publisher, 5$^{th}$edition.
2. Callister W.D., "Materials Science and Engineering", John Wiley & Sons.

**JOURNALS/MAGAZINES**

1. https://www.sciencedirect.com/journal/water-science-and-technology
2. https://iwaponline.com/wst
3. https://www.scitechnol.com/nanomaterials-molecular-nanotechnology.php
4. https://www.journals.elsevier.com/journal-of-energy-storage

**SWAYAM/NPTEL/MOOCs**

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

<table>
<tr><td>CourseTitle</td><td colspan="3">Introduction to Python Programming</td><td colspan="2">CourseType</td><td colspan="2">Hard Core</td></tr>
<tr><td>CourseCode</td><td>B20CI0101</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">II Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">TotalNumber of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Total</td><td>3</td><td>4</td><td>4</td><td>26</td><td>26</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSE OVERVIEW**

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

**COURSE OBJECTIVES**

The objectives of this course are to:

1. Explain the fundamentals of python programming language constructs and their applications.
2. Inculcate knowledge of parsing of regular expressions and their usage in various application domains.

3. Gain expertise in Object oriented programming and NumPy package.

4. Discuss the files, Pandas and Data Virtualization concepts.

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Make use of fundamentals of python programming to solve real world problems. | 1,2,3 ,9, 10 | 1 |
| CO2 | Develop solutions for text processing and other application domains by making use of regular expressions. | 1,2,3, 9, 10 | 2 |
| CO3 | Apply features of object oriented and NumPy package to develop computationally intensive applications to analyze and interpret the data. | 1,2,3,4 | 2-3 |
| CO4 | Create data science solutions with the help of files, Pandas and Data Visualization. | 1-4,5 | 1,2, 3 |
| CO5 | Develop sustainable solutions/projects for the needs of society, organizations and other sectors. | 7,11, 9, 10 | 1,2,3 |
| CO6 | Recognize the need and engage in learning new libraries and tools in python. | 12 | 3 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | | | | | | 3 | 3 | | | 3 | | |
| CO2 | 3 | 2 | 3 | | | | | | 3 | 3 | | 1 | | 3 | |
| CO3 | 3 | 1 | 2 | 1 | | | | | | | | | | 3 | 2 |
| CO4 | 3 | 2 | 3 | 2 | 2 | | | | | | | | 3 | 3 | 2 |
| CO5 | | | | | | | 3 | | 3 | 3 | 2 | | 3 | 3 | 2 |
| CO6 | | | | | | | | | | | | 2 | | | 2 |
| **Average** | **3.0** | **1.5** | **2.8** | **1.5** | **2.0** | | **3.0** | | **3.0** | **3.0** | **2.0** | **1.5** | **3.0** | **3.0** | **2.0** |

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

**COURSE CONTENT**

**THEORY**

**Unit-1**

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

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

**Unit-2**

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

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

**Unit-3**

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

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

**Unit-4**

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

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

**PRACTICE:**

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

| Sl.No | Titleof theExperiment | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| 3. | a).A substring "Substr" between index1 and index2 is to be extracted from the given input string "Str1", which is read using input (). Display the substring "Substr" using a user defined function if available in string "Str1",<br>b) A string containing multiple words is to be read from the user one at a time, after reading perform following operations.<br>i) Convert all the strings to uppercase and display<br>ii) Split the words of a string using space as the separation character and display. | Windows/Linux OS, IDE, Jupyter | String operations. |
| 4. | a).Consider the text file, "Std.txt", with the details of students like SRN, NAME, SEMESTER, SECTION AND AVG_MARKS. Read the file, "Std.txt" and display the details of all the students of 4th Semester "A" Section who have scored more than 75%. | Windows/Linux OS, IDE, Jupyter | File Handling. |
| | b).Consider the text file "Emp.txt", with the details of Employees like EMP_CODE, EMP_NAME, BASIC_SALARY, DA, GROSS_SALARY, NET_SALARY, LIC, PF and TOTAL-DEDUCTIONS. Read EMP_CODE, EMP_NAME, BASIC_SALARY, DA, LIC and PF from the user using input() and compute the following:<br>i) TOTAL_DEDUCTIONS= (LIC+PF)<br>ii) GROSS_SALARY= BASIC_SALARY+ DA<br>iii) NET_SALARY= GROSS_SALARY – TOTAL_DEDUCTIONS.<br>Write the above data to file for each employee. Read the content of "Emp.txt" and display the details of each employee. | | File Handling. |
| 5. | a). A "CAR" has the attributes COMPANY_NAME, MODEL, COLOR, MANUFACUTING_YEAR and PRICE. A Class is required to be created for "CAR" to store the above attributes and perform the following operations:<br>i) Get the details of "CAR" object from user and store into Array of objects<br>ii) Display the details of "CAR" object based on "COMPANY", "MODEL" and "PRICE". | Windows/Linux OS, IDE, Jupyter | Classes and objects usage. |
| | b). Airline Reservation System contains the attributes of passengers such as NAME, PAN_NO. MOBILE_NO, EMAIL_ID, SOURCE, DESTINATION, SEAT-NO, AIR-FARE and TRAVEL_DATE. A Class is required to be created for "Airlilne" with the above attributes and perform the following operations:<br>i) Get the details of "Airline" object from user and store into Array of objects<br>ii) List details of all the passengers who travelled From "Bengaluru to London".<br>iii) List details of all the passengers who travelled From "Chicago to Beijing" on 10th of Feb, 2020. | | |

| Sl.No | Titleof theExperiment | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| 6. | a). "Arr_1" is an integer array of size M x N. Size and content of the array is to be read using input () by using the user defined function READ_DATA (). It is required to display the<br>i) Diagonal elements of "Arr_1"<br>ii) Elements of $m^{th}$ row ( row no should be entered by user) | Windows/Linux OS, IDE, Jupyter | NumPy arrays usability. |
| | b).The dictionary "DICT1" contains the pass percentage of each semester of B. Tech in CSE, where, " Semester" acts as the key and "Pass Percentage" acts as the value. A Python Pandas data frame is required to be created using the dictionary "DICT1" and display it using a user defined function. | | Pandas Series usability. |
| | Part-B (Mini Project: Library Management System) | | |
| 1. | Develop a program to create the class "USER" with the attributes USER_NAME, USER_ID, SCHOOL_NAME, ADDRESS, PHONE_NO, EMAIL_ID, DOB and AGE. The functions add_ user (), delete user (), edit user (), search user () should be part of the class. Instantiate "User" class with 10 objects. Read the attributes of each "User" object using input () and store them in the file "User_File.txt". | Windows/Linux OS, IDE, Jupyter | Create a class user to read the attributes of user and store them in a file. |
| 2 | Develop a program to get the name of the "User" object whose details are to be deleted. Read the "User_File.txt" and delete the "User" object if found. Display the contents of "User_File.txt" after deletion. | Windows/Linux OS, IDE, Jupyter | Create a class user to read the attributes and delete the object. |
| 3 | Develop a program to get the name of the "User" object whose details are to be edited (modified). Edit the details of the user object in the file "User_File.txt" and display the contents after modification. | Windows/Linux OS, IDE, Jupyter | To create a class and edit the file. |
| 4 | Develop a program to create the class "BOOK" with the attributes TITLE, AUTHOR, PUBLISHER, YEAR, PRICE, SCHOOL_NAME and the functions add book(), delete book(), edit book() and search book(). Instantiate "Book" class with 10 objects. Read the attributes of each "BOOK" object using input () and store them in the file "Book_File.txt". | Windows/Linux OS, IDE, Jupyter | Create a class book to read the attributes of user and store them in a file. |
| 5 | Develop a program to get the name of the "BOOK" object whose details are to be deleted. Read the "Book_File.txt" and delete the "BOOK" object whose details match with the data entered. Display the contents of "Book_File.txt" after deletion. | Windows/Linux OS, IDE, Jupyter | Create a class book to read the attributes and delete the object. |
| 6 | Develop a program to get the name of the "BOOK" object whose details are to be edited (modified). Edit the details of the "Book" object in the file "Book_File.txt" and display the contents after | Windows/Linux OS, IDE, Jupyter | To create a class and edit the file. |

| Sl.No | Titleof theExperiment | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| 7 | Develop a program to create the class "TRANSACTION" with the attributes USER_ID, USER_NAME, AUTHOR, TITLE, EDITION, ISSUE_DATE,DUE_DATE and RETURN_DATE and the functions issue book(), return book() and search book(). Instantiate "Transaction" class with 10 objects. Read the attributes of each "Transaction" object using input () and store them in the file "TransactionFile.txt". Develop a program to issue the book as requested by the user. Update the | Windows/Linux OS, IDE, Jupyter | Create class and perform string operations. |
| 8 | Develop a program to return the book. Edit the details of the user like USER_ID, USER_NAME, AUTHOR, TITLE, EDITION, ISSUE_DATE, DUE_DATE and RETURN_DATE in "TransactionFile.txt" and display the contents after modification. Compute the fine amount to be paid if return date is not same as due date. If both return date and due date are same and put zero in fine amount. | Windows/Linux OS, IDE, Jupyter | Create class and perform string operation. |
| 9 | Develop a program to search for a book using its "author". Display the message "available" if search is successful otherwise display the message "not available". | Windows/Linux OS, IDE, Jupyter | Create class and object, perform file operations and regular expressions. |
| 10 | Develop a program to get a list of users by referring to "User_File.txt" and "Transaction_File.txt". | Windows/Linux OS, IDE, Jupyter | Create class and object, perform file operations and regular expressions. |
| 11 | Develop a program to get List of Books in stock by referring to "Book_File.txt" and "Transaction_File.txt". | Windows/Linux OS, IDE, Jupyter | Create class and object, perform file operations and regular expressions. |
| 12 | Develop a program to get List of Books Issued by referring to "User File", "Book File" and "Transaction File". | Windows/Linux OS, IDE, Jupyter | Create class and object, perform file operations and |
| 13 | Develop a project by integrating User, Books, Transaction and Reports Modules. | Windows/Linux OS, IDE, Jupyter | Module integration and project development. |

**TEXTBOOKS**

1. Mark Pilgrim, "Dive into Python 3", Apress Special Edition, 2nd Edition, 20l5.
2. Travis E. Oliphant, "Guide to NumPy", Trelgol Publishers, 2006.

**REFERENCEBOOKS**

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

9. https://www.tutorialspoint.com/computer_fundamentals/computer_fundamentals_tutorial.pdf

**JOURNALS/MAGAZINES**

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

**SWAYAM / NPTEL / MOOCs**

1. Coursera – Python for everybody, University of Michigan
2. Coursera – Python Basics, University of Michigan
3. https://nptel.ac.in/courses/106/106/106106182/
4. https://www.edx.org/learn/python

<table>
<tr><td>CourseTitle</td><td colspan="3">Basic Electrical and Electronics Engineering</td><td colspan="3">CourseType</td><td colspan="2">Hard Core</td></tr>
<tr><td>CourseCode</td><td>B20EE0101</td><td>Credits</td><td colspan="2">4</td><td colspan="3">Class</td><td colspan="2">II Semester</td></tr>
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<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory Hours</td><td rowspan="2">Practical Hours</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>4</td><td>5</td><td>4</td><td>39</td><td>26</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSEOVERVIEW**

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

**COURSE OBJECTIVES**

1. Explain the basics of electrical and electronics engineering terminologies.
2. Distinguish the single and three phase systems.
3. Illustrate the different building blocks in digital electronics using logic gates and explain simple logic functions using basic universal gates.
4. Discuss the applications of diode in rectifiers, filter circuits and wave shaping.
5. To build a broad concept for hands on experience in various types of electrical apparatus, tools andinstrumentation with electrical safety norms.
6. To analyze the schematics for making electrical connection and to interpret experimentaldata for various electricalappliances.

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Summarize the basics of electrical engineering terminology and the usage. | 1,2 | 1 |
| CO2 | Analyze the concepts and applications of DC & AC Machines. | 1,2 | 1 |
| CO3 | Apply the concept of domestic wiring, importance of safety and sensing devices | 1,2,10 | 1 |
| CO4 | Analyze the different building blocks in digital electronics using logic gates and applications of diode in rectifiers, filter circuits and wave shaping. . | 1,2 | 1 |
| CO5 | Interpret, Identify and use appropriate electrical tools for electrical connections and to repair electricalequipment's | 1,2,9,10 | 1,2 |
| CO6 | Compare experimental results with theoreticalanalysis and the ability to critically evaluate the performance of electricalappliances. | 1,2,9,10 | 1,2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | | | | | | | | | | | 1 | |
| CO2 | 1 | 1 | | | | | | | | | | | 1 | |
| CO3 | 2 | 2 | | | | | | | | 2 | | | 1 | |
| CO4 | 3 | 1 | | | | | | | | | | | 1 | |
| CO5 | 2 | 2 | | | | | | | 3 | 1 | | | 3 | 3 |
| CO6 | 2 | 2 | | | | | | | 3 | 1 | | | 3 | 3 |
| **Average** | **2.0** | **1.5** | | | | | | | **3.0** | **1.3** | | | **1.7** | **3.0** |

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

**COURSE CONTENT**
**THEORY**

**Unit-1**

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

**Unit-2**

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

**Unit-3**

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

**Unit-4**

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

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

**PRACTICE:**

| Sl. No | Titleof theExperiment | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| 1. | **Electrical Safety Training.**<br>a) To Study the importance of Earthing during accidental shorting of line wire and the body of<br>b) To conduct experiment and to know the Importance and mechanism of FUSE<br>c) To study the Importance and mechanism of MCB. | Trainer kit<br>Ohms Law<br>Fall of resistance | Importance & applications of Earthing, Fuse & MCB |
| 2. | Home Electrical Wiring Demonstration.<br>a) To study & verify the connection procedure for fluorescent lamp wiring.<br>b) To study the connection of Fan with switch and regulator. | Fluorescent Lamp wiring Panel<br>Fan with switch and regulator Kit | Connection & Trouble shooting of Fluorescent lamp wiring & Fan with switch and regulator |
| 3. | Two-way switch/ staircase wiring.<br>To study & verify the connection procedure for two-way switch or staircase wiring | Two-way switch or staircase wiring Kit | Connection, Working & application of Two-way switch |
| 4. | Behaviour of current and voltage in series and parallel circuits.<br>a) To study and verify the behaviour of current and voltage in series circuit.<br>b) To study and verify the behaviour of current and voltage in parallel circuit. | Series and parallel circuits Kit | Connection & behaviour of current & voltage in series , parallel circuit |
| 5. | Polarity test on single phase transformer.<br>a) To determine the additive polarity of a single-phase transformer.<br>b) To determine the subtractive polarity of a single-phase transformer. | Transformer Kit | Polarities of single phase transformer |
| 6. | Determination of VI characteristics of Zener Diode | VI characteristics of Zener Diode kit | VI characteristics of Zener Diode |
| 7. | Determination of VI characteristics of Silicon Diode | VI characteristics of Silicon Diode kit | VI characteristics of Silicon Diode |
| 8. | Analyze the Half Wave and Full Wave rectifiers using Diode with and without filter | Rectifier kit | Determine the efficiency, Voltage regulation, ripple factor of rectifiers |
| 9. | Determine the Characteristics of BJT in Common Emitter Configuration | Characteristics of BJT in Common Emitter Configuration | Input & Output Characteristics of BJT |
| 10. | Determine the Characteristics of JFET in Common Source Configuration | Characteristics of JFET in Common Source | Input & Output Characteristics of JFET |
| 11. | Realization of Universal gates using basic logic gates. | Trainer kit | Universal gates will be realized using basic gates |

**TEXTBOOKS**

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

**REFERENCEBOOKS**

1. Theodore Wildi, “Electrical Machines, Drives and Power”, Pearson Prentice Hall,5thEdition, 2007.
2. Hughes, “Electrical Technology”, Addison Wesley Longman Limited, 9th Edition, 2005.

**JOURNALS/MAGAZINES**

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

**SWAYAM/NPTEL/MOOCs**

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

| CourseTitle | Elements of Mechanical Engineering | | | | CourseType | | Hard Core | |
|---|---|---|---|---|---|---|---|---|
| CourseCode | B20ER0201 | Credits | 4 | | Class | | IISemester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | TotalNumber of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 1 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | - | - | | | | |
| | **Total** | **4** | **5** | **5** | **39** | **26** | **50 %** | **50 %** |

**COURSEOVERVIEW**

Elements of Mechanical Engineering is a basic course of Mechanical Engineering discipline. It focuses on overall view of mechanical engineering area’s like thermal, design and manufacturing streams. The course is designed to understand basic concept like formation of steam and compute the steam properties like specific volume, enthalpy, and internal energy using steam tables. The students are introduced to internal combustion engines, turbines (water, steam and gas) and refrigeration-air conditioning system. The students will be imparted to calculate BP, IP, mechanical efficiency of IC engines. The students are exposed to the machine elements like springs, belt drives and gear drives. Acquainted with different machine tools like lathe, drilling machines and CNC machines. The students will be exposed to joining processes like Soldering, Brazing and Welding and various power transmission systems. Students are introduced to the engineering materials and modern manufacturing Technology like 3D printing technology.

**COURSE OBJECTIVES**

1. To develop the basic knowledge on heat & work, steam formation, working principle of boilers, turbines, IC engines and refrigeration - air conditioning systems
2. To incorporate the concept of different types of machine elements like springs, belt drives & chain drives
3. To give exposure in the field of engineering materials and manufacturing processes
4. To incorporate the concepts of modern manufacturing processes like CNC, 3D printing technology and its applications

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Describe the concepts of heat & work, steam formation, properties, working principle of boilers, turbines, and IC engines. | 1,2,3,9,10 | 1,2 |

| | | | |
|---|---|---|---|
| CO2 | Explain the working principle of refrigeration and air conditioning systems | 1,2 | 1,2 |
| CO3 | Discuss the application of machine elements. | 1,2 | 1,2 |
| CO4 | Calculate the speed ratio of belt drives and Gear Drives. | 1,2,3 9,10 | 1,2 |
| CO5 | Compare the different kinds of machine tools and select the suitable machine tool for processing the materials and different metal joining process for the different applications | 1,2, 3, 9,10 | 1,2 |
| CO6 | Classify the engineering materials and discuss the concept of casting, CNC and 3D printing technology | 1,2, 9,10 | 1,2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | | | | | | 3 | 3 | | | 1 | 2 | |
| CO2 | 3 | 2 | | | | | | | | | | | 1 | 2 | |
| CO3 | 3 | 2 | | | | | | | | | | | 1 | 2 | |
| CO4 | 3 | 2 | 3 | | | | | | 3 | 3 | | | 2 | 1 | |
| CO5 | 3 | 2 | 1 | | 1 | | | | 3 | 3 | | | 2 | 1 | |
| CO6 | 3 | 2 | | | | | | | 2 | 2 | | | 3 | 1 | |
| **Average** | **3.0** | **2.0** | **1.7** | | **1.0** | | | | **2.8** | **2.8** | | | **1.7** | **1.5** | |

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

**COURSE CONTENT**

**THEORY**

**Unit-1**

**Introduction to Energy Systems:**Concept of heat and work, Steam formation, Types of steam, Steam properties. Introduction to boilers, working of Babcock and Wilcox boiler.

**Unit-2**

**Prime Movers:** Types and working principle of turbines and IC Engines.

**Introduction to Refrigeration and Air Conditioning:**Working principle of refrigeration system, working of domestic refrigerator and window air conditioner

**Unit-3**

**Machine Elements:** Types and applications of springs, belt drives, gear drives and chain drives, Numerical on belt drives and gear drives.

**Unit-4**

**Materials and Manufacturing Processes:** Introduction to engineering materials and classifications, casting, Machine Tools- lathe & drilling machine, metal joining process-welding, brazing and soldering, modern manufacturing technology-CNC machines and 3D printing.

**PRACTICE**

| Sl. No | Titleof theExperiment | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| 1. | Dismantling and Assembly of 2-Wheeler (2–stroke) Engine | 2-Stroke Engine | Hands on Experience |
| 2. | Identification of parts of an engine of Toyota Innova and Toyota Fortuner | Toyota Engine | Hands on Experience |
| 3. | Calculation of Speed ratio of belt, chain and gear drives | - - - | Thinking Skill |
| 4. | Study of Power train of Bicycle, 2-Wheeler and 4-Wheeler | Engines | Hands on Experience |
| 5 | Study of Fitting tools and preparation of fitting models(2 Models) | Fitting tools | Hands on experience |
| 6 | Study of sheet metal tools and development of pen stand and funnel | Sheet metal tools and soldering tools | Creative Thinking |
| 7 | Hands on training on basic welding joints | Welding tools | Hands on experience |
| 8 | Preparations of welding models like 3-Legged table, 4-legged table, Name boards, Window frame etc. | Welding tools | Creative Thinking & team work |

**TEXTBOOKS**

1. K.R. Gopal Krishna, “Elements of Mechanical Engineering”, Subhash Publishers, 12th Edition, 2012.
2. Roy & Choudhury, "Elements of Mechanical Engineering", Media Promoters & Publishers Pvt. Ltd, 2000.

**REFERENCE BOOKS**

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

**JOURNALS/MAGAZINES**

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

**SWAYAM/NPTEL/MOOCs**

1. https://www.coursera.org/browse/physical-science-and-engineering/mechanical-engineering
2. https://www.my-mooc.com/en/categorie/mechanical-engineering
3.https://nptel.ac.in/course

| CourseTitle | Biology for Engineers | | | | CourseType | | FC | |
|---|---|---|---|---|---|---|---|---|
| CourseCode | B20AS0109 | Credits | 1 | | Class | | II Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | TotalNumber of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 1 | 1 | 1 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **1** | **1** | **1** | **13** | **0** | **50%** | **50%** |

**COURSE OVERVIEW**

Understanding biological systems, principles and concepts in order to create usable, tangible, economically viable product or process has become need of the hour. Hence irrespective of the parent engineering discipline, knowledge and expertise from pure and applied sciences is necessary to create product or process related to healthcare, agriculture, environmental issues and many more. Any engineer will have a high probability of using biology related skills and concepts to create products and processes beneficial to the mankind and as well for the sustainable environmental friendly approach. For example, the knowledge can be used to create medical devices,

diagnostic equipment's, bioreactor designing, agriculture related equipment/instruments or anything related to surface science, fluid mechanism and polymer science. This course is designed to lay foundation in the field of Cell biology, Molecular biology and Genetics, so that anyone who is interested can design better product/process to enhance the overall quality of life.

**COURSE OBJECTIVES**

1. To inculcate the basic concepts of biology from engineering perspective among students
2. To understand the interplay between biology and engineering disciplines
3. To conceptualize the engineering design/process/product for life science challenges

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Understand and explain the concepts regarding origin and evolution of life. | 1, 7 | |
| CO2 | Demonstrate the structure and functions of various biomolecules in living system. | 1 | |
| CO3 | Comprehend the organization of cell structure in prokaryotes and eukaryotes. | 1 | |
| CO4 | Describe the process of cell division involving mitosis and meiosis | 1 | |
| CO5 | Predict the inheritance pattern of genes from parents to offspring | 1 | |
| CO6 | Apply the principles of Biology either for the process/product development from the engineering perspective. | 1,6, 7 | |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | 1 | | | | | | | | |
| CO2 | 3 | | | | | | | | | | | | | | |
| CO3 | 3 | | | | | | | | | | | | | | |
| CO4 | 3 | | | | | | | | | | | | | | |
| CO5 | 3 | | | | | | | | | | | | | | |
| CO6 | 3 | | | | | 1 | 2 | | | | | | | | |
| **Average** | **3** | | | | | **1** | **1.5** | | | | | | | | |

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

**COURSE CONTENT**

**Unit-1**

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

**Unit-2**

Cell structure and function – Prokaryotes, Cell structure and function – Eukaryotes, Cell cycle-Mitosis and Meiosis, Mendelian genetics: Mendelian inheritance, Genetic diseases and Mendelian inheritance, Central Dogma – Replication, Transcription and Translation.

**TEXTBOOKS**

1. G.K. Suraishkumar,"Biology for Engineers", Oxford University Press, 2019
2. Biology for Engineers, As per AICTE curriculum, Wiley publication,
3. Dr.Sohini Singh and Dr.Tanu Allen,"Biology for Engineers", Vayu Education of India.

**REFERENCE BOOKS**

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

**SWAYAM/NPTEL/MOOCs:**

1. https://onlinecourses.nptel.ac.in/noc19_ge31/preview
2. Coursera: Biology everywhere

<table>
<tr><td>CourseTitle</td><td colspan="4">Design Thinking</td><td colspan="2">CourseType</td><td colspan="2">Hard Core</td></tr>
<tr><td>CourseCode</td><td>B20ME0102</td><td>Credits</td><td colspan="2">2</td><td colspan="2">Class</td><td colspan="2">II Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">TotalNumber of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>2</td><td>3</td><td>3</td><td>13</td><td>26</td><td>50%</td><td>50%</td></tr>
</table>

**COURSE OVERVIEW**

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

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

**COURSE OBJECTIVES**

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

**COURSE OUTCOMES (CO'S)**

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

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

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | | | | | | | 2 | 2 | | 2 | 3 | 2 | |
| CO2 | 1 | 3 | | | | | | | 2 | 3 | | 2 | | 2 | |
| CO3 | 1 | 2 | | | | | | | 3 | 2 | | 3 | 1 | 2 | |
| CO4 | 1 | 2 | | | | | | | 3 | 2 | | 2 | 1 | 2 | |
| CO5 | 2 | | 3 | | 2 | | | | 3 | 3 | | 2 | 2 | 3 | |
| CO6 | 2 | | | 2 | | | | 1 | 3 | 2 | | 2 | 2 | 3 | |
| **Average** | **1.7** | **2.3** | **3.0** | **2.0** | **2.0** | | | **1.0** | **2.7** | **2.3** | | **2.2** | **1.8** | **2.3** | |

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

**COURSE CONTENT**

**THEORY**

**Unit-1**

**Design Thinking Process:**

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

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

**Unit-2**

**Defining the problems:**

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

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

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

**PRACTICE:**

| Sl. No | Name of the Practice Session | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| 1 | Identifying the problem that can be solved using Design Thinking approach | Observation and survey | Develop identifying human centered problems |
| 2 | Build the empathy maps for simple problems like single user | Visualization | Develop ability to understand other's emotions |
| 3 | Build the detailed empathy maps for | Visualization | Develop ability to understand other's |

| Sl. No | Name of the Practice Session | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| | problem identified in the teams formed | | emotions |
| 4 | Presentation by student teams | PPT | Develop ability to express their views |
| 5 | Obtain the insights into user's problems and make PoV statement | Understanding | Develop making problem statements from user perception |
| 6 | Presentation by student teams | PPT | Develop ability to express their views |
| 7 | Carry out Brain storming between the groups and generate as many as ideas possible | Ideation tools | Develop innovative mind set |
| 8 | Prototype for best 3 ideas selected | Sketching, simple model making etc. | Develop prototyping techniques |
| 9 | Presentation by student teams | PPT | Develop ability to express their plan |
| 10 | Test the developed prototype with set of identified users | Google forms , cold calls, social media etc. | Develop understanding of various testing methods |
| 11 | Pitching final solution | PPT | Develop ability to express their views |

**TEXT BOOKS**

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

**REFERENCE BOOKS**

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

**JOURNALS/MAGAZINES/ADDITIONAL SOURCES**

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

**SWAYAM/NPTEL/MOOCs**

1. https://nptel.ac.in/courses/109/104/109104109/
2. https://nptel.ac.in/courses/11010612

# 3rd Semester

| CourseTitle | Laplace Transforms and Fourier Series | | | | CourseType | | FC | |
|---|---|---|---|---|---|---|---|---|
| CourseCode | B20AS0304 | Credits | 3 | | Class | | IIISemester | |
| Course Structure | TLP | Credits | ContactHours | WorkLoad | TotalNumberofClasses PerSemester | | Assessment inWeightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | | | IA | SEE |
| | Tutorial | 0 | 0 | 0 | Theory | Practical | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSEOVERVIEW**

In this course students will study the Laplace Transforms, inverse Laplace Transforms, Fourier series, Fourier transforms and Numerical Methods. The purpose of this course is to provide students with skills and knowledge required to perform mathematical procedures and processes for solution of engineering problems. This course is widely used in all streams of Engineering particularly in the field of Mechanical Engineering.

**COURSE OBJECTIVES**

1. To impart the Knowledge of Laplace transforms and its applications in the field of engineering.
2. To impart the Knowledge of Inverse Laplace transforms and its applications in the field of engineering.
3. To study and understand the application approach of the concepts of Fourier series and transforms.
4. To study and understand the application approach of the concepts of Numerical methods.

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Apply the knowledge of Laplace transformation technique to convert physical function form from the time domain to the frequency domain. | 1,2,3 | 1 |
| CO2 | Study the periodic function, unit step function and unit impulse function by using Laplace transform. | 1,2 | 1 |
| CO3 | Compute Inverse Laplace transform and apply them to ODEs arising in engineering | 1,2 | 1 |
| C04 | Find the Fourier series and half range series expansion of different functions in different intervals | 1,2 | 1 |
| CO5 | Find the Fourier & inverse Fourier transforms of different functions and apply this knowledge in solving different Mechanical engineering problems. | 1,2 | 1 |
| C06 | Apply the numerical methods to solve various engineering problems. | 1,2 | 1 |

**BLOOM'SLEVELOFTHECOURSEOUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | | | | | | | | | | 2 | | |
| CO2 | 3 | 2 | | | | | | | | | | | 2 | | |
| CO3 | 3 | 2 | | | | | | | | | | | 3 | | |
| CO4 | 3 | 2 | | | | | | | | | | | 2 | | |
| CO5 | 3 | 2 | | | | | | | | | | | 2 | | |
| CO6 | 3 | 3 | | | | | | | | | | | 3 | | |
| **Average** | **3.0** | **2.3** | **1.0** | | | | | | | | | | **2.3** | | |

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

**COURSECONTENT**
**THEORY**

**Unit-1**

**Laplace Transforms:** Definition, transforms of elementary functions, Properties-transform of $e^{at}$ f(t) , $t^n$ f(t) and f(t)/t. Laplace transform of derivatives, integrals, periodic functions, unit step function and unit impulse function.

**Unit-2**

**Inverse Laplace Transforms:** Inverse Laplace Transforms, Inverse Laplace transform of standard functions, convolution theorem (without proof), Solution of linear differential equations using Laplace Transforms.
Applications: Applications of Laplace transforms to Mechanical engineering problems.

**Unit- 3**

**Fourier Series**: Periodic functions, Dirichlet's condition, Fourier series of periodic functions with period $2\pi$ and with arbitrary period $2l$. Fourier series of even and odd functions. Half range Fourier series, practical harmonic analysis-Illustrative examples from engineering field.
**Fourier Transforms:** Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Applications to Mechanical engineering problems.

**Unit - 4**

**Numerical Methods:** Numerical solution of algebraic and transcendental equations by Regula- Falsi Method and Newton-Raphson method.
**Finite Differences:** 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 (all formulae without proof)-Problems.

**TEXT BOOKS**

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 48th edition.
2. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 1stedition.

**REFERENCEBOOKS**

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 13th edition.
2. R.K.Jain and S.R.K.Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, 4th edition.

| Course Title | Thermal Engineering | | | | Course Type | | Hard Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ES0301 | Credits | 3 | | Class | | III semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 1 | 1 | 1 | | | | |
| | **Total** | **4** | **4** | **4** | **52** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

This course develops an understanding of mass, energy, heat, work, efficiency, ideal and real thermodynamic cycles and processes. Covers first and second laws of thermodynamics, and the general energy equation for closed and open systems. Also fundamental principles and theory of heat transfer by conduction, convection, and radiation are discussed in detail with relevant practical applications.

As this course is focused to give insights of thermodynamics and heat transfer as an extended part its relevance is explained in Thermal management of Electronics. Thermal management is essential in electronics, as it improves reliability and enhances performance by removing heat generated by the devices. From a reliability and performance point of view, thermal management needs to be carried out for every electronic device which dissipates heat. This is essential for modern electronics, for as they consume more power, they also generate more heat.

**COURSE OBJECTIVE(S)**

The objective of this course is to enable graduating students to identify, analyze, formulate, and solve engineering problems by applying principles of thermodynamics and heat transfer.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Describe the fundamental concepts of thermodynamic systems and various processes of heat and work interactions | 2 | 2 |
| CO2 | Discuss the first and second laws of thermodynamics. | 2, 4, 7 | 2 |
| CO3 | Identify & explain the three modes of heat transfer (conduction, convection and radiation) with mathematical model | 2 | 2 |
| CO4 | Discuss and analyze the application to implement governing laws pertaining to the mode of heat transfer. | 1,2,3,4,7 | 1,2,3 |
| CO5 | Understand how and where heat is generated in electronics | 1, 2, 4 | 1,2 |
| CO6 | Identify the various options available for thermal management of electronics | 1,2, 3, 4, 7 | 1,2,3 |

**BLOOM'S LEVELOF THE COURSE OUTCOMES**

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

| | | | | | | |
|---|---|---|---|---|---|---|
| CO4 | | | | √ | | |
| CO5 | | | √ | | | |
| CO6 | | | | √ | | |

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | 3 | | | | | | | | | | | | 3 | |
| CO2 | | 3 | | 2 | | | 3 | | | | | | | 3 | |
| CO3 | | 3 | | | | | | | | | | | | 3 | |
| CO4 | 3 | 3 | 3 | 3 | | | 2 | | | | | | 2 | 3 | 3 |
| CO5 | 3 | 3 | | 3 | | | | | | | | | 2 | 3 | |
| CO6 | 3 | 3 | 3 | 3 | | | 2 | | | | | | 2 | 3 | 3 |
| **Average** | **3** | **3** | **3** | **2.8** | | | **2.4** | | | | | | **2** | **3** | **3** |

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

**COURSE CONTENT**

**THEORY**

**Unit-1**

**Thermodynamics:** Systems and control volumes, Properties of system, Continuum, State and Thermodynamic equilibrium, Processes and cycles, Zeroth law of thermodynamics, Heat and thermodynamic work, Displacement work equations for thermodynamic processes, First law of thermodynamics applicable to Open and Closed system, Enthalpy and Specific heats, Second laws of thermodynamics, Thermal energy reservoirs, Direct and Reversed Heat Engine, Carnot Cycle and Theorem, Reversibility and Irreversibility, Concept of entropy, Principle of Increase of entropy. Numerical only for SFEE.

**Unit-2**

**Thermodynamic Applications:** HCCI, Stratified Engine, LHR Engine, Plasma Ignition System, Gas turbines and Jet Propulsions, Refrigeration systems and refrigerants – properties and selection, Air conditioning systems, Reciprocating and rotary air compressors.

**Heat Transfer:** Modes of heat transfer, Basic laws of conduction, convection, and radiation, one dimensional steady state heat transfer through Composite walls, hollow cylinder and sphere, Critical thickness of insulation, Extended Surfaces: Heat transfer from finned surfaces (no derivations), Fin Efficiency, Effectiveness, Introduction to Transient conduction – Lumped system analysis (Theory). Numerical (Basic laws, composite walls, Fins)

**Unit-3**

**Convection Heat Transfer:** Introduction to free and forced convection, Velocity and thermal boundary layer, Physical significance of dimensionless numbers, critical Reynolds number, Local heat transfer coefficient, average heat transfer coefficient, internal flow through duct. Simple problems.

**Unit-4**

**Radiation Heat Transfer:** Introduction to thermal radiation, Radiation heat transfer terminologies, Laws pertaining to radiation heat transfer, Heat exchange between different surfaces, Simple problems.

**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.

**CASE STUDIES:**

1. Applications related to temperature measurements, first and second law of thermodynamics
2. Performance evaluation of vapor compression refrigeration system by using MATLAB software.
3. Temperature distribution in a Printed Circuit Board.

**TEXT BOOK:**


1. P. K. Nag, "Basic and Applied Thermodynamics", Tata McGraw Hill, 6th Edition, 2018.
2. R. K. Rajput, "Thermal Engineering", Lakshmi Publications, New Delhi, India, 18th Edition, 2011.
3. Tirumaleshwar, "Heat & Mass transfer", Pearson education 2006
4. Ozisik, "Heat transfer-A basic approach", Tata McGraw Hill 2002.
5. S. M. Sohel Murshed, "Electronics Cooling", Intech Open, 2016.


**REFERENCE BOOKS:**


1. Yunus A. Cengel, "Thermodynamics: An Engineering Approach", McGraw - Hill Education, 9th Edition, 2019.
2. Yunus A-Cengel, "Heat transfer-A practical approach", Tata McGraw hill, 2nd Edition, 2008.
3. Y.V.C.Rao, "An Introduction to Thermodynamics", Universities Press 2004.
4. Mahesh M Rathore, "Heat and Mass Transfer", Laxmi publications , 3rd Edition , 2015.
5. Younes Shabany, "Heat Transfer: Thermal Management of Electronics", S.Chand (G/L) & Company Ltd, 2010


**JOURNALS/MAGAZINES:**

1. https://www.ripublication.com/irph/ijmt.htmhttps://www.scimagojr.com/journalsearch.php?q=22062&tip=sid, International Journal of Mechanics and Thermodynamics (IJMT), ISSN 2278-361X, International Research Publication House
2. International journal of Thermodynamics and Chemical Kinetics Journal – 1 January 2019
3. https://www.springer.com/in/book/9780792327363?utm_campaign=3_pier05_buy_print&utm_content=en_08082017&utm_medium=referral&utm_source=google_books.

**SWAYAM/NPTEL/MOOCs:**

1. https://www.coursera.org/courses?query=thermodynamics
2. https://www.udemy.com/course/thermodynamics-for-engineering-students
3. https://swayam.gov.in/nd1_noc20_ce27/preview

<table>
<tr><td>Course Title</td><td colspan="4">Signals and Networks</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B20ES0302</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">III Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>-</td><td>50%</td><td>50 %</td></tr>
</table>

**COURSE OVERVIEW:**

The course covers the fundamentals of signal and system analysis tackling both continuous-time (CT) and discrete-time (DT) systems. Fourier analysis in the course includes the Fourier series for periodic continuous-time signals, the continuous-time Fourier transform (CTFT) and the discrete-time Fourier transform (DTFT). This course introduces the concepts to determine voltage, current and power in branches of any circuits excited by dc and ac voltages and current sources by simplifying techniques to solve dc circuit problems using basic circuit theorems and structured methods like node voltage and mesh current analysis. The goal also includes derivation of the transient responses of RC, RL and RLC circuits, steady state response of circuits and application of Laplace transform in network theory.

**COURSE OBJECTIVES:**

The objectives of this course are:

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

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Illustrate the operations on Signals and summarize the properties of Systems. | 1 | 1 |
| CO2 | Apply Convolution operation on an LTI System. | 1 | 2 |
| CO3 | Represent continuous time periodic signals in frequency domain using Fourier technique. | 1,2 | 1 |
| CO4 | Evaluate circuit branch currents and node voltage of electrical circuit by application of super mesh, super node method. | 1,2 | 1,2 |
| CO5 | Analyze various network theorems. | 1,2 | 1,2 |
| CO6 | Analyze transient behavior of electrical circuit by applying Laplace Transforms. | 1,2 | 1,2 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | | 1 | | |
| CO2 | 3 | | | | | | | | | | | | | | |
| CO3 | 3 | 2 | | | | | | | | | | | 1 | | |
| CO4 | 3 | 3 | | | | | | | | | | | 1 | 1 | |
| CO5 | 3 | 3 | | | | | | | | | | | 1 | 1 | |
| CO6 | 3 | 3 | | | | | | | | | | | 1 | 1 | |
| Average | 3 | 2.6 | | | | | | | | | | | 1 | 1 | |

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

**COURSE CONTENT**
**THEORY**

**Unit-1**

**Introduction to Signals and Systems:**Definitions of a signal and system, Elementary signals, Basic operations on signals, Classification of signals, Properties of systems. Time domain representation of LTI system: Convolution Sum.

