11 YEARS OF UNIVERSITY RECOGNITION

21 YEARS OF ACADEMIC EXCELLENCE

REVA UNIVERSITY
Bengaluru, India

SCHOOL OF MECHANICAL ENGINEERING

B.Tech
Mechanical Engineering

HAND BOOK
2022-26

RUKMINI EDUCATIONAL
Charitable Trust

www.reva.edu.in

REVA UNIVERSITY
Bengaluru, India

SCHOOL OF MECHANICAL ENGINEERING

HANDBOOK

B. Tech. in Mechanical Engineering

2022 Scheme

Applicable for 2022-26 Batch

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Charitable Trust

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Chancellor's Message

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

- Nelson Mandela.

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

It is deemed virtuous to serve seekers of knowledge 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

Pro-Chancellor's Message

REVA University is most sought-after destination for higher education in the major streams of engineering, science, commerce, management, architecture, law, arts and humanities. University practices modern tools and ICT based technologies that focus on digital learning, project-based learning, personalized learning, etc. Educational reforms are adopted in terms of STEM education, teacher professional development with good mix of diversity and inclusivity.

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. 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 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. CBCS courses also provide knowledge on local, regional, national and global level issues along with enabling them to be employable and also aid to inculcate entrepreneurial skills across all the programs. Ample of opportunities are given for students to enhance their skill-sets through value added courses.

The current trends in engineering education engineering profession in the next two decades will undergo dramatic changes, driven by not only technological developments but also societal transformation. Besides increased globalization, more acute concern for environment for sustainable development will characterize changes and challenges for future engineers in their roles.

REVA University is fully prepared to all such challenges and ready for creating talented engineers and leaders. Such growth has been witnessed in terms of design and delivery of curriculum, student centric methods in teaching-learning, hands-on based practices through state-of-the-art laboratories and research centres and effective outreach activities with premiere industries and academic institutions.

I thank all our students, parents, faculty, staff and well-wishers for their effort and contribution to take this university as one of next generation globally recognized education hub.

Mr. Umesh S Raju
Pro-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. 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 over 50 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. Benchmarked 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 STI HUB, ISRO, 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.

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.N Ramesh
Vice Chancellor (I/C), REVA University

Director's Message

With great pleasure, I welcome you to the School of Mechanical Engineering at REVA University. The School offers Undergraduate programs in Mechanical Engineering, Mechatronics Engineering and Aerospace Engineering leading to B. Tech. Degree, in addition to Master's Program leading to M. Tech. Degree in Machine Design. More than 1500 students