**Unit-2**

**Fourier Representation for Aperiodic signals:**FT representation of aperiodic CT signals, definition, FT of standard CT signals, Properties and their significance. FT representation of aperiodic discrete signals-DTFT, definition, DTFT of standard discrete signals. Inverse Fourier Transform.

**Unit-3**

**Circuit Analysis Techniques:**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-4**

**Applications of LT technique in circuit analysis:** 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.

**Case Studies:**

1. Electric Circuit Analysis Using a Simple Assumption-Based Technique.
2. Sensing, measurement and analysis of mechanical motion, fault analysis.

**TEXT BOOKS:**

1. Simon Haykins, "Signals and Systems", John Wiley, India Pvt Ltd, Second Edition, 2021.
2. W H Hayt, J E Kemmerly, S M Durbin, "Engineering Circuit Analysis", Tata McGraw-Hill Publication,6th Edition,2013.

**REFERENCE BOOKS:**

1. A. Nagoor Kani, "Signals and Systems", Mc Graw Hill, 2010.
2. Allan V. Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", Pearson Education, Second Edition, 1997.
3. Nahvi and Edminister, "Electric Circuits" Schaum's Outline Series, McGraw Hill, 2017.
4. J. David Irwin and R. Mark Nelms, "Basic Engineering Circuit Analysis", 10th Edition, John Wiley, 2022.

**JOURNALS/MAGAZINES/ ADDITIONAL SOURCES:**

1. https://www.tutorialspoint.com/signals_and_systems/index.htm
2. https://www.tutorialspoint.com/network_theory/index.htm

**SWAYAM/NPTEL/MOOCs:**

1. https://www.udemy.com/course/signals-and-systems-from-basics-to-advance/
2. https://www.udemy.com/course/electrical-circuits-module-1-from-basics/

<table>
<tr><td>CourseTitle</td><td colspan="4">Analog and Digital Circuits</td><td colspan="2">CourseType</td><td colspan="2">Integrated</td></tr>
<tr><td>CourseCode</td><td>B20ES0303</td><td>Credits</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2">III Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">TotalNumber of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory Hours</td><td rowspan="2">Practical Hours</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>4</td><td>5</td><td>5</td><td>39</td><td>26</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSEOVERVIEW**

Analog and Digital Circuits is the base of any electronic circuits. In this course the working of various amplifiers is explained. Students learn how BJT works and different types of oscillators and their working is analyzed. Introduction to Op-Amps is given in the course. Digital Electronics course opens with an introduction to combinational logic, logic gates, minimization techniques, arithmetic circuits. It then moves to deal with sequential circuits: flip-flops, synthesis of sequential circuits, and case studies, including counters, registers.

**COURSE OBJECTIVE (S)**

1. Understand how Bipolar Junction transistors are modeled and how the models are used in the design and analysis of useful circuits.
2. Perform a load-line analysis of the most common BJT configurations.
3. Become acquainted with the design process for BJT biasing.
4. Apply concepts for the design of Amplifiers
5. Analyze the concepts of Oscillator circuits.
6. Illustrate Boolean laws and systematic techniques for minimization of expressions.
7. Demonstrate the methods for simplifying Boolean expressions.
8. Familiarize the commonly used terms like min-term, canonical expression, SOP etc.
9. Introduce the Basic concepts of combinational and sequential logic.

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Develop the capability to analyze and design simple circuits containing non-linear elements such as transistors using the concepts of load lines and operating points | 1,2 | 1,2 |
| CO2 | Compute the DC values of voltages and currents in biasing circuits. | 1 | 1,2 |
| CO3 | Analyze the working of Operational Amplifier, oscillators and their characteristics. | 1,2 | 1,2 |
| CO4 | Construct the K-map from a Boolean expression and to find the minimal SOP/POS forms | 1,2 | 1,2 |
| CO5 | Design digital circuits using gates, encoders and decoders. | 1,2 | 1,2 |
| CO6 | Determine the output and performance of given combinational and sequential circuits and document in the results in the form of technical report. | 1,2,9,10 | 1,2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

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

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

**COURSE CONTENT**
**THEORY**

**Unit-1**

**Transistor and its Biasing Techniques:** Bipolar Junction Transistors Construction, BJT Operation, BJT Configuration: Common Base, Common Emitter and Common Collector Characteristics, Operating Point, DC Analysis: Fixed Bias, Voltage-Divider Bias, Emitter-Follower configurations, Bias Stabilization, Problems linked to above topics.

**Unit-2**

**Oscillator Circuits:** Condition for oscillations, Oscillator operation, BJT based oscillators: RC Phase Shift Oscillator, Wein Bridge, Colpitts, Hartley and Crystal Oscillators. Problems linked to above topics.

**Operational Amplifiers:** Basic Operational Amplifier Circuit, The 741 IC Op-Amp, Voltage Follower, Non-inverting and inverting Amplifiers. Operational Amplifier Parameters. Problems linked to above topics.

**Unit-3**

**Design of Combinational Logic Circuits:** Basic Theorems and Properties of Boolean Algebra, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3,4 variables, Incompletely specified functions (Don't care terms) Simplifying Max term equations, Binary adders and subtractor, Parallel adder, Carry Look Ahead adder, BCD adder. Principle of Encoder and Decoder with cascading of decoder s. Principle of Multiplexers and Demultiplexer with cascading of Mux and Boolean function implementation using Mux and decoders, Comparators.

**Unit-4**

**Introduction to Sequential Logic:** Basic Bistable elements, Latches, Flip-Flops-SR, D, JK & T The master-slave flip-flops: SR flip-flops, JK flip-flops, Shift Registers- SISO, SIPO, PISO, PIPO, binary ripple counters and synchronous binary counters, Design of a synchronous mod-n counter using clocked JK, D, T and SR flip-flops.

**PRACTICE:**

| Sl. No | Titleof theExperiment | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| 1. | Design a Single stage BJT RC Coupled Amplifier and obtain frequency response curve and find Bandwidth, Input & Output Impedances. | Spring board, CRO o Trainer kit, Ohms Law, Fall of resistance. | Frequency response curve and find Bandwidth, Input & Output Impedances. |
| 2. | Design a Two stage voltage series BJT Amplifier and Obtain frequency response curve, also find Bandwidth, Input & Output Impedances | Spring board, CRO | Frequency response curve and find Bandwidth, Input & Output Impedances. |
| 3. | Design a BJT Hartley &Colpitts's Oscillators for frequency ≥100kHz. | Spring board, CRO | Frequency of an Oscillator |
| 4. | Design an OPAMP Inverting & Non-Inverting Amplifier. | Spring board, CRO | Amplitude and Phase |
| 5. | Realization of parallel Adder and Subtractor using IC7483 | IC Trainer Kit | Design and circuit debugging. Working in a team |
| 6. | Realization of 3-bit Binary to Grey code conversion and vice versa using basic/Universal gates. | IC Trainer Kit | Design and circuit debugging. Working in a |
| 7. | Realization of 4:1 MUX and 1:4 DEMUX using basic/universal gates | IC Trainer Kit | Design and circuit debugging. Working in a |
| 8. | Arithmetic circuit realization (Half/Full, Adder/Subtractor) using MUX. | IC Trainer Kit | Design and circuit debugging. Working in a team |

| Sl. No | Titleof theExperiment | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| 9. | Construction and verification of JK master slave, T, D flip flop using logic gates | IC Trainer Kit | Design and circuit debugging. Working in a team |
| 10. | Construction and realization of 3- bit ripple up/down counter using IC 7476 and other logic gates. | IC Trainer Kit | Design and circuit debugging. Working in a team |
| 11. | Design and verification of 3-bit synchronous counter using 7476. | IC Trainer Kit | Design and circuit debugging. Working in a team |

**Case Studies:**

1. Biasing with Collector feedback resistor
2. Case study on instrumentation amplifier in data acquisition
3. A Simple Flip-Flop Circuit for Typical-Case Designs for DFM

**TEXTBOOKS:**


1. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", 11th edition PHI/Pearson Education. 2017.
2. David A. Bell, "Electronic Devices & Circuits", 4th Edition, Prentice Hall of India/Pearson Education, ninth printing, 2015.
3. David A. Bell, "Operational Amplifiers and Linear ICs", 2nd Edition, Prentice Hall of India, 2011.
4. John M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 1st Edition, 2006.
5. Donald D Givone, "Digital Principles and Design", Tata McGraw-Hill 1st Edition, 2017.


**REFERENCEBOOKS:**


1. Floyd, "Electronic Devices", 6th Edition, Prentice Hall of India, Pearson Education.2010.
2. Moshe Morris Mano, "Digital Design" Prentice Hall, 3rd Edition, 2018.


**JOURNALS/MAGAZINES**

1. IEEE Transactions on Circuits and Systems
2. IEEE Transactions on Digital circuits and Systems

**SWAYAM/NPTEL/MOOCs:**

1. http://nptel.ac.in/courses/117106086/6
2. http://nptel.ac.in/courses/117105080/12
3. http://nptel.ac.in/courses/117105080/21
4. http://nptel.ac.in/courses/117106086/26

| CourseTitle | Mechanics of Materials | | | | CourseType | | Integrated | |
|---|---|---|---|---|---|---|---|---|
| CourseCode | B20ER0304 | Credits | 4 | | Class | | IIISemester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | TotalNumber of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 1 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | - | - | | | | |
| | **Total** | **4** | **5** | **5** | **39** | **26** | **50 %** | **50 %** |

**COURSEOVERVIEW**

This course of Mechanics of Solids deals with behavior of bodies subjected to various types of loadings. This course explores the topic of solid objects subjected to stress and strain. The methods taught in the course are used to predict the response of engineering structures to various types of loading, and to analyze the vulnerability of these structures to various failure modes. This course introduces students to the fundamental principles and methods of structural mechanics. Topics covered include: static equilibrium, force resultants, support conditions, analysis of determinate planar structures , stresses and strains in structural elements, states of stress (shear, bending, torsion), statically indeterminate systems, displacements and deformations, elastic stability, and approximate methods. Design exercises are used to encourage creativity in students.

**COURSE OBJECTIVES**

1. To develop the basic knowledge on different stress & strain in materials under various loading conditions
2. To incorporate the concept of Transformation of Stress and Strain and to understand the concepts of torsion and its application to design of shafts
3. To incorporate the concept of Shear Force, Bending Moment Diagram, Bending stress and deflection of beams
4. To understand the concepts of column loading and its effect due to buckling, stress & strain in cylinders and Static failure criteria

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Explain concept of stress & strain in materials under various loading conditions. | 1,2 | 1,2 |
| CO2 | Compute various types of stresses and strains, elastic constants for given load conditions. | 1,2 | 1,2 |
| CO3 | Plot Shear Force, Bending Moment Diagrams for various types of beams under different loading and boundary conditions and Mohr's Circle for given type of loading. | 1,2 | 1,2 |
| CO4 | Derive general torsion and bending equations and compute torque, bending moment, shear stress, bending stress, deflection of beams for different loads and boundary conditions. | 1,2 | 1,2 |
| CO5 | Explain the behavior of columns under different loads and end conditions and compute crippling load. | 1,2 | 1,2 |
| CO6 | Apply Lame's Theorem to predict the failure of cylinders and Experimentally determine various mechanical properties of materials and document the results in the form of technical report. | 1,2, 9,10 | 1,2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

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

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Average** | **3.0** | **2.2** | | | | | | | **3** | **3** | | | **3.0** | **3.0** | |

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

**COURSE CONTENT**

**Unit-1**

**Simple Stress and Strain**: Types of Loading, Axial, Shear, Concept of stress, Strain, Stress-strain diagram, Hooke's law, Young's modulus, Application to the Analysis and Design of Simple Structures, deformation in statically determinate problems, Elastic Constants, complementary shear stress, lateral strain and Poisson's ratio, Thermal Stresses.

**Unit-2**

**Transformation of Stress and Strain:** Transformation of plane stress, Principal Stresses, Maximum Shearing Stress, Mohr's Circle for Plane Stress.

**Torsion:** Torsion in Solid & Hollow Circular Shafts, Torque and Power Transmitted by Solid and Hollow Shafts, Strength of Shafts.

**Unit-3**

**Analysis of Beams:** Shear force and bending moment diagrams of cantilevers, simply supported beams under concentrated, uniformly loaded, varying loads and externally applied moments with and without overhangs. Stresses in beams: beam of uniform strength, bending equation, Beam Deflection: slope and deflection at a section for cantilevers under concentrated and uniformly distributed loads using MaCaulay's method.

**Unit-4**

**Columns:** Classification of columns, end connections, Euler's formulae and Rankine Gordon equations.

**Cylinders:** Thin and thick cylinders, Lame's Theorem, compound cylinders, Static and Dynamic failure criteria.

**PRACTICE**

| Sl. No | Titleof theExperiment | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| 1. | Identification of Microstructure | Polishing Machine and Metallurgical Microscope | Material Identification |
| 2 | Tensile Test | Universal Testing Machine | Hands on Experience |
| 3. | Compression Test | Universal Testing Machine | Hands on Experience |
| 4. | Bending Test | Universal Testing Machine | Hands on Experience |
| 5. | Shear Test | Universal Testing Machine | Hands on Experience |
| 6. | Torsional Test | Torsion Testing Machine | Hands on Experience |
| 7. | Hardness Test | Hardness testing machine | Hands on Experience |
| 8. | Impact Test | Pendulum type impact testing machine | Hands on Experience |
| 9 | Wear Test | Pin on Disc | Hands on Experience |

**Case studies:**

1) Develop a Python code to draw Mohr's circles and SFD , BMD for given beam under loaded conditions.
2) Stress Analysis in hanging shelf for keeping books.
3) Flexural study of bridges.

**TEXTBOOKS**

1. F.P.Beer & Russell Johnstan, John T Dewolf, David F Mazurek "Mechanics of Materials", in S.I. Units, TATA Mc Graw Hill, New York, 6th Edition, 2012.
2. S. H. Crandall et al., "An Introduction to Mechanics of Solids (In SI Units)", McGraw-Hill. Third Edition, 2017.
3. Singer, F.L. Strength of Materials, 3rd Edition, Harper and Row Publishers, New York, 1980.

**REFERENCE BOOKS**

1. R.C.Hibbeler,"Mechanics of Materials", Printice Hall. Pearson Edu., 2005
2. S.S.Bhavikatti,"Strength of Materials", Vikas publications House -1 Pvt. Ltd., 2nd Edition, 2006.
3. Timoshenko.S.P, "Strength of Materials", Part1, D.Van Nostrand Company, Inc. Newyork

4. R K Bansal, “Engineering Mechanics and Strength of Materials”, Laxmi Publications-New Delhi, 2004.

**JOURNALS/MAGAZINES**

1. International Journal of Mechanics of solids.
2. International Journal of Strength of Materials.

**SWAYAM/NPTEL/MOOCs:**

1. https://www.udemy.com/course/basic-concepts-of-mechanics-of-materials-for-machine-design/
2. https://nptel.ac.in/courses/105/106/105106172/
3. https://www.coursera.org/learn/mechanics-1

| Course Title | Communication Skills | | | | Course Type | | FC | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20AH0301 | Credits | 2 | | Class | | III Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 2 | 2 | 2 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **2** | **2** | **2** | **26** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

This course is aimed to develop basic communication skills in English in the learners, to prioritize listening andreadingskillsamonglearners,tosimplifywritingskillsneededforacademicaswellasworkplacecontext, to examine that the learners use the electronic media such as internet and supplement the learning materials used in theclassroom.

**COURSE OBJECTIVES**

The objectives of this course are to:

1. Develop basic communication skills inEnglish.
2. EmphasizeonthedevelopmentofspeakingskillsamongstlearnersofEngineeringandTechnology
3. Impart the knowledge about use of electronic media such as internet and supplement the learning materials used in theclassroom.
4. Inculcatethehabitofreadingandwritingleadingtoeffectiveandefficientcommunication.

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

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

**BLOOM’S LEVELOF THECOURSE OUTCOMES**

| CO | Bloom’s Level | | | | | |
|---|---|---|---|---|---|---|
| | Remember (L1) | Understand (L2) | Apply (L3) | Analyze (L4) | Evaluate (L5) | Create (L6) |
| CO1 | | √ | | | | |
| CO2 | | | √ | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO3 | | | √ | | | |
| CO4 | | | | | | √ |
| CO5 | | | √ | | | |
| CO6 | | | √ | | | |

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 2 | 3 | | | | | |
| CO2 | | | | | | | | | | 3 | | | | | |
| CO3 | | | | | | | | | 1 | 3 | | | | | |
| CO4 | | | | | | | | | 2 | 3 | | | | | |
| CO5 | | | | | | | | | | 2 | | | | | |
| CO6 | | | | | | | | | 2 | 2 | | | | | |
| **Average** | | | | | | | | | **1.7** | **2.6** | | | | | |

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

**COURSE CONTENT**

**Unit – 1**

**FunctionalEnglish:**Grammar:Prepositions;ModalAuxiliaries, Reading Comprehension, Activeandpassivevoice, Giving Instructions.

**Unit – 2**

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

**Unit – 3**

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

**Unit – 4**

**Communication Skills Grammar:** Direct and indirect speech, Interpretingvisualmaterials(linegraphs, pie charts etc.), Single word substitutes.

**TEXT BOOKS**


1. Green,David, "ContemporaryEnglishGrammarStructuresandComposition", New Delhi:MacMillan Publishers,20l0.
2. Thorpe, Edgar and Showick Thorpe, "Basic Vocabulary", Pearson Education India, 20l2.
3. Leech,GeoffreyandJanSvartvik, "ACommunicativeGrammarofEnglish", Longman,2003.


**REFERENCE BOOKS**


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


| **Course Title** | **Indian Constitution and Professional Ethics** | | | | **Course Type** | | **FC** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20LS0301** | **Credits** | **2** | | **Class** | | **III Semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 2 | 2 | 2 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **2** | **2** | **2** | **26** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

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

**COURSE OBJECTIVES**

The objectives of this course are to:

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

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Analyze the Fundamental Rights, Duties and other Rights protected under Indian Constitution. | 6,7,8,9, 12 | |
| CO2 | Demonstrate the practicality of Constitution perspective and make them to face the world as a bonafide citizen. | 8 ,12 | |
| CO3 | Illustrate the professional ethics and human values. | 6,8,12 | |
| CO4 | Summarize ethical standards followed by different companies. | 7,8,12 | |
| CO5 | Demonstrate the Knowledge of Ethics to protect environment as an Engineer | 6, 7, 8, 12 | |
| C06 | Apply the principles of Ethics as an employee employer in the professional life | 6, 8, 9, 12 | |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

| CO | Bloom's Level | | | | | |
|---|---|---|---|---|---|---|
| | Remember (L1) | Understand (L2) | Apply (L3) | Analyze (L4) | Evaluate (L5) | Create (L6) |
| CO1 | | | | √ | | |
| CO2 | | √ | | | | |
| CO3 | | | √ | | | |
| CO4 | | | √ | | | |
| CO5 | | √ | | | | |
| C06 | | √ | | | | |

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 2 | 2 | 3 | 2 | | | 1 | | | |
| CO2 | | | | | | | | 3 | | | | 1 | | | |
| CO3 | | | | | | 2 | | 3 | | | | 1 | | | |
| CO4 | | | | | | | 2 | 3 | | | | 1 | | | |
| CO5 | | | | | | 2 | 2 | 3 | | | | 1 | | | |
| C06 | | | | | | 2 | | 3 | 1 | | | 1 | | | |
| **Average** | | | | | | **2** | **2** | **3** | **1.5** | | | **1** | | | |

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

**COURSE CONTENT**

**Unit – 1**

**Indian constitution:** Sailent features, fundamental rights and duties (Directive principle and state policy), Legislature (Loka Sabha & Rajya Sabha), Executive ( President& Governor) and Judiciary (Supreme court & high

court), Composition and function of parliament, Council of ministers, prime minister, Speaker, Passing of bills.

**Unit – 2**

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

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

**Unit – 3**

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

**Unit – 4**

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

**TEXT BOOKS**

1. Kapoor, S.K., "Human rights under International Law and Indian Law", Prentice Hall of India, New Delhi, 2002.
2. Basu, D.D., "Indian Constitution", Oxford University Press, New Delhi, 2002.
3. Chakraborty, S.K., "Values and ethics for Organizations and Theory Practice", Oxford University Press, New Delhi, 2001.

**REFERENCES BOOKS**

1. Meron Theodor, "Human Rights and International Law Legal Policy Issues", Vol. 1 and 2, Oxford University, Press, New Delhi, 2000.
2. M V Pylee, "An Introduction to Constitution of India", S Chand & Company, 5th Edition
3. Durga Das Basu, "Introduction to constitution of India", LexisNexis, 23rd Edition.

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

REVA UNIVERSITY
Bengaluru, India

ರುಕ್ಮಿಣಿ ಜ್ಞಾನವನ, ಕಟ್ಟಿಗೇನಹಳ್ಳಿ, ಯಲಹಂಕ, ಬೆಂಗಳೂರು – 560064

# ಕನ್ನಡಿಗರಿಗೆ ಇಂಜಿನಿಯರಿಂಗ್ ಪ್ರಥಮ ಪದವಿ ಪಠ್ಯ

## ಪರಿವಿಡಿ



- ಬಿ ಎಂ ಎಸ್ ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು ಕನ್ನಡಿಗರಿಗೆ '**ಕನ್ನಡ ಕಲಿ**' ಪಠ್ಯ ಪುಸ್ತಕ
- ಕರ್ನಾಟಕ ತಾಂತ್ರಿಕ ಶಿಕ್ಷಣ ವಿಭಾಗ ಕನ್ನಡಿಗರಿಗೆ '**ಸಾಹಿತ್ಯ ಸಿಂಚನ**' ಪಠ್ಯ ಪುಸ್ತಕ
- ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಳಗಾವಿ ಕನ್ನಡಿಗರಿಗೆ '**ಬಳಕೆ ಕನ್ನಡ**' ಪಠ್ಯ ಪುಸ್ತಕ

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

REVA UNIVERSITY
Bengaluru, India

ರುಕ್ಮಿಣಿ ಜ್ಞಾನವನ, ಕಟ್ಟಿಗೇನಹಳ್ಳಿ, ಯಲಹಂಕ, ಬೆಂಗಳೂರು – 560064

# ಕನ್ನಡೇತರರಿಗೆ ಇಂಜಿನಿಯರಿಂಗ್ ಪ್ರಥಮ ಪದವಿ ಪಠ್ಯ

## ಭಾಷಾ ಕೌಶಲ್ಯಗಳು

ಘಟಕ – 1

**1. ಆಲಿಸುವುದು**

- ಆಲಿಸುವ ಕೌಶಲ್ಯ
- ಆಲಿಸುವಿಕೆಯಲ್ಲಿನ ದೋಷಗಳು
- ಉತ್ತಮ ಆಲಿಸುವಿಕೆ

ಘಟಕ – 2

**2. ಮಾತನಾಡುವುದು**

- ಸಂಭಾಷಣೆ
- ವ್ಯವಹಾರಿಕ ಸಂಭಾಷಣೆ
- ದೋಷಗಳು ಮತ್ತು ಪರಿಹಾರಗಳು

ಘಟಕ – 3

**3. ಓದುವುದು**

- ಓದು ಕಲಿಸುವಾಗ ಗಮನಿಸಬೇಕಾದ ಅಂಶಗಳು
- ಧ್ವನ್ಯಾಂಗಗಳ ಪರಿಚಯ
- ಓದಿನ ವಿಧಗಳು

ಘಟಕ – 4

**4. ಬರೆಯುವುದು**

- ವರ್ಣಮಾಲೆಯ ಸ್ವರೂಪ
- ಕಾಗುಣಿತ ಸ್ವರೂಪ
- ಕನ್ನಡ ಸಂಖ್ಯೆಗಳು

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

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

## 4th Semester

| CourseTitle | Probability and Sampling Theory | | | | CourseType | | FC | |
|---|---|---|---|---|---|---|---|---|
| CourseCode | B20AS0403 | Credits | 3 | | Class | | IVSemester | |
| Course Structure | TLP | Credits | ContactHours | WorkLoad | TotalNumberof Classes PerSemester | | Assessment inWeightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **-** | **50 %** | **50 %** |

**COURSEOVERVIEW**

Axiomatic probability theory, independence, conditional probability. Discrete and continuous random variables, special distributions of importance to Mechanical Engineering. Expectation simulation of random variables and Curve fitting, basic statistical inference, parameter estimation, hypothesis testing, and linear regression and correlation. Introduction to stochastic processes and Sampling theory.

**COURSEOBJECTIVES**

Student will be able to learn,

1. The concept of curve fitting and few statistical methods.
2. Fundamentals of probability- Random variables.
3. Joint probability and regarding stochastic process.
4. Concept of test of hypothesis and able to apply in the various fields of Mechanical engineering.

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Approximate a linear and non-linear equation to the given data by the method of least squares. | 1,2 | 1 |
| CO2 | Apply the concept of correlation and regression lines for distinct civil engineering problems. | 1,2 | 1 |
| CO3 | Define concepts of probability space, random variable, discrete & continuous distribution and use to solve various Mechanical engineering problems | 1,2,3 | 1 |
| C04 | Calculate Joint probabilities and derive the marginal and conditional distributions of bivariate random variables. | 1,2 | 1 |
| CO5 | Define and use stochastic processes and Markov chains in discrete and continuous time. | 1,2 | 1 |
| C06 | Apply sampling theory concepts to solve various Mechanical engineering problems. | 1,2,3 | 1 |

**BLOOM'SLEVELOFTHECOURSEOUTCOMES**

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

**COURSE ARTICULATION MATRIX**

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

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | 3 | 2 | | | | | | | | | | | 3 | | |
| CO6 | 3 | 2 | | | | | | | | | | | 2 | | |
| **Average** | **3.0** | **2.0** | **1.0** | | | | | | | | | | **2.3** | | |

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

**COURSECONTENT**

**Unit -1**

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

**Statistical Methods:** Measures of central tendency and dispersion. Correlation-Karl Pearson's coefficient of correlation-problems. Regression analysis- lines of regression (without proof) –problems.

**Unit - 2**

**Probability Theory:** Recap of Probability theory (definition, addition theorem, multiplication theorem and conditional probability and Baye's theorem).

**Probability Distributions:** Random variables (discrete and continuous), probability mass/density functions, mean, variance and moments. Binomial distribution, Poisson distribution. Exponential and normal distributions, problems.

**Unit - 3**

**Joint Probability Distribution:** Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient.

**Stochastic Process:** Stochastic processes, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability-simple problems.

**Unit - 4**

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

**TEXTBOOKS**

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 48th edition.
2. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 1stedition.

**REFERENCEBOOKS**

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 13th edition.
2. R.K.Jain and S.R.K.Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, 4th edition.

| **CourseTitle** | **Mechanical Measurements and Metrology** | | | | **CourseType** | | **Hard Core** | |
|---|---|---|---|---|---|---|---|---|
| **CourseCode** | **B20ER0401** | **Credits** | **3** | | **Class** | | **IV Semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | TotalNumber of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 2 | 2 | 2 | | | | |
| | Practice | 1 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **4** | **4** | **26** | **26** | **50 %** | **50 %** |

**COURSEOVERVIEW**

Metrology is the science of pure measurement. It is concerned with the establishment, reproduction, conservation and transfer of units of measurements and their standards. It's also concerned with the methods, execution and estimation of accuracy of measurements, the measuring instruments and the inspectors. Basic applications include measurement of length, diameter, taper, flatness, and squareness. Etc. Further the course intends to introduce the technological and engineering concepts and study the applications of measuring quantities like force, torque, pressure, temperature, strain.

**COURSE OBJECTIVES**

1. Understand metrology, its advancements & measuring instruments, acquire knowledge on different standards of length, calibration of End Bars, linear and angular measurements.
2. To introduce the fundamental concepts & derive the relations for the design of gauges, types of gauges,

concepts involving comparators, angular measurements.

3. To gain knowledge about various aspects of pressure, speed and surface roughness measurement.
4. To explore the various aspects regarding the force, torque, strain & temperature measurement.

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Outline the objectives of metrology, methods of measurement, standards of measurement and describe slip gauges, manufacturing of slip gauges & building of slip gauge blocks for calibration. | 1 | 1 |
| CO2 | Describe the need of limit system and working of different types of comparators. | 1 | 1 |
| CO3 | Enumerate the pressure, speed and surface roughness measurement | 1 | 1 |
| CO4 | Elaborate the concept of measuring force, torque, temperature and strain measurement. | 1 | 1 |
| CO5 | Measure the depth and thickness of the given gear tooth using gear tooth Vernier caliper | 1,2 | 2 |
| CO6 | Demonstrate the measurement of cutting forces, thread components, angular components in groups and document the results in the form of report. | 1, 2, 9, 10 | 2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | | 3 | | |
| CO2 | 3 | | | | | | | | | | | | 3 | | |
| CO3 | 3 | | | | | | | | | | | | 3 | | |
| CO4 | 2 | | | | | | | | | | | | 3 | | |
| C05 | 1 | 1 | | | | | | | | | | | 2 | | |
| C06 | 1 | 1 | | | | | | | 2 | 2 | | | 2 | | |
| **Average** | 2.2 | 1 | | | | | | | 2 | 2 | | | 2.7 | | |

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

**COURSE CONTENT**

**THEORY**

**Unit-1**

**Basic of Metrology, Linear and Angular Measurement:** 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 on building of slip gauges, Vernier bevel protractor, Angle gauges, Sine principle, Sine bar & Sine Centre.

**Unit-2**

**Limit Gauges and Comparators**: 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, design of GO and NO GO gauges using Taylor's principle. Numerical on Limits, Fits and Tolerances.

Comparators-types and characteristics Johanson Mikrokator, Sigma comparator, Principle of optical comparator, Zeiss ultra-optimeter, Solex pneumatic comparator, LVDT

**Unit-3**

**Measurement of Pressure, Speed and Surface Roughness**: Pressure Measurements: principle, use of elastic members in pressure measurement, Bridgeman gauge, McLeod gauge, Pirani gauge. Speed Measurement: Mechanical counters, contact and non-contact type measurement. Surface Roughness: Introduction, modes of defining surface texture, surface roughness evaluation CLA, RMS, Rmax and Rz, surface texture symbols and specifications, profilometer and Tomlinson surface meter.

**Unit-4**

**Measurement of Force, Torque, Temperature and Strain Force Measurement**: Analytical balance, unequal arm balance, proving ring. **Torque Measurement:** Prony brake and hydraulic dynamometer, **Temperature Measurement:** Resistance thermometer, thermocouple, law of thermocouple, materials used for construction, optical pyrometer and radiation pyrometer. **Strain Measurement**: Mechanical and optical strain gauge, electrical strain gauge: Bonded and unbounded resistance strain gauges, strain gauge backing and bonding materials, preparation & mounting of strain gauges.

**PRACTICE**

| Sl. No | Titleof theExperiment | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| 1. | Calibration of Micrometer using slip gauges | Micrometer, slip gauges | Hands on experience |
| 2. | Calibration of LVDT | LVDT, Micrometer | Hands on experience |
| 3 | Measurement of taper angle using Sine bar, sine centre and Roller set method. | Sine bar, sine centre and Tapered specimen, slip gauges, rollers | Hands on experience |
| 4 | Measurement of effective diameter of the given screw thread by two wire / three wire method | Screw thread, wire, Bench micrometer | Hands on experience |
| 5 | Measurement of flatness by using Autocollimator | Autocollimator, Reflector, surface plate. | Hands on experience |
| 6 | Measurement of gear tooth thickness using gear tooth Vernier | Gear tooth Vernier caliper, spur gear | Hands on experience |
| 7 | Measurement of cutting forces using lathe tool dynamometer | Lathe machine with dynamometer | Hands on experience |
| 8 | Measurement of cutting forces using drill tool dynamometer | Drilling machine with dynamometer | Hands on experience |

**TEXTBOOKS**

1. R.K. Jain, Engineering Metrology, Khanna Publishers, 1994.
2. I.C.Gupta, Engineering Metrology Dhanpath Rai Publications, 2005.

**REFERENCE BOOKS**

1. Beckwith Marangoni and Lienhard, Mechanical Measurements, Pearson Education, 6th Ed., 2006.
2. Anand K. Bewoor & Vinay A. Kulkarni Metrology & Measurement, Tata McGraw, 2017.
3. N.V Raghavendra & L. Krishnamurthy, Engineering Metrology and Measurements, Oxford University Press, 2018.

**JOURNALS/MAGAZINES**

1. https://www.journals.elsevier.com/measurement
2. https://iopscience.iop.org/journal/0957-0233

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/112/106/112106179/
2. https://nptel.ac.in/courses/112/106/112106139/

| Course Title | Kinematics and Dynamics of Machines | | | | Course Type | | Integrated | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ER0403 | Credits | 4 | | Class | | IV Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 1 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **4** | **5** | **5** | **36** | **24** | **50 %** | **50 %** |

**COURSEOVERVIEW**

Kinematics and dynamics of Machines is a subject which deals with the basic components of machines and mechanisms .It also deals with the study of the velocity and acceleration of mechanisms, gears and arrangement of gear trains, types of cam and follower. It also gives an insight about the balancing of rotating and reciprocating parts used in IC engines, CNC Machineries etc. It also helps to predict the unbalanced and balanced forces and keep the system in dynamic equilibrium between the moving parts. It also provides the gyroscopic principles on plane disc, aeroplane, ship, 2 and 4 wheelers. It also aims at the study of controlling forces on governors.

**COURSE OBJECTIVES**

1. To gain the knowledge on mobility of mechanisms, velocity and acceleration of mechanisms.
2. Computation of degree of freedom for different mechanisms and machines.
3. To analyze velocity, acceleration, different tooth forms, mesh and their arrangements.
4. To introduce the concept of gyroscopic effect in aero plane, ship, two wheeler, and four wheeler vehicle.
5. To explain the working principal, mechanism and application of governors.
6. To develop the analytical approach and graphical methods in balancing the unbalanced forces and couples in engine.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Differentiate the different mechanisms and determine, velocity, acceleration and their instantaneous center | 1,2 | 1,2 |
| CO2 | Computation of DOF for different mechanisms and structures | 1,2 | 1,2 |
| CO3 | Compare the various types of gears and gear train and evaluating their performance | 1,2 | 1,2 |
| CO4 | Draw the various cam profile based on the follower motionsand followers and their terminologies | 1,2 | 1,2 |
| CO5 | Analyze the balancing forces and couples polygon of engines, and derive the balancing condition for rotating and reciprocating masses. | 1,2 | 1,2 |
| CO6 | Evaluate the performance of governor and Analyze the gyroscopic effect and stability of aeroplane, two wheeler and four wheelers. | 1,2 | 1,2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | | | | | | | | | | | 1 | 2 | |
| CO2 | 3 | 2 | | | | | | | | | | | 1 | 3 | |
| CO3 | 3 | 2 | | | | | | | | | | | 3 | 1 | |
| CO4 | 3 | 2 | | | | | | | | | | | 2 | 1 | |
| CO5 | 3 | 2 | | | | | | | | | | | 1 | 2 | |
| CO6 | 3 | 2 | | | | | | | | | | | 1 | 2 | |
| **Average** | **3** | **2** | | | | | | | | | | | **1.5** | **1.8** | |

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

**COURSE CONTENT**

**Unit-1**

**Introduction**: Links-types, Kinematics pairs-classification, Kinematic Chain ,Constrained Motions-types, Degrees of freedom of planar mechanism, linkage mechanisms, inversions of four bar chain, slider crank chain and double slider crank chain.

**Velocity and Acceleration of Mechanism:** Velocity of point in mechanism, Relative and Instantaneous Velocities in four bar and slider crank mechanism, Instantaneous center method, Types & location of instantaneous centers for different mechanisms, Kennedy's theorem. Introduction to Acceleration of a point on a link

**Unit -2**

**Gears and Gear Trains**: 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, Gear Trains: Simple, compound, reverted and Epicyclic gear train. **(No derivation and Problems in gears and gear trains)**

**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 Simple numerical (no offset follower)

**Unit 3**

**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 and V- engine. Numerical.

**Unit 4**

**Governors**: Introduction, principles, Types of governors, Terminology, force analysis of Porter, sensitivity, stability, Hunting, Isochronism, effort and power of governor, controlling force diagram. Numerical. Introduction to speed synchronizer.

**Gyroscope**: Principles, Gyroscopic Torque, effect of gyroscopic couple on the stability of disc, aero plane, two wheeler and four wheeler.

**PRACTICE**

| Sl. No | Title of the Experiment | Tools and Techniques | Expected Skill /Ability |
|---|---|---|---|
| 1. | Analysis of 4 bar Mechanism and Slider Mechanism, 2 problems each | Adams | Hands on Experience |
| 2. | Analysis of Cams , Gears and gear Trains | Adams | Hands on Experience |
| 3. | To determine the power, effort, controlling force, sensitiveness of the porter governor | Porter governor experimental setup | Hands on Experience |
| 4. | To determine the magnitude, position of unknown rotating masses using Balancing Machine. | Balancing Machine | Hands on Experience |
| 5 | Gyroscope(Demo Only) | Gyroscope | Hands on Experience |
| 6 | Analysis of gear trains and gear for a small machine component | Analyzing and suggesting | Thinking |

**Case Studies:**

1) Construct a model for understanding CAM profile in opening and closing of cylinder valves in a 4-stroke petrol engine.
2) Simulate any gym equipment by taking appropriate length using any simulation software.
3) Develop a program to compute the velocity of connecting rod in a slider crank mechanism.

**TEXT BOOKS**

1. R S Khurmi, “Theory of Machines”, S Chand Publishing House, 14th edition, 2020.
2. S S Rattan, "Theory of Machines”, Tata Mc Graw Hill Education Private Limited New Delhi, 5th edition, 2020.

**REFERENCE BOOKS:**

1. VP Singh, “Theory of Machines”, Dhanpat Rai Publishing, 6th edition, 2021.
2. Gordon R. Pennock & Joseph E. Shigley John J. Uicker“Theory of Machines and Mechanisms”, Oxford Higher Education International Version, 4th edition, 2016.
3. R K Bansal, “Theory of Machines, Lakshmi Publications Ltd, New Delhi, 5th edition, 2020.

**JOURNALS/MAGAZINES**

1. Mechanism and Machine Theory | journal | sciencedirect.com by elsevier
2. Applied Theories on Machines | List of High Impact Articles | PPts | Journals | Videos (longdom.org)

**SWAYAM/NPTEL/MOOCs:**

1. NPTEL: Mechanical Engineering - Theory of Mechanisms
2. http://ecoursesonline.iasri.res.in/course/view.php?id=522
3. Adams Tutorial Kit for Mechanical Engineering Courses (mscsoftware.com)

| Course Title | Microcontrollers and Applications | | | | Course Type | | Integrated | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ES0401 | Credits | 4 | | Class | | IV Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 1 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **4** | **5** | **5** | **39** | **26** | **50 %** | **50 %** |

**COURSE OVERVIEW**

This course introduces 8051 microcontroller to provide basic understanding of architecture, instruction set, assembly level programming, interfacing to various sensors, relays, motors, actuators through various types of serial and parallel communication. Timers and interrupt functions are illustrated through the selection and control activities using suitable programming platforms such as Assemblers, C compilers, Kiel, , etc. This fundamental

knowledge on microcontrollers lead to explore large number of controller families like ATMEGA, TI and PIC that are used in industrial and automation applications.

**COURSE OBJECTIVE (S)**

The objectives of this course are to:

1. Introduce Microcontroller 8051 Architecture.
2. Give an insight into instruction set of microcontroller 8051.
3. Introduce assembly and C programming for 8051.
4. Provide insight into timer, serial communication and interrupts modules of 8051.
5. Interface a microcontroller with peripheral devices.

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Describe the Architecture of 8051 microcontroller. | 1 | 1 |
| CO2 | Describe Instruction Set of 8051 | 1 | 1 |
| CO3 | Write Assembly and C Programs for 8051. | 1,2 | 1,2 |
| CO4 | Interface various peripherals. | 1,2 | 1,2 |
| CO5 | Analyse the data transfer information through serial & parallel ports | 1,2 | 1 |
| CO6 | Write assembly language programs and generate the machine code that will provide solutions real-world control problems and document the results in the form of report. | 1,2,9,10,12 | 1,2 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

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

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

**COURSE CONTENT**

**THEORY:**

**Unit – 1**

**8051 Architecture, Addressing Modes and Instruction Set:** Introduction to Microprocessors and Microcontrollers, 8051 Architecture, Memory organization, Addressing Modes, Data transfer Instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instruction. Assembler Directives, Stack, Assembly language programs.

**Unit – 2**

**Timers/Counters, Serial Communication and Interrupts:**Basics of interrupts, 8051 interrupt structure. Timers and Counters, Timer delay calculations, Serial Communication, connections to RS-232, UART. Programming in Assembly and C Language.

**Unit – 3**

**Interfacing and Applications :**8051 Memory Interfacing, Interfacing 8051 to LCD, parallel and serial ADC, DAC, Stepper motor and DC Motor,MAX232, Interfacing Programming in C Language.

**Unit – 4**

**Advanced microcontrollers:** Architecture and memory organization: PIC16F877A, MSP430, ARM Cortex-3, AtMega32, arduino and raspberry Pi.

**PRACTICE:**

| Sl. No. | Name of the Practice Session | Tools and Techniques | Expected Skill /Ability |
|---|---|---|---|
| 1 | Data Transfer Instructions: Block Data Transfer without overlap, Sorting | Keil uvision3 | Writing programs for a given task |
| 2 | Arithmetic Instructions: 32-bit multi-precision Addition, Subtraction, square and cube of 8-bit number and 8-bit Division. | Keil uvision3 | Writing programs for a given task |
| 3 | Logical Instructions: ASCII to packed BCD and Vice versa, Implementation of Boolean expressions (Bit Manipulation). | Keil uvision3 | Writing programs for a given task |
| 4 | Timers: Wave form generation with varying Duty Cycle using Interrupt and Polling Techniques. | Keil uvision3 | Writing programs for a given task |
| 5 | Serial Communication: Serial data transmission with Polling and Interrupt technique (Regular and Look up table). | Keil uvision3 | Writing programs for a given task |
| 6 | Interfacing DAC to generate various waveforms with output voltage varying between -12V to 12V with Amplitude and Frequency control. | Keil uvision3 | Writing programs for a given task |
| 7 | DC Motor speed control using external interrupt. | Keil uvision3 | Writing programs for a given task |
| 8 | Stepper motor interfacing by controlling the steps and direction. | Keil uvision3 | Writing programs for a given task |
| 9 | Display the ASCII value of Key pressed on LCD. | Keil uvision3 | Writing programs for a given task |

**Case Studies:**

1. 8051 Microcontroller Case Study on Closed Loop DC Motor Speed Control.
2. Case study on TMODE (Timer Mode Control) Register, TCON (Timer Control Register) Register.

**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, 2007.


**REFERENCE BOOKS:**


1. Harprit Singh Sandhu, "Making PIC microcontroller instruments and controllers", McGraw-Hill,2009.


**JOURNALS/MAGAZINES**

1. https://e2echina.ti.com/group/c8df485b47/m/msp430/11060/download.

**SWAYAM/NPTEL/MOOCs:**

1. https://www.arm.com/zh/files/word/Yiu_Ch1.pdf
2. http://ce.sharif.edu/~pourmohammadi/AVR%20Microcontroller%20and%20Embedded%20Systems/AVR%20Microcontroller%20and%20Embedded%20Systems.pdf

| **Course Title** | **Sensors and Actuators** | | | | **Course Type** | | **Hard Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ES0402** | **Credits** | **3** | | **Class** | | **IVsemester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

One of the key elements in the implementation of mechatronic systems is the integration of computational intelligence with sensing (measurement of environmental conditions) and actuation (affecting the surrounding environment through a controlled response). In this course, students are introduced to advanced concepts in sensing and actuation for mechatronic systems, including both traditional sensors and actuators an introduction to advanced topics in micro electromechanical system (MEMS) sensing, and smart materials.

**COURSE OBJECTIVE**

This course enables graduating students to describe the operation of various sensors and actuators, select an appropriate sensor and actuator for sensing and control action respectively. Discuss the latest technology in sensors development.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Understand the principle of operation of different sensors and actuators. | 1 | 1 |
| CO2 | Classify sensors and actuators on different basis. | 1, 2 | 1,2 |
| CO3 | Select proper sensor electrode for electrochemical application. | 1, 2,3 | 1,2 |
| CO4 | Design a smart sensor using conventional sensors and microcontroller. | 1, 2,3 | 1,2 |
| CO5 | Demonstrate the operation of various actuators. | 1,2 | 1, 2 |
| CO6 | Select proper amotor for given application. | 1, 2,3 | 1,2 |

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | | 3 | | |
| CO2 | 3 | 3 | | | | | | | | | | | 2 | 3 | |
| CO3 | 3 | 2 | 3 | | | | | | | | | | 3 | 2 | |
| CO4 | 3 | 3 | 2 | | | | | | | | | | 3 | 3 | |
| CO5 | 3 | 2 | | | | | | | | | | | 3 | 3 | |
| CO6 | 3 | 2 | 3 | | | | | | | | | | 2 | 2 | |
| Average | 3 | 2.4 | 2.7 | | | | | | | | | | 2.6 | 2.6 | |

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

**BLOOM'S LEVELOF THECOURSE OUTCOMES:**

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

**COURSE CONTENT**

**THEORY**

**Unit-1**

**Introduction to Sensors:** Principles of operation Sensors and transducers, classification, characteristics. Recent trends in sensors technology: Fibre Optic Sensors, Film Sensors, Semiconductor IC Technology, Microelectromechanical System (MEMS), Nano Sensors, Smart passive sensors.

**Unit-2**

**Electroanalytical Sensors:** Introduction, Electro-chemical Cell, Cell potential, Sd. Hydrogen Electrode (SHE),Liquid Junction and Other potentials, Polarization, Reference Electrodes, Sensor Electrodes, Radiation Sensors: Basic Characteristics, Photo-emissive Cell and Photomultiplier, Photovoltaic Cell, X-ray and Nuclear Radiation Sensors.

**Unit-3**

**Digital Transducers:** Digital Encoder, Shaft Encoder, Switches: Pressure, Level, Flow, Temperature, Proximity Switches, Limit Switches and its types, Isolators (or Barriers).Application of Sensors, Automotive Sensors, Home Appliance Sensors, Aerospace Sensors, Sensors for manufacturing, Medical Diagnostic Sensors, Sensors for Environmental Monitoring Introduction to Intelligent sensor architecture, Primary Sensors Excitation, Amplification, Fitters, Converters, Compensation, Information Coding/Processing, Data Communication, Smart Transmitters.

**Unit-4**

**Actuators:** Introduction to actuators, transducer, Types of actuators, Pneumatic and hydraulic actuators, Pneumatic cylinders, Single acting, Double acting and Rotary cylinders, I to P converter, Electrical actuators, Motors, Servomotors, Stepper motors, Relay, Solenoid valves, Pneumatic Valves.

**Case Studies:**

1.Electrochemical Sensing Platforms for Food and Drink Safety.
2. PCBs for Automotive Sensors- to identify and notify changes in the operating environment.
3. Electrical Actuators for Solar panel operation.

**TEXT BOOK:**

1. D. Patranabis, "Sensors and Transducers", PHI Publications, 2nd Edition, 2021.
2. A.K.Shawhney, "Electrical & Electronics Measurements and Instrumentation" Dhanpat Rai & Sons, 5th Edition, 2015.
3. H. S. Kalsi, "Electronics instrumentation", Tata McGraw-Hill Publishing Company, 3rd edition, 2017.

**REFERENCE BOOKS:**

1. C D Johnson, "Process control Instrumentation Technology", PHI Learning, 8th Edition, 2015.

**JOURNALS/MAGAZINES:**

1. https://www.journals.elsevier.com/sensors-and-actuators-a-physical
2. https://www.mdpi.com/journal/sensors

**SWAYAM/NPTEL/MOOCs:**

1. https://onlinecourses.nptel.ac.in/noc19_ee41/preview
2. https://nptel.ac.in/courses/108/108/108108147/

<table>
<tr><td>CourseTitle</td><td colspan="4">MATLAB</td><td colspan="2">CourseType</td><td colspan="2">Hard Core</td></tr>
<tr><td>CourseCode</td><td>B20ES0403</td><td>Credits</td><td colspan="2">1</td><td colspan="2">Class</td><td colspan="2">IVSemester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">TotalNumber of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>1</td><td>2</td><td>2</td><td>0</td><td>26</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSEOVERVIEW**

This Course provides students a practical introduction to MATLAB by going beyond simple explanations of commands and it demonstrates as how to actually program for real-time applications in Mechanical Domain. It is intended to cater to the needs of budding mechanical engineer in advanced computing.

MATLAB integrates mathematical computing, visualization and powerful language to provide flexible environment for technical computing. The open architecture makes it easy to use MATLAB and its companion products to explore data, create algorithms and custom tools that provide early insights and competitive advantages. It is an all-rounder tool for simulations, programming, graphs, and measurement for an engineer.This course covers the analysis of the problems in basic engineering mechanics, strength of materials, theory of machines thermodynamics based applications along with the introduction to basic MATLAB capabilities.

**COURSE OBJECTIVES**

1. To make the students to understand the basic computation capabilities of MATLAB
2. To understand plotting for various 2D and 3D requirements
3. To make them solve simple problems of engineering mechanics, strength of materials, theory of machines thermodynamics based applications

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|

| | | | |
|---|---|---|---|
| CO1 | Apply MATLAB to create and manipulate different types of arrays. | 1,5, 10 | 1,2 |
| CO2 | Apply MATLAB to analyze, represent and plot 2D and 3D graphs. | 1,2,5, 10 | 1,2 |
| CO3 | Use MATLAB's built-in capabilities to solve engineering problems involving systems of linear equations and Curve fitting. | 1,2,5,10 | 1,2 |
| CO4 | Develop, test and debug MATLAB programs using modern, structured programming methods, including graphical user interfaces | 1,2,3, 5, 10 | 1,2 |
| CO5 | Apply MATLAB to solve real-time problems in the areas of Engineering Mechanics, Strength of materials and thermal based problems. | 1,2,3,5,10 | 1,2 |
| CO6 | Apply MATLAB to solve real-time problems in the areas of stability analysis of four and two wheelers | 1,2,3,5,10 | 1,2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | 3 | | | | | 3 | | | 3 | 3 | |
| CO2 | 3 | 3 | | | 3 | | | | | 3 | | | 3 | 3 | |
| CO3 | 3 | 2 | | | 3 | | | | | 3 | | | 3 | 3 | |
| CO4 | 3 | 1 | 3 | | 3 | | | | | 3 | | | 3 | 3 | |
| CO5 | 3 | 2 | 3 | | 3 | | | | | 3 | | | 3 | 3 | |
| CO6 | 3 | 1 | 3 | | 3 | | | | | 3 | | | 3 | 3 | |
| **Average** | **3** | **1.8** | **3** | | **3** | | | | | **3** | | | **3** | **3** | |

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

**COURSE CONTENT**

**PRACTICE**

| Sl. No | Titleof theExperiment | Tools and Techniques | ExpectedSkill /Ability |
|---|---|---|---|
| 1. | Introduction to MATLAB: Starting of MATLAB, elementary functions, commands and variables | MATLAB | Hands on Experience |
| 2 | Arrays: Creation and Manipulations of array, built in functions for arrays, Reading Data from Files | MATLAB | Hands on Experience |
| 3. | Graphics: Two dimensional and three dimensional plots and formatting of plots. | MATLAB | Hands on Experience |
| 4. | Numerical Analysis: Curve Fitting, Interpolation and Solving Systems of Linear Equations. | MATLAB | Hands on Experience |
| 5. | Programing in MATLAB: Loops and conditional statements | MATLAB | Hands on Experience |
| 6. | Force analysis in flexible elements like cables of cranes | MATLAB | Hands on Experience |
| 7. | Stress analysis in simple bodies subjected to axial loading, shear loading, bending and torsional loading | MATLAB | Hands on Experience |

| | | | |
|---|---|---|---|
| 8. | Beam Analysis for SFD and BMD | MATLAB | Hands on Experience |
| 9. | Analysis of Thermal Systems such as Performance of Air Standard Cycles , Gas Power and Vapor Power Cycles | MATLAB | Hands on Experience |
| 10. | Performance analysis of Compressor and Refrigeration Systems | MATLAB | Hands on Experience |
| 11. | Stability analysis of four and two wheelers | MATLAB | Hands on Experience |

**TEXTBOOKS**


1. Peter I. Kattan,"MATLAB forBeginners: A Gentle Approach", Petra Books, 2nd edition, 2022.
2. R. V Dukkipati, "MATLAB for Mechanical Engineers", New Age Science Limited, 2009.
3. Dr.Niranjan H and Siva.S, Manual on "Mechanical Engineers and MATLAB", School of Mechanical Engineering, REVA University, Bangalore.


**REFERENCE BOOKS**


1. J. Srinivas and R. V Dukkipati, Solving Engineering Mechanics Problems with MATLAB, New Age International (P) Limited, 2009.
2. Simin Nasseri, "Solving Mechanical Engineering Problems with MATLAB", Linus Learning, 2016.


**SWAYAM/NPTEL/MOOCs:**

1. https://www.udemy.com/course/matlab-basics-for-mechanical-engineers/
2. https://www.coursera.org/courses?query=matlab

| **Course Title** | **Management Science** | | | | **Course Type** | | **Hard Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20MGM301** | **Credits** | **2** | | **Class** | | **IV Semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 2 | 2 | 2 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **2** | **2** | **2** | **26** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

The course intends to familiarize students to understand the management principles and applications, which lays a strong foundation for managers and leaders in critical thinking and decisions making process. The course emphasizes on giving an overview of the functional area of management

**COURSE OBJECTIVES**

1. To help the students gain understanding of the functions and responsibilities of managers.
2. To provide them tools and techniques to be used in the performance of the managerial job.
3. To enable them to analyze and understand the environment of the organization.
4. To help the students to develop cognizance of the importance of management principles.

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Make use of Plan organizational structure for a given context in the organization carry out production operations through Work-study. | 1, 11 | 1, 2 |
| CO2 | Analyze production operations through Work-study. | 1, 11 | 1, 2 |
| CO3 | Understand the markets, customers and competition better and price the given products Appropriately. | 1, 11 | 1, 2 |
| CO4 | Summarize the HR function better. | 1, 11 | 1, 2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | 2 | 1 | 1 | 1 | |
| CO2 | 2 | 1 | | | | | | | | | 2 | 1 | 1 | 1 | |
| CO3 | 2 | | | | | | | | | | 2 | 1 | 1 | 1 | |
| CO4 | 2 | 1 | | | | | | | | | 2 | 1 | 1 | 1 | |
| **Average** | **2** | **1** | | | | | | | | | **2** | **1** | **1** | **1** | |

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

**COURSE CONTENT**

**Unit – 1**

**Introduction to Management and Organization**: Concepts of Management and organization- nature, importance and Functions of Management. Systems Approach to Management - Taylor's Scientific Management Theory-Taylor's Principles of Management, Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's Theory X and Theory - Hertzberg Two Factor Theory of Motivation - Leadership Styles, Social responsibilities of Management. Designing Organizational Structures: Basic concepts related to Organization Depart mentation and Decentralization.

**Unit – 2**

**Operations and Marketing Management:** Principles and Types of Plant Layout-Methods of Production( Job, batch and Mass Production), Work Study --Basic procedure involved in Method Study and Work Measurement - Business Process Reengineering(BPR) Statistical

**Quality Control**: control charts for Variables and Attributes (simple Problems) and Acceptance Sampling, TQM, Six Sigma, Deming's contribution to quality. Objectives of Inventory control, EOQ, ABC Analysis. Purchase Procedure, Stores Management and Store Records - JIT System, Supply Chain Management, Functions of Marketing, Marketing Mix. And Marketing Strategies based on Product Life Cycle. Channels of distribution.

**Unit – 3**

**Human Resources Management (HRM):** Concepts of HRM. HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR. Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development. Placement, Wage and Salary Administration, Promotion. Transfer, Separation, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating - Capability Maturity Model (CMM) Levels - Performance Management System.

**Unit – 4**

**Strategic Management and Contemporary strategic Issues**: Mission, Goals, Objectives, Policy, Strategy. Programmes, Elements of Corporate Planning Process, Environmental Scanning. Value Chain Analysis, SWOT Analysis. Steps in Strategy Formulation and implementation, Generic. Strategy alternatives. Bench Marking and Balanced Score and as Contemporary Business Strategies.

**TEXTBOOKS**

1. Kotler Philip and Keller Kevin Lane, "Marketing Management", Pearson, New York, 15th Edition, 2012.
2. Koontz and Weihrich, "Essentials of management", McGraw Hill, New Delhi, 11th Edition, 2012.

**REFERENCEBOOKS**

1. Thomas N. Duening and John M. Lvancevich, "Management - Principles and Guidelines", Dreamtech Press; 1st Edition, 2012.
2. Samuel C. Certo, "Modern Management", Prentice Hall, New York, 9th Edition, 2012.
3. Schermerhorn, Capling, Poole and Wiesner, "Management", Wiley, New York, 6th Edition, 2012.
4. John A. Parnell, "Strategic Management – Theory and Practice", Cengage Publications, 2018.
5. Lawrence R Jauch, R. Gupta and William F. Glucek, "Business Policy and Strategic Management Science", McGraw Hill, New York, 5th Edition, 2012.

<table>
<tr><td>Course Title</td><td colspan="4">Environmental Science</td><td>Course Type</td><td colspan="2">FC</td></tr>
<tr><td>Course Code</td><td>B20AS0303</td><td>Credits</td><td colspan="2">2</td><td>Class</td><td colspan="2">IV Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td>IA</td><td>SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>2</td><td>2</td><td>2</td><td>26</td><td>50 %</td><td>50 %</td></tr>
</table>

## COURSE OVERVIEW

This introductory course is designed to introduce you to the foundational concepts of environmental engineering, types of resources, biodiversity, threats and methods of conservation, sources and control measures of environmental pollution and ways to protect the environment.

## COURSE OBJECTIVES

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

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Understand, analyze and execute favorable environmental conditions and the role of individual, government and NGO in environmental protection. | 1,7,8,10,12 | 3 |
| CO2 | List the causes, effects & remedial measures and find ways to overcome them by suggesting the pollution-controlled products | 1,7,8,10,12 | 3 |
| CO3 | Classify different wastes, sources of waste and their effect on population. | 1,7,8,10,12 | 3 |

| | | | |
|---|---|---|---|
| CO4 | Get motivation to find new renewable energy resources with high efficiency through active research and innovation. | 1,7,8,10,12 | 3 |
| CO5 | Critically analyze the ecological imbalances and provide recommendations to protect the environment. | 1,2, 7,8,10,12 | 3 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

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

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

**COURSE CONTENT**

**Unit – 1**

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

**Environmental protection:** Role of Government - Assignments of MOEF, Functions of central and state boards, Institutions in Environment and People in Environment, Environmental Legislations, Initiative and Role of Non-government organizations in India and world.

**Unit-2**

**Environmental Pollution:** Definition, sources and types, Pollutant-Definition & classification, Concepts of air pollution, water pollution, Soil pollution, Automobile Pollution-Causes, Effects & control measures.

**Environmental degradation:** Introduction, Global warming and greenhouse effect, Acid rain-formation & effects, Ozone depletion in stratosphere and its effect.

**Waste management:** Municipal solid waste, biomedical waste and Electronic waste (E-Waste).

**Unit-3**

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

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

**Unit-4**

**Ecology:**-Definition, branches, objectives and classification, Concept of an ecosystem – Structure and functions, **Ecosystem:**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.

**Field Work:**Visit to waste water treatment and biogas plant at REVA university campus, and/orVisit to a local polluted site-Urban/Rural/Industrial/Agricultural.

**TEXT BOOKS**


1. R.J. Ranjit Daniels and Jagadish Krishnaswamy, "Environmental Studies", Wiley India Private Ltd., New Delhi, Co-authored &Customized by Dr.MS Reddy & Chandrashekar, REVA University, 1st Edition, 2017.
2 R.J. Ranjit Daniels and Jagadish Krishnaswamy, "Environmental Studies", Wiley India Private Ltd., New Delhi, 2nd Edition, 2014.
3. Benny Joseph, "Environmental Studies", Tata McGraw – Hill Publishing Company Limited, New Delhi, 2nd Edition, 2008.


**REFERENCE BOOKS**


1. Dr.S.M.Prakash, "Environmental Studies", Elite Publishers, Mangalore, 2nd Edition, 2009.
2. Rajagopalan R, "Environmental Studies – from Crisis to cure", Oxford University Press, New Delhi, 3rd Edition, 2016
3. Anil Kumar Dey and Arnab Kumar Dey, "Environmental Studies", New age international private limited publishers, New Delhi, 2nd Edition, 2007.
4. Michael Allaby, "Basics of environmental Science", Routledge-Tayler & Francis e-library, New York, 2nd Edition, 2002.
5. Dr.Y.K Singh, "Environmental Science", New age international private limited publishers, New Delhi, 1st Edition, 2006


**JOURNALS/MAGAZINES**

1. International Journal of Environmental Science and Technology, https://www.springer.com/journal/13762/.
2. Journal of Environmental Sciences, https://www.journals.elsevier.com/journal-of-environmental-sciences.

**SWAYAM/NPTEL/MOOCs:**

1. Environmental Studies: https://onlinecourses.swayam2.ac.in/cec19_bt03/preview
2. Environmental Studies: https://nptel.ac.in/courses/120/108/120108004/

**SELF-LEARNING EXERCISES**

1. Discussion on the need for public awareness on the environment, Gaia Hypothesis
2. Case studies of London smog, Bhopal gas tragedy, marine pollutions and study of different waste water treatment processes, Disaster management, early warning systems-bio indicators for Tsunami and other natural disasters.
3. Hydrology & modern methods adopted for mining activities, remote sensing and its applications, Chernobyl (USSR) nuclear disaster and Fukushima (Japan) nuclear disaster.
4. Discussion on the need for balanced ecosystem and restoration of degraded ecosystems.

| Course Title | Universal Human Values | | | | Course Type | | FC | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20AHM401 | Credits | 0 | | Class | | IV Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 0 | 2 | 2 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **0** | **2** | **2** | **26** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

Basic human values refer to those values which are at the core of being human. The values which are considered basic inherent values in humans include truth, honesty, loyalty, love, peace, etc. because they bring out the fundamental goodness of human beings and society at large. Tis subject focuses on developing holistic perspective and harmony on self-exploration among individuals, family and society.

**COURSE OBJECTIVES**

1. Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Understand the significance of value inputs in a classroom and start applying them in their life and profession. | 3,6,7,8,9, | |
| CO2 | Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc. | 3,6,7,8,9,10 | |
| CO3 | Understand the role of a human being in ensuring harmony in society and nature. | 3,6,7,8 | |
| CO4 | Demonstrate the role of human being in the abetment of pollution | 3,6,7,9 | |
| CO5 | Describe appropriate technologies for the safety and security of the society as responsible human being. | 9,10,11,12 | |
| CO6 | Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work. | 9,10,11,12 | |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | 1 | | | 3 | 3 | 3 | 3 | 3 | | | | | |
| CO2 | | | 1 | | | 3 | 3 | 3 | 3 | 3 | | | | | |
| CO3 | | | 1 | | | 3 | 3 | 3 | | | | | | | |
| CO4 | | | 1 | | | 3 | 3 | | 3 | | | | | | |
| CO5 | | | | | | | | | 3 | 3 | 3 | 2 | | | |
| CO6 | | | | | | | | | 2 | 3 | 3 | 2 | | | |
| **Average** | | | **1** | | | **3** | **3** | **3** | **2.8** | **3** | **3** | **2** | | | |

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

**COURSE CONTENT**

**Unit- 1**

**Happiness and Prosperity**: A look at basic Human Aspirations. Right understanding, Relationship, basic requirements for fulfilment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly, Method to fulfil human aspirations: understanding and living in harmony at various levels, Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. Understanding the Body as an instrument of 'I' (I being the doer, seeker and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.

**Unit- 2**

**Understanding values in human-human relationship:** meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family

**Unit- 3**

**Understanding the harmony in the Nature:** Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

**Unit- 4**

**Natural acceptance of human values**: Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human

Order: a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers b) At the level of society: as mutually enriching institutions and organizations

## TEXT BOOKS


1. R R Gaur, R Sangal, G P Bagaria, "Human Values and Professional Ethics", Excel Books, New Delhi, 2010.
2. A.N Tripathy, "Human Values", New Age Intl. Publishers, New Delhi, 2004.
3. R.R. Gaur, R. Sangal and G.P. Bagaria, "A Foundation Course in Human Values and Professional Ethics", Excel Books, New Delhi, 2010
4. Bertrand Russell, "Human Society in Ethics & Politics", Routledge Publishers, London, 1992


## REFERENCE BOOKS


1. Corliss Lamont, "Philosophy of Humanism", Humanist Press, London, 1997
2. I.C. Sharma, "Ethical Philosophy of India", Nagin & Co Julundhar, 1970
3. Mohandas Karamchand Gandhi, "The Story of My Experiments with Truth", Navajivan Mudranalaya, Ahmadabad, 1993
4. William Lilly, "Introduction to Ethics", Allied Publisher, London, 1955


**JOURNALS/MAGAZINES/ONLINE COURSES**

1. Value Education websites, http://uhv.ac.in, http://www.uptu.ac.in
2. Story of Stuff, http://www.storyofstuff.com
3. Al Gore, An Inconvenient Truth, Paramount Classics, USA
4. Charlie Chaplin, Modern Times, United Artists, USA
5. IIT Delhi, Modern Technology – the Untold Story
6. Gandhi A., Right Here Right Now, Cyclewala Production

**SELF-LEARNING EXERCISES**

1. Observe that each one of us has Natural Acceptance, based on which one can verify right or not right for him. Verify this in case of i) What is Naturally Acceptable to you in relationship- Feeling of respect or disrespect? ii) What is Naturally Acceptable to you – to nurture or to exploit others? Is our living the same as your natural acceptance or different?
2. Out of the three basic requirements for fulfilment of your aspirations- right understanding, relationship and physical facilities, observe how the problems in your family are related to each. Also observe how much time & effort you devote for each in your daily routine.
3. Choose any two current problems of different kind in the society and suggest how they can be solved on the basis of natural acceptance of human values. Suggest steps you will take in present conditions.

## 5th Semester

| Course Title | Electrical Machines& Drives | | | | Course Type | | Hard Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ES0501 | Credits | 3 | | Class | | V Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

Electric Motors and Drives play a vital role in electric power generation and Electro-Mechanical Energy conversion, hence the course "Electrical Machines and Drives" is important for Mechatronics Engineers. The course deals mainly with characteristics of DC and AC machines and covers topics like starting, speed control techniques and calculation of power losses and efficiency. The course also deals with the application of Power Electronics into electrical machines such as control of Speed and Torque.

**COURSE OBJECTIVE (S)**

The objectives of this course are:

1. To study the performance characteristics of D.C. motors, three phase induction motor and single phase induction motor.
2. 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.
3. To study the selection criteria of Drives for different applications.
4. To study the Power electronics application in controlling the Torque and Speed of Motor.
5. To study the basic of selection of drive for a given application.
6. To study the concept of controlling the speed of D.C. and A.C. motors using solid state devices

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Describe the performance characteristics of D.C. motors, three phase induction motor and single phase induction motor. | 1 | 1,2 |
| CO2 | Describe the different starting methods of D.C. motor and threephase induction motor. | 1 | 1,2 |
| CO3 | Explain DC drives and induction motor drives. | 1 | 1,2 |
| CO4 | Analyse the controlling oftorque and speed of Motors by usingpower electronics concept. | 1,2 | 1,2 |
| CO5 | Select a suitable Drive for different applications | 1,2 | 1,2 |
| CO6 | Describe the concept of controlling the speed of D.C. and A.C. motors using solid state devices. | 1 | 1,2 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

| CO | Bloom's Level | | | | | |
|---|---|---|---|---|---|---|
| | Remember (L1) | Understand (L2) | Apply (L3) | Analyze (L4) | Evaluate (L5) | Create (L6) |
| CO1 | | ✓ | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO2 | | | | ✓ | | |
| CO3 | | ✓ | | | | |
| CO4 | | | | ✓ | | |
| CO5 | | | | ✓ | | |
| CO6 | | ✓ | | | | |

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | | 3 | 1 | |
| **CO2** | 3 | | | | | | | | | | | | 3 | 1 | |
| **CO3** | 3 | | | | | | | | | | | | 3 | 2 | |
| **CO4** | 3 | 2 | | | | | | | | | | | 3 | 1 | |
| **CO5** | 3 | 3 | | | | | | | | | | | 3 | 1 | |
| **CO6** | 3 | | | | | | | | | | | | 3 | 1 | |
| **Average** | 3 | 2.5 | | | | | | | | | | | 3 | 2 | |

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

**COURSE CONTENT**

**THEORY:**

**Unit – 1**

**Electrical Motors:** 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, construction and principle of operation of BLDC motors.

**Unit – 2**

**Speed Control and Starting Methods:**Speed control of D.C. motors – three phase induction motors – starting methods of D.C. motor and threephase induction motor – electrical braking, simple problems.Introduction to drives - Selection of Motor power rating - Drive specifications - Constant speed and constant power operation.

**Unit – 3**

**DC DRIVE :**DC motor and their performance - Armature control and Field control – WardLeonard drives - converter fed and chopper fed Drive - four quadrant operation - closed loop control

**Unit – 4**

**INDUCTION MOTOR DRIVE:** Induction motor fundamentals - voltage control and variable frequency control: AC Chopper, Inverter fed induction motor drives, Rotor resistance control: slippower recovery scheme.

**TEXT BOOKS:**


1. Dubey.G.K, “Fundamentals of Electric Drives”, Narosa publishing house, 2nd edition, 2002.
2. I.J.Nagrath, D.P. Kothari., “Electric Machines”, McGraw – Hill Publishing company Ltd., 5th edition, 2017
3. S.K. Bhattacharya, “Electrical Machines”, Tata McGraw – Hill Pvt.Company Ltd.,4th edition 2017.
4. Pillai.S.K, “A first course on Electrical Drives”, New Age International (p),Ltd.,3rd Edition, 2012.


**REFERENCE BOOKS:**


1. Vedam Subramanian, “Thyristor Control of Electrical Drives”, Tata Mc Graw Hill Publications, 2017.


**JOURNALS/MAGAZINES**

1. https://www.sciencedirect.com/book/9780080316857/electrical-machines-and-drives

**SWAYAM/NPTEL/MOOCs:**

1. **https://nptel.ac.in/courses/108104140**

| Course Title | Material Science | | | | Course Type | | Hard Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ER0302 | Credits | 3 | | Class | | III Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

The subject explores the structure of materials and how the structure of materials can be classified as per the materials. Material science is an interdisciplinary subject expended from side to side of physics and chemistry of matter, engineering applications and industrial manufacturing processes. The purpose of study of material science is to understand the relationship between structure and properties of a material. This course focuses of fundamentals of material, properties and applications. Topics include: crystal structures, solidification of metals and alloys, defects in materials, phase diagrams, heat treatment, corrosion, types of engineering materials and characterization techniques.

**COURSE OBJECTIVES**

1. To provide the basic knowledge and to enhance the knowledge of the structure of materials this includes crystallography, microstructure, defects, and diffusion.
2. To develop the knowledge about the phase diagrams, solidification, heat treatment process, stress strain diagram, mechanical properties, fracture, fatigue and creep.
3. To enhance the knowledge of iron carbon phase diagram, CCT, TTT diagrams, Hardenability, heat treatment and corrosion.
4. To incorporate the knowledge in various class of engineering materials, applications and characterization techniques.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Identify the structure of materials which includes crystallography, microstructure, defects, and diffusion. | 1,2 | 1,2,3 |
| CO2 | Identify various phases of metals and alloys through appropriate phase diagrams and will be able to evaluate the effect of alloying elements, properties and application of ferrous and non-ferrous metals. | 1,2 | 1,2,3 |
| CO3 | Select suitable heat treatment process based on material properties and will be to provide suitable methods to avoid corrosion | 1,2 | 1,2,3 |
| CO4 | Suggest suitable engineering materials for different application and will be able to Correlate the structure-property relationship in metals/alloys in as-received and heat treated conditions | 1,2 | 1,2,3 |
| CO5 | Describe the applications of super alloys, composites and nanomaterials | 1 | 1,2,3 |
| CO6 | Choose the suitable characterization techniques for analysis of surface topography and to find out the Properties of metals and alloys | 1,2,5 | 1,2,3 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

| CO | Bloom's Level | | | | | |
|---|---|---|---|---|---|---|
| | Remember | Understand | Apply | Analyze | Evaluate | Create |

| | (L1) | (L2) | (L3) | (L4) | (L5) | (L6) |
|---|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | | | | |
| CO2 | ✓ | ✓ | ✓ | | | |
| CO3 | ✓ | ✓ | ✓ | ✓ | | |
| CO4 | ✓ | ✓ | ✓ | ✓ | | |
| CO5 | ✓ | ✓ | ✓ | | | |
| CO6 | ✓ | ✓ | ✓ | ✓ | | |

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | | | | | | | | | | | 3 | 1 | 3 |
| CO2 | 3 | 1 | | | | | | | | | | | 3 | 1 | 3 |
| CO3 | 3 | 1 | | | | | | | | | | | 3 | 1 | 3 |
| CO4 | 2 | 1 | | | | | | | | | | | 3 | 1 | 3 |
| CO5 | 3 | 2 | | | | | | | | | | | 3 | 1 | 3 |
| CO6 | 3 | 2 | | | 1 | | | | | | | | 3 | 1 | 3 |
| **Average** | **2.8** | **1.3** | | | **1** | | | | | | | | **3** | **1** | **3** |

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

**COURSE CONTENT**

**Unit-1**

**Introduction:** Structure of crystalline solids: Basic idea of lattice, crystalline and non-crystalline materials, unit cell, crystal structure of simple cubic, BCC, FCC and HCP, coordination number, packing of atoms. Simple numerical

**Defects and diffusion in solids:** Point, linear, planar and volume defects, edge and screw dislocations, Burger vector, grain boundaries, twin and stacking faults. Diffusion mechanism, Fick's first law and simple numerical.

**Unit-2**

**Phase diagrams:** Isomorphous and eutectic binary phase diagrams, Gibbs phase rule concept of tie line and lever rule, equilibrium and non-equilibrium cooling, microstructure development in eutectic phase diagram. Simple numerical on phase diagrams and lever rule, Solidification of metals and alloys, nucleation and growth phenomena, heterogeneous and homogeneous nucleation,

**Mechanical Properties of Materials:** concept of stress and strain diagram for ductile and brittle materials, Hooks law, elastic and plastic deformation, tensile properties, fatigue, fracture and creep.

**Unit-3**

Iron-carbon system, Fe-Fe3C diagram, invariant reactions, different phases. Effect of alloying elements. Isothermal and continuous cooling transformation (CCT) diagrams, TTT diagrams, Hardenability; Jominy-end quench test.

Fundamentals of heat treatments of Steels. Annealing, Homogenisation. Spheroidising, Normalising, Quenching media, Austempering, Martempering, Hardening and Tempering. Age hardening of Al-Cu alloy. Corrosion: introduction, Types of corrosion; dry and wet corrosion, electro chemical and oxidation (chemical) corrosion, factors influencing corrosion.

**Unit-4**

**Engineering materials**: Introduction to polymers- properties & applications of thermoplastic engineering polymers. Ceramics- classification of ceramics, applications of ceramics. Types of glasses and their chemical compositions, Physical properties of glasses.

**Composite Materials:** classification of composite materials based on matrix and reinforcement, matrix and fiber materials. Different types of super alloys: properties and applications of super alloys. Nanomaterials: introduction, bottom up and top down approaches.

Introduction to optical microscopic technique and working principle, Scanning and Transmission Electron **Microscopy:** Introduction to EM, construction and working principle, the necessity of characterization using SEM and TEM techniques, Diffraction: Fundamentals of Diffraction, Bragg's law, X-ray diffraction pattern of crystalline and amorphous material.

**TEXT BOOKS**

1. William D. Callister, "Materials Science and Engineering", (Adopted by R. Balasubramaniam), Wiley-Eastern. 2008.
2. Raghavan V, "Materials Science and Engineering - A First Course", Prentice Hall, India, 2007.

**REFERENCE BOOKS**

1. James F. Shackelford, "Introduction to Materials Science for Engineers", Prentice Hall, India, 1996.
2. Askeland D.R. and P. P. Fullay, "The Science and Engineering of Materials", Cengage Learning Publishers,4th Edition, 2007.
3. T.V. Rajan, C.P. Sharma and Ashok Sharma, "Heat Treatment – Principles & Techniques", Prentice Hall of India, New Delhi.
4. Charles S. Barrett &T.B. Massalski, "Structure of Metals – Crystallographic Methods, Principles & Data", Eurasia Publishing House (Pvt.) Ltd., New Delhi.
5. B.D. Cullit, "Elements of X-ray Diffraction", Addison – Wesley Publishing CompanyInc., USA.
6. Robert E, "Physical Metallurgy Principles", Attiliated East-West Press Private. Ltd., New Delhi.

**JOURNALS/MAGAZINES**

1. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology
2. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/113/102/113102080/
2. https://nptel.ac.in/courses/122/102/122102008/

| **Course Title** | **Control Systems** | | | | **Course Type** | | **Hard Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ES0502** | **Credits** | **3** | | **Class** | | **V semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW:**

This course focuses on various aspects of control systems which will be applicable to automation. It provides knowledge on mathematical modeling of the various systems and analysis of the system under time domain. It equips the students with knowledge on checking the stability of the designed system under various graphical methods like Bode plot, Nyquist plot and root locus.

**COURSE OBJECTIVES:**

1. To understand various types of control system and types of controllers
2. To develop the skill on mathematical modeling of the physical system
3. To understand the response of a system which is subjected to various inputs
4. To understand various analytical techniques and graphical methods to study the stability of the system
5. To study the state space concept and application of MATLAB and lab view to understand various concepts of control systems

**COURSE OUTCOMES (COs)**

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

| **CO** | **Course Outcomes** | **POs** | **PSOs** |
|---|---|---|---|
| CO1 | Describe various types of control system and controllers. | 1 | 1 |
| CO2 | Develop mathematical models and transfer function model for mechanical and electrical system. | 1,2,3 | 1,2 |
| CO3 | Analyze the time response of a first and second order system and behavior of various | 1,2 | 1,2 |

| | | | |
|---|---|---|---|
| | controllers. | | |
| CO4 | Examine the stability of the system using R H Criteria and Root locus technique constructing root locus plot. | 1,2,5 | 1,2 |
| CO5 | Investigate the stability of the system by constructing Bode and Nyquist plot. | 1,2,4,5 | 1,2,3 |
| CO6 | Analyze the control system under state space model. | 1,2 | 1,2 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | | 3 | | |
| CO2 | 3 | 3 | 2 | | | | | | | | | | 3 | 3 | |
| CO3 | 3 | 2 | | | | | | | | | | | 3 | 3 | |
| CO4 | 3 | 3 | | | 2 | | | | | | | | 3 | 3 | |
| CO5 | 3 | 3 | | 2 | 2 | | | | | | | | 3 | 3 | 2 |
| CO6 | 3 | 3 | | | | | | | | | | | 3 | 3 | |
| Average | 3 | 2.8 | 2 | 2 | 2 | | | | | | | | 3 | 3 | 2 |

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

**COURSE CONTENT**

**Unit-1**

**Modeling of Systems:** Introduction to control system**,** types of control system, Modeling and writing Transfer function (Both Electrical & Mechanical), Block Diagram representation, Signal flow graph. Introduction to Digital Control System.

**Unit-2**

**Time Domain Stability Analysis:** Performance of feedback control system, Test input signals, performance of first order, second order system (No derivation), steady state errors. Concept of stability, S-plane Root location, RH Criteria, Relative Stability. Root locus: Introduction to root locus, Procedure and problems, Effect of addition of pole zero to open loop systems. Tuning rules for PID controllers, Computational Approach, Modification schemes, Zero-placement approach to improve response characteristics.

**Unit-3**

**Frequency Domain Stability Analysis:** Frequency domain specifications - Correlation between time domain and frequency domain specifications - Bode plot - Performance and Stability analysis using Bode plot- Transfer Function from Bode Plot – Analysis using Polar plot – Nyquist stability criterion. Compensator and compensation techniques; Cascade and Parallel, Lead, Lag, and Lead Lag Compensators.

**Unit-4**

**State space analysis of Discrete time Systems :** Introduction, state space representation of discrete time systems, pulse-transfer function matrix, discretization of continuous-time state space equation, Liapunov Stability analysis, controllability, Observability, useful transformations in state space analysis and design, design via pole placement, servo systems

**TEXT BOOKS:**

1. Katsuhiko Ogata, "Modern Control Engineering", Pearson Education, 2004.
2. J. Nagarath and M.Gopal, "Control Systems Engineering", New Age International (P) Limited, Publishers, 6th edition,2017.

**REFERENCE BOOKS:**

1 B.C.Kuo, F.Golnaraghi, "Automatic Control Systems", John Wiley & Sons, 10th edition,2018.
2. Richard C Dorf & Robert H Bishop, "Modern Control Systems, , Prentice Hall, 2008.

**JOURNALS/MAGAZINES**

1. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=87
2. https://www.journals.elsevier.com/control-engineering-practice

**SWAYAM/NPTEL/MOOCs:**

1.https://nptel.ac.in/courses/107106081
2.https://www.edx.org/course/dynamics-control-upvalenciax-dc201x-0

| **Course Title** | **Robotics** | | | | **Course Type** | | **Hard Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ES0503** | **Credits** | 4 | | **Class** | | **V Semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 4 | 4 | 4 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | **IA** | **SEE** |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **4** | **4** | **4** | **52** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

Robotics is an interdisciplinary branch of electronic engineering and mechanical engineering. Robotics involves design, construction, operation, and use of robots. The goal of robotics is to design machines that can help and assist humans. Robotics integrates fields of mechanical engineering, electrical engineering, information engineering, mechatronics, electronics, bioengineering, computer engineering, control engineering, software engineering, mathematics, etc.

**COURSE OBJECTIVE (S)**

The objectives of this course are to:

1. Introduction to fundaments of robotics and specification associated with robot.
2. Give an insight into Robot arm kinematics and apply to 2R and 3R manipulator and puma 560 robot
3. Discuss on different types of end effector and sensors used in robots.
4. Introduce to Image processing basics.
5. Discuss different types of programming language and industrial application of robots.

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| **CO** | **Course Outcomes** | **POs** | **PSOs** |
|---|---|---|---|
| CO1 | Identify different types of robots, its physical configuration and associated movements. | 1 | 1 |
| CO2 | Apply the knowledge of matrix transformation methods to identify object in 3D space. | 1 | 1,2 |
| CO3 | Apply robot kinematics equation for 2R & 3R manipulator and Puma 560 robot. | 1 | 1,2 |
| CO4 | Identify different types of grippers and sensors associated with robots. | 1,2 | 1 |

| | | | |
|---|---|---|---|
| CO5 | Apply programming knowledge to program a robot. | 1 | 1 |
| CO6 | Identity different uses of industrial robots and its area of applications. | 1 | 1 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | | 3 | | |
| **CO2** | 2 | | | | | | | | | | | | 3 | 2 | |
| **CO3** | 2 | | | | | | | | | | | | 2 | 3 | |
| **CO4** | 3 | 2 | | | | | | | | | | | 3 | | |
| **CO5** | 2 | | | | | | | | | | | | 2 | | |
| **CO6** | 3 | | | | | | | | | | | | 3 | | |
| **Average** | 2.7 | 2 | | | | | | | | | | | 2.7 | 2.5 | |

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

**COURSE CONTENT:**

**UNIT – 1**

**INTRODUCTION TO ROBOTICS:** Automation and Robotics, Robotics in Science Fiction, Brief History of Robotics, the Robotics Market and the Future Prospects.

**FUNDAMENTALS OF ROBOTICS**: Definition of a Robot – Basic Components -Robot Anatomy- Robot Configurations: Polar, Cylindrical, Cartesian coordinate and Jointed – Arm, Robot Motion: Degrees of Freedom, types of movements – Vertical, Radial and Rotational Traverse, Roll, Pitch and Yaw: Joint Notation Scheme: Wok Volume.

**Unit – 2**

**INTRODUCTION TO MATRIX FORMULATIONS:**Descriptions - Positions - Orientations, frames, Mappings - Changing descriptions from frame to frame. Transformation arithmetic - translations - rotations - transformations - transform equations.

**ROBOT ARM KINEMATICS :** Introduction, Rotation Matrices, Composite Rotation Matrix, Rotation Matrix about an Arbitrary Axis,Homogeneous Coordinates and Transformation Matrix, Composite Homogeneous Transformation Matrix, Links, Joints, and Their Parameters, The Denavit-Hartenberg Representation and algorithm, Kinematic Equations for Manipulators, transformation matrix for 2R and 3R manipulator, puma 560, numerical on rotation matrix, composite homogenous transformation matrix.

**Unit – 3**

**END EFFECTORS AND SENSORS:** Mechanical gripper, vacuum cups, magnetic gripper, Tools as end effectors, Tactile sensors, proximity and range sensors, vision sensors, Introduction to Image processing.

**Unit – 4**

**Robot programming and industrial applications:**

Robot language classification - programming methods - off and on line programming - Lead through method - Teach pendent method - VAL systems and language, simple program.

**INDUSTRIAL Applications:** Application of robots - Material handling - Machine loading and unloading, Assembly, Inspection, Welding, Spray painting, Mobile robot, Microdots - Recent developments in robotics- safety consideration.

**Case Study:**

1. Robotics post-test processing of ABB Robot.
2. Report on how ABB Robotics reduced development time?
3. ABB Robotic calibration.

**TEXT BOOKS:**


1. Groover, Mikell P., Mitchell Weiss, and Roger N. Nagel. "Industrial robotics: technology, programming and application". McGraw-Hill Higher Education, 1986**.**
2. Fu, King Sun, Ralph Gonzalez, and CS George Lee, "Robotics: Control Sensing, Vision and Intelligence", Tata McGraw-Hill Education, 1987.


**REFERENCE BOOKS:**


1. Klafter, R. D, Chmielewski, T. A. and Noggins. "Rabot Engineering: An integrated Approach", Prentice hall of India Pvt. Ltd., New Delhi, 1993.
2. Deb, S. R. "Robotics Technology and Flexible Automation", Tata McGraw Hill publishing company limited, New Delhi, 2017.
3. Craig, J. J. "Introduction to Robotics: Mechanics and Control". Pearson, 2008.


**JOURNALS/MAGAZINES**

1. https://e2echina.ti.com/group/c8df485b47/m/msp430/11060/download
2.https://www.hindawi.com/journals/jr/

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/112105249
2. https://nptel.ac.in/courses/107106090

| **Course Title** | **CNC MACHINES** | | | | **Course Type** | | **Soft Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ESS511** | **Credits** | **3** | | **Class** | | **V Semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**Course Objectives:**

The objectives of this course are to:

1. Obtainthe fundamentalsofCNC machines andrelatedconceptstounderstandits mechanism anditstechniques to manufacture.
2. InterpretvariousconceptsofCNC system,theproductdevelopmentcyclecanbereducedin thedesign stagesandalsoreduction ofmanufacturingLeadtime.

3. DeveloptheNCprogramminganditsimportanceinpracticalapplicationsbyusing codingsystem.
4. Haveahandsonexperienceonvarioustoolsusedformodelingandmanufacturing aspects.
5. Understand the fixed cycles of programming for CNC machines.

**Course Outcomes:**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Explain the fundamentals of CNC system and its interfacing, monitoring, diagnostics. | 1 | 1,2 |
| CO2 | Develop PLC program for CNC and gain knowledge of guide ways and various mechanical transmission elements. | 1,2 | 1,2 |
| CO3 | Explain measuring devices, feedback devices, digital and analog devices. | 1,2 | 1,2 |
| CO4 | Predict the performance of CNC machines and explain Automatic tool changing system | 1,2 | 1,2 |
| CO5 | Explain toolCompensation and offsetting in CNC Machines. | 1,2 | 1,2 |
| CO6 | Identify machine axes and write CNC programs and demonstrate cutting tool offset for turning and milling operations. | 1,2 | 1,2 |

**BLOOM'S LEVEL OF THECOURSE OUTCOMES:**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | | | 3 | 2 | |
| **CO2** | 3 | 3 | | | | | | | | | | | 3 | 3 | |
| **CO3** | 3 | 3 | | | | | | | | | | | 3 | 2 | |
| **CO4** | 3 | 2 | | | | | | | | | | | 3 | 3 | |
| **CO5** | 3 | 3 | | | | | | | | | | | 3 | 3 | |
| **CO6** | 3 | 2 | | | | | | | | | | | 3 | 2 | |
| **Average** | 3 | 2.5 | | | | | | | | | | | 3 | 2.5 | |

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

## Course Content:

**UNIT I**

**INTRODUCTION OF CNC SYSTEMS AND ADAPTIVE CONTROL :** Classification of machine tools , Types, functions and processes , Fundamentals of NC and CNC technologies , CNC systems -Configuration of the CNC system

,Interfacing ,Monitoring, Diagnostics, Machine data Compensations for Machine accuracies, Adaptive control : Types, application and benefits.

**UNIT II**

**ELEMENTS IN CNC SYSTEMS AND MACHINE TOOLS :** PLC in CNC ; PLC programming for CNC - Machine structure - Types of loads on CNC machine -Guide ways and types - Mechanical transmission elements - Elements for rotary motion to linear motion - Ball screw and types - Roller screw and types - Rack and pinion - Various torque transmission elements - Requirements of feed drives and spindle drive.

**UNIT III**

**ELEMENTS IN CNC MEASURING SYSTEM AND TOOLING:** Measuring systems -Feedback devices -Velocity feedback -Analog and digital - Position Feedback Tooling - Requirement and planning - Preset, qualified and semi qualified tools. Tool identification -Touch trigger probe. Automatic tool changing system - types and benefits - tool magazine – sensors in CNC.

**UNIT IV**

**CNC PROGRAMMING FOR MACHINE TOOLS :**Machine axes identification - Primary, secondary and tertiary – Programming Types - Manual CNC programming - Milling programming fundamentals - Compensation and offset in milling -Fixed cycles in milling. Turning programming fundamentals - compensation and offset in turning -fixed cycles in turning.

**Case Study:**

1. Tool wear reduction in CNC machines.
2. Industrial Automation using IOT.
3. Assembly Line balancing methods.

**Text Books:**


1. Radhakrishnan.P, “CNC Machine”, New Central Book Agency, 2013.
2. Groover.M.P, “Automation, Production System and CIM”, Prentice Hall of India Pvt. Ltd, 2003.


**ReferenceBooks:**


1. Sehrawatt.M.S and Narang.J.S, “CNC Machine”, Dhanpat Rai And Co, 2016.
2. Jayakumar.V and Mahendran.B, “Computer Aided Manufacturing”, Lakshmi Publications, 2005.
3. Stenerson and Curran, “Computer Numerical Control-Operation and Programming”, PHI Learning Pvt. Ltd., 2008.
4. Steave Krar and Arthur Gill, CNC Technology and Programming, McGraw–Hill Publishing Company, 1990.


<table>
<tr><td>Course Title</td><td colspan="4">Conventional and Electric Vehicles</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B20ESS512</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">V Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSE OVERVIEW:**

The course deals with various vehicle body constructions, vehicle sizes and different clutches & transmission systems. It covers different types of chassis systems of Electric and Hybrid Electric Vehicles. Modelling and Characteristics of EV/HEV Powertrains Components are also studied in this course along with Energy Storage Technologies.

**COURSE OBJECTIVES:**

1. To introduce the fundamental concepts, principles, analysis and design of electric vehicles.
2. To understand the basic concepts of vehicle dynamics.
3. To impart the knowledge of electric motor drives and its components.
4. To introduce vehicle chassis structure.
5. To broaden the understanding of components of transmission systems.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Elucidate the importance of vehicle frame | 1 | 1,2 |
| CO2 | Explain different types of tyres and their specification. | 1 | 1,2 |
| CO3 | Select a suitable transmission system for given requirements. | 1,2 | 1,2 |
| CO4 | Explain architectures, dynamics and body chassis of electric/hybrid drive train. | 1 | 1,2 |
| CO5 | Model the EV/HEV Powertrain Components using Electric Motor Performance Characteristics | 1,2 | 1,2 |
| CO6 | Describe energy storage systems used in modern EVs. | 1 | 1,2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | | 3 | 1 | |
| CO2 | 3 | | | | | | | | | | | | 3 | 2 | |
| CO3 | 1 | 3 | | | | | | | | | | | 3 | 1 | |
| CO4 | 2 | | | | | | | | | | | | 3 | 1 | |
| CO5 | 2 | 2 | | | | | | | | | | | 3 | 1 | |
| CO6 | 3 | | | | | | | | | | | | 3 | 2 | |
| Average | 2.5 | 2.5 | | | | | | | | | | | 3 | 1.5 | |

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

**COURSE CONTENT**

**Unit-1**

**Vehicle Body:** Vehicle construction and layouts, Full frame, Unibody, space frame; front section, central section and rear section parts; Vehicle sizes - compact, intermediate, full sizes. Engine Wheel Drive: Front engine front wheel, Front engine rear wheel and rear engine and rear wheel drive, all-wheel drive.

**Unit-2**

**Clutches:** Friction clutches, electromagnetic clutches, dual clutches, hydrodynamic clutches. Meshing Orders of Drivetrain Systems, Noise and Vibration Characteristics of the Drivetrain System, differential – limit slip differential.

**Transmission systems:** Manual transmission-Sliding mesh gearbox, constant mesh gearbox, synchro mesh gearbox; automatic transmission- Overdrive (semi-automatic), Fluid drive; Fully automatic- Epicyclic gearbox, freewheeling unit, torque convertor.

**Automobile tyres:** Desirable properties, conventional tubed and tubeless tyre, Wheel wobble and wheel alignment. NVH in tyres- excitation characteristics.

**Unit-3**

**Body and Chassis Technologies:** Body and Chassis Fundamentals - Different Types of Structural Systems - Chassis Systems of Electric and Hybrid Electric Vehicles.

**Modelling and Characteristics of EV/HEV Powertrains Components:** Electric Motor Performance Characteristics – Power Electronic Systems - Transmission and Drivetrain Characteristics.

**Unit-4**

**Energy StorageTechnologies:** Comparison of Different Energy Storage Technologies – Battery Systems - Capacitor systems - Flywheel systems.

**Control of Electric and Hybrid Electric Vehicle Dynamics:** Fundamentals of Vehicle Dynamic Control Systems - VDC Implementation on Electric and Hybrid Vehicles.

**TEXT BOOK:**


1. P L Kohli, Automotive Chassis and Body, Papyrus Publishing House, 1st edition , 2003.
2. Jornsen Reimpell, Helmut Stoll, The Automotive Chassis: Engineering Principles, Oxford ,2001
3. Iqbal Hussain, Electrci and Hybrid Vehicles- Design Fundamentals, CRC Press, Second Edition,2011
4. Amir Khajepour, M. Saber Fallah, Avesta Goodarzi, “Electric and Hybrid Vehicles: Technologies, Modeling and Control - A Mechatronic Approach”, Wiley, 2014


**REFERENCE BOOKS:**


1. Mehrdad Ehsani, Yimin Gao, and Ali Emadi, "Modern Electric, Hybrid and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.
2. Chris Mi, MA Masrur, and D W Gao, "Hybrid Electric Vehicles- Principles and Applications with Practical Perspectives", Wiley, 2011.


**JOURNALS/MAGAZINES**

1. IEEE Vehicular Technology Magazine.
2. IEEE Transactions on Intelligent Transportation Systems.
3. International Journal of Impact Engineering.
4. IEEE Transactions on Vehicular Technology.
5. IEEE Transactions on Transportation Electrification.

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/107106088
2. https://nptel.ac.in/courses/108106170

| Course Title | Product Design and Development | | | | Course Type | | Soft Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ESS513 | Credits | 3 | | Class | | V Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

This course introduces product design and its process of product planning in the organizations. It defines the way of identifying the customer needs of the product and arrives at the specifications. It also emphasizes on product concept generation, selection and testing to start with the detail design of the product. An introduction to the industrial design and design for manufacturing are the beneficial knowledge of the product design and development.

**COURSE OBJECTIVE (S)**

1. To implement the characteristics of successful product development in the development process.
2. To planning the product's process flow and identifying the needs of the customers to establish the product specifications.
3. To generate the concepts of the product to be developed, select and testing for further development.
4. To provide an insight into the industrial design aspect of the product and design for effective manufacturability.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | Pos | PSOs |
|---|---|---|---|
| CO1 | Describe the product design and development process in manufacturing industries | 1,2 | 1,2 |
| CO2 | Describe the components and their functions of product design and development processes and their relationships from concept to customer over whole product lifecycle | 1,2 | 1,2 |
| CO3 | Identify the customer needs of the product to be developed and arrive at the specifications | 1,2,3,4 | 1,2,3 |
| CO4 | Generate the concepts for products and select the best out of it using concept screening and scoring methods. | 1,2,3 | 1,2,3 |
| CO5 | Describe the concept testing process by choosing different survey methods to measure customer response | 1,2 | 1,2,3 |
| CO6 | Identify the different methods of industrial design process involving in the product development phases which helps to reduce the manufacturing and assembly cost of the product. | 1,2 | 1,2 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

| | | | | | | |
|---|---|---|---|---|---|---|
| CO5 | | | | ✓ | | |
| CO6 | | ✓ | | | | |

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | | | 3 | 2 | |
| **CO2** | 3 | 2 | | | | | | | | | | | 3 | 2 | |
| **CO3** | 3 | 3 | 3 | 2 | | | | | | | | | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | | | | | | | | | | 3 | 3 | 2 |
| **CO5** | 3 | 3 | | | | | | | | | | | 3 | 2 | 2 |
| **CO6** | 3 | 3 | | | | | | | | | | | 3 | 2 | |
| **Average** | 3 | 2.8 | 3 | 2 | | | | | | | | | 3 | 2.8 | 2 |

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

**COURSE CONTENT**

**THEORY:**

**Unit – 1**

**Introduction to Product Design & processes:**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, product development organizations.

**Unit – 2**

**Product Planning:** The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning.

**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.

**Product Specifications:** What are specifications, when are specifications established, establishing target specifications, setting the final specifications.

**Unit – 3**

**Concept Generation:** The activity of concept generation - clarifies the problem, search externally, search internally, explore systematically.

**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 and interpret the result.

**Unit – 4**

**Industrial Design:** Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process and 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. Karl.T.Ulrich, Steven D Eppinger "Product Design and Development" McGrawHill ,8th Edition, 2020.
2. Chitale.A.K , R.C.Gupta "Product Design and Manufacturing" 6th Edition, PHI, 2014.

**REFERENCE BOOKS:**

1. Harry Nystrom "Creativity and Innovation", John Wiley & Sons, 1979.
2. Jones S.W., "Product Design and Process Selection", Butterworth Publications, 1973.
3. Donald E. Carter "Concurrent Engineering", Addison Wesley, 1992.

**JOURNALS/MAGAZINES**

1. https://www.researchgate.net/journal/International-Journal-of-Product-Development-1741-8178

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/112107217
2. https://nptel.ac.in/courses/112104230

| Course Title | Data Structures | | | | Course Type | | Integrated Soft Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ESS514 | Credits | 3 | | Class | | V Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 2 | 2 | 2 | | | | |
| | Practice | 1 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **4** | **4** | **26** | **26** | **50 %** | **50 %** |

**COURSE OVERVIEW**

The course focuses on basic and essential topics in data structures, including array-based lists, linked lists, recursion, stack, queues, and binary trees, heaps, sorting, and searching algorithms. It also covers the analysis and design of fundamental data structures and engages learners to use data structures as tools to algorithmically design efficient computer programs that will cope with the complexity of actual applications.

**COURSE OBJECTIVE (S)**

1. To discuss the concept of Abstract Data Types (ADT)
2. To provide the knowledge of stacks and queues.
3. To understand the importance of Linked lists
4. To illustrate the operations of trees
5. To demonstrate the use of appropriate data structures for a given problem.
6. To design a data structure application for real-time problems.

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Explain the abstract data types and structures. | 1 | 1,2 |
| CO2 | Formulate the solution for any computational problem using stacks and queues. | 1,2 | 1,2 |
| CO3 | Analyse the importance of linked lists. | 1,2 | 1,2 |
| CO4 | Solve real-time problems using the tree data structure. | 1,2,3 | 1 |
| CO5 | Apply appropriate data structures to solve a given problem. | 1,2 | 1,2 |
| CO6 | Compare the performance of various data structures. | 1,2 | 1,2 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | | 3 | 1 | |
| **CO2** | 2 | 2 | | | | | | | | | | | 3 | 2 | |
| **CO3** | 3 | 2 | | | | | | | | | | | 3 | 1 | |
| **CO4** | 3 | 3 | 2 | | | | | | | | | | 3 | | |
| **CO5** | 3 | | | | | | | | | | | | 3 | 2 | |
| **CO6** | 2 | 2 | | | | | | | | | | | 3 | 2 | |
| **Average** | 2.6 | 2.2 | 2 | | | | | | | | | | 3 | 1.6 | |

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

**COURSE CONTENT**

**THEORY:**

**Unit – 1**

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

**Unit – 2**

**Data Structures-1:** Stacks, Evaluation of expressions: Infix, Prefix, postfix; Queues: Simple, circular and priority Queues.

**Unit – 3**

**Data Structures-2:** Pointers; Dynamic memory allocation; Linked List: singly linked list, doubly linked list, stack using linked list, queue using linked list.

**Unit – 4**

**Trees:** Binary Tree, Binary Tree Traversals, Binary search Tree. AVL Trees, Threaded Binary Trees, Heaps, Sparse Matrix, Searching and sorting techniques.

**TEXT BOOK:**


1. Horowitz, Sahni, Anderson-Freed, "Fundamentals of Data Structures in C", Universities Press, 2nd Edition, 2008.
2. Sunil Joshi, Jay Prakash Maurya , Data Structure Practice Using C Programming: Data Structure a Programming Perspective , Tata McGraw-Hill Education, 2020.


**REFERENCE BOOKS:**


1. Addison-Wesley , The design and analysis of computer algorithms, 4th Edition,2005.
2. Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft, Data Structures and Algorithms, Addison-Wesley, 1987.
3. Richard Gilberg, Behrouz Forouzan, Data Structures: A Pseudocode Approach with C, Cengage Learning, 2004.


**JOURNALS/MAGAZINES**

1. ACM Transactions on Data structures
2. ACM Journal of Algorithms and Computational Technology.

**PRACTICE:**

| | |
|---|---|
| 1 | Design, Develop and Implement menu-driven driven Program in C/Python for the following Array operations<br>a. Creating an Array of N Integer Elements<br>b. Display of Array Elements with Suitable Headings<br>c. Inserting an Element (ELEM) at a given valid Position (POS)<br>d. Deleting an Element at a given valid Position(POS)<br>e. Exit.<br>Support the program with functions for each of the above operations. |
| 2 | Design, Develop and Implement a Program in C/Python for the following operations on Strings<br>a. Read a main String (STR), a Pattern String (PAT) and a Replace String (REP) |

| | |
|---|---|
| | b. Perform Pattern Matching Operation:<br>c. Find and Replace all occurrences of PAT in STR with REP if PAT exists in STR.<br>d. Report suitable messages in case PAT does not exist in STR Support the program with functions for each of the above operations.<br>Note: Don't use Built-in functions |
| 3 | Design, Develop and Implement a menu driven Program in C/Python for the following operations on STACK of Integers (Array Implementation of Stack with maximum size MAX)<br>a. Push an Element on to Stack<br>b. Pop an Element from Stack<br>c. Demonstrate how Stack can be used to check Palindrome<br>d. Demonstrate Overflow and Underflow situations on Stack<br>e. Display the status of Stack<br>f. Exit<br>Support the program with appropriate functions for each of the above operations |
| 4 | Design, Develop and Implement a Program in C/Python for converting an Infix Expression to Postfix Expression. Program should support for both parenthesized and free parenthesized expressions with the operators: +, -, *, /, %( Remainder), ^ (Power) and alphanumeric operands. |
| 5 | Design, Develop and Implement a Program in C/Pythonfor the following Stack Applications a. Evaluation of Suffix expression with single digit operands and operators: +, -, *, /, %, ^ b. Solving Tower of Hanoi problem with n disks 21 6 Design, Develop and Imp |
| 6 | Design, Develop and Implement a menu driven Program in C/Python for the following operations on Circular QUEUE of Characters (Array Implementation of Queue with maximum size MAX)<br>a. Insert an Element on to Circular QUEUE<br>b. Delete an Element from Circular QUEUE<br>c. Demonstrate Overflow and Underflow situations on Circular QUEUE<br>d. Display the status of Circular QUEUE<br>e. Exit<br>Support the program with appropriate functions for each of the above operations |
| 7 | Design, Develop and Implement a menu driven Program in C/Python for the following operations on Singly Linked List (SLL) of Student Data with the fields: USN, Name, Branch, Sem, PhNo<br>a. Create a SLL of N Students Data by using front insertion.<br>b. Display the status of SLL and count the number of nodes in it<br>c. Perform Insertion and Deletion at End of SLL<br>d. Perform Insertion and Deletion at Front of SLL<br>e. Demonstrate how this SLL can be used as STACK and QUEUE<br>f. Exit |
| 8 | Design, Develop and Implement a menu driven Program in C/Python for the following operations on Doubly Linked List (DLL) of Employee Data with the fields: SSN, Name, Dept, Designation, Sal, PhNo<br>a. Create a DLL of N Employees Data by using end insertion.<br>b. Display the status of DLL and count the number of nodes in it<br>c. Perform Insertion and Deletion at End of DLL<br>d. Perform Insertion and Deletion at Front of DLL<br>e. Demonstrate how this DLL can be used as Double Ended Queue<br>f. Exit |
| 9 | Design, Develop and Implement a Program in C/Python for the following operations on Singly Circular Linked List (SCLL) with header nodes a. Represent and Evaluate a Polynomial P(x,y,z) = 6x2y2z-4yz5+3x3yz+2xy5z-2xyz3 b. Find the sum of two polynomials POLY1(x,y,z) and POLY2(x,y,z) and store the result in POLYSUM(x,y,z) Support the program with appropriate functions for each of the above operations |
| 10 | Design, Develop and Implement a menu driven Program in C/Python for the following operations on Binary Search Tree (BST) of Integers<br>a. Create a BST of N Integers: 6, 9, 5, 2, 8, 15, 24, 14, 7, 8, 5, 2<br>b. Traverse the BST in Inorder, Preorder and Post Order<br>c. Search the BST for a given element (KEY) and report the appropriate message |

| | |
|---|---|
| | d. Delete an element(ELEM) from BST<br>e. Exit |

| Course Title | Smart Materials | | | | Course Type | | Open Elective | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20MEO501 | Credits | 3 | | Class | | V Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

Overview of the course is to enhance holistic development of students and improve their knowledge about the smart materials, MR, ER fluids, Biomimeticsand smart actuators, advanced in smart structures, smart composites and applications of smart materials.

**COURSE OBJECTIVES**

The objectives of this course are to:

1. Understand the basic concepts of composites and ceramics materials, electro-magnetic materials andshape memory alloys
2. Study about the MR and ER fluids, High-Band Width, Low Strain Smart Sensors and Application of Smart Sensors for Structural Health Monitoring (SHM)
3. Analyze the smartactuators and smart composites, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control and Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials.

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Apply the fundamental knowledge of smart materials, smart structures, piezoelectric, MR, ER fluidsto solve problems in the field of medicine and engineering. | 1 | 1 |
| CO2 | Identify, compare and contrast alternative solution processes to select the best process of smart actuators in automobiles and biomedical field. | 1, 2 | 1 |
| CO3 | Generate information through appropriate tests to improve or revise the design ofsmart composites. | 1, 2, 3 | 2 |
| CO4 | Recognize the need of analysis to good problem definition ofsmart structures. | 1, 2, 3 | 2 |
| CO5 | Establish a relationship between measured data and underlying physical principlessmart composites applications for corrosion coating and self-healing and MEMs products. | 1, 2, 3,4 | 3 |
| CO6 | Examine the relevant methods and techniques of advances inSensing applications of smart sensors of structural health monitoring. | 1, 2, 3,4,5 | 3 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

| CO | Bloom's Level | | | | | |
|---|---|---|---|---|---|---|
| | Remember (L1) | Understand (L2) | Apply (L3) | Analyze (L4) | Evaluate (L5) | Create (L6) |
| CO1 | | ✓ | | | | |
| CO2 | | ✓ | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO3 | | | ✓ | | | |
| CO4 | | | ✓ | | | |
| CO5 | | | | ✓ | | |
| CO6 | | | | ✓ | | |

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | | 2 | | |
| CO2 | 3 | 2 | | | | | | | | | | | 2 | | |
| CO3 | 3 | 2 | 1 | | | | | | | | | | 1 | 2 | |
| CO4 | 3 | 2 | 1 | | | | | | | | | | 1 | 2 | |
| CO5 | 3 | 3 | 1 | 1 | | | | | | | | | 1 | 2 | 2 |
| CO6 | 3 | 2 | 1 | 1 | 1 | | | | | | | | 1 | 2 | 2 |
| **Average** | **3** | **2.2** | **1** | **1** | **1** | | | | | | | | **1.3** | **2** | **2** |

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

**COURSE CONTENT**

**Unit-1**

**Overview of Smart Materials:** Introduction to Smart Materials - Smart structures - classification of smart structures, common smart materials. Piezoelectric materials, piezoelectric effect, Piezoceramics, Piezopolymers, Shape memory alloys (SMAs) - Shape memory effect - Shape memory polymers, Introduction to Electro-active Materials, Electro-active Polymers, Ionic Polymer - Electro-rheological Fluids - Magneto Rhelological Fluids.

**Unit-2**

**Smart Actuators:** Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magneto-volume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control**.**

**Unit-3**

**Smart composites:** Review of Composite Materials, Micro and Macro-mechanics, Laminated Composites based on the Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, governing Equation of Motion.Advances in smart structures; Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials.

**Unit-4**

**Applications:** Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, MEMS - MEMS Product development - Deployment devices - Molecular machines.

**Sensing Applications;** Piezeoelctric Strain Sensors, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM).

**TEXT BOOKS**

1. Mohsini Shahenpoor (Ed.), "Fundamentals of Smart Materials", RSC, Cambridge, UK, 2020
2. Chander Prakash, Sunpreet Singh, J. Paulo Davim (Ed.), Functional and Smart Materials, CRC Press, 1st Edition, 2021.
3. Chang Liu, "Foundation of MEMS", Pearson Education, 2nd edition, 2012.
4. M.V.Gandhi and B.S.Thompson, "Smart Materials and Structures", Chapmen & Hall, London, 1992.

5. Mel M. Schwartz, “Smart Materials”, CRC Press, 1st Edition, 2009.
6. Donald J. Leo, “Engineering analysis of smart material systems”, John Wiley & Sons, 1stEdition, 2007.

**REFERENCE BOOKS**

1. Radhashyam Rai, “Smart Materials for Smart Living”, Nova Publishers, USA, 2017.
2. Qun Wang (Ed.), “Smart Materials for Tissue Engineering”, RSC, UK, 2017.
3. Johannes Michael Sinapius, Adaptronics – “Smart Structures and Materials”, Springer, 2020.
4. Anca Filimon (Ed.), “Smart Materials”: Integrated Design, Engineering Approaches and Potential Applications, CRC Press, 2019.
5. Vijay K. Varadan, “Smart material systems and MEMS: design and development methodologies”, John Wiley & Sons, 2006.
6. Seung- Bok Choi & Young-Min Han, “Piezoelectric actuators: control applications of smart materials”, CRC Press - 2010.
7. Kwang J. Kim & S. Tadokoro, “Electroactive polymers for robotics applications: artificial muscles and sensors”, Springer, 2007

**JOURNALS/MAGAZINES**

1. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology
2. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/113/102/113102080/
2. https://nptel.ac.in/courses/122/102/122102008/

<table>
<tr><td>Course Title</td><td colspan="4">Control System Lab</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B20ES0504</td><td>Credits</td><td colspan="2">1</td><td colspan="2">Class</td><td colspan="2">Vsemester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>1</td><td>2</td><td>2</td><td>00</td><td>26</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSE OVERVIEW:**

This laboratory course deal with conducting experiments related to response analysis of first and second order systems. Stability analysis of a system using Bode and Nyquist Plots also covered. It also deals with Steady state error analysis of control systems along with design of feedback controller using Root locus method.

**COURSE OBJECTIVES:**

1. To provide the understanding of time response analysis of first and second order systems.
2. To understand the stability Analysis based on Pole position
3. To carry out stability analysis of a system using Bode Plot and Nyquist Plot.
4. To analyse the controller design using State-Space method

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Describe various types of control system and controllers. | 1 | 1 |

| | | | |
|---|---|---|---|
| CO2 | Develop mathematical models and transfer function model for mechanical and electrical system. | 1,2,3 | 1,2,3 |
| CO3 | Analyze the time response of a first and second order system and behavior of various controllers using simulation tool. | 1,2 | 1,2 |
| CO4 | Design of feedback controller usingroot locus plot by employing simulation tool. | 1,2,3 | 1,2 |
| CO5 | Investigate the stability of the system using Bode and Nyquist plot using simulation tool. | 1,2,3 | 1,2,3 |
| CO6 | Analyze the controller design using state space model by employing simulation tool and document the results in the form of technical report. | 1,2,3, 10 | 1,2,3 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | | 3 | 1 | 2 |
| CO2 | 3 | 3 | 2 | | | | | | | | | | 3 | 3 | 2 |
| CO3 | 3 | 2 | | | | | | | | | | | 3 | 3 | |
| CO4 | 3 | 3 | 2 | | | | | | | | | | 3 | 3 | |
| CO5 | 3 | 3 | 2 | | | | | | | | | | 3 | 3 | 2 |
| CO6 | 3 | 3 | 2 | | | | | | | 3 | | | 3 | 3 | 2 |
| Average | 3 | 2.8 | 2 | | | | | | | 3 | | | 3 | 2.1 | 2 |

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

**COURSE CONTENT**

**Part-A**

1. Introductiontocontrolsystemsandsimulation tool.
2. TimeResponseanalysisoffirstorder systems.
3. TimeResponseanalysisofsecond order system.
4. Stability Analysis based on Pole position.
5. Time domain analysis of PID Controllers.

**Part-B**

1. Stability Analysis of system using Bode Plot.
2. Steady State error analysis of control systems.
3. Design of feedback controller using Root locus method.
4. Stability Analysis of a system using Nyquist Plot.
5. Study and analysis of Controller design using State-Space method.

**TEXT BOOKS:**

1. Katsuhiko Ogata, "Modern Control Engineering", Pearson Education, 2004.
2. J. Nagarath and M.Gopal, "Control Systems Engineering", New Age International (P) Limited, Publishers, 6th edition,2017.

**REFERENCE BOOKS:**

1 B.C.Kuo, F.Golnaraghi, "Automatic Control Systems", John Wiley & Sons, 10th edition,2018.
2. Richard C Dorf & Robert H Bishop, "Modern Control Systems, , Prentice Hall, 2008.

**JOURNALS/MAGAZINES**

1. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=87
2. https://www.journals.elsevier.com/control-engineering-practice

**SWAYAM/NPTEL/MOOCs:**

1.https://nptel.ac.in/courses/107106081
2.https://www.edx.org/course/dynamics-control-upvalenciax-dc201x-0

<table>
<tr><td>Course Title</td><td colspan="4">Robotics Lab</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B20ES0505</td><td>Credits</td><td colspan="2">1</td><td colspan="2">Class</td><td colspan="2">Vsemester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>1</td><td>2</td><td>2</td><td>00</td><td>26</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSE OVERVIEW**

Robotics is an interdisciplinary branch of electronic engineering and mechanical engineering. Robotics involves design, construction, operation, and use of robots. The goal of robotics is to design machines that can help and assist humans. Robotics integrates fields of mechanical engineering, electrical engineering, information engineering, mechatronics, electronics, bioengineering, computer engineering, control engineering, software engineering, mathematics, etc.

**COURSE OBJECTIVE (S)**

The objectives of this course are to:

1. Introduction to fundaments of robotics and specification associated with robot.
2. Give an insight into Robot arm kinematics and apply to 2R and 3R manipulator and puma 560 robot
3. Discusson different types of end effector and sensors used in robots.
4. Introduce to Image processing basics.
5. Discuss different types of programming language and industrial application of robots.

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Identify different types of robots, its physical configuration and associated movements. | 1 | 1 |
| CO2 | Design and model Robotic base, links, Joints and grippers using a suitable CAD Software. | 1,2,3,5 | 1,2 |
| CO3 | Demonstrate the Configuration of servo motors. | 1,2, 9 | 1,2 |

| | | | |
|---|---|---|---|
| CO4 | Identifydifferent types of grippers and sensors associated with robots. | 1 | 1 |
| CO5 | Assemble robotic ARM/perro/spider. | 1,2,9 | 1,2 |
| CO6 | Demonstrate the operation and controlling of Arm/spider/Perro and document the results in the form of technical report. | 1,2, 9, 10 | 1 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | | 3 | | |
| **CO2** | 2 | 3 | 3 | | 3 | | | | | | | | 3 | 2 | |
| **CO3** | 2 | 2 | | | | | | | 2 | | | | 2 | 3 | |
| **CO4** | 3 | | | | | | | | | | | | 3 | | |
| **CO5** | 2 | 2 | | | | | | | 3 | | | | 2 | 3 | |
| **CO6** | 3 | 2 | | | | | | | 2 | 2 | | | 3 | | |
| **Average** | 2.5 | 2.3 | 3 | | 3 | | | | 2.3 | 2 | | | 2.6 | 2.6 | |

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

**COURSE CONTENT:**

**Part-A**

1. Introduction to robotics, Overview of lab syllabus, Introduction on required tools and technologies.
2. 3D design and modelling of robotic ARM: ARM Part1: Base.
3. 3D design and modelling of robotic ARM: ARM Part2: Links.
4. 3D design and modelling of robotic ARM: ARM Part3: Joints and grippers.
5. Configuration of servo motors: Dynamixel AX motors.

**Part-B**

1. Configuration of Ds servo : RDS3115MG
2. Assembly of robotic ARM/perro/spider.
3. Operation and controlling of Arm/spider/Perro
4. Arduino based robotics experiment 1: Light following robot
5. Arduino based robotics experiment 2: Obstacle avoiding robot

**TEXT BOOKS:**

1. Groover, Mikell P., Mitchell Weiss, and Roger N. Nagel. "Industrial robotics: technology, programming and application". McGraw-Hill Higher Education, 1986.
2. Fu, King Sun, Ralph Gonzalez, and CS George Lee, "Robotics: Control Sensing, Vision and Intelligence", Tata McGraw-Hill Education, 1987.

**REFERENCE BOOKS:**

1. Klafter, R. D, Chmielewski, T. A. and Noggins. "Rabot Engineering: An integrated Approach", Prentice hall of India Pvt. Ltd., New Delhi, 1993.
2. Deb, S. R. "Robotics Technology and Flexible Automation", Tata McGraw Hill publishing company limited, New Delhi, 2017.
3. Craig, J. J. "Introduction to Robotics: Mechanics and Control". Pearson, 2008.

**JOURNALS/MAGAZINES**

1. https://e2echina.ti.com/group/c8df485b47/m/msp430/11060/download
2.https://www.hindawi.com/journals/jr/

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/112105249
2. https://nptel.ac.in/courses/107106090

| **CourseTitle** | **Indian Traditions and Culture** | | | | **CourseType** | | **FC** | |
|---|---|---|---|---|---|---|---|---|
| **CourseCode** | **B20PA0501** | **Credits** | **1** | | **Class** | | **V Semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 1 | 1 | 1 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **1** | **1** | **1** | **13** | **0** | **50 %** | **50 %** |

**COURSEOBJECTIVES**

1. Provide conceptual knowledge of Indian culture and traditions
2 .Introduce students to the science and technological advancements related to Indian culture
3. Help students understand the Indian spiritual aspects of Indian culture
4. Help learners understand the factors which unite the diverse cultures of India

**COURSEOUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| **CO** | **CourseOutcomes** | **POs** | **PSOs** |
|---|---|---|---|
| CO1 | Gain conceptual understanding of Indian culture and traditions. | 8,9,10 | |
| CO2 | Describe various ancient theories in treatment of any disease. | 8,9,10 | |
| CO3 | Appreciate the science and technological advancements in ancient India. | 8,9,10 | |
| CO4 | Comprehend the Indian spiritual aspects of Indian culture like yoga, meditation and nirvana. | 8,9,10 | |
| CO5 | Demonstrate the theory behind celebrating Hindu festivals and concept of making varieties of food | 8,9,10 | |
| CO6 | Understand India as a land united by cultural diversity. | 8,9,10 | |

**BLOOM'SLEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

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

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

**COURSECONTENT**

**Unit-1**

**Indian Tradition**

**Culture**:Indus Valley Civilization and early cultural practices, The Vedic culture, Influence of Buddhism and Jainism on Indian Culture, Influence of Islam and Christianity, Indian Cultural Renaissance of the 19th Century

**Religion:** Pre-vedic and Vedic religion, Jainism, Buddhism, Hinduism, Religious Reform Movements, Advent of Christianity

**Art:** Introduction to Natyashastra, classical and contemporary art forms (dance and music), regional art forms (dance and music), Folk art, puppetry

**Architecture**: – Engineering and Architecture in Ancient India, Evolution of Hindu Temple Structures, Sculptures, Coins and Pottery from Ancient India v. Literature- Vedas, Upanishads, Ramayana, Mahabharata & Bhagavat Gita.

**Unit-2**

**Contribution of ancient India to Science and Maths**

**Development of Science in Ancient India:** Astronomy, Mathematics, Medicine, Metallurgy.

**Scientists of Ancient India:** Mathematics and Astronomy- Baudhayan, Aryabhata, Brahmagupta, Bhaskaracharya, Mahaviracharya. Science- Kanad, Varahamihira, Nagarjuna. Medical Sciences (Ayurveda and Yoga) - Susruta, Charaka, Yoga and Patanjali

**Science and Scientists in Medieval India**: Mathematics, Biology, Chemistry, Astronomy, Medicine, Agriculture.

**Scientists in Modern India:** Srinivas Ramanujan, Chandrasekhara V Raman, Jagadish Chandra Bose, Homi Jehangir Bhabha, Dr,Vikram Ambalal Sarabhai, ,Dr. APJ Abdul Kalam.

**Unit-3**

**Indian Spiritual Aspects**

**Hindu Spirituality Based on Shruti and Smriti**: Hinduism in General, Basic notions of Vedas, Upanishads, Ramayana, Mahabharata and Bhagavat Gita.

**Hata Yoga and Pranayama:** Main Features, Basics of Yoga –Different kinds of Yoga; Raja Yoga (Ashtanga yoga); Karma yoga;

**Bhakti Yoga**: Yoga of Loving Devotion; Jnana yoga – Yoga of Knowledge; Hatha Yoga (Asana/ Pranayamas); Kundalini Yoga; Nada Yoga; Sannyasa Yoga

**Buddhist, Jaina Spiritualities:** Main Doctrines of Buddhism: Four Noble Truths (Arya Satya), Concept of Nirvana - Ashtanga Marga.

**Unit-4**

**Unity in Diversity**

**Commensality and the Significance of Food**: Eating Together as Family and as a Society, Food at Rituals, annaprasan, marriage and funeral, Kitchen as Shared Space for Women, Food and Nationalist Response of Indian Community, Visibility of Indian Cuisine in the World

**Celebrating Diverse Festivals:** Festival Types: Religious and Seasonal, Religious - Holi, Diwali, Ganesh Chaturthi, Janmashtami, Mahavir Jayanthi, Ramadan, Christmas, Buddha Purnima; Seasonal (harvest festivals) - Baisakhi, Pongal, Sankranti

**Attire:** Indus Valley Civilization, Vedic period, Modern India.

**TEXTBOOKS**

1. Sundararajan K.R., “Hindu Spirituality - Vedas through Vedanta, Cross Road Publications”, New York, 1997.
2. Griffiths Bede, “Yoga and the Jesus Prayer Tradition, Asian Trading Corporation”, Bangalore, 1992
3. Ansh Mishra, Science in Ancient India, Indian Corporation, New Delhi, 1998
4. Sen Taylor, Collen. Feasts and Fasts: A History of Food in India. Reaktion Books, New Delhi, 2014.
5. Thapar, Romila, Readings in Early Indian History. Oxford University Press. New Delhi, 2018

**6th Semester**

| Course Title | Automation in Production | | | | Course Type | | Hard Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ES0601 | Credits | 3 | | Class | | VI semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **00** | **50 %** | **50 %** |

**COURSE OVERVIEW:**

This course explores the production facilities, need of automation in the manufacturing sectors. It deals with different industrial control system, support system for automation in this competitive environment. This subject describes about the flexibility concept for manufacturing products, group technology and inspection process through automation to provide the products with better quality.

**COURSE OBJECTIVES:**

1. Explore the concept of automation and building blocks, Fundamentals of manufacturing.
2. Identify the manufacturing support systems to different industries.
3. Enumerate the knowledge of automated production, group technology and cellular manufacturing concept.
4. Exposure to gain knowledge about automated inspection technologies.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Explore the need of digitalization for manufacturing to achieve higher quality and productivity standards. | 1 | 1,2 |
| CO2 | Use manufacturing support systems for productivity improvement | 1 | 1,2 |
| CO3 | Compare the cellular and flexible manufacturing methods | 1 | 1,2 |
| CO4 | Implement the concept of inspection technology for modern automated industry Requirements and Critique on intelligent manufacturing system for the competitive world | 1,5 | 1,2 |
| CO5 | Understand the ladder diagram to automate different process | 1,2,5 | 1,2 |
| CO6 | Demonstration and analysis the pneumatic circuits for different applications. | 1,2,5 | 1,2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | | 2 | 2 | |
| CO2 | 2 | | | | | | | | | | | | 2 | 2 | |
| CO3 | 3 | | | | | | | | | | | | 2 | 2 | |
| CO4 | 3 | | | | 2 | | | | | | | | 2 | 2 | |
| CO5 | 3 | 2 | | | 2 | | | | | | | | 2 | 2 | |
| CO6 | 3 | 2 | | | 1 | | | | | | | | 2 | 2 | |
| Average | 2.8 | 2 | | | 1.6 | | | | | | | | 2 | 2 | |

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

**COURSE CONTENT**

**Unit-1**

**Introduction:**Production System Facilities, Automation definition, type and Importance of automation in the manufacturing industry, Manuel labour in production system, product and production relationship, cost of manufacturing operation.

**Basic Elements of an Automated System:** Advanced Automation Functions & Levels of Automation, Continuous versus Discrete control, Computer Process control, Forms of Computer Process Control.

**Unit-2**

**Manufacturing Support System:** Process Planning, Computer Aided Process Planning, and Concurrent Engineering & Design for Manufacturing, Advanced Manufacturing Planning, Just-in Time Production System, Basic concepts of lean manufacturing tools and techniques and Agile manufacturing and its case studies, Toyota Production System.

**Elements of electro-pneumatic**,advantages over hydraulics & pneumatic control, solenoid valves, relays, factory automation sensors, electrical sensors, process automation sensors and their interfaces.

**Unit-3**

**Group Technology and Flexible Manufacturing Systems:**Part Families, Parts Classification and coding, Production Flow Analysis, Cellular Manufacturing, Flexible Manufacturing Systems (FMS) and its components, FMS Applications & Benefits, FMS Planning & Implementation Issues. Case studies.

**Intelligent Manufacturing Systems:** Introduction, need of intelligent manufacturing system & applications.

**Unit-4**

**Inspection Technologies:** Automated Inspection, Coordinate Measuring Machines Construction, operation & Programming, Software, Application & Benefits, Flexible Inspection System, Inspection Probes on Machine Tools, Machine Vision, Optical Inspection Techniques & Non-contact Non-Optical Inspection Technologies, Case studies onautomated inspection.

**Industrial Control Systems:** Programmable Logic Controllers (PLC) based control system,programming languages & instruction set, ladder logic, functional blocks, structured text, andtheir applications with various automation examples. Human Machine Interface (HMI) &Supervisory Control and Data Acquisition System (SCADA), motion controller, smartsensors, RFID technology and its application, machine vision and control applications.

**Case study:**

1. Lean manufacturing and agile manufacturing, Toyota Production System.
2. Flexible Manufacturing Process, Group Technology and intelligent manufacturing.
3. Automated inspection techniques in different industries.

**TEXT BOOKS:**


1. M. P. Groover, "Automation, Production Systems and Computer Integrated manufacturing", Pearson education. 5th Edition, 2019.
2. Vajpayee, "Principles of computer-integrated manufacturing", Prentice Hall India Learning Private Limited, 1995.
3. John R. Hackworth & Frederick D. Hackworth Jr, "Programmable Logic Controllers –Programming Methods and Applications", Pearson, 2011.

**REFERENCE BOOKS:**


1. Amber G.H & P. S. Amber, "Anatomy of Automation", Prentice Hall, 1962.
2. Viswanandham, "Performance Modeling of Automated Manufacturing Systems", Prentice Hall India Learning Private Limited, 1994.
3. Krishna Kant, "Computer Based Industrial Control", Revised 2nd Edition, Prentice Hall India Learning Private Limited, 2011.
4. Nakra, B. C., "Theory and Applications of Automatic Controls", Revised 2nd Edition, New Age International Publishers, 2014.
5. Morriss, S. B., "Automated Manufacturing Systems", McGraw Hill ,2006.
6. John W. Webb & Ronald A. Reis, "Programmable Logic Controllers – Principles and Applications", Fifth Edition, Pearson Education, 2008.


**JOURNALS/MAGAZINES**

1. https://www.sciencedirect.com/search?qs=automation
2. https://asmedigitalcollection.asme.org/manufacturingscience
3. https://www.industrialautomationindia.in/

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/112103293
2. https://www.digimat.in/nptel/courses/video/112104288/L01.html

<table>
<tr><td>Course Title</td><td colspan="3">Introduction to Finite Element Methods</td><td colspan="2">Course Type</td><td colspan="2">Hard core</td></tr>
<tr><td>Course Code</td><td>B20ES0602</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">VI Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Tutorial</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>1</td><td>2</td><td>2</td></tr>
<tr><td>Total</td><td>4</td><td>5</td><td>5</td><td>26</td><td>26</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSE OVERVIEW**

The FEM course deals with the Steps involved in FEM, Selection of Elements, and analyze1D and 2D solutions. This course covers higher Order Elements, the Hermite Shape function and 1D heat transfer problems.

**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 the basics of the Finite element method as an analysis tool.
3. To teach the students the characteristics of various elements and the 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 (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Discuss the steps involved in the Finite Element Method. | 1 | 1,2 |
| CO2 | Select the suitable elements and apply boundary conditions for structural analysis. | 1,2,3 | 1,2 |
| CO3 | Provide FE solutions for bars, trusses, and beam for stated structural boundary conditions. | 1,2,3,5, 12 | 1,2,3 |
| CO4 | Develop shape functions for Higher-Order Elements by using Lagrange's interpolation Method. | 1,2,3 | 1,2, 3 |
| CO5 | Develop and apply the Hermite Shape function to determine the deflection in beams carrying concentrated and UDL loads. | 1,2, 3 | 1,2,3 |
| CO6 | Apply the FEM method to solve 1D heat transfer on the pin- fins and composite walls. | 1,2,3,12 | 1,2,3 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | | | | | | | | | | | 3 | 2 | |
| CO2 | 3 | 1 | | | | | | | | | | | 3 | 3 | |
| CO3 | 3 | 3 | 2 | | 3 | | | | | | | 1 | 3 | 2 | 1 |
| CO4 | 3 | 3 | 2 | | | | | | | | | | 3 | 3 | 1 |
| CO5 | 3 | 3 | 2 | | | | | | | | | | 3 | 2 | 1 |
| CO6 | 3 | 3 | 3 | | 3 | | | | | | | 1 | 3 | 3 | 1 |
| **Average** | **3** | **2.66** | **2.2** | | **3** | | | | | | | **1** | **3** | **2.5** | **1** |

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

**COURSE CONTENT**

**Unit: 1**

**Introduction:** Various stress analysis methods: Numerical , Analytical , Experimental ; General description of FEM, Steps involved in FEM, Phases of CAE: Preprocessing, solutionandPost processing, Advantages and Limitations of FEM, List of commercial FEM Packages, Typical applications: Automotive, Manufacturing process simulation, Electrical and Electronics engineering, Aerospace, role of FEM in the analysis of mechatronics systems.

**Discretization:** Types of Elements used in FEM, Mesh quality parameters, Shape and behavior, Choice of element types, Location of nodes, coordinate systems.

**Unit: 2**

**Interpolation polynomials:**1D Linear, quadratic and cubic. Simplex, complex, and multiplex elements.Convergence criteria. 2D PASCAL's triangle, Derivation of shape functions and Jacobian for CST element in NCS (simple numerical), Expression for Strain displacement matrix and its importance.

**Solution of 1-D Bars:**Derivation of element stiffness matrix for 2 noded bar element, Properties of stiffness matrix, Numerical on bars on uniform, stepped and tapered cross-sections to analyze displacements, reactions and stresses. Elimination approach of handling boundary conditions.

**Unit: 3**

**Trusses:**Definition,Types of trusses, Derivation of stiffness matrix, Numerical involving trusses with 2 and 3 elements.

**Higher Order Elements**: Lagrange's interpolation, shape functions for higher order 1D elements - Quadratic and cubic element, iso-parametric, sub-parametric and super parametric elements, Shape function for linear and quadratic quadrilateral element.

**Unit: 4**

**Beams:**Hermite shape functions for beam element, Derivation of stiffness matrix using Hermite shapefunctions, Numerical on beams carrying concentrated, UDL and UVL.

**Heat transfer:**Steady state heat transfer,1D heat conduction governing equation, Boundary condition, Numerical on 1D element functional approach for heat conduction and convection in composite walls, and pin fins.

**CASE STUDIES**

1. Parametric Finite Element Analysis of Bicycle Frame Geometries
2.Truss bridge structure frame section analysis by using Finite element analysis
3.Stress Analysis of the truck chassis using Finite Element Analysis (FEA)
4. Thermal analysis of PCB.

**TextBooks:**


1. R. D. Cook, D. S Malkus, Michael. E. Plesha, Robert. J. Witt, "Concepts and applications of Finite Element Analysis", Wiley 4th Edition, 2009.
2. Tirupathi. R. Chandrapatla, Ashok. D. Belegundu, "Finite Elements in Engineering", 5th Edition, Cambridge University Press, 2021.
3. Nithin Gokhale, "Practical Finite Element Analysis", Finite to Infinite, 2020.


**Reference Books:**


1. Daryl .L. Logon, "Finite Element Methods", Thomson Learning 3rd edition, 2017.
2. J. N. Reddy, "Finite Element Method", McGraw – Hill International Edition.
3. S. S. Bhavikatti, "Finite Element Analysis", New Age International publishers, 2021.


**JOURNALS/MAGAZINES**

1. https://www.sciencedirect.com/journal/finite-elements-in-analysis-and-design
2. https://www.hindawi.com/journals/mpe/si/632341/

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/112104116
2. https://onlinecourses.nptel.ac.in/noc20_me91/preview.

| Course Title | Optimization Methods | | | | Course Type | | Hard Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ES0603 | Credits | 3 | | Class | | VI Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

The course introduces various optimization methods. Optimization problems arise in all walks of human activity – particularly in engineering, business, finance and economics. The simplest optimization problems are linear in nature which may be subject to a set of linear constraints. This course will equip the student with the expertise to mathematically solve problems in linear programming, transportation, and subsequently educate the student to solve these problems with the help of the available methods. The course also introduces decision analysis, queuing theory and Monte Carlo simulation techniques for optimization problems.

**COURSE OBJECTIVE (S)**

The objectives of this course are to:

1. Learn Formulation of an LPP and determine the optimal solution for a LPP Problem.
2. Learn applications of LPP such as transportation problem, Assignment problem, travelling salesman problem.
3. Analyze the waiting line model for real world applications.
4. Understand the importance of queuing theory and Monte Carlo simulation technique.

**COURSE OUTCOMES (COs)**

Aftercompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Formulate and solve linear programming problems using Simplex method and its variants. | 1,2,12 | 1,2 |
| CO2 | Solve linear goal programming problem graphically. | 1,2,12 | 1,2 |
| CO3 | Construct and optimize various network models. | 1,2,3,12 | 1,2 |
| CO4 | Study two-person zero sum game and its solutions. | 1,2,12 | 1,2 |
| CO5 | Classify and modeling of queuing system. | 1,2,12 | 1,2 |
| CO6 | Apply Monte Carlo simulation technique to obtain better optimization. | 1,2,12 | 1,2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

| | | | | | | |
|---|---|---|---|---|---|---|
| CO6 | | | | ✓ | | |

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | | | | | | | | | | 1 | 3 | 3 | |
| CO2 | 3 | 3 | | | | | | | | | | 1 | 3 | 3 | |
| CO3 | 3 | 2 | 3 | | | | | | | | | 1 | 3 | 3 | |
| CO4 | 3 | 3 | | | | | | | | | | 2 | 3 | 3 | |
| CO5 | 3 | 3 | | | | | | | | | | 2 | 3 | 3 | |
| CO6 | 3 | 3 | | | 1 | | | | | | | 3 | 3 | 3 | |
| Average | 3 | 2.6 | 3 | | 1 | | | | | | | 1.67 | 3 | 3 | |

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

**COURSE CONTENT**

**Unit – 1**

**Scope of Operations Research:**Introduction to linear and non-linear programming formulationof different models.

**Linear Programming:**Geometry of linear programming, Graphical method, Linear programming (LP) in standard form, Solution of LP by simplex method, Exceptional cases in LP, Duality theory, Dual simplex method, Sensitivity Analysis.

**Unit – 2**

**Integer Programming:**Branch and Bound Technique.

**Transportation and Assignment Problem:**Initial basic feasible solution of balanced and unbalanced transportation problems, optimal solutions, Assignment Problem.

**Goal programming:**Introduction to Goal programming, Standard form of linear Goal programming problem, Solution of linear Goal Programming problem by graphical method.

**Unit – 3**

**Network Models:**Construction of Networks, network computations, free floats, critical path method, optimal scheduling.

**Decision Analysis:**Decision analysis with minimax (maximin) criteria, Dominance property, Two person zero-sum game, Game with mixed strategies, Graphical method.

**Unit – 4**

**Queuing Theory:**Pure birth and death model, Classification of Queuing models, M/M/1 model, Introduction to cost models in queuing.

**Monte Carlo simulations:**Mid-square algorithm for random number generation, Introduction to simulation of queuing system.

**TEXT BOOKS:**

1. PremKumarGuptaandD.S.Hira, “Problems in OperationsResearch”,S.ChandPublication,NewDelhi, 2021.
2. Chandra, S., Jayadeva, Mehra, A., “Numerical Optimization and Applications”, Narosa Publishing House, 2013.
3. Taha H.A., “Operations Research-An Introduction”, PHI, 2007.

**REFERENCE BOOKS:**

1. Pant J. C., “Introduction to optimization Operations Research”, Jain Brothers, 2008.
2. Bazaarra Mokhtar S., Jarvis John J. and ShiraliHanif D., “Linear Programming and Network Flows”, John Wiley and Sons , 2011.

3. H.S. Kasana and K.D. Kumar, “Introductory Operations research”, Springer publication, 2004.
4. Ravindran, D. T. Phillips and James J. Solberg,“Operations Research- Principles and Practice”, John Wiley & Sons, 2nd edition, 2005.

**JOURNALS/MAGAZINES**

1. https://www.inderscience.com/jhome.php?jcode=ijor

2.https://www.springer.com/journal/12597

**SWAYAM/NPTEL/MOOCs:**

1.https://nptel.ac.in/courses/110106062

2. https://nptel.ac.in/courses/112106131

| **Course Title** | **Robot Dynamics and Control** | | | | **Course Type** | | **Soft Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ESS611** | **Credits** | 3 | | **Class** | | **VI Semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | **IA** | **SEE** |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

This graduate course will explore the dynamics and control of robots, both from a foundational level together with a view toward application. In particular, the course will first build the necessary mathematical framework in which to understand dynamic robotic systems, including: Rigid body transformations, forward and inverse kinematics, forward and inverse dynamics, stability and control.

The control part presents the floating time technique for time-optimal control of robots. The outcome of the technique is applied for an open loop control algorithm. Then, a computed-torque method is introduced, in which a combined ion of feed forward and feedback signals are utilized to render the system error dynamics.

**COURSE OBJECTIVES:**

The objectives of this course are to:

1. Review of robot kinematics and introduction to acceleration kinematics
2. Building mathematical models of robot under dynamics conditions.
3. Introduction to path planning methods andtime optimal controls
4. Discussion on different control techniques and its applications.

**COURSE OUTCOMES (COs):**

Afterthecompletionofthecourse,thestudentwillbeableto:

| **CO** | **Course Outcomes** | **POs** | **PSOs** |
|---|---|---|---|
| CO1 | Illustrate kinematics analysis of robot systems | 1,2 | 1,2 |
| CO2 | Apply the knowledge of Motion dynamics | 1 | 1,2 |
| CO3 | Identify and apply Robot dynamics problems | 1 | 1,2 |
| CO4 | Interpret motion sequence tasks in robotic control | 1,2 | 1,2 |
| CO5 | Identify optimal time sequence techniques | 1 | 1,2,3 |
| CO6 | Apply different control techniques to problem related to robotic controls. | 1,2 | 1,2 |

**BLOOM’S LEVEL OF THE COURSE OUTCOMES**

| **CO** | **Bloom’s Level** | | | | | |
|---|---|---|---|---|---|---|
| | **Remember (L1)** | **Understand (L2)** | **Apply (L3)** | **Analyze (L4)** | **Evaluate (L5)** | **Create (L6)** |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO1 | | ✓ | | | | |
| CO2 | | | ✓ | | | |
| CO3 | | | ✓ | | | |
| CO4 | | | ✓ | | | |
| CO5 | | | ✓ | | | |
| CO6 | | | ✓ | | | |

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | | | | | | | | | | | 3 | 3 | |
| **CO2** | 2 | | | | | | | | | | | | 2 | 3 | |
| **CO3** | 2 | | | | | | | | | | | | 2 | 3 | |
| **CO4** | 2 | 3 | | | | | | | | | | | 2 | 3 | |
| **CO5** | 2 | | | | | | | | | | | | 2 | 2 | 3 |
| **CO6** | 2 | | | | | | | | | | | | 2 | 3 | |
| **Average** | 2.2 | 3 | | | | | | | | | | | 2.2 | 2.8 | 3 |

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

**COURSE CONTENT**

**THEORY:**

**Unit – 1**

**Review of Robot Kinematics:** Examples of Robotic Systems, Transformations: Joint/Task space, Forward Kinematics, Inverse Kinematics

**Acceleration Kinematics**:Angular Acceleration Vector and Matrix, Rigid Body Acceleration, Acceleration Transformation Matrix, Forward Acceleration Kinematics, Inverse Acceleration Kinematics.

**Unit – 2**

**Motion Dynamics:**Force and Moment, Rigid Body Translational Kinetics, Rigid Body Rotational Kinetics, Mass Moment of Inertia Matrix, Lagrange's Form of Newton 's Equations of Motion, Lagrangian Mechanics

**Robot Dynamics:**Rigid Link Recursive Acceleration, Rigid Link Newton-Euler Dynamics, Recursive Newton-Euler Dynamics, Robot Lagrange Dynamics, Lagrange Equations and Link Transformation Matrices.

**Unit – 3**

**Robot control and Path planning**: Joint cubic path, higher polynomials path,Higher Polynomial Path, Non-Polynomial Path Planning, Manipulator Motion by Joint Path, Cartesian Path, Rotational Path, Manipulator Motion by End-Effector Path. Numerical.

**Time Optimal Control**: Minimum Time and Bang-Bang Control Floating Time Method, Time-Optimal Control for Robots. Numerical.

**Unit – 4**

**Control Techniques:** Open and Closed-Loop Control, Computed Torque Control, Linear Control Technique, Sensing and Control, Numerical.

**TEXT BOOKS:**

1. Reza. N. Jazar "Theory of Applied Robotics: Kinematics, Dynamics and Control" Springer publication, 2007
2. Frank L.Lewis, Darren M.Dawson, Chaouki T.Abdallah "Robot Manipulator Control Theory and Practice" Second edition 2004/ Marcel Dekker Inc..
3. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar "Robot Modeling and Control"First edition/ Marcel Dekker Inc.

**REFERENCE BOOKS:**

1. Hassan K.Khali "Nonlinear Systems"Third Edition/ Prentice Hall (2009).

**JOURNALS/MAGAZINES**

1. https://www.springer.com/journal/40435/

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/112105249
2. https://onlinecourses.nptel.ac.in/noc20_me03/preview

| Course Title | Hybrid Vehicles | | | | Course Type | | Soft Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ESS612 | Credits | 3 | | Class | | VIsemester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW:**

Hybrid-electric vehicles combine the benefits of gasoline engines and electric motors to provide improved fuel economy. The engine provides most of the vehicle's power, and the electric motor provides additional power when needed, such as for accelerating and passing. This allows a smaller, more-efficient engine to be used. The electric power for the motor is generated from regenerative braking and from the gasoline engine, so hybrids don't have to be "plugged in" to an electrical outlet to recharge.

**COURSE OBJECTIVE:**

1. Explain electric, hybrid electric and plug-in hybrid electric vehicle (PHEV), their architecture, technologies, and fundamentals.
2. Explain the design, component sizing of various electric drives suitable for hybrid electric vehicles.
3. Discuss different energy storage technologies used for hybrid electric vehicles and their control and energy balancing techniques.
4. Demonstrate different configurations of electric vehicles and charging techniques.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Explain the basics of electric and hybrid electric vehicles, their architecture, technologies, and fundamentals. | 1,2 | 1,2 |
| CO2 | Analyze the use of different electrical machines in hybrid electric vehicles. | 1,2 | 1,2 |
| CO3 | Interpret the working of different configurations of electric vehicles and its components, hybrid vehicle configurations | 1,2 | 1,2 |
| CO4 | Explain the use of different energy storage systems used for hybrid electric vehicles | 1,2 | 1,2 |
| CO5 | Explain the use of different energy techniques and select appropriate energy balancing technology | 1,2,3 | 1,2 |
| CO6 | Describe the control and configurations of HEV charging stations. | 1,2 | 1,2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

| CO | Bloom's Level | | | | | |
|---|---|---|---|---|---|---|
| | Remember (L1) | Understand (L2) | Apply (L3) | Analyze (L4) | Evaluate (L5) | Create (L6) |
| CO1 | ✓ | ✓ | | | | |
| CO2 | ✓ | ✓ | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO3 | ✓ | ✓ | ✓ | | | |
| CO4 | ✓ | ✓ | | ✓ | | |
| CO5 | ✓ | ✓ | | ✓ | | |
| CO6 | ✓ | ✓ | ✓ | | | |

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | | | | | | | | | | 3 | 3 | |
| CO2 | 3 | 3 | | 1 | | | | | | | | | 3 | 3 | |
| CO3 | 3 | 3 | | | | | | | | | | | 3 | 3 | |
| CO4 | 3 | 3 | | | | | | | | | | | 3 | 3 | |
| CO5 | 3 | 2 | | 1 | | | | | | | | | 3 | 3 | |
| CO6 | 3 | 3 | | | | | | | | | | | 3 | 2 | |
| Average | 3 | 2.6 | 1 | 1 | | | | | | | | | 3 | 3 | |

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

**COURSE CONTENT**

**Unit-1**

**HEV Fundamentals:**Vehicle Basics, Vehicle model, Vehicle Resistance-Rolling Resistance, Aerodynamic Drag, Grading Resistance.

**Hybridization of the Automobile:**Basics of the EV, Basics of the HEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV) and vehicle architectures: Series Hybrid Vehicle, Parallel Hybrid Vehicle, Basics of Fuel Cell Vehicles (FCVs)

**Unit-2**

**Electric Machines and Drives in HEVs:**Fundamental of Drives and Control of EV Using DC motor, Induction Motor, Permanent Magnet Motor, Switched Reluctance Motor, BLDC motor, Design and Sizing of Traction Motors.

**Unit-3**

**Batteries, Ultracapacitor, Fuel Cells, and Controls:**Introduction, Different batteries for EV, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System and Battery Management System.

**Unit-4**

**EV Charging Technologies:**Classification of different charging technology for HEV charging station, introduction to Grid-to-Vehicle, Vehicle to Grid (V2G) or Vehicle to Buildings (V2B) or Vehicle to Home (V2H) operations, bi-directional EV charging systems, energy management strategies used in hybrid and electric vehicle, Wireless power transfer (WPT) technique for EV charging.

**CASE STUDIES**

1. Advances in battery health monitoring and prognostics technologies for electric vehicle (EV) safety and mobility.
2. Energy storage systems for electric vehicle applications: issues and challenges.
3. Design of a hybrid electric vehicle powertrain for optimum performance parameters.
4. A comprehensive review on estimation strategies used in hybrid and battery electric vehicles.
5. Data-driven reinforcement learning–based real-time energy management system for plug-in hybrid electric vehicles.
6. Impacts assessment of plug-in hybrid vehicles on electric utilities and regional Indian power grids.

**TEXT BOOK:**

1. M. Ehsani, Y. Gao and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press London, 3rd Edition, 2019.

2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press , 3rd Edition, 2021.

**REFERENCE BOOKS:**

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley , 2003
2. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons Ltd. , 2011

**JOURNALS/MAGAZINES**

1. https://www.mdpi.com/2032-6653/7/1/59
2. https://www.mdpi.com/2032-6653/5/1/217
3. https://www.mdpi.com/2032-6653/4/3/544

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/108103009

| **Course Title** | **Digital Manufacturing Systems** | | | | **Course Type** | | **Soft Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ESS613** | **Credits** | **3** | | **Class** | | **VIsemester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW:**

This course exhibits the benefits of digitalization in manufacturing. It deals with Digital twins and its applications, online predictive modeling, Manufacturing support Systems, Intelligent Manufacturing Systems.
It also covers IoT and cloud based manufacturing, Global Manufacturing Networks, Digital enterprise technologies.

**COURSE OBJECTIVES:**

1. To impart the fundamentals of digital transformation in manufacturing
2. To introduce the basics of digital manufacturing technologies and its applications in various fields
3. Demonstrate the basics of CAD/CAM concepts
4. Discuss the latest advancements in digital manufacturing perspectives

**COURSE OUTCOMES (COs)**

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

| **CO** | **Course Outcomes** | **POs** | **PSOs** |
|---|---|---|---|
| CO1 | Explain the need for digitalization of manufacturing to achievehigher quality and productivity standards. | 1,2 | 1,2 |
| CO2 | Demonstrate the knowledge on rapid manufacturing applications in tooling, biomedical, architecture, etc | 1,2 | 1,2 |
| CO3 | Explain the digital fabrication and design techniques. | 1,2 | 1,2 |
| CO4 | Explain the monitoring and Intelligent Control of production and Logistics/Supply Chain Processes**.** | 1,2 | 1,2 |
| CO5 | Critique on intelligent manufacturing system and digital enterprises. | 1,2,3 | 1,2 |
| CO6 | Use manufacturing support systems for productivity improvement. | 1,2 | 1,2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

| | **Bloom's Level** |
|---|---|

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | | | | | | | | | | | 3 | 3 | |
| CO2 | 3 | 3 | | 1 | | | | | | | | | 3 | 3 | |
| CO3 | 3 | 3 | | | | | | | | | | | 3 | 3 | |
| CO4 | 3 | 3 | | | | | | | | | | | 3 | 3 | |
| CO5 | 3 | 2 | 1 | | | | | | | | | | 3 | 3 | |
| CO6 | 3 | 3 | | | | | | | | | | | 3 | 2 | |
| Average | 3 | 2.6 | 1 | | | | | | | | | | 3 | 3 | |

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

**COURSE CONTENT**

**Unit-1**

**Introduction:**Overview of digitalization of manufacturing process, Concepts and common tools for digital manufacturing, Digital design and modeling, Common modeling and analysis tools

**Digital design and fabrication:** Digital twins and applications , Digital process twins in manufacturing , Agile (Additive) Manufacturing Systems , Mass Customization , Smart Machine Tools , Robotics and Automation (perception, manipulation, mobility, autonomy) ,Sensor networks and Devices

**Unit-2**

**Digital applications:** Online Predictive Modeling - Monitoring and Intelligent Control of production and Logistics/Supply Chain Processes - Smart Energy Management of manufacturing processes and facilities

**Unit-3**

**Manufacturing support Systems:** Flexible manufacturing, Building blocks of FMS, FMS layout, FMS planning and implementation issues, Just-in-Time manufacturing, lean manufacturing, Cellular manufacturing

**Unit-4**

**Intelligent Manufacturing Systems:** Artificial Intelligence based systems, Knowledge Based Systems, Expert Systems Technology, Agent Based Technology, Virtual Business, IoT and cloud based manufacturing, Global Manufacturing Networks, Digital enterprise technologies.

**TEXT BOOK:**


1. Andrew Kusiak, "Smart Manufacturing", Taylor & Francis, 2018.
2. Mikell P. Grover, "Automation, Production Systems and Computer Integrated Manufacturing",Fourth Edition, Pearson Education, 2016.


**REFERENCE BOOKS:**


1. William MacDougall, "Industrie 4.0: Smart Manufacturing for the Future", Germany Trade & Invest, 2014.

2. E. Turban, L. Volonino, "Information Technology for Management: Transforming Organizations in the Digital Economy", 7th edition, Wiley India Private Limited, 2010.

**JOURNALS/MAGAZINES:**
https://www.journals.elsevier.com/journal-of-manufacturing-processes

**SWAYAM/NPTEL/MOOCs:**
1. https://nptel.ac.in/courses/108103009

| **Course Title** | **Computer Vision** | | | | **Course Type** | | **Soft Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ESS614** | **Credits** | 3 | | **Class** | | **VI Semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | **IA** | **SEE** |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**
Computer Visionexplores the variety of techniques commonly used to analyse and interpret images. It also describes challenging real-world applications where vision is being successfully used, both for specialized applications such as medical imaging, and Robotics, consumer-level tasks such as image editing and stitching, which students can apply to their own personal photos and videos. This course focuses on basic techniques that work under real-world conditions and encourages students to push their creative boundaries. Its design and exposition also make it eminently suitable as a unique reference to the fundamental techniques and current research literature in computer vision.

**COURSE OBJECTIVES:**
The objectives of this course are to:
1. Introduce computer vision and image processing.
2. Give an insight into deep learning and fundamental computer vision tasks.
3. Explain the camera model and geometric calibration.
4. Introduce SfM, SLAM and their application in Autonomous systems.
5. Familiarize depth estimation methods and their application in 3D reconstruction.

**COURSE OUTCOMES (COs)**
Afterthecompletionofthecourse,thestudentwillbeableto:

| **CO** | **Course Outcomes** | **POs** | **PSOs** |
|---|---|---|---|
| CO1 | Understand Image formation process | 1,2 | 1 |
| CO2 | Implement fundamental image processing techniques required for computer vision | 1,2, 5 | 1 |
| CO3 | Implement recognition tasks using deep learning models | 1,2,4,5 | 1,2 |
| CO4 | Extract features from Images and do analysis of Images | 1,2,4,5 | 1,2,3 |
| CO5 | Understand the geometry of a camera system and SLAM process | 1,2,4,5 | 1 |
| CO6 | Understand the concept of depth estimation and generate 3D model from images | 1,2,4,5 | 1 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

| **CO** | **Bloom's Level** |
|---|---|

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | | | | | | | | | | | 2 | | |
| **CO2** | 2 | 1 | | | 2 | | | | | | | | 2 | | |
| **CO3** | 2 | 3 | | 2 | 3 | | | | | | | | 1 | 2 | |
| **CO4** | 2 | 2 | | 2 | 2 | | | | | | | | 1 | 1 | 2 |
| **CO5** | 3 | 3 | | 2 | 2 | | | | | | | | 2 | | |
| **CO6** | 2 | 3 | | 2 | 3 | | | | | | | | 1 | | |
| **Average** | 2.3 | 2.5 | | 2 | 2.4 | | | | | | | | 1.5 | 1.5 | 2 |

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

**COURSE CONTENT**

**THEORY:**

**Unit – 1**

**Basics of Computer Vision, Image Formation and Processing:**What is computer vision?, A brief history. Image formation: Geometric primitives and transformations, Photometric image formation, The digital camera. Image Processing: Point operations, Linear filtering, Fourier transforms

**Unit – 2**

**Deep Learning, Recognition and Feature Extraction:** Supervised learning, Unsupervised learning, Deep neural networks, Convolutional networks, Recognition: Instance Recognition, Image classification, Object detection, Semantic segmentation, Feature detection and matching: Points and patches, Edges and contours, Lines and vanishing points.

**Unit – 3**

**Structure from Motion & SLAM:**Geometric intrinsic calibration, Pose estimation, Two-frame structure from motion, multi-frame structure from motion, Simultaneous localization and mapping (SLAM).

**Unit – 4**

**Depth Estimation and 3D Reconstruction:** Epipolar geometry, Sparse correspondence, Dense correspondence, Local methods, Global optimization, Deep neural networks, Multi-view stereo, Monocular depth estimation, 3D Reconstruction: 3D scanning, Surface representations, Point-based representations, Volumetric representations, Model-based reconstruction, Recovering texture maps and albedos.

**TEXT BOOKS:**

1. Richard Szeliski, "Computer Vision Algorithms and Applications,"Springer publication, 2nd edition, 2022.
2.Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing," Pearson, 4th Edition, 2018.

**REFERENCE BOOKS:**

1. D. Forsyth and J. Ponce, "Computer Vision - A modern approach," Prentice Hall, 2nd Edition, 2012.
2. I. Goodfellow, Y. Bengio and A.Courville "Deep Learning: Algorithms and Applications," MIT Press, 1st

Edition,2016.
3. François Chollet, “Deep Learning with Python”, Manning Publications Co., 2nd Edition, 2021.

**JOURNALS/MAGAZINES**
1. Nature Machine Intelligence, Springer Nature Switzerland AG
2. Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition
3. Proceedings of the IEEE International Conference on Computer Vision
4. IEEE Transactions on Pattern Analysis and Machine Intelligence

**SWAYAM/NPTEL/MOOCs:**
1. NOC:Computer Vision, IIT Kharagpur,Prof. Jayanta Mukhopadhyay, https://nptel.ac.in/courses/106105216
2. NOC:Computer Vision and Image Processing - Fundamentals and Applications, IIT Guwahati, Prof. M. K. Bhuyan, https://nptel.ac.in/courses/108103174
3. Introduction to Computer Vision and Image Processing, Aije Egwaikhide, https://www.coursera.org/learn/introduction-computer-vision-watson-opencv
4. Robotics: Perception, Kostas Daniilidis, https://www.coursera.org/learn/robotics-perception

<table>
<tr><td>Course Title</td><td colspan="3">Autotronics and Vehicle Automation</td><td colspan="3">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B20ESS621</td><td>Credits</td><td colspan="2">3</td><td colspan="3">Class</td><td colspan="2">VI Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSE OVERVIEW**

This course is to introduce the students about the role of electronics in modern vehicles. The course begins with automotive fundamentals and fuel supply systems followed by various automotive sensors like Accelerator-pedal sensor, Steering-angle sensor, Position sensor for transmission control, knock sensor, force and torque sensor etc.,. Digital Engine Management System and Networking are introduced. Smart vehicle automation systems like vehicle security, unmanned ground vehicles and Vision based autonomous road vehicles will be dealt in detail.

**COURSE OBJECTIVE (S)**

The objectives of this course are to:
1. Understand the automotive electronics
2. Introduce the different vehicle systems
3. Study the importance of vehicle intelligence system

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Describe the basics of an automotive vehicle | 1 | 1 |
| CO2 | Demonstrate the fundamental and technical knowledge of sensors and transducers used in auto vehicles and vehicle automation. | 1 | 1 |
| CO3 | Analyze and use various engine management systems and network protocols | 1,2 | 1,2 |
| CO4 | Select automotive sensors and actuators for a specific application | 1,2,3 | 1,2 |
| CO5 | Analyze several intelligent vehicle systems and safety systems | 1,2 | 1,2 |
| CO6 | Explain the adaptive Cruise control system employed in | 1,2,3 | 1 |

| | | | |
|---|---|---|---|
| | Vehicle Motion Controls | | |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | | 3 | | |
| **CO2** | 2 | | | | | | | | | | | | 2 | | |
| **CO3** | 2 | 3 | | | | | | | | | | | 2 | 3 | |
| **CO4** | 2 | 3 | 2 | | | | | | | | | | 2 | 3 | |
| **CO5** | 2 | 3 | | | | | | | | | | | 2 | 2 | |
| **CO6** | 2 | 2 | 2 | | | | | | | | | | 2 | | |
| **Average** | 2.2 | 2.8 | 2 | | | | | | | | | | 2.2 | 3.5 | |

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

**COURSE CONTENT**

**Unit – 1**

**Automotive Fundamentals:**Engine Components – Drive train – suspension system, Steering System.
**Fuel Supply System:**Fuel Injection system – Types, MPFI- CRDI. Fuel Ignition System – Types – Electronic spark timing control.

**Unit – 2**

**Automotive Sensors:**Engine-speed sensors - Wheel-speed sensors, Pressure sensors - Manifold Absolute Pressure (MAP) Sensors, Accelerator-pedal sensor, Steering-angle sensor, knock sensor, force and torque sensor, Rain/light sensor, Lambda oxygen sensors, Mass air flow (MAF) sensor, crash sensor, Coolant/brake fluid level sensors – operation, types, characteristics.
**Digital Engine Management System and Networking :** Digital Engine Control Features, fuel control modes, Idle speed control, EGR Control, Exhaust emission control, Catalytic Converters, New Developments in engine management system, On-board diagnostics, Network communication system – Network topology, CAN ,LIN, MOST, Bluetooth, FlexRay Systems, Ethernet.

**Unit – 3**

**Vehicle Motion Controls:** Adaptive Cruise control system – Cruise control electronics, Electronic Suspension System, Traction control, Electronic stability Program (ESP), ABS, EBS, Sensotronics brake control.

**Automotive Safety Sensor Systems :**Airbag Safety device, Blind spot detection, Automatic collision avoidance system, Tire pressure monitoring systems, Enhanced Vehicle stability, drowsy-driver sensing system, Active and passive Safety Sensor systems - Side Impact Sensing, front impact sensing System.

**Unit – 4**

**Smart Vehicle Automation:**Vehicle security systems, Acoustic signaling devices, Central locking system - Locking systems - Biometric systems Intelligent Vehicle Systems.
**Vision based autonomous road vehicles** - Driverless Car Technology-Different Levels of Automation -Localization - Path Planning -Controllers to Actuate a Vehicle - PID Controllers -Model Predictive Controllers - ROS Framework, LIDARS and DAS.

## Text Books:

1. William B.Ribben, "Understanding Automotive Electronic: An Engineering Perspective", Elsevier Science, 2017.

## References Books:

1. Konrad Reif, "Automotive Mechatronics", Springer Vieweg, 2015
2. Tom Denton, "Automobile Electrical and Electronic systems", Rouletedge, Taylor & Francis Group, 2013.
3. Najamuz Zaman, "Automotive Electronics Design Fundamentals'', Springer Cham Heidelberg, 2015

**SWAYAM/NPTEL/MOOCs:**
1. https://onlinecourses.nptel.ac.in/noc22_ae01/preview
2. https://onlinecourses.nptel.ac.in/noc22_ae02/preview

| Course Title | Aircraft Flight and Control System | | | | Course Type | | Soft Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ESS622 | Credits | 3 | | Class | | VI Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**
This course is to introduce the students the essential knowledge and skills they need to be able to do conceptual and preliminary design of various aircraft flight and control systems. The course begins with aircraft hydraulic and pneumatic system followed by some introductory definitions and classifications of flight control systems and aerodynamic considerations in control system design. Then the performance of different control methods is compared. Flight actuators and sensors are introduced including their mathematical modelling. Then, we focus on the aerodynamic control system design process of different missiles and aircrafts in some detail.

**COURSE OBJECTIVE (S)**
The objectives of this course are to:
1. To impart knowledge on importance and operating principles of aircraft systems.
2. To acquaint students with design, build, test, operate and disposal phases of aircraft systems and aircraft operating environment system.
3. To Comparison of various flight control systems.
4. To Design of Aircraft control system.

**COURSE OUTCOMES (COs)**
Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Understand the principles of Aircraft Hydraulic and Pneumatic systems. | 1 | 1,2 |
| CO2 | Understand the environment control systems. | 1,2,6 | 1,2 |
| CO3 | Compare the features of various flight control systems. | 1,2 | 1,2 |
| CO4 | Analyze different control system performance. | 1,2 | 1,2 |
| CO5 | Acquire knowledge of Flight control actuators and sensors. | 1,2 | 1,2,3 |
| CO6 | Design of Aircraft control system. | 1,2,3 | 1,2,3 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | | | | | | | | | | | 3 | 3 | |
| **CO2** | 2 | 3 | | | | 2 | | | | | | | 2 | 3 | |
| **CO3** | 2 | 3 | | | | | | | | | | | 2 | 3 | |
| **CO4** | 2 | 3 | | | | | | | | | | | 2 | 3 | |
| **CO5** | 2 | 3 | | | | | | | | | | | 2 | 2 | 3 |
| **CO6** | 2 | 3 | 2 | | | | | | | | | | 2 | 3 | 3 |
| **Average** | 2.8 | 3 | 2 | | | 2 | | | | | | | 2.8 | 2.8 | 3 |

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

**COURSE CONTENT**

**Unit – 1**

**Aircraft Hydraulic and Pneumatic Systems:** Hydraulic systems – Study of typical systems – components – Hydraulic systems controllers – Modes of operation – Pneumatic systems – Working principles – Typical Pneumatic Power system – Brake system – Components, Landing Gear Systems – Classification – Shock absorbers – Retractive mechanism.

**Unit – 2**

**Environment Control Systems:** Need for controlled environment, heat sources, ram air cooling, fuel cooling, engine bleed, bleed flow and temperature control, air cycle refrigeration, humidity control, hypoxia, tolerance.
Introduction to Flight Control Systems
History, Guidance, Navigation and Control, Flight Control Channels, Flight Control Methods, SAS vs. Autopilot.

**Unit – 3**

**Aerodynamic Considerations of Flight Control Systems:** Static and Dynamic Stability, Stability and Maneuverability Static Margin, Variations of the Center of Pressure.
**Control System Performance:** Canard Control, Wing Control, Tail Control, Fin Configuration Effects, Side Jet Control, Thrust Vector Control, Variation of Mass and CG.

**Unit – 4**

**Flight Control Actuators and Sensors:** Servomechanism, Reversible vs. Irreversible mechanisms, Hydraulic Actuators, Pneumatic Actuators, Electric Actuators, Accelerometers, Gyroscopes, Angle of attack vane, other sensors, Sensor Selection

**Aircraft Control System Design:** Longitudinal Control, Lateral Control, Attitude Control Systems, Flight Path Control Systems, Active Control Systems.

**Case Study:**

1. Study and analyze the different parts of shock absorber used in Aircraft.
2. Modeling, Simulation, and Flight Control Design of an Aircraft with Simulink.
3. Stability analysis by constructing Bode plot using LabVIEW.
4. Design of an Automatic Flight Control System using LabVIEW.

## Text Books:


1. Anderson, J.D., "Introduction to Flight", McGraw-Hill ,8th edition, 2015.
2. Roy Langton, Chuck Clark, Martin Hewitt and Lonnie Richards, "Aircraft Fuel Systems", Wiley & Sons Ltd, England, 2009.
3. Ion Moir and Allan Seabridge, "Aircraft Systems", John Wiley & Sons Ltd, England, Third edition, 2008.
4. Ian Moir and Allan Seabridge, "Aircraft Systems – Mechanical, electrical and avionics subsystems integration", Second Edition, Professional Engineering Publishing Limited, 2001.
5. McLean, D., "Automatic Flight Control Systems", Prentice Hall International (UK) Ltd, 1990.


## References Books:


1. Blakelock, J. H.,"Automatic Control of Aircraft and Missiles", 2nd Edition, John Wiley & Sons, 1990.
2. General Hand Books of Airframe and Power plant Mechanics", U.S. Dept. of Transportation, Federal Aviation Administration, The English Book Store, New Delhi,1995.
3. Pallet, E.H.J. "Aircraft Instruments & Principles", Pitman & Co, 1993.
4. Garnell, P, "Guided Weapon Control Systems", 2nd Edition, Pergamon Press, 1980.


**SWAYAM/NPTEL/MOOCs:**

1. https://onlinecourses.nptel.ac.in/noc22_ae01/preview
2. https://onlinecourses.nptel.ac.in/noc22_ae02/preview

<table>
<tr><td>Course Title</td><td colspan="4">Operations Management</td><td colspan="2">Course Type</td><td colspan="2">Soft core</td></tr>
<tr><td>Course Code</td><td>B20ESS623</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">VIsemester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSE OVERVIEW**

This course provides insight in to various fundamental aspects of production planning and forecasting techniques. It also presents various decision making techniques, aggregating and master production scheduling methods, various inventory monitoring and controlling methods are discussed. Handling dependent demand items and techniques for MRP and continuous improvement methods are included. The course contains routing methods and supply chain managements. Quantitative techniques are heavily used in analyzing operations and improving their efficiency and effectiveness. Overall objective of this course is to manage production systems in a better way

**COURSE OBJECTIVES**

1. To acquire the knowledge of production planning process and its functions
2. To study the fundamentals of Inventory management
3. To provide knowledge about MRP and ERP systems
4. To introduce the concepts of purchasing and supply chain management

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Describe the concept of operations management and apply the decision models to solve real time problems. | 1,2,3 | 1,2,3 |
| CO2 | Recognize the role of operations management in business functions and organizations strategic planning. | 1 | 1,2,3 |
| CO3 | Formulate and analyze aggregate planning and master production schedule concepts. | 1,2 | 1,2,3 |
| CO4 | Analyze inventory modelsfor a range of operations. | 1,2 | 1,2,3 |
| CO5 | Evaluate a selection of frameworks used in the design and delivery of operations using MRP and ERP | 1,2,3 | 1,2,3 |
| CO6 | Summarize the concepts of routing, purchasing and SCM. | 1,2,3 | 1,2,3 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | | | | | | | | | | 3 | 1 | 1 |
| CO2 | 3 | | | | | | | | | | | | 3 | 1 | 1 |
| CO3 | 3 | 2 | | | | | | | | | | | 3 | 1 | 1 |
| CO4 | 3 | 3 | | | | | | | | | | | 3 | 1 | 1 |
| CO5 | 3 | 2 | 1 | | | | | | | | | | 3 | 1 | 1 |
| CO6 | 3 | 2 | 1 | | | | | | | | | | 3 | 1 | 1 |
| Average | 3 | 2.2 | 1 | | | | | | | | | | 3 | 1 | 1 |

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

**COURSE CONTENT**

**Unit-1**

**Introduction to Process Planning, Control and Forecasting**: Definitions, Objectives of production Planning and Control, Functions of production planning and control, Types of production, Organization of production planning and control.

**Forecasting**: Importance of forecasting, Types, principles, qualitative and quantitative methods, time series methods, Exponential smoothing, Regression methods, numerical.

**Unit-2**

**Operations Decision:** Introduction, Characteristics of decisions, framework for Decision Making, Decision methodology, Decision supports systems, Economic models-Break-even analysis in operations, numerical.

**Aggregate Planning and Master Scheduling**:Planning and Scheduling, Objectives of Aggregate Planning, Aggregate Planning Methods, Master Scheduling Objectives, Master Scheduling Methods, numerical.

**Unit-3**

**Inventory Management:** Definition and need, components of Inventory, inventory control. Functions of inventories, inventory costs, EOQ model, Inventory control systems, P–Systems and Q-Systems, ABC analysis, VED analysis, numerical.

**MRP & ERP:**Introduction to MRP & ERP, JIT inventory, MRP Logic, Capacity Management, CRP activities. Concept of continuous improvement of process, numerical.

**Unit-4**

**Routing – Dispatching**: Definition, Routing & Dispatching procedure, Route sheets, Bill of material, Factors affecting routing procedure.

**Supply Chain Management:** Introduction to supply chain management- Approaches to purchase and supply chain management, Bull whip effect, make or buy decision, e-Procurement, Vender development, vendor rating methods, simple numerical.

**CASE STUDIES**

1. Forecasting of CSP (Critical Spare Parts) for an Indian Automobile Industry
2. SAP Successful story of developing ERP software in Manufacturing Industry.
3. Inventory Management - "A case study at Various Manufacturing Sectors".
4. Implementation of supply chain management at various global enterprise - Honda / TVS / Motorola /Amazon / Flipkart.

**TEXT BOOKS**

1. Samuel Eilon, “Elements of Production Planning and Control”, 1st Edition, Universal Publishing Corp., 1999.
2. Joseph Monks, “Operations Management Theory and Problems”, 3rd Edition, McGraw-Hill’s, 1987.

**REFERENCE BOOKS**

1. P Rama Murthy, “Production and Operations Management”, 1st Edition, New Age, 2002
2. Baffa & Rakesh Sarin, “Modern Production / Operations Management”, 8th Edition, John Wiley & Sons, 2002.
3. S.N. Chary, “Operations Management”, 1st Edition, TMH, 1996
4. Pannerselvam R, “Production and Operation Management”, PHI publications, 2nd Edition
5. Everett E. Adams, Ronald J. Ebert“Production and Operations Management”, Prentice Hall of India Publications, Fourth Edition

**JOURNALS/MAGAZINES**

1. https://www.tandfonline.com/toc/tprs20/current- International journal of Production research
2. https://www.emerald.com/insight/publication/issn/0144-3577-- International journal of operation and

production management

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/110107141
2. https://nptel.ac.in/courses/112107238

| Course Title | Machine Learning with Python | | | | Course Type | | Integrated Soft Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ESS624 | Credits | 3 | | Class | | VI Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 2 | 2 | 2 | | | | |
| | Practice | 1 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **4** | **4** | **26** | **26** | **50 %** | **50 %** |

**COURSE OVERVIEW:**

The Course introduces the various machine learning techniques and algorithms needed for software development (for automation). The course also explores various packages of python used for implementing machine learning algorithms and also develops programming and analytical skills in students.The course is conceptual.

**COURSE OBJECTIVES:**

The objectives of this course are to:

1. Explainthe theory underlying machine learning.
2. Develop an insight into concept learning.
3. Applypython programming for solving real world problems using machine learning.
4. Analyse thedifferent machine learning techniques.

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Explain Machine learning | 1 | 1 |
| CO2 | Apply concept learning to arrive at hypothesis for a real world problem | 1,2,3 | 1,3 |
| CO3 | Utilize various python packages like numpy, pandas and scikit learn | 1,2,3 | 1,2 |
| CO4 | Solve problems related to Supervised learning techniques | 1,2,3 | 1,2,3 |
| CO5 | Analyse unsupervised learning techniques | 1,2,3,4 | 1,3 |
| CO6 | Developpython programs that will use machine learning algorithms to provide solutions to real-world problems. | 1,2,4,5 | 1,2,3 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | | | | | | | | | | | | 2 | | 2 |
| **CO2** | 2 | 2 | 2 | | | | | | | | | | 2 | | 2 |
| **CO3** | 2 | 2 | 2 | | | | | | | | | | 2 | 2 | |
| **CO4** | 2 | 2 | 2 | | | | | | | | | | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | | | | | | | | | 2 | | 2 |
| **CO6** | 3 | 3 | | 2 | 2 | | | | | | | | 2 | 2 | 2 |
| **Average** | 2.2 | 2.2 | 2 | 2 | 2 | | | | | | | | 2 | 2 | 2 |

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

**COURSE CONTENT**

**THEORY:**

**Unit – 1**

**Python:** Introduction to python and its data structures, NumPy Basics: Arrays and Vectorized Computation: The NumPy ndarray: A Multidimensional Array Object, Universal Functions: Fast Element-wise Array Functions, Array oriented Programming with Arrays, File Input and Output with Arrays,

**Getting Started with pandas :** Introduction to pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics, Correlation and Covariance, Unique Values, Value Counts, and Membership

**Unit – 2**

**Machine Learning:** Introduction, Well-Posed Learning Problems, Designing a Learning System, Perspectives and Issues in Machine Learning Examples of Machine Learning Applications, Classification, Regression, Unsupervised Learning, and Reinforcement Learning. Supervised Learning.

**Unit – 3**

**Concept Learning**: Concept Learning and the General-to-Specific Ordering: A Concept Learning Task, Concept Learning as Search, FIND-S, version spaces.

**Supervised Learning**: Decision trees, K-nearest neighbors,

**Artificial Neural Networks :** Perceptron, linear functions, basic gates using perceptron's, multi layer neural network, feed forward networks, back propagation.

**Unit – 4**

**Unsupervised Learning:** Clustering, Introduction, kmeans clustering, hierarchical clustering, choosing the number of clusters

**PRACTICE:**

| Sl. No. | Name of the Practice Session | Tools and Techniques | Expected Skill /Ability |
|---|---|---|---|
| 1 | Data reading, writing and pre-processing | Python, numpy, pandas, scikit learn | Writing programs for a given task |
| 2 | Data wrangling using Numpy and Pandas | Python, numpy, pandas, scikit learn | Writing programs for a given task |
| 3 | Concept learning: to arrive at a hypothesis using find-s algorithm for a given dataset | Python, numpy, pandas, scikit learn | Writing programs for a given task |
| 4 | Binary classification using K-nearest neighbours | Python, numpy, pandas, scikit learn | Writing programs for a given task |
| 5 | Multiclass classification: using Decision trees | Python, numpy, pandas, scikit learn | Writing programs for a given task |
| 6 | Artificial neural networks: | Python, numpy, pandas, scikit learn | Writing programs for a |

| | | | |
|---|---|---|---|
| | implementation | | given task |
| 7 | Clustering: To implement clustering using K-means algorithm | Python, numpy, pandas, scikit learn | Writing programs for a given task |
| 8 | Clustering: To implement clustering using hierarchical clustering | Python, numpy, pandas, scikit learn | Writing programs for a given task |
| 9 | Clustering: To implement clustering using DBSCAN | Python, numpy, pandas, scikit learn | Writing programs for a given task |

**Case Study:**

1. Predicting Mechanical Failure by continuously monitoring data (power plant, manufacturing unit operations) and providing them smart decision support systems using machine learning algorithms.
2. Predicting the occurrence of a fire in any industrial plant by monitoring the sensors data using machine learning algorithms.
3. Prediction of estimation of fuel needed/ distance that can be travelled for automobiles and sending messages accordingly using machine learning algorithms.

**TEXT BOOKS:**

1. Tom Mitchell,"Machine Learning", Second edition, McGraw-Hill, 2017.
2. Ethem Alpaydin,"Introduction to Machine Learning", Second edition MIT press, 2010.
3.Wes McKinny, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", Second edition, O'Reilly Media, 2012.

**REFERENCE BOOKS:**

1. Yoshua Bengio and Aaron Courville,Ian Good fellow, "Deep Learning ", MIT Press book,2016
2. Richard o. Duda, Peter E. Hart and David G. Stork, "Pattern Classification", John Wiley & Sons Inc., 2001
3. Chris Bishop, "Neural Networks for Pattern Recognition", Oxford University Press, 1995

**JOURNALS/MAGAZINES**

1. https://e2echina.ti.com/group/c8df485b47/m/msp430/11060/download

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/106106198 Machine Learning for Engineering and Science Applications
2.https://nptel.ac.in/courses/106106139Introduction to Machine Learning

| **Course Title** | **Energy Technology** | | | | **Course Type** | | **Open Elective** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20MEO601** | **Credits** | **3** | | **Class** | | **VI Semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

This course explores the concept of thermal energy conversion, also introduces the, different types of fuels used for steam generation and equipment for burning coal in lump form. This course introduces to bio mass energy and its characteristics. It also emphasizes on conversion of various biomass energy into solid, liquid and gaseous forms. Further the course deals with conversion of biomass into methanol, ethanol, biogas, bio diesel etc.

**COURSE OBJECTIVES**

1. To understand energy scenario, energy sources and their utilization
2. To gain the knowledge about diesel engine power plant.

3. To enhance the knowledge about renewable energy sources.

4. To enable the students to gain the knowledge on hydrogen energy generation.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Summarize the basic concepts of thermal energy systems and identify coal and ash handling systems used in steam power plants. | 1 | 1 |
| CO2 | Identify renewable energy resources and their utilization. | 1,6,7 | 1 |
| CO3 | Discuss the principles of energy conversion of wind, geothermal, ocean, biomass, and biogas energy systems. | 1,6,7 | 1,2 |
| CO4 | Describe the methods used to generate Hydrogen energy. | 1, 7 | 1 |
| CO5 | Describe the main characteristics of renewable energy sources and their comparison with fossil fuels. | 1,6,7 | 1 |
| CO6 | Investigate the design parameters of biogas digesters. | 1,2,3,7 | 1,2,3 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | | 3 | | |
| CO2 | 3 | | | | | 2 | 2 | | | | | | 3 | | |
| CO3 | 3 | 2 | | | | 2 | 2 | | | | | | 3 | 2 | |
| CO4 | 3 | | | | | | 1 | | | | | | 3 | | |
| CO5 | 3 | | | | | 2 | 1 | | | | | | 3 | | |
| CO6 | 3 | 2 | 1 | | | | | | | | | | 3 | 1 | 1 |
| Average | **3** | **2** | **1** | | | **2** | **1.5** | | | | | | **3** | **1.5** | **1** |

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

**COURSE CONTENT**

**Unit-1**

**Thermal Energy Conversion System:**Review of energy scenario in India, General Philosophy and need of Energy, Different Types of Fuels used for steam generation, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace,

**Coal and Ash Handling:** Chimneys: Natural, forced, induced and balanced draft, Cooling towers and Ponds

**Unit-2**

**Diesel Engine Power System:** Applications of Diesel Engines in Power field. Method of starting Diesel engines. Auxiliaries like cooling and lubrication system, filters, centrifuges, Oil heaters, intake and exhaust system, Layout of diesel power plant.

**Solar Energy and Applications:** Solar radiation - Availability- Measurement and estimation- Solar radiation geometry

**Hydrogen Energy:** Introduction to hydrogen energy, methods of hydrogen production (electrolytic and thermo chemical method).

**Unit-3**

**Wind Energy:**Wind energy - General considerations - Wind Power plant design – Horizontal axis wind turbine

**Tidal Power:** Power generation using OTEC - Wave and Tidal energy - Scope and economics - Limitations**.**

**Hydro-Electric Energy:**General layout of hydel power plants, Hydrographs, flow duration and mass curves and numerical. Storage and pondage, pumped storage plants, low, medium and high head plants, Penstock, water hammer, surge tanks, gates and valves.

**Unit-4**

**Biomass Energy Sources:**Biomass production for energy farming, origin of Biomass-Photosynthesis process, Energy through fermentation -Ethanol Production from sugarcane and starch, Biomass characteristics.

**Bio-Methanization:**Anaerobic digestion, Basic principles, factors affecting biogas yield, biogas digester (floating gas holder and fixed dome type with working principle and diagram).

**Geothermal Energy Conversion:** Availability - Geographical distribution.

**TEXT BOOKS**

1. P.K Nag, “Power Plant Engineering”, 3rd Ed. Tata McGraw Hill, 2nd edition 2001.
2. Morse F.T, Van Nstrand, “Power Plant Engineering”, 1998.
3. B H Khan, “Non-conventional energy resources”, McGraw Hill Education, 3rd Edition, 2017.
4. A. W. Culp Jr, “Principles of Energy conversion”, McGraw Hill. 1996

**REFERENCE BOOKS**

1. Stanier, “Plant Engg. Hand Book, McGraw Hill, 1998.
2.Domakundawar, “Power Plant Engineering”, Dhanpath Raisons, 2003
3. S.P. Sukhatme, “Solar Energy: principles of Thermal Collection and Storage”, Tata McGraw-Hill, 1984.
4. L.L. Freris, “Wind Energy Conversion Systems”, Prentice Hall, 1990.

**JOURNALS/MAGAZINES**

1.https://www.sciencedirect.com/topics/engineering/ash-handling-plant
2.https://www.researchgate.net/publication/267838546_Survey_of_modern_power_plants_driven_by_diesel_and_gas_engines.
3.https://www.journals.elsevier.com/international-journal-of-hydrogen-energy
4.https://www.sciencedirect.com/science/article/pii/S2211467X19300379

**SWAYAM/NPTEL/MOOCs:**

1.https://onlinecourses.nptel.ac.in/noc21_me86/preview
2.https://nptel.ac.in/courses/103107157
3.https://onlinecourses.nptel.ac.in/noc21_ch11/preview
4.https://onlinecourses.nptel.ac.in/noc22_ch27/preview

| **CourseTitle** | **Research Based Mini Project** | | | | **CourseType** | **Hard Core** |
|---|---|---|---|---|---|---|
| **CourseCode** | **B20ES0604** | **Credits** | **1** | | **Class** | **VI Semester** |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes | Assessment in Weightage |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Theory | 0 | 0 | 0 | Per Semester | | | |
| Practice | 1 | 2 | 2 | Theory | Practical | IA | SEE |
| Tutorial | 0 | 0 | 0 | | | | |
| **Total** | **1** | **2** | 2 | **0** | **26** | **50 %** | **50 %** |

**COURSE OVERVIEW**

Mini project is one of the integral parts of mechatronics engineering curriculum where the students can learn and equip new skill sets by building projects practically. By doing mini projects, students can develop more skills in addition to the technical skills like critical thinking, problem solving ability, collaborating with team members, solving problems hands-on etc. This will also help them to showcase their practical skills to the recruiters and impress them.

**COURSEOBJECTIVES**

1. To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
2. To inculcate the process of self-learning and research.

**COURSEOUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Identify problems based on societal /research needs. | 1,6 | 1 |
| CO2 | Apply Knowledge and skill to solve societal problems in a group. | 1,2,3,6 | 1,2 |
| CO3 | Develop interpersonal skills to work as member of a group or leader. | 1,9,10 | 1,2 |
| CO4 | Draw the proper inferences from available results through theoretical / experimental/simulations. | 1,2,5 | 1,2 |
| CO5 | Demonstrate project management principles during project work. | 9.10,11 | 1,2 |
| CO6 | Communicate effectively the procedure to solve engineering problems with the engineering community and with society at large through effective reports and design documentation. | 1,9,10,11,12 | 1,2 |

**BLOOM'SLEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

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

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Average** | **1.8** | **3** | **2** | | **3** | **2** | | | **3** | **2.6** | **2.5** | **2** | **3** | **2** | |

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

**COURSECONTENT**

Research based project is aim to identify the research gap though extensive literature survey on a recent trends in mechatronics engineering and allied areas. The research focus may be on modelling, simulation, experimental & analysis, model/prototype design, fabrication of new equipment, analysis of data, software development, etc. or a combination of these. Through this the team should publish a review research paper in the selected field of study.

The students have to make a project team consisting of two, three or four members. Every student in a group shall take up a project in the beginning of sixth semester in consultation with the guide and the project must be completed before the end of semester. The project team has to work to identify the research gap though extensive literature survey on a recent trends in mechanical engineering and allied areasand formulate the problem statement. The team submit a report prepared as per the guidelines/format of the university (one report per group).

**TEXTBOOKS**

1. Biswajit Mallick, "Innovative Engineering Projects", Entertinement Science and Technology Publication,Bhubaneswar, India, 1st Edition 2015.
2. C R Kothari, "Research Methodology- Methods and Techniques", New Age International, 2nd Edition, 2015.
3. A.K. Chitale, R.C. Gupta, "Product Design and Manufacturing", Prentice –Hall of India,Sixth Edition, 2013.

**REFERENCE BOOKS**

1. O. Molloy, S. Tilley and E. A. Warman, "Design for Manufacturing and Assembly: Concepts, Architectures and Implementation", Springer. USA, 2012.
2. Boothroyd, G.Peter Dewhurst and Winston A, "Knight, Product Design for Manufacture and Assembly", CRC Press, Taylor & Francis,Third Edition, 2010.
4. Navi Radjou, Jaideep Prabhu and Simone Ahuja, "JUGAAD Innovation: A Frugal and Flexible Approach to Innovation for the 21st Century", Random house India, Noida, 2012.
5. Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development", McGraw-Hill,Sixth Edition, 2015.

**JOURNALS/MAGAZINES**

1. Global Innovative research Journal: https://freeprojectsforall.com/journal-publication/
2. International Journal of Project Management: https://www.journals.elsevier.com/international-journal-of-project-management

**SWAYAM/NPTEL/MOOCs:**

1. Project Management: https://nptel.ac.in/courses/110104073

| **CourseTitle** | **Technical Documentation** | | | | **CourseType** | | **FC** | |
|---|---|---|---|---|---|---|---|---|
| **CourseCode** | **B20ER0605** | **Credits** | **1** | | **Class** | | **VI semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 1 | 1 | 1 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **1** | **1** | **1** | **13** | **0** | **50%** | **50%** |

**COURSE OVERVIEW**

This course describes the method used to document the procedures and tools used in testing or research and aims to describe the primary purpose of preparing an Engineering technical report. Also helps in preparing report that describes the progress, process, or results of scientific or technological research. It also covers how to prepare and include some recommendations and conclusions in report.

**COURSEOBJECTIVES**

1. To understand the purpose of technical documents/specifications.
2. To create effective technical documents.

**COURSEOUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Create effective written documents after an audience analysis. | 1,5,9,10,12 | |
| CO2 | Recognize various forms of technical communication and Select the most appropriate format to convey the technical information. | 1,5,9,10,12 | |
| CO3 | Discuss the complex technical concepts lucidly for the common man to understand easily. | 1,5,9,10,12 | |
| CO4 | Adhere to formatting, best practices and avoid pitfalls. | 1,5,9,10,12 | |
| CO5 | Write formal reports detailing the process, result or progress of a project. | 1,5,9,10,12 | |
| CO6 | Create visually appealing documents with the incorporation of design elements, enhancing the reading experience as well. | 1,5,9,10,12 | |

**BLOOM'SLEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | | | | 1 | | | | 1 | 3 | | 1 | | | |
| CO2 | 1 | | | | 1 | | | | 2 | 3 | | 1 | | | |
| CO3 | 1 | | | | 1 | | | | 3 | 3 | | 1 | | | |
| CO4 | 1 | | | | 1 | | | | 2 | 2 | | 1 | | | |
| CO5 | 2 | | | | 1 | | | | 2 | 2 | | 1 | | | |
| CO6 | 1 | | | | 1 | | | | 2 | 3 | | 1 | | | |
| **Average** | **1.2** | | | | **1** | | | | **2** | **2.6** | | **1** | | | |

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

**COURSECONTENT**

**Unit-1**

**Introduction:** A basic understanding of the role of a technical writer in an organization, Audience Analysis, Topic Research, Writing the document, competitor analysis and writing own document.

**Creating the Content and Technical Report:**Developing Flowcharts, Block diagrams/schematics, Infographics, using MS application or other open-source tools. Creating a technical report using different styling techniques.

**Unit-2**

**Interpretation and Report Writing:** Meaning of Interpretation, need of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report , Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions

**TEXTBOOK**

1. C R Kothari, "Research Methodology- Methods and Techniques", New Age International, 2nd Edition, 2015.

**SWAYAM/NPTEL/MOOCs:**

1.Technical Writing Master Course: https://iimskills.com/technical-writing-course/

2. Technical Report Writing for Engineers The University of Sheffield: https://www.futurelearn.com/courses/technical-report-writing-for-engineers.

| **Course Title** | **Automation Lab** | | | | **Course Type** | | **Hard Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ES0606** | **Credits** | **1** | | **Class** | | **VI semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 0 | 0 | 0 | | | | |
| | Practice | 2 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **1** | **2** | **2** | **00** | **26** | **50 %** | **50 %** |

**COURSE OVERVIEW:**

This laboratory course deal with conducting experiments related to response automation and PLC. The training systems in this laboratory provide undergraduate and graduate students with practice-oriented knowledge in the areas PLC interpret and control the automated process. By means of the training systems, students work out practical exercises and gain technical specialized knowledge plc role in automated modern industry.

**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
4. To analyse and simulate the PLC ladder diagram by using ISP software.

**COURSE OUTCOMES (COs)**

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

| **CO** | **Course Outcomes** | **POs** | **PSOs** |
|---|---|---|---|
| CO1 | Understand the concept of logic gates | 1 | 1 |
| CO2 | Design the concepts of building a ladder diagram for different virtual models | 1,2,3 | 1,2 |
| CO3 | Analyses the construction of ladder diagram for control devices with respect time. | 1,2 | 1,2 |
| CO4 | Understand the application of PLC circuit for conveyer feed movement with emitter | 1 | 1,2 |

| | | | |
|---|---|---|---|
| | & receiver | | |
| CO5 | Design the concept PLC program in real time applications. | 1,2,3 | 1,2 |
| CO6 | Demonstration and analysis the pneumatic circuits for different applications and record the results in the form of technical report. | 1,2,10 | 1,2 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

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

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

**COURSE CONTENT**

**Part-A**

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

**Part-B**

1. Lift control system using programmable logic controller
2. Star delta starter using programmable logic controller
3. Build a pneumatic circuit for Stamping operation by using single acting cylinder being controlled by 3way 2 position directional control valves
4. Traffic control system using programmable logic controller

**TEXT BOOK:**

1. M. P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson education. Third Edition, 2008.
2. Vajpayee, "Principles of computer-integrated manufacturing", Prentice Hall India Learning Private Limited, 1995.
3.John R. Hackworth & Frederick D. Hackworth Jr, "Programmable Logic Controllers – Programming Methods and Applications", Pearson, 2011.

**REFERENCE BOOKS:**


1. Amber G.H & P. S. Amber, "Anatomy of Automation", Prentice Hall, 1962.
2. Viswanandham, "Performance Modeling of Automated Manufacturing Systems", Prentice Hall India Learning Private Limited, 1994.
3. Krishna Kant, "Computer Based Industrial Control", Revised 2nd Edition, Prentice Hall India Learning Private Limited, 2011.
4. Nakra, B. C., "Theory and Applications of Automatic Controls", Revised 2nd Edition, New Age International Publishers, 2014.
5. Morriss, S. B., "Automated Manufacturing Systems", McGraw Hill ,2006.
6. John W. Webb & Ronald A. Reis, "Programmable Logic Controllers – Principles and Applications", Fifth Edition, Pearson Education, 2008.


**JOURNALS/MAGAZINES**

1. https://www.sciencedirect.com/search?qs=automation
2. https://asmedigitalcollection.asme.org/manufacturingscience
3. https://www.industrialautomationindia.in/

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/112103293
2. https://www.digimat.in/nptel/courses/video/112104288/L01.html

<table>
<tr><td>Course Title</td><td colspan="4">Computer Aided Engineering Lab</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B20ES0607</td><td>Credits</td><td colspan="2">1</td><td colspan="2">Class</td><td colspan="2">VI semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Practice</td><td>2</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>2</td><td>2</td><td>2</td><td>--</td><td>26</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSE OVERVIEW:**

This laboratory course deal with solving boundary value problems using finite element analysis. Stress analysis of bars, beams and trusses subjected to different loading and boundary conditions are considered. Also, stress analysis of rectangular plate with holes and 1D heat transfer problems are studied.

**COURSE OBJECTIVES:**

1. To describe the working methodology of finite element modeling and analysis software (Ansys Workbench)
2. To apply the basic principles of Mechanics to find out the deformation and stresses in bars and trusses subjected to different loading conditions.
3. To demonstrate the SFD and BFD for statically determinate beams with various loading and boundary conditions
4. To apply the basic heat transfer principles to solve heat transfer in pin fins and composite walls using 1D elements.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Demonstrate the analysis software to create geometry, discretize, apply boundary condition to solve various boundary value problems. | 1,5 | 1 |
| CO2 | Compare the shear force and bending moment diagrams for beams by FEM and SOM approaches | 1,2,5 | 1,2 |

| | | | |
|---|---|---|---|
| CO3 | Interpret the stress distribution in plates with circular holes | 1,2,5 | 1,2 |
| CO4 | Examine the deformation and stresses in 2D trusses | 1,2,5 | 1,2 |
| CO5 | Test the bars of constant and varying cross-sections when subjected to various loading and boundary conditions. | 1,2,5 | 1,2 |
| CO6 | Analyze given semiconductor and PCBs to find out thermal expansion and thermal stress distribution and record the results in the form of technical report. | 1,2,5,10 | 1,2 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | 3 | | | | | | | | 3 | 1 | 2 |
| CO2 | 3 | 3 | | | 3 | | | | | | | | 3 | 3 | 2 |
| CO3 | 3 | 2 | | | 3 | | | | | | | | 3 | 3 | 2 |
| CO4 | 3 | 3 | | | 3 | | | | | | | | 3 | 3 | 2 |
| CO5 | 3 | 3 | | | 3 | | | | | | | | 3 | 3 | 2 |
| CO6 | 3 | 3 | | | 3 | | | | | 3 | | | 3 | 3 | 2 |
| Average | 3 | 2.8 | | | 3 | | | | | 3 | | | 3 | 2.1 | 2 |

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

**COURSE CONTENT**

**Part-A**

1. Introduction to ANSYS Workbench: pre-processor, solver, post-processor, element library.
2. Analysis of Bars of uniform cross-section area, tapered cross-section area, and stepped bars.
3. Analysis of Trusses.
4. Analysis of Beams – Simply supported, cantilever, beams with UDL, beams with varying load, etc

**Part-B**

1. Stress analysis of a rectangular plate with stress concentration features.
2. Thermal Analysis – 1D & 2D problem with conduction and convection boundary Conditions.
3. Thermal Analysis in a semiconductor, PCBs. , battery pack
4. Importing any CAD model and carrying out required analysis based on given application – Challenging Experiment.

**TextBooks:**

1. R. D. Cook, D. S Malkus, Michael. E. Plesha, Robert. J. Witt, "Concepts and applications of Finite Element Analysis", Wiley 4th Edition, 2009.
2. Tirupathi. R. Chandrapatla, Ashok. D. Belegundu, "Finite Elements in Engineering", 5th Edition, Cambridge

University Press, 2021.
3. Nithin Gokhale, “Practical Finite Element Analysis”, Finite to Infinite, 2020.

**Reference Books:**

1. Daryl .L. Logon, “Finite Element Methods”, Thomson Learning 3rd edition, 2017.
2. J. N. Reddy, “Finite Element Method”, McGraw – Hill International Edition.
3. S. S. Bhavikatti, “Finite Element Analysis”, New Age International publishers, 2021.

**JOURNALS/MAGAZINES**

1. https://www.sciencedirect.com/journal/finite-elements-in-analysis-and-design
2. https://www.hindawi.com/journals/mpe/si/632341/

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/112104116
2. https://onlinecourses.nptel.ac.in/noc20_me91/preview.

**7th Semester**

| Course Title | Design of Machine Elements | | | | Course Type | | Hard Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ES0701 | Credits | 4 | | Class | | VII Semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 1 | 1 | 1 | | | | |
| | **Total** | **4** | **4** | **4** | **52** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW:**

Design of Machine elements deals with the basics of design concepts of the structural members, failure theories, stress concentration, fatigue failure.It provides the students with fundamental skills of engineering, and the ability to apply the theories of science to practice. This course also covers the design of shafts, joints springs, keys, couplings, power screws, flexible power transmission elements and design of spur gear.

**COURSE OBJECTIVE (S)**

The objectives of this course are to:

1. To understand the concept of stress, strength, codes and standards, theories failure, stress concentration factor and fatigue failure.
2. To enable students to design important machine elements such as shafts, springs, flexible power transmission elements.
3. To enable students to design keys, couplings, joints and power screws.
4. To learn the concept of design for spur gear.

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Apply concepts of mechanics of materials to estimate the stresses in a machine element and predict failure of components based on theories of failure | 1,2 | 1,2 |
| CO2 | Analyze the effect of static, fatigue load and stress concentration factor forvarious machine elements. | 1,2 | 1,2 |

| | | | |
|---|---|---|---|
| CO3 | Describe ergonomics, control & displays and apply anthropometric data in ergonomic design of automated systems. | 1,2,3 | 1,2 |
| CO4 | Solve for stresses in design of springs and power screws. | 1,2,3 | 1,2 |
| CO5 | Design mechanical power transmission members such as belt & chains drives for various applications. | 1,2,3,4 | 1,2 |
| CO6 | Design spur gears subjected to static,dynamic & wear load conditions | 1,2,3 | 1,2 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | | | 3 | 3 | |
| **CO2** | 3 | 3 | | | | | | | | | | | 3 | 3 | |
| **CO3** | 3 | 2 | 3 | | | | | | | | | | 3 | 3 | |
| **CO4** | 3 | 2 | 2 | | | | | | | | | | 3 | 3 | |
| **CO5** | 3 | 3 | 2 | 1 | | | | | | | | | 3 | 3 | |
| **CO6** | 3 | 3 | 2 | | | | | | | | | | 3 | 3 | |
| **Average** | 3 | 2.5 | 2.2 | 1 | | | | | | | | | 3 | 3 | |

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

**COURSE CONTENT**

**Unit – 1**

**Introduction to Machine Design:** Introduction to Machine design, classification of machine design, design consideration, selection of material, 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).

**Theories of failure and Fatigue:** Maximum Normal Stress Theory, Maximums shear Stress Theory, Distortion Energy

Theory (Simple Problems), Introduction to fatigue, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance Limit, Modifying factors: size effect, surface effect, Stress concentration effects, Goodman and Soderberg Relationship, simple problems.

**Unit – 2**

**Industrial Design**: Introduction, Ergonomics;general approach to the man-machine relationship, workstation design, working position.Anthropometric data and its applications in ergonomic, Control and Displays: Shapes and sizes of various controls and displays, multiple displays and control situations.

**Power Screws:** Stresses in Power Screws, Efficiency and Self-locking, Design of Power Screw, Design of Screw Jack, Features and specification of electric screw jacks.

**Unit – 3**

**Design of Shafts:**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 – 4**

**Design of Gears:** Design of Spur Gears: Beam strength of spur gear, Stresses in gear teeth (Lewis equation), dynamic tooth load, and design for wear.

**Design of Flexible Drives:** Design of V-Belt and chain drives.

**Design Data Hand Books:(Allowed for reference during IA & SEE Examination):**

1.Lingaiah K, "Machine Design Databook" (Vol I and II), , McGraw Hill Education; 2nd edition ,2017.

**TEXT BOOKS:**

1. Richard G Budynas and J Keith Nisbett, Shiegly,"Mechanical Engineering Design", McGraw Hill Education, Special Indian Edition, 10th Edition 2014.
2. V. B. Bhandari**,** "Design of Machine Elements", Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition 2017.
3. Mayall W.H. "Industrial Design for Engineers", London Hiffee books Ltd. 1988.
4. Bridger R.S, "Introduction to Ergonomics", McGraw Hill Publications, 1995.
5. Mark Sanders &Ernest McCormick, "Human Factors in Engineering and Design" –7th Edition, McGraw-Hill Publications 1993.

**REFERENCE BOOKS:**

1. Robert L. Norton , "Machine Design, An Integrated Approach", Pearson Education 4th Edition, 2010
2. M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. SI Contributions by A P Harsha , "Design of Machine Elements", Pearson Education, 8th Edition, 2019.
3. C S Sharma and Kamlesh Purohit , "Design of Machine Design Elements", PHI, T e n t h Printing, 2015
4. Stephen Pheasant, Christine M Haslegrave, "Bodyspace: Anthropometry, Ergonomics and the Design of Work", 7th Edition, Taylor & Francis, 2005.

**JOURNALS/MAGAZINES**

1. http://www.ijerd.com/paper/vol12-issue1/Version-1/G12015667.pdf

**SWAYAM/NPTEL/MOOCs:**

1. NPTEL : Design of Machine Elements I (Mechanical Engineering) (digimat.in)
2. Gear and Gear Unit Design : Theory and Practice - Course (nptel.ac.in)

<table>
<tr><td>Course Title</td><td colspan="4">Introduction to Hydraulics and Pneumatics</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B20ES0702</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">VII semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSE OVERVIEW**

The Fluid Power Engineeringcourse is designed to equip delegates with the basic foundation knowledge and building blocks that underpin all hydraulic pneumatic systems. This course deals with the basic components and functions of hydraulic and pneumatic systems. Fluid power has the highest power density of all conventional power-transmission technologies. Learn the benefits and limitations of fluid power, analyze fluid power components and circuits, and design and simulate fluid power circuits for applications. Topics include standard symbols, pumps, control valves, control assemblies, actuators, maintenance procedures, and switching and control devices.

**COURSE OBJECTIVES**

1. To attain the knowledge of hydraulic and pneumatic systems.
2. To familiar with the power transmission in hydraulic cylinders and motors and solve the Problems.
3. To impart the knowledge on controlling components of hydraulics and pneumatics systems.
4. To understand the hydraulic and pneumatic circuits and interpret their applications.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Apply the concept of Pascal's law for designing of fluid power devices. | 1,2 | 1,2 |
| CO2 | Identify and select the hydraulic and pneumatic components for the various applications | 1,2 | 1,2 |
| CO3 | Design the hydraulic, pneumatic power circuits for the given applications and simulate using fluidSIM software. | 1,2,3,5 | 1,2 |
| CO4 | Identify and select the suitable fluids for the fluid power applications. | 1,2 | 1,2 |
| CO5 | Analyze the performance of fluid power components. | 1,2 | 1,2 |
| CO6 | Use PLCs for controlling of fluid power devices. | 1,2 | 1,2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | | | | | | | | | | | 3 | 1 | |
| CO2 | 3 | 3 | | | | | | | | | | | 3 | 1 | |
| CO3 | 3 | 3 | 1 | | 1 | | | | | | | | 3 | 1 | |
| CO4 | 3 | 2 | | | | | | | | | | | 3 | 1 | |
| CO5 | 3 | 2 | | | | | | | | | | | 3 | 1 | |
| CO6 | 3 | 2 | | | | | | | | | | | 3 | 1 | |
| **Average** | **3** | **2.5** | **1** | | **1** | | | | | | | | **3** | **1** | |

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

**COURSE CONTENT**

**Unit-1**

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

**Hydraulic Pumps:** Pumping theory, Gear pump, Vane Pump, Piston pump, construction and working of pumps, pump performance, Factors for selection of pumps, Numerical on calculation of volumetric displacements, eccentricity and efficiencies of hydraulic pumps.

**Unit-2**

**Control Valves and Fluid Power Actuators:** Control Valves-DCV: Check valve,3/2, 4/3, 5/3, 5/2, Solenoid operated DCV working, PRV: Pressure regulating and reducing valve, FCV: needle valve, Linear hydraulic actuators, Types of hydraulic cylinders, Single acting, Double acting, Special types of cylinders, Loading Mechanism, Cylinder Mounting, Cylinder load, speed and power, numerical.

**Rotary Actuators:** construction and working of motors, External Gear motor, Vane motor, Piston motor, Applicationsof Hydraulics Motors, Hydraulic motor performance, Numerical.

**Unit-3**

**Hydraulic Circuits:** Fluid Power Symbols, Single acting, Double acting, Regenerative, Double pump, Sequencing, Cylinder locking, Synchronizing, pump unloading circuit, counter balance circuit, Meter-in, Meter-out, Accumulators and Applications of Accumulators using circuits.

**Demonstration:** Hydraulics circuit design, simulation using FluidSIM software.

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

**Unit-4**

**Pneumatic Systems and Components:** Pneumatic Components: Properties of air, types of 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 programmable logic controllers (PLC), Applications of PLCs in Fluid power sectors, Pneumatic logic circuits by using OR & AND logic gates.

**Demonstration:** Pneumatics circuit design, simulation using FluidSIM software.

**TEXT BOOKS**

1. Anthony Esposito, "Fluid Power with Applications", Seventh Edition, Pearson Education, 2013.
2. Majumdar S.R, "Oil Hydraulics", Tata McGraw-Hill, New Delh, 2017

**REFERENCE BOOKS**

1. Majumdar S.R, "Pneumatic systems – Principles and Maintenance", Tata McGraw Hill, New Delhi, 2017.
2. James R. Daines, Martha J. Daines, "Fluid Power: Hydraulics and Pneumatics", Goodheart-Willcox; 3rdEdition, 2021.
3. Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 2nd Edition, 1982.

**JOURNALS/MAGAZINES**

1. https://www.sciencedirect.com/journal/procedia engineering.
2. https://link.springer.com/article/10.1631/jzus.A1500042

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/112106300/

2. https://nptel.ac.in/courses/112105046/

| Course Title | Digital Signal Processing | | | | Course Type | | Hard Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ES0703 | Credits | 3 | | Class | | VII Semester | |
| Digital Signal Processing | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment inWeightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | | | | |
| | Tutorial | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50%** | **50 %** |

**COURSE OVERVIEW:**

The signal for processing is mathematically modelled as a function or a sequence of numbers that represent the state or behaviour of a physical system. The examples of the signals range from speech, audio, image and video in multimedia systems, Fault tolerance of different sensor signals in Mechanical and Robotics systems, to electronic radar waveforms in military. Signal processing is concerned with the representation, transformation, and manipulation of signals and the information they contain. For example, we may wish to remove the noise in speech to make it clear, or to enhance an image to make it more natural, or separate the different frequency signals from the vibration signals from aircraft for the detection of faulty functionality. Signal processing is one of the fundamental theories and techniques to construct modern information systems. During the last half century, lots of theories and methods have been proposed and widely studied in digital signal processing. In this semester, we only study the Discrete Fourier Transform and Fast Fourier Transform and IIR and FIR filter designs

**COURSE OBJECTIVES:**

The objectives of this course are:

1. Explain the concept of DFT and FFT.
2. Apply the concept of FFT algorithms to compute DFT.
3. Design IIR filter using impulse invariant, bilinear transform.
4. Describe the concept of linear filtering Technique and to demonstrate FIR & IIR filters for digital filter structures.

**COURSE OUTCOMES(COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| **CO1** | Apply the DFT for the analysis of digital signals. | 1,2 | 1,2 |
| **CO2** | Solve signal representation problems using DFT properties. | 1,2,3 | 2 |
| **CO3** | Compute DFT using FFT algorithms. | 1,2 | 2 |
| **CO4** | Design and analyse DSP systems like IIR filters. | 1,2,3,4,5 | 1 |
| **CO5** | Design and analyse DSP systems like FIR filters. | 1,2,3,4,5 | 1 |
| **CO6** | Describe the significance of various filter structures. | 1 | 1 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

| CO# | Bloom's Level | | | | | |
|---|---|---|---|---|---|---|
| | **Remember (L1)** | **Understand (L2)** | **Apply (L3)** | **Analyze (L4)** | **Evaluate (L5)** | **Create (L6)** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | | | | |
| **CO2** | ✓ | | | ✓ | | |
| **CO3** | ✓ | | | | ✓ | |
| **CO4** | ✓ | | | ✓ | | |
| **CO5** | ✓ | | | ✓ | | |
| **CO6** | ✓ | | | | | |

**COURSE ARTICULATION MATRIX**

| CO#/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | | | 3 | 2 | |
| **CO2** | 3 | 2 | 1 | | | | | | | | | | | 2 | |
| **CO3** | 3 | 3 | | | | | | | | | | | | 2 | |
| **CO4** | 3 | 2 | 1 | 1 | 2 | | | | | | | | 3 | | |
| **CO5** | 3 | 2 | 1 | 1 | 2 | | | | | | | | 3 | | |
| **CO6** | 1 | | | | | | | | | | | | 2 | | |
| **Average** | 2.8 | 2.2 | 1 | 1 | 2 | | | | | | | | 2.8 | 2 | |

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

**COURSE CONTENT**
**THEORY:**

**UNIT - 1**

**Discrete Fourier Transforms and its Properties:** The Discrete Fourier Transform (DFT), Time domain concepts of Circular time shift, time reversal, auto correlation and cross correlation. Properties of the DFT: Periodicity, Linearity, Circular time shift, time reversal, circular frequency shift, Symmetry Properties, auto correlation, cross correlation, Parseval's theorem.

**UNIT - 2**

**Fast Fourier Transform Algorithms:** Circular Convolution Concept and Its DFT Property, Examples on Time and Frequency domain. A linear filtering approach to computation of the DFT using overlap – add & Save method, efficient computation of the DFT: FFT algorithms, direct computation of the FFT. Radix–2 FFT algorithms.

**UNIT - 3**

**Design of IIR Filters:** Characteristics of commonly used analog filters and design of Butterworth and Chebyshev analog filters. Frequency transformations in the analog domain, design of IIR filters from analog filters, IIR Butterworth and Chebyshev filter design using impulse invariance and bilinear transformation method.

**UNIT - 4**

**Design of FIR Filters and Digital Filter Structures:** 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.

**TEXT BOOKS:**

1. Proakis & Monalakis, “Digital signal processing – Principles Algorithms & Applications”, PHI, 4th Edition, New Delhi, 2007.

**REFERENCE BOOK:**

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.

**SWAYAM/NPTEL/MOOCs:**

1. **https://nptel.ac.in/courses/117102060**
2. **https://nptel.ac.in/courses/108106151**

<table>
<tr><td>Course Title</td><td colspan="4">Additive Manufacturing</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B20ESS711</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">VII Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Lecture</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practical</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50%</td><td>50 %</td></tr>
</table>

**COURSE OVERVIEW:**

Additive Manufacturing (AM) which is commonly known as 3D printing is a process of joining materials to make objects from 3D model data by building the model layer on layer, as opposed to subtractive manufacturing methodologies, such as traditional machining. The basic principle of AM is that a model, initially generated using a three-dimensional Computer Aided Design (3D CAD) system, can be fabricated directly. AM technologies have significantly evolved over the last decade because of their potential to extensively transform the nature of manufacturing processes, e.g., by enabling "Freedom of Design" in several industries are attracted by these technologies. Using AM, manufacturing of highly complex parts can be an economically viable alternative to convention al manufacturing technologies.

**COURSE OBJECTIVES:**

1. To acquaint students with the concept of AM, various AM technologies,
2. To provide the understanding of selection of materials for AM, basics of Design for Additive Manufacturing, and their applications in various fields.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Apply the fundamental knowledge of the working principles and process parameters of additive manufacturing processes to manufacture the components. | 1 | 1,2,3 |
| CO2 | Identify, compare and contrast alternative solution processes to select the best process of additive manufacturing processes and suggest suitable methods for building a component. | 1,2, 3 | 1,2,3 |

| | | | |
|---|---|---|---|
| CO3 | Generate information through appropriate tests to improve or revise the design of suitable post processing operation based on product repair requirement. | 1,2, 3, 4 | 1,2,3 |
| CO4 | Recognize the need of analysis to good problem definition of a development of working model using additive manufacturing Processes. | 1, 2, 3 | 1,2,3 |
| CO5 | Establish a relationship between measured data and underlying physical principles to Identify the need of design for additive manufacturing. | 1, 5 | 1,2,3 |
| CO6 | Examine the relevant methods and techniques to Identify design constraints and choose a metal additive manufacturing process. | 1, 3, 5 | 1,2,3 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | | 1 | 2 | 1 |
| CO2 | 2 | 1 | 3 | | | | | | | | | | 1 | 2 | 1 |
| CO3 | 2 | 1 | 2 | 1 | | | | | | | | | 1 | 2 | 1 |
| CO4 | 3 | 1 | 1 | | | | | | | | | | 1 | 2 | 1 |
| CO5 | 1 | | | | 1 | | | | | | | | 1 | 2 | 1 |
| CO6 | 3 | | 2 | | 1 | | | | | | | | 1 | 2 | 1 |
| **Average** | **2.2** | **1** | **2** | **1** | **1** | | | | | | | | **1** | **2** | **1** |

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

**COURSE CONTENTS:**

**UNIT – 1**

**Introduction to Additive Manufacturing:** Introduction to Powder Metallurgy, Reverse engineering, Different AM processes and relevant process physics, AM process chain, Application level: Direct processes – Rapid Prototyping, Rapid Tooling. Rapid Manufacturing; Indirect Processes - Indirect Prototyping. Indirect Tooling, Indirect Manufacturing.

**Guidelines for Process Selection**: Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Process Planning and Control.

**UNIT – 2**

**Materials Science forAdditive Manufacturing:** Multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, microstructural studies, Structure property relationship, Grain structure and microstructure

**Post Processing of Additive Manufacturing Parts:** Support Material Removal, Surface Texture Improvement,

Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques,

**UNIT – 3**

**Additive ManufacturingTechnologies:** Powder-based AM processes involving sintering and melting (selective laser sintering, shaping, and electron beam melting involvement).

**Directed Energy Deposition Processes:** Process Description, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structure-properties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes.

**Sheet Lamination Processes:** Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.

**Wire Arc Additive Manufacturing:** Process, parameters, applications, advantages and disadvantages, case studies.

**UNIT – 4**

**Introduction to Design for Additive Manufacturing:**Introduction to geometric modelling, Modelling of Synthetic curves like Hermite, Bezier and B-spline, Parametric Representation of freeform surfaces, Design freedom with AM, Need for Design for Additive Manufacturing (DFAM), CAD tools vs. DFAM tools, Requirements of DFAM methods, General Guidelines for DFAM, The Economics of Additive Manufacturing, Design to Minimize Print Time, Design to Minimize Post-processing

**Design for Metal Additive Manufacturing:** Powder Morphology, Powder Size Distribution, Material Characteristics, Designing to Minimize Stress concentrations, Residual Stress, Overhangs, shrinkage, warpage and Support Material, Design Guidelines for Wall Thickness, Clearance Between Moving Parts, Vertical Slots, Circular Holes, fillets, channels, vertical Bosses, circular pins, External
Screw Threads and part positioning.

**TEXT BOOKS**


1. Ian Gibson, David W. Rosen and Brent Stucker, "Additive manufacturing technologies: rapid prototyping to direct digital manufacturing", Springer, 2010.
2. C.K. Chua, K.F. Leong and C.S. Lim, "Rapid prototyping: Principles and applications, 3rd Edition", World Scientific, 2010.
3. Diegel, Olaf, Axel Nordin, and Damien Motte "A Practical Guide to Design for Additive Manufacturing", Springer, 2020.
4. Redwood, Ben, Filemon Schoffer, and Brian Garret "The 3D Printing Handbook: Technologies, Design and Applications", 3D Hubs, 2017.


**REFERENCE BOOKS**


1. Patri K. Venuvinod and Weiyin Ma,"Rapid Prototyping: Laser-based and Other Technologies", Springer, 2004.
2. D.T. Pham and S.S. Dimov, "Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling", Springer 2001.
3. Rafiq Noorani, "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley & Sons, 2006.
4. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing, CRC Press, Second Edition, 2020.
5. C.P Paul and A.N Junoop, "Additive Manufacturing: Principles, Technologies and Applications", Mc Graw Hill, 2021.
6. Laroux K and Gillespie, "Design for Advanced Manufacturing: Technologies and Process", Mc Graw Hill, 2017.


| **Course Title** | **Smart Materials** | | | | **Course Type** | | **Soft Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ESS712** | **Credits** | **3** | | **Class** | | **VIISemester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

Overview of the course is to enhance holistic development of students and improve their knowledge about the smart materials, MR, ER fluids, Biomimeticsand smart actuators, advanced in smart structures, smart composites and applications of smart materials.

**COURSE OBJECTIVES**

The objectives of this course are to:

1. Understand the basic concepts of composites and ceramics materials, electro-magnetic materials andshape memory alloys
2. Study about the MR and ER fluids, High-Band Width, Low Strain Smart Sensors and Application of Smart Sensors for Structural Health Monitoring (SHM)
3. Analyze the smartactuators and smart composites, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control and Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials.

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Apply the fundamental knowledge of smart materials, smart structures, piezoelectric, MR, ER fluids to solve problems in the field of medicine and engineering. | 1 | 1 |
| CO2 | Identify, compare and contrast alternative solution processes to select the best process of smart actuators in automobiles and biomedical field. | 1, 2 | 1 |
| CO3 | Generate information through appropriate tests to improve or revise the design ofsmart composites. | 1, 2, 3 | 2 |
| CO4 | Recognize the need of analysis to good problem definition ofsmart structures. | 1, 2, 3 | 2 |
| CO5 | Establish a relationship between measured data and underlying physical principles smart composites applications for corrosion coating and self-healing and MEMs products. | 1, 2, 3,4 | 3 |
| CO6 | Examine the relevant methods and techniques of advances in Sensing applications of smart sensors of structural health monitoring. | 1, 2, 3,4,5 | 3 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

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

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | 3 | 2 | 1 | | | | | | | | | | 1 | 2 | |
| CO5 | 3 | 3 | 1 | 1 | | | | | | | | | 1 | 2 | 2 |
| CO6 | 3 | 2 | 1 | 1 | 1 | | | | | | | | 1 | 2 | 2 |
| **Average** | **3** | **2.2** | **1** | **1** | **1** | | | | | | | | **1.3** | **2** | **2** |

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

**COURSE CONTENT**

**Unit-1**

**Overview of Smart Materials:** Introduction to Smart Materials - Smart structures - classification of smart structures, common smart materials. Piezoelectric materials, piezoelectric effect, Piezoceramics, Piezopolymers, Shape memory alloys (SMAs) - Shape memory effect - Shape memory polymers, Introduction to Electro-active Materials, Electro-active Polymers, Ionic Polymer - Electro-rheological Fluids - Magneto Rhelological Fluids.

**Unit-2**

**Smart Actuators:** Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magneto-volume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control**.**

**Unit-3**

**Smart composites:** Review of Composite Materials, Micro and Macro-mechanics, Laminated Composites based on the Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, governing Equation of Motion.Advances in smart structures; Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials.

**Unit-4**

**Applications:** Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, MEMS - MEMS Product development - Deployment devices - Molecular machines.

**Sensing Applications;** Piezeoelctric Strain Sensors, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM).

**TEXT BOOKS**


1. Mohsini Shahenpoor (Ed.), “Fundamentals of Smart Materials”, RSC, Cambridge, UK, 2020
2. Chander Prakash, Sunpreet Singh, J. Paulo Davim (Ed.), Functional and Smart Materials, CRC Press, 1st Edition, 2021.
3. Chang Liu, “Foundation of MEMS”, Pearson Education, 2nd edition, 2012.
4. M.V.Gandhi and B.S.Thompson, “Smart Materials and Structures”, Chapmen & Hall, London, 1992.
5. Mel M. Schwartz, “Smart Materials”, CRC Press, 1st Edition, 2009.
6. Donald J. Leo, “Engineering analysis of smart material systems”, John Wiley & Sons, 1st Edition, 2007.


**REFERENCE BOOKS**


1. Radhashyam Rai, “Smart Materials for Smart Living”, Nova Publishers, USA, 2017.
2. Qun Wang (Ed.), “Smart Materials for Tissue Engineering”, RSC, UK, 2017.
3. Johannes Michael Sinapius, Adaptronics – “Smart Structures and Materials”, Springer, 2020.
4. Anca Filimon (Ed.), “Smart Materials”: Integrated Design, Engineering Approaches and Potential Applications, CRC Press, 2019.
5. Vijay K. Varadan, “Smart material systems and MEMS: design and development methodologies”, John Wiley & Sons, 2006.
6. Seung- Bok Choi & Young-Min Han, “Piezoelectric actuators: control applications of smart materials”, CRC Press

- 2010.
7. Kwang J. Kim & S. Tadokoro, "Electroactive polymers for robotics applications: artificial muscles and sensors", Springer, 2007

**JOURNALS/MAGAZINES**

1. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology
2. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/113/102/113102080/
2. https://nptel.ac.in/courses/122/102/122102008/

| **Course Title** | **Engineering Economics and Financial Management** | | | | **Course Type** | | **Soft Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ESS713** | **Credits** | **3** | | **Class** | | **VIIsemester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

This course explores the importance of economics in the industries. Engineering economics is an interdisciplinary subject in which financial aspect of the industrial product and investment interest rates are discussed. The course emphasis on evaluation of different interest rates, comparison of different alternatives using PW, AW, FW and Internal rate of return. This subject also deals with evaluation of selling price and depreciation, financial aspects such as book keeping, ratios and budgeting.

**COURSE OBJECTIVES**

1. To Study principles and techniques of economic evaluation in different field of Engineering
2. To know the assessment procedure for the evaluation of alternatives.
3. To calculate interest under various conditions.
4. To learn Budgeting process and its preparation.

**COURSE OUTCOMES (COs)**

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

| **CO** | **Course Outcomes** | **POs** | **PSOs** |
|---|---|---|---|
| CO1 | Describe the economic and financial benefits of organization in the decision making process related to Engineering activity. | 1,11 | 1,2 |
| CO2 | Analyze the financial statements to evaluate financial status of an engineering project for different interest rates. | 1,2,11 | 1,2 |
| CO3 | Estimate the Present, annual and future worth comparisons for each of the cash flows. | 1,2,11 | 1,2 |
| CO4 | Calculate the rate of return, depreciation charges and income taxes | 1,2,11 | 1,2 |
| CO5 | Identify financial strength and weakness of organization by considering various | 1,2,11 | 1,2 |

| | | | |
|---|---|---|---|
| | financial Ratios | | |
| CO6 | Use management techniques to enumerate different cost entities in estimation and costing, budgeting. | 1,2,11 | 1,2 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | 1 | | 1 | | 1 | 3 | |
| CO2 | 3 | 3 | | | | | | | | | 3 | 1 | 1 | 3 | |
| CO3 | 3 | 3 | 2 | 1 | | | | | 1 | | 3 | 1 | 1 | 3 | |
| CO4 | 3 | 3 | 2 | 1 | | | | | | | 3 | 1 | 1 | 3 | |
| CO5 | 3 | 3 | 1 | | | | | | | | 3 | | 1 | 3 | |
| CO6 | 3 | 3 | | | | | | | | | 3 | | 1 | 3 | |
| **Average** | 3 | 3 | 1.6 | 1 | | | | | 1 | | 2.6 | 1 | 1 | 3 | |

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

**COURSE CONTENT**

**Unit-1**

**Introduction to Engineering Economy**: 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, numerical.

**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, Simple Exercises.

**Unit-2**

**Evaluation of Projects and Depreciation:** Annual worth method, and internal rate of return method. Numerical covering all the above method with comparisons. Rate-of-Return Calculations, Minimum acceptable rate of Return, ERR, IRR.

**Depreciation:**Causes of Depreciation, Methods of depreciation. Simple Numerical, Tax- Direct and Indirect tax, GST and simple concepts of taxing.

**Unit-3**

**Estimation, Costing and Final Accounts:** 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-4**

**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

**Profit Planning:** 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.

**CASE STUDIES:**

1.Computation of different financial ratios for various sectors by using current financial annual report.

2. Comparison of the quarterly results of various manufacturing and IT sectors for the financial year and preparation of the financial statement with total revenue and Net profit.

3. SWOT analysis of Manufacturing sectors and Interpretation of opinions for the Investors.

**TEXT BOOKS**

1. R Paneerselvam, "Engineering Economy", PHI Publishers, 2nd Edition, 2013.

2. Thuesen H.G. "Engineering Economy",PHI, 9th Edition, 2002.

**REFERENCE BOOKS**

1.Riggs.J L, "Engineering Economy", McGraw Hill, 4th edition, 2002.

2. O P Khanna, "Industrial Engineering and Management", Dhanpat Rai & Sons. 2018

3. Prasanna Chandra, "Financial Management", TMH, 10th Edition, 2019.

4. IM Pandey, "Financial Management",Pearson, 12th Edition, 2021.

**JOURNALS/MAGAZINES**

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

2. https://www.sciencedirect.com/journal/journal-of-materials-science-and-technology

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/113/102/113102080/

2. https://nptel.ac.in/courses/122/102/122102008/

| **Course Title** | **Internship** | | | | **Course Type** | | **Soft core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ESS714** | **Credits** | **3** | | **Class** | | **VII semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 0 | 0 | 0 | | | | |
| | Practice | 3 | 3 | 3 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **0** | **39** | **50 %** | **50 %** |

**COURSE OVERVIEW**

The internship in field of study is essential to achieve successful outcomes after graduation. Classroom environment may involve only with discussion, debate, peer interaction, and shared learning experiences. But it is important to seek opportunities for a student to apply academic concepts to meet industrial requirements.

**COURSE OBJECTIVES**

1. To gain a practice-oriented and 'hands-on' working experience in the real world and to enhance the student'slearning experience.

2. To develop a right work attitude, self-confidence, interpersonalskills and ability to work as a team in real organizational setting.
3. To enhance operational, customer service, life-long knowledge and skills in a real world workenvironment.
4. To get pre-employment training opportunities and an opportunity for the company ororganization to assess the performance of the student and to offer an employment opportunity after his/her graduation, if it deems fit.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Solve real life challenges in the workplace by analyzing work environment and conditions, and selecting appropriate skill sets acquired from the course. | 1, 2 | 1, 2 |
| CO2 | Demonstrate the application of knowledge and skill sets acquired from the course and workplace in the assigned job functions. | 1,2,3 | 1, 2 |
| CO3 | Articulate career options by considering opportunities in company, sector, industry, professional and educational advancement. | 1, 2, 5, 6 | 1, 2 |
| CO4 | Communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means. | 9, 10, 11, 12 | 1, 2 |
| CO5 | Exhibit critical thinking and problem solving skills by analyzing underlying issue/s to challenges. | 1, 2, 3,4 | 1, 2, 3 |
| CO6 | Exhibit professional ethics by displaying positive disposition during internship. | 7,8 | 1 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

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

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

**COURSE CONTENT**

Student should do internship for 21 days in one stretch or 15 days in two slot before the commencement of 7th semester classes. The internship can be completed during the summer or winter vacations.

Student should prepare a comprehensive report to indicate what he/she has observed and learnt in the training period. The student may contact Faculty Mentor taking guidance on how to make presentation and preparation of report. Student should prepare the final report on internship topic.

**The Internship report will be evaluated on the basis of following criteria:**

I. Originality.
II. Adequacy and purposeful write-up.
III. Organization, format, drawings, sketches, style, language etc.
IV. Variety and relevance of learning experience.
V. Practical applications, relationships with basic theory and concepts taught in the course.

**Evaluation through Seminar Presentation, Assignments/Case Studies /Simulation and Viva-Voce:**

The student expected to give a seminar / presentation and submit of case studies / assignment/ simulation whichever the faculty mentor expect.

The evaluation will be based on the following criteria:

I. Submission of Assignment/Case Studies/Simulation Solution relevance to Internship completed.
II. Quality of content presented.
III. Proper planning for presentation.
IV. Effectiveness of presentation.
V. Depth of knowledge and skills.
VI. Report Writing

**TEXTBOOKS**

1. C R Kothari, "Research Methodology- Methods and Techniques", New Age International, 2nd Edition, 2015.
2. A.K. Chitale, R.C. Gupta, "Product Design and Manufacturing", Prentice –Hall of India, Sixth Edition, 2013.

| **Course Title** | **IoT& Cyber Physical Systems** | | | | **Course Type** | | **Soft Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ESS721** | **Credits** | 3 | | **Class** | | **VII Semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | **IA** | **SEE** |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

IoT is the technology enabling the inter-connection of all types of devices through the internet to exchange data, optimize processes, and monitor devices in order to generate benefits for the industry, the economy, and the end user. It is composed of network of sensors, actuators, and devices, forming new systems and services. Many protocols are used for faithful transmission data based on the applications. The Cyber Physical Systems (CPS) is an engineering discipline and specifies the integrations of and interaction between computation and physical processes. CPS integrates the dynamics of the physical processes with those of the communications, computation and networking, and analysis techniques for the integrated systems.

**COURSE OBJECTIVE (S)**

The objectives of this course are to:

1. Provide knowledge about Internet of Things, embedded systems design and prototyping
2. Describe Internet-of-Things and Communication protocols.
3. Explain the ease of security and privacy features importance in IoT.

4. Gain expertise in integrating sensing, actuation and software.

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Describe the IoT system architecture and system design. | 1 | 1 |
| CO2 | Analyse the Internet-connected products using appropriate tools. | 1,2,5 | 1,2 |
| CO3 | Examine the different network protocols | 1,2 | 1,2 |
| CO4 | Understand the Significance Cyber Security System. | 1 | 1 |
| CO5 | Analyse the challenges with respect to Security and Privacy through Cyber physical systems. | 1,2,12 | 1,2 |
| CO6 | Synthesize the solution for challenges in Cloud Interconnected Cyber Physical System. | 1,2,3,4 | 1,2,3 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | | 3 | | |
| **CO2** | 3 | 3 | | | 2 | | | | | | | | 3 | 3 | |
| **CO3** | 3 | 2 | | | | | | | | | | | 3 | 2 | |
| **CO4** | 3 | | | | | | | | | | | | 3 | | |
| **CO5** | 3 | 3 | | | | | | | | | | 2 | 3 | 1 | |
| **CO6** | 3 | 3 | 3 | 1 | | | | | | | | | 3 | 1 | 1 |
| **Average** | 3 | 2.8 | 3 | 1 | 2 | | | | | | | 2 | 3 | 1.5 | 1 |

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

**COURSE CONTENT**

**THEORY:**

**Unit -1**

**Introduction to IoT and Embedded prototyping:** Introduction to IOT, Wireless sensor networks, Applications of WSN, Roles in WSN, Calm and Ambient technology; Embedded prototyping: Embedded systems, Processor embedded in to system, Embedded hardware units and software system, Examples of embedded system, System on Chip, Complex system design and processors, Design process and examples in Embedded systems, Classifications of embedded systems, Skills required for embedded system designer.

**Unit -2**

**Internet communications:** Internet Communications: An Overview, IP, TCP, The IP Protocol Suite (TCP/IP) ,UDP ;IP Addresses :DNS ,Static IP Address Assignment ,Dynamic IP Address Assignment ,IPv6,MAC Addresses ;TCP and UDP Ports :An Example: HTTP Ports ,Other Common Ports ;Application Layer Protocols :HTTP , HTTPS; Encrypted HTTP, Performance, ,Libraries, Debugging.

**Unit -3**

**Overview of Security and Privacy in Cyber physical systems :** Defining security and Privacy, Defining Cyber physical systems, Examples of security and privacy in action, Approaches to secure cyber physical systems, ongoing security and privacy challenges for cyber physical systems; Local network security for Cyber physical systems, Internet wide secure communication, Security and privacy for cloud interconnected Cyber physical systems.

**Unit -4**

**Data Security and Privacy Challenges in IoT and Distributed systems:**Context awareness for adaptive access control management in IoT Environments: Introduction, Security challenges in IoT environment, Surveying access control models and solutions for IoT; Data privacy issues in distributed security monitoring systems: Information security in distributed data collection systems, Technical approaches for assuring information security, Approaches for building trust in data collection systems.

**CASE STUDIES**

1. Remote machine monitoring as an extension of machine service options using IoT Remote machine monitoring: A Game changer for machine builders.
2. IoT in logistics and supply chain management: Evaluating the adoption rate,associated challenges and impact on cost and business efficiency.
3. Material handling to monitor materials and products using IoT

**Text Books:**

1.Raj Kamal, "Embedded systems", McGraw-Hill, 2nd edition, 2008.
2. Antonio Liñán Colina, Alvaro Vives, Antoine Bagula, Marco Zennaro and Ermanno PietroSemesteroli, "IoT in 5 days ",Revision 1.0 March 2015.
3. Adrian McEwen, Hakim Cassimally, 'Designing the Internet of Things', Wiley, 2014.

**Reference Books:**

1. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key Applications and Protocols", Wiley, 2015.
2. Kurose, James F Ross, Keith W, 'Computer networking: a top-down approach', 5 th edition, international edition, Boston, Mass Pearson, cop. 2010.
3. Frank Vahid, Tony Givargis, 'Embedded System Design: A Unified Hardware/Software Introduction', Wiley, 2006.

<table>
<tr><td>Course Title</td><td colspan="3">Agriculture Automation and Smart Farming</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B20ESS722</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">VII Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSE OVERVIEW**

This course deals with Soil science, Plant anatomy and need for agriculture digitalization. It covers the topics like sensors and actuators for farming tools, sensor data acquisition and telemetry. It also encompasses plant health monitoring techniques like leaf health, ripeness level, crop mapping, fertilizing etc.,

**COURSE OBJECTIVE (S)**

The objectives of this course are to:

1. Know the principle, design and application of various measurement and assisted devices for the sustainable farming.
2. Provide knowledge of the agriculture devices and their functions.

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Describe Soil science, Plant anatomy and need for agriculture digitalization. | 1 | 1 |
| CO2 | Explain different sensors and actuators for farming tools, sensor data acquisition and telemetry. | 1 | 1,2 |
| CO3 | Select suitable sensors and actuators for given customized automation. | 1,2,3 | 1,2 |
| CO4 | Demonstrate Plant health monitoring for leaf health, ripeness level, crop mapping, fertilizing etc., | 1,2 | 1,2 |
| CO5 | Apply advanced technologies for smart farming for improved production. | 1 | 1 |
| CO6 | Develop machines for smart irrigation system. | 1,2,3,4 | 1,2,3 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | | | | |
| **CO2** | 3 | | | | | | | | | | | | 3 | 3 | |
| **CO3** | 3 | 2 | 2 | | | | | | | | | | 3 | 2 | 1 |
| **CO4** | 3 | 3 | | | | | | | | | | | 3 | 1 | 1 |
| **CO5** | 3 | | | | | | | | | | | | 3 | | |
| **CO6** | 3 | 3 | 3 | 1 | | | | | | | | | 3 | 1 | 1 |
| **Average** | 3 | 2.7 | 2.5 | 1 | | | | | | | | | 3 | 1.5 | 1 |

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

**COURSE CONTENT**

**Unit -1**

**Introduction:** Overview of smart agriculture: Nature and origin of soil; soil minerals, classification and composition, soil properties including structure, PH, surface tension and soil nutrients. Standards for agriculture, need for agriculture digitalization

**Sensors in agriculture:**Smart sensors, Colorimetry based detection, MEMS Electrochemical Sensors, Dielectric Soil Moisture Sensors, ISFET, Weather sensors, Proximity Sensors, Air flow sensors, Thermal camera, Image processing

**Unit -2**

**Actuators & controls in agriculture:**AC & DC Motors, Stepper motor, Solenoid actuators, piezoelectric motors, Electric drives, Hydraulic and Pneumatic actuators

**Telemetry:** Wireless communication modules and topology, Zig-bee, Bluetooth, LORA, Zero power devices, Energy Harvesting technology, GIS enabled smart technology

**Unit -3**

**Plant health monitoring:** Measurement of leaf health, chlorophyll detection, ripeness level, crop mapping, fertilizing, Drone technology for soil field analysis and assistive operations.

**Technologies for farming:** Water quality monitoring, smart water management, micro-irrigation system, solar pump and lighting system, Fencing, Android based automation, AI and IOT in farming

**Unit -4**

**Case Studies:**Case studies on sorting, seeding and weeding machine, fruit picking robots, Autonomous unmanned ground vehicles and Drones.

**Text Books:**


1. Ramesh C. Poonia, Xiao-Zhi Gao, Linesh Raja, Sugam Sharma and Sonali Vyas, "Smart Farming Technologies for Sustainable Agricultural Development", IGI Global, 2018.
2. Pradeep Tomar and Gurjit Kaur, "Artificial Intelligence and IoT-Based Technologies for Sustainable Farming and Smart Agriculture", IGI Global, 2021.


**Reference Books:**


1. Annamaria Castrignano, Gabriele Buttafuoco, Raj Khosla, Abdul Mouazen, Dimitrios Moshou and Olivier Naud, "Agricultural internet of things and decision support for precision smart farming", Elsevier, 2020.


| **Course Title** | **Micro and Nano Mechatronics Systems** | | | | **Course Type** | | **Soft Core** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20ESS723** | **Credits** | 3 | | **Class** | | **VII Semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | **IA** | **SEE** |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

The course introduces the students about various applications of MEMS and NEMS. The manufacturing process and strategies for MEMS and NEMS fabrication is also discussed. It also covers various micro and nano sensors and actuators.The course makes the students to understand the diverse technological and functional approaches and applications of micro and nano systems.

**COURSE OBJECTIVE (S)**

The objectives of this course are to:

1. To impart knowledge to the students about the basic concepts in development and synthesizing of micro and nano systems.
2. To introduce students to various micro and nano sensors and actuators.
3. To understand the diverse technological and functional approaches and applications of micro and nano systems.

**COURSE OUTCOMES (COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Explain the suitability of MEMS and NEMS for given applications. | 1 | 1 |
| CO2 | Select the most suitable manufacturing process and strategies for MEMS and NEMS fabrication. | 1,2,3 | 1,2 |
| CO3 | Select a suitable micro and nano sensors and actuators for given application. | 1,2,3 | 1,2 |
| CO4 | Demonstrate the understanding of Micro pumps, Micro dispensers and Micro nozzles. | 1 | 1 |
| CO5 | Assess whether using a MEMS based solution is the relevant and best approach. | 1,2 | 1,2 |
| CO6 | Explain the case studies on Micro and nano systems like Micro robots and Nano robots, Micro insects, Night Vision System | 1,2 | 1 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | | 3 | | |
| **CO2** | 3 | 3 | 3 | | | | | | | | | | 3 | 3 | |
| **CO3** | 3 | 2 | 2 | | | | | | | | | | 3 | 2 | |
| **CO4** | 3 | | | | | | | | | | | | 3 | | |
| **CO5** | 3 | 2 | | | | | | | | | | | 2 | 1 | |
| **CO6** | 3 | 3 | | | | | | | | | | | 3 | | |
| **Average** | 3 | 2.5 | 2.5 | | | | | | | | | | 2.8 | 2 | |

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

**COURSE CONTENT**

**THEORY:**

**Unit -1**

**Introduction:** Introduction to MEMS & materials, fabrication processes - Nanoelectromechanical systems (NEMS) – a journey from MEMS to NEMS - MEMS vs. NEMS - MEMS based nanotechnology – fabrication, film formation and micromachining - NEMS physics.

**Fabrication Techniques:** Structure of silicon and other materials - Silicon wafer processing – bulk micromachining - Nano structuring- Nano defects - Nano particles and Nano layers-science and synthesis ofMicro and Nano materials-lithography-basedmicromachining-Photolithography - vacuum systems - etching methods - deposition methods - LIGA and laser-assisted processing.

**Unit -2**

**Micro and nano sensors :**Si active tactile sensor - Fabric tactile sensor and its application – accelerometer - capacitive silicon – wall in-tube flow sensor and its application- Inertial Sensors – Gyroscope – Pressure Sensors –

Piezoresistive –Capacitive – micro channel heat sinks – optical MEMS – Visual Display– optical data switching – RF MEMS – MEMS variable capacitors – MEMS switches – Resonators- Pressure Sensor, Nano tweezers

**Unit -3**

**Micro and nano actuators :**Requirement for Micro Actuators - Nano Positioners - Micro Mechanical Testing Apparatus - Classification of Micro Actuator-Electrostatic Distributed Actuator-Force Distance various Actuators– Inch Worm, Zipper and Scratch Drive -Thermal Actuation - Bimorph - Buckle Beam -Electro thermal Actuator - Electro Thermal Relay with Mechanical Latch – Piezoelectric Actuation Advantages - MEMS Switch -Thin Film Bulk Acoustic Resonator (FBAR)

**Microfluidics :**Fundamentals of fluid mechanics- Basic components of a micro fluidic system- Micro flows- Micro pumps- Capillarity and Surface Tension- Micro pumping methods- Micro dispensers- Micro nozzles

**Unit -4**

**Micro and nano systems :** Micro engine driven by electrostatically actuated comb drive – Micro robots and Nano robots –Micro insects - Night Vision System - BioMEMS-MEMS as Gas sensors – Development of Proximity Sensor - MEMS based Current sensors - MEMS for Smart homes - MEMS for Visually impaired -MEMS Sensors for object detection - MEMS based touch sensor

**CASE STUDIES**

1. Commercial MEMS Case Studies: The Impact of Materials, Processes and Designs.
2. Fabrication of MEMS devices - a scanning micro mirror case study- principle, design, and fabrication of a silicon-based scanning micromirror with a new type of action mechanism as an example of MEMS.
3. MEMS Manufacturing Testing: An Accelerometer Case Study
4. Introduction to Applications and Industries for Microelectromechanical Systems (MEMS) - MEMS fabricated combustible gas sensor.

**Text Books:**

1. Chang Liu, “Foundations of MEMS”, 2nd Edition, Pearson, 2018.
2. Charles P Poole, Frank J Owens, “Introduction to Nano technology”, John Wiley and Sons, 2003.

**Reference Books:**

1. Fahrner W.R., “Nanotechnology and Nanoelectronics”, Springer (India) Private Ltd., 2017
2. Waqar Ahmed and Mark J. Jackson, “Emerging Nanotechnologies for Manufacturing”, Elsevier Inc.,2013
3. Tai – Ran Hsu, “MEMS and Microsystems Design and Manufacture”, Tata-McGraw Hill, New Delhi, 2018

<table>
<tr><td>Course Title</td><td colspan="4">ArtificialIntelligence</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B20ESS724</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">VIISemester</td></tr>
<tr><td rowspan="5">CourseStructure</td><td>TLP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">TotalNumberofClasses PerSemester</td><td colspan="2" rowspan="2">Assessment inWeightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Practice</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">IA</td><td rowspan="2">SEE</td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

**COURSEOVERVIEW**

This course introduces the basics of Artificial Intelligence (AI), AI problems and search strategies. The students

can exploreknowledge representationissues andmethods. This course provides planning methods /algorithms for, problemsolvingand controlling the knowledge and also demonstrates various learning methods for constructing knowledge and takingdecisions

**COURSEOBJECTIVE(S):**

Theobjectivesofthiscourseareto:

1. DescribethebasicsofArtificialIntelligence(AI).
2. Illustrateknowledgerepresentationissuesandmethods
3. Explainplanningmethods/algorithmsinproblemsolving
4. Discuss theapplicationofAIinRobot.

**COURSEOUTCOMES (COs):**

Afterthecompletion ofthecourse, the student willbeableto:

| CO# | CourseOutcomes | Pos | PSOs |
|---|---|---|---|
| CO1 | SolveAIproblemsusingAIsearchstrategiesandproductionsystem | 1,2,4,5 | 1,2 |
| CO2 | Developknowledgebaseforrepresentingthegivenrealworlddatausing logicandreasoningmethods | 1,2,4,5 | 1,2 |
| CO3 | Makeuseofplanningandprobabilitytosolveuncertaintyproblems. | 1,2,3,4,5 | 1,2 |
| CO4 | Designanddevelopanintelligentagentforroboticsinaspecific Environment tosolverealworldproblems. | 1,2,3,4,5 | 1,2,3 |
| CO5 | LearnnewtoolsandtechnologiesinArtificialIntelligenceandapplyfor suitableapplicationdevelopment. | 1,2,12 | 1 |
| CO6 | DevelopsolutionsintheArtificialIntelligencetothecomplexproblems,eitherindividuallyorasapartoftheteamandreporttheresults. | 5,9,10 | 1,2,3 |

**BLOOM'SLEVELOFTHECOURSEOUTCOMES**

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

**COURSEARTICULATIONMATRIX**

| CO#/POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | | 1 | 3 | | | | | | | | 3 | 3 | |
| CO2 | 3 | 3 | | 2 | 3 | | | | | | | | 3 | 3 | |
| CO3 | 3 | 2 | 3 | 3 | 3 | | | | | | | | 3 | 3 | 1 |
| CO4 | 3 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 3 | 3 |
| CO5 | 2 | 2 | | | | | | | | | | 3 | 3 | | |
| CO6 | | | | | 3 | | | | 3 | 3 | | | 3 | 3 | 3 |
| Average | 2.8 | 2.8 | 2.5 | 2 | 2.8 | | | | 3 | 3 | | 3 | 3 | 3 | 2.8 |

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

**COURSE CONTENT**

**UNIT-1**

**Problems and search:** What is AI, AI Problems; AI Techniques; Problem Space and Problem Search techniques; Defining theproblem as a state space search, production systems; Problem characteristics, production system characteristics, Issues inthe design of search programs; Heuristic search techniques, generate-and-test; Hill climbing, BFS, DFS; Problem reduction;Constraintsatisfaction.

**UNIT-2**

**Knowledge Representation:** Knowledge representation Issues, representations and mappings; Approaches to knowledgerepresentation; Issues in knowledge representation; Using Predicate logic: Representing simple facts in logic; RepresentingInstance and ISA relationships; Computable functions and predicates; Representing Knowledge using Rules; Proceduralversusdeclarativeknowledge; Resolution Forward versusbackward reasoning;Matching.

**UNIT-3**

**Planning:** A simple planning agent; Representations for planning; A partial-order planning example; A partial-order planningalgorithm; Planning with partially Instantiated operators; Knowledge Engineering for planning; Uncertainty: Sources ofUncertainty;Probability Theory,Issues withProbability;Advantages& Disadvantagesof Bayesian Network.

**UNIT-4**

**RoboticSensingandManipulation:**Introductiontorobotics,Sensing,Manipulation,Human-robotinteraction.

**Mobile Robots:** Navigation and path planning, Learning and robotics: Reinforcement learning.

**Case study:** Autonomousvehiclestechnologiesand impacts.

**TEXTBOOKS:**


1. Russell&Norvig,"ArtificialIntelligence:AModernApproach",3rd Edition,Prentice-Hall,2010.
2. ElaineRich,KevinKnight,"ArtificialIntelligence",3rd Edition,TataMcgrawHill,2009.

**REFERENCEBOOKS:**


1. NilsJ. Nilsson,Elsevier,"PrinciplesofArtificialIntelligence",1980."ArtificialNeuralNetworks",
2. KrishanMehrotra,ChilkuriK.Mohan,SanjayRanka,"ArtificialNeuralNetworks",PenramInternationalPublishing,1997.
3. B. Yegananarayana,"ArtificialNeuralNetworks",PHI,2001.


**JOURNALS/MAGAZINES:**


1. Springer-Springertransactionforsecuritybasedintelligentsystems
2. IEEEtransactionforcomputationalIntelligence
3. ACM,ACMtransactiononMulti-AgentSystem.
4. BostonDynamicsvideos,2018,https://www.youtube.com/user/BostonDynamics
5. Priday,R."What'sReallyGoingoninthoseBostonDynamicsVideos,"Wired,February18,2018
6. https://www.wired.co.uk/article/bostondynamics-robotics-roboticist-how-to-watchoRANDInstitute,"Autonomous
7. RANDInstitute,"AutonomousVehicleTechnology:AGuideforPolicymakers",2016
8. https://www.rand.org/content/dam/rand/pubs/research_reports/RR400/RR443-2/RAND_RR443-2.pdf


**SWAYAM/NPTEL/MOOCS:**

1. https://onlinecourses.nptel.ac.in/noc21_cs42/preview
2. IntroductiontoArtificialIntelligence-Coursera

**SELF-LEARNINGEXERCISES:**

NaturalLanguageProcessing, DeepLearning

| **Course Title** | **Electric and Hybrid Vehicles** | | | | **Course Type** | | **Open Elective** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20MEO701** | **Credits** | **3** | | **Class** | | **VII semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

This course is targeting students who wish to pursue research & development in industries or higher studies in the field of Electric and Hybrid Vehicles and upcoming market for retrofit of existing IC engine vehicles with electric motors. It also offers in depth knowledge about working of an Electric Vehicle by covering study of Vehicle fundamentals of EVs and its various components. The course gives an introductory level knowledge on working fundamentals of different electric motors, motor controllers, control techniques, electric vehicle drive train, regenerative braking and different types of hybrid vehicles.

**COURSE OBJECTIVES**

1. To provide the students with sufficient knowledge on series, parallel and complex hybrid architectures of automobile vehicles.
2. To enable the students to understand the concept of electric drive trains, hybrid architectures and hybrid power plant specifications.

3. To help the students to understand the concept of sizing the drive system, energy storage and their alternatives, energy management and control system.
4. To provide the knowledge of the various hybrid and load tracking architectures with knowledge on Hybrid power plant specifications.
5. To impart knowledge on various energy management and control strategies, energy storage systems like batteries and alternate energy storage systems like fuel cells.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Describe the systems of electric vehicles, hybrid electric vehicles and their relevance to society and environment. | 1,6,7 | 1 |
| CO2 | Recognize different configurations of power trains used in hybrid vehicles andidentify the hybrid load tracking architectures. | 1 | 1 |
| CO3 | Illustrate the working of different types of electrical machines, motors and drive topologies. | 1 | 1 |
| CO4 | Demonstrate the electric propulsion unit and Identifythe communication protocols and technologies used in vehicle networks. | 1 | 1 |
| CO5 | Analyze performance of battery based energy storage and problems associated with battery systems used in electric hybrid vehicles. | 1, 2 | 1 |
| CO6 | Describe the characteristics of fuel cell technology. | 1 | 1 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | 2 | 2 | | | | | | 2 | | |
| CO2 | 3 | | | | | | | | | | | | 3 | | |
| CO3 | 3 | | | | | | | | | | | | 2 | | |
| CO4 | 3 | | | | | | | | | | | | 3 | | |
| CO5 | 3 | 1 | | | | | | | | | | | 2 | | |
| CO6 | 2 | | | | | | | | | | | | 3 | | |
| **Average** | **2.8** | **1** | | | | **2** | **2** | | | | | | **2.5** | | |

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

**COURSE CONTENT**

**Unit-1**

**Introduction:**Sustainable Transportation, A Brief History of EHVs, Need of EHV technology, Architectures of EHVs, social and environmental importance of hybrid and electric vehicles, Challenges and Key Technology of EHVs.

**EHV Fundamentals:**Basics of vehicle performance, vehicle power source characterization, transmission characteristic and mathematical models to describe vehicle performance

**Unit-2**

**Hybrid Electric Drive-trains:**Basic Architecture of Hybrid Drive Trains, Energy Savings Potential of Hybrid Drivetrains, Hybrid drive train configurations- series configuration, Parallel configurations, Series-Parallel configurations and complex configurations, power flow control in hybrid drive-train topologies

**Basic Architecture of Electric Drive Trains:**Electric Vehicles drive train configurations, Introduction to various electric drive-train topologies, Electric Vehicle (EV) drivetrain Alternatives Based on Drivetrain Configuration, Electric Vehicle (EV) Drivetrain Alternatives Based on Power Source Configuration.

**Unit-3**

**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, introduction to Permanent Magnet Motors.

**Control Systems for the EHV and EVs:** 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

**Unit-4**

**Energy Storage:**Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery Parameters, Different types of Battery used in EHVs, Battery based energy storage and its analysis, Problems associated with battery systems in EHVs,Temperature controlling methods, advanced battery technologies.

**Fuel Cells:**Fuel Cell Characteristics - Fuel Cell Types – Alkaline Fuel Cell - Proton Exchange Membrane - Direct Methanol Fuel Cell - Solid OxideFuel Cell- Hydrogen Storage Systems- Reformers - Fuel Cell EV - Super and Ultra Capacitors -Flywheels.

**TEXT BOOKS**


1. Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, 4th Edition, CRC Press, 2003.
2. M. Ehsani, Y. Gao and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, 2nd Edition, CRC Press, London, 2010.
3. James Larminie, John Lowry, “Electric Vehicle Technology”, Wiley publications, 3rd Edition, 2003.


**REFERENCE BOOKS**


1. James Larminie, John Lowry, “Electric Vehicle Technology Explained”, 3rd edition, Wiley, 2003
2. Seth Leitman, “Build Your Own Electric Vehicle” McGraw-Hill, 2nd Edition, 2013.
3. Chris Mi, M A Masrur, D W Gao,“Hybrid Electric Vehicles – Principles and applications with practical perspectives”, 4th edition, Wiley, 2011
4. C.C Chan, K.T Chau,“Modern Electric Vehicle Technology”, Oxford University Press Inc., New York 2001


**JOURNALS/MAGAZINES**

1. https://www.sciencedirect.com/book/9780444535658/electric-and-hybrid-vehicles
2. https://www.scimagojr.com/journalsearch.php?q=11600153305&tip=sid

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/108/103/108103009/
2. https://www.edx.org/course/electric-cars-technology
3. https://www.classcentral.com/course/edx-hybrid-vehicles-10285

| Course Title | Hydraulics and Pneumatics Lab | | | | Course Type | | Hard Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ES0704 | Credits | 1 | | Class | | VII semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 0 | 0 | 0 | | | | |
| | Practice | 1 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **1** | **2** | **2** | **00** | **26** | **50 %** | **50 %** |

**COURSE OVERVIEW:**

This laboratory course deal with conducting experiments related to response analysis of Pascal's law. The training systems in this laboratory provide undergraduate and graduate students with practice-oriented knowledge in the areas hydraulics, pneumatics, electropnuematics and robotics. By means of the training systems, students work out practical exercises and gain technical specialized knowledge step-by-step.

**COURSE OBJECTIVES:**

1. To provide the understanding of applications of Pascal's law.
2. To understand the design and analysis of hydraulics and pneumatics circuits.
3. To carry out hands on training on construct the pneumatic circuits by suing different control valves.
4. To analyse and simulate the hydraulic circuit by using FLUIDSIM software.

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Apply the concept of Pascal's law for the fluid power applications | 1 | 1 |
| CO2 | Identify and select the hydraulic and pneumatic control valves for the different applications | 1,2 | 1,2 |
| CO3 | Design the different hydraulic and pneumatic circuits for the given applications | 1,2,3 | 1,2 |
| CO4 | Demonstrate on pneumatic circuit by using different control valves. | 1,2,3 | 1,2 |
| CO5 | Analyze of hydraulic circuit by suing FLUIDSIM software. | 1,2,3 | 1,2 |
| CO6 | Select suitable system for automation applications and document the results in the form of report. | 1,2,3,9,10 | 1,2,3 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | | 3 | 1 | |
| CO2 | 3 | 3 | | | | | | | | | | | 3 | 3 | |
| CO3 | 3 | 2 | 2 | | | | | | | | | | 3 | 3 | |
| CO4 | 3 | 3 | 2 | | | | | | | | | | 3 | 3 | |
| CO5 | 3 | 3 | 2 | | | | | | | | | | 3 | 3 | |
| CO6 | 3 | 3 | 2 | | | | | | | 3 | | | 3 | 3 | |
| Average | 3 | 2.8 | 2 | | | | | | | 3 | | | 3 | 2.1 | |

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

**COURSE CONTENT**

**Part-A**

1. Build a pneumatic circuit for Stamping operation by using single acting cylinder being controlled by 3way 2 position directional control valves TimeResponseanalysisoffirstorder systems.
2. 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.
3. Build a pneumatic circuit for forward and reverse speed control of a double acting cylinder(meter in meter out)
4. Design and analysis single acting hydraulic circuit using FLUIDSIM software.
5. Design and analysis double acting hydraulic circuit using FLUIDSIM software.

**Part-B**

1. Design and analysis regenerative hydraulic circuit using FLUIDSIM software.
2. Design and analysis double cylinder sequencing hydraulic circuit using FLUIDSIM software.
3. Design and analysis double cylinder meter-in and meter-out hydraulic circuit using FLUIDSIM software.
4. Design and analysis double cylinder synchronous hydraulic circuit using FLUIDSIM software.

**TEXT BOOK:**

1. Anthony Esposito, “Fluid Power with Applications”, Seventh Edition, Pearson Education, 2013.
2. Majumdar S.R, “Oil Hydraulics”, Tata McGraw-Hill, New Delh, 2017

**REFERENCE BOOKS:**

1. Majumdar S.R, “Pneumatic systems – Principles and Maintenance”, Tata McGraw Hill, New Delhi, 2017.

2. James R. Daines , Martha J. Daines, “Fluid Power: Hydraulics and Pneumatics”, Goodheart-Willcox; Third Edition, 2021.
3. Anthony Lal, “Oil hydraulics in the service of industry”, Allied publishers, 1982.

**JOURNALS/MAGAZINES**

1. https://www.sciencedirect.com/journal/procedia engineering.
2. https://link.springer.com/article/10.1631/jzus.A1500042

**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/112106300/
2. https://nptel.ac.in/courses/112105046/

| Course Title | Digital Signal Processing Lab | | | | Course Type | | Hard Core | |
|---|---|---|---|---|---|---|---|---|
| Course Code | B20ES0705 | Credits | 1 | | Class | | VII semester | |
| Course Structure | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 0 | 0 | 0 | | | | |
| | Practice | 2 | 2 | 2 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **1** | **2** | **2** | **00** | **26** | **50 %** | **50 %** |

**COURSE OVERVIEW:**

The signal for processing is mathematically modelled as a function or a sequence of numbers that represent the state or behaviour of a physical system. The examples of the signals range from speech, audio, image and video in multimedia systems, Fault tolerance of different sensor signals in Mechanical and Robotics systems, to electronic radar waveforms in military. Signal processing is concerned with the representation, transformation, and manipulation of signals and the information they contain. In this course, students carry out the experiments related to Discrete Fourier Transform and Fast Fourier Transform and IIR and FIR filter designs.

**COURSE OBJECTIVES:**

**The objectives of this course are to:**

1. Explain the concept of DFT and FFT.
2. Calculate the DFT of a sequence, relate it to the DTFT, and use the DFT to compute the linear convolution of two sequences.
3. 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(COs)**

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

| CO# | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Apply the DFT for the analysis of digital signals | 1 | 1,2 |
| CO2 | Demonstrate the concept of sampling, DFT,IDFT. | 1,2 | 2 |
| CO3 | Compute DFT using FFT algorithms. | 1,2 | 2 |
| CO4 | Design and analyse DSP systems like IIR and FIR filters | 1,2,3,5 | 1 |
| CO5 | Design of Butterworth and chebyshev filter for different specification. | 1,2,3 | 1 |
| CO6 | Compute the convolution of the pair of signals in time domain and document the results in the form of technical report. | 1,2,3,9,10 | 2 |

**BLOOM'S LEVEL OF THE COURSE OUTCOMES**

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

**COURSE ARTICULATION MATRIX**

| CO#/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | | | 2 | |
| CO2 | 3 | 2 | | | | | | | | | | | | 2 | |
| CO3 | 3 | 3 | | | | | | | | | | | | 2 | |
| CO4 | 3 | 2 | 1 | | 2 | | | | | | | | 3 | | |
| CO5 | 3 | 2 | 1 | | 2 | | | | | | | | 3 | | |
| CO6 | 1 | 3 | 1 | | | | | | 3 | 3 | | | | 2 | |
| Average | 2.8 | 2.8 | 1 | | 2 | | | | 3 | 3 | | | 3 | 2 | |

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

**COURSE CONTENT:**

**Part-A**

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.

**Part-B**

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. 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.

**TEXT BOOKS:**


1. Proakis & Monalakis, "Digital signal processing – Principles Algorithms & Applications", PHI, 4th Edition, New Delhi, 2007.


**REFERENCE BOOK:**


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.


**SWAYAM/NPTEL/MOOCs:**

1. https://nptel.ac.in/courses/117102060
2. https://nptel.ac.in/courses/108106151

**8th Semester**

| **Course Title** | **Total Quality Management and Six Sigma** | | | | **Course Type** | | **Open Elective** | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **B20MEO801** | **Credits** | **3** | | **Class** | | **VIII semester** | |
| **Course Structure** | TLP | Credits | Contact Hours | Work Load | Total Number of Classes Per Semester | | Assessment in Weightage | |
| | Theory | 3 | 3 | 3 | | | | |
| | Practice | 0 | 0 | 0 | Theory | Practical | IA | SEE |
| | Tutorial | 0 | 0 | 0 | | | | |
| | **Total** | **3** | **3** | **3** | **39** | **0** | **50 %** | **50 %** |

**COURSE OVERVIEW**

The course offers fundamental aspects of quality, quality control and management. The course provides insights into basic approaches of total quality management (TQM), evolution of quality management and contributions of quality gurus to the development of TQM. Techniques and tools which Focus on customer satisfaction and their involvement in the TQM program are included .The course presents various tools and techniques which are widely used in continuous improvement (CI) and TQM implementation programs. Various quality management tools, six sigma methodology (DMAIC) and design for six sigma (DFSS) techniques are also elaborated in this course.

**COURSE OBJECTIVES**

1. To provide the knowledge of quality and its evolution
2. To introduce the basics of leadership and customer perception of quality
3. To impart the knowledge of quality tools
4. To attain the knowledge of six sigma and its methodology

**COURSE OUTCOMES (COs)**

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

| CO | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Describe the principles of total quality management and to explain how these principles can be applied within quality management systems. | 1,2 | 1,2,3 |
| CO2 | Explore the various dimensions of customer satisfaction and their involvement | 1,2 | 1,2,3 |
| CO3 | Use appropriate process improvement techniques for measuring and improving quality control. | 1,2 | 1,2,3 |
| CO4 | Select appropriate statistical techniques for improving processes and analyze the strategic issues in quality management. | 1,2,5 | 1,2,3 |
| CO5 | Analyze and apply six sigma methodology for design optimization of process. | 1,2,3,5 | 1,2,3 |
| CO6 | Use simulation tools to enhance the process capability. | 1,2,5 | 1,2,3 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

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

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | | | | | | | | | | 3 | 1 | 1 |
| CO2 | 3 | 2 | 1 | | | | | | | | | | 3 | 1 | 1 |
| CO3 | 3 | 3 | | | 1 | | | | | | | | 3 | 1 | 1 |
| CO4 | 3 | 1 | | | 1 | | | | | | | | 3 | 1 | 1 |
| CO5 | 3 | 2 | 1 | | 1 | | | | | | | | 3 | 1 | 1 |
| CO6 | 3 | 3 | 1 | | | | | | | | | | 3 | 1 | 1 |
| **Average** | **3** | **2.2** | **1** | | **1** | | | | | | | | **3** | **1** | **1** |

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

**COURSE CONTENT**

**Unit-1**

**Principles and Practices:** Basic approach, gurus of TQM, TQM frame work, awareness, defining quality, historical review, obstacles, benefits of TQM.

**Leadership:** Definition, characteristics of quality leaders, leadership concepts, Deming philosophy, role of TQM leaders, implementation, strategic planning communication

**Unit-2**

**Customer Satisfaction and Customer Involvement**: Perception of quality, feedback using customer complaints, service quality, translating needs into Requirements, Kano model, customer retention. Employee involvement -

Motivation, employee surveys, Empowerment teams, suggestion system, recognition and reward, gain sharing, performance appraisal

**Unit-3**

**Continuous Process Improvement:** Juran triology, improvement strategies, PDCA cycle, problem solving methods, Kaizen, 5S concepts, six sigma. Tool and Techniques - Statistical process control-7QC tools,
Benching marking, information technology, quality management systems, QFD, FMEA, product liability, Total productive maintenance. TQMEX model.

**Unit-4**

**Quality Management Tools**: Forced filed analysis, nominal group techniques, affinity diagram, interrelationship digraph, tree diagram, matrix diagram, process decision program chart and activity network diagram.
**Design for Six Sigma**: Introduction to DMAIC approach and DFSS, tools for concept development, design development, design optimization and design verification problems.

**TEXT BOOKS**

1. Dale H.Bester field, "Total quality Management", Pearson Education India, ISBN: 8129702606, 2018.
2. M.Zairi, "Total quality Management for Engineers", 3rdEdition, McGraw-Hill's, 1987.

**REFERENCE BOOKS**

1. Shoji shiba, Aln Graham, David Walden, "A new American TQM, four revolutions in Management", Productivity Press, Orgeon, 1990.
2. Gopal K.Kanji and Mike Asher, "100 Methods for TQM", Sage Publications, Inc., 1st Edition.
3. H.Lal, "Organizational Excellence through TQM" New age Publication.

**JOURNALS/MAGAZINES**

1. https://www.emerald.com/insight/publication/issn/0265-671X - International journal of quality and Reliability Management
2. https://www.emerald.com/insight/publication/issn/2040-4166---- internal journal of six sigma

**SWAYAM/NPTEL/MOOCs:**

1. https://onlinecourses.nptel.ac.in/noc21_mg03/preview
2. https://nptel.ac.in/courses/110104085

| CourseTitle | Major Project | | | CourseType | Hard Core |
|---|---|---|---|---|---|
| CourseCode | B20ES0801 | Credits | 7 | Class | VIIISemester |
| Course Structure | TLP | Credits | Contact Hours | Assessment in Weightage | |
| | Theory | 0 | 0 | | |
| | Practice | 7 | 21 | IA | SEE |
| | Tutorial | 0 | 0 | | |
| | **Total** | **7** | **21** | **50 %** | **50 %** |

**COURSEOVERVIEW**

This course introduces the students to professional engineering practice by providing them with an opportunity to work on an open ended engineering problem. Typically, the students would apply knowledge gained from different courses and training, which they have studied in their curriculum using methods, tools and techniques to find solution to the stated problem. It also emphasizes the importance of life-long learning as a fundamental attribute of graduate engineers.

**COURSE OBJECTIVES**

1. To provide a definite circumstances, to apply the leanings from various courses of the program and solve problem related to society.
2. To develop a multidisciplinary approach for problem solving.

3. To provide an exposure to take up a real life research problem, product development, industrial problem and arrive at meaningful conclusions / product design / solution.

**COURSEOUTCOMES(COs)**

Afterthecompletionofthecourse,thestudentwillbeableto:

| CO | CourseOutcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Articulate problem statements for real life problems with suitable assumptions and constraints. | 1 | 1,2,3 |
| CO2 | Perform literature search and / or patent search in the area of interest. | 2, 12 | 1,2,3 |
| CO3 | Design solutions for complex engineering problems and design system components or processes that meet the specified needs or understanding the social, environmental and in economic contexts. | 3, 6, 7 | 1,2,3 |
| CO4 | Analyze data and reach a valid scientific conclusion or product or solution. | 4 | 1,2,3 |
| CO5 | Apply appropriate techniques, resources, and modern engineering and IT tools to solve complex engineering activities as per ethical principles and norms of the engineering practice. | 5, 8 | 1,2,3 |
| CO6 | Function effectively as a member or leader in diverse teams and in multidisciplinary settings. | 9 | 1,2,3 |
| CO7 | Write effective reports, design documentation and make effective presentations. | 10 | 1,2,3 |
| CO8 | Demonstrate knowledge and understanding of the engineering and management principles to manage projects. | 11 | 1,2,3 |

**BLOOM'S LEVELOF THECOURSE OUTCOMES**

| CO | Bloom'sLevel | | | | | |
|---|---|---|---|---|---|---|
| | Remember (L1) | Understand (L2) | Apply (L3) | Analyze (L4) | Evaluate (L5) | Create (L6) |
| CO1 | | | √ | | | |
| CO2 | | | | √ | | |
| CO3 | | | | | | √ |
| CO4 | | | | √ | | |
| CO5 | | | | | √ | |
| CO6 | | √ | | | | |
| CO7 | | | | √ | | |
| CO8 | | | √ | | | |

**COURSE ARTICULATIONMATRIX**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | | 3 | 3 | 3 |
| CO2 | | 3 | | | | | | | | | | 3 | 3 | 3 | 3 |
| CO3 | | | 3 | | | 3 | 3 | | | | | | 3 | 3 | 3 |
| CO4 | | | | 3 | | | | | | | | | 3 | 3 | 3 |
| CO5 | | | | | 3 | | | 3 | | | | | 3 | 3 | 3 |
| CO6 | | | | | | | | | 3 | | | | 3 | 3 | 3 |
| CO7 | | | | | | | | | | 3 | | | 3 | 3 | 3 |
| CO8 | | | | | | | | | | | 3 | | 3 | 3 | 3 |
| **Average** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

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

**COURSE CONTENT**

Project may be a modelling, simulation, experimental & analysis, model/prototype design, fabrication of new equipment, analysis of data, software development, etc. or a combination of these.

The students have to make a project team consisting of two, three or four members. The project work should be started in the beginning of seventh semester and to be completed before the end of eighth semester. Select the problems which will provide solution to an industry or in the society or any innovative ideas that benefit the society. The project team has to work for the solution or converting their ideas into product/ process and present the progress of the work as per university schedule. The group is expected to complete, literature review, problem definition, detailed project plan, methodology of work and estimated project cost, in seventh semester, and submit the same in the form of a report prepared as per the guidelines/format of the university (one report per group).

**TEXTBOOKS**


1. Biswajit Mallick, "Innovative Engineering Projects", Entertinement Science and Technology Publication, Bhubaneswar, India, 1st Edition 2015.
2. C R Kothari, "Research Methodology- Methods and Techniques", New Age International, 2nd Edition, 2015.
3. A.K. Chitale, R.C. Gupta, "Product Design and Manufacturing", Prentice –Hall of India, Sixth Edition, 2013.


**REFERENCE BOOKS**


1. O. Molloy, S. Tilley and E. A. Warman, "Design for Manufacturing and Assembly: Concepts, Architectures and Implementation", Springer. USA, 2012.
2. Boothroyd, G.Peter Dewhurst and Winston A, "Knight, Product Design for Manufacture and Assembly", CRC Press, Taylor & Francis, Third Edition, 2010.
4. Navi Radjou, Jaideep Prabhu and Simone Ahuja, "JUGAAD Innovation: A Frugal and Flexible Approach to Innovation for the 21st Century", Random house India, Noida, 2012.
5. Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development", McGraw-Hill, Sixth Edition, 2015.


**JOURNALS/MAGAZINES**

1. Global Innovative research Journal: https://freeprojectsforall.com/journal-publication/
2. International Journal of Project Management: https://www.journals.elsevier.com/international-journal-of-project-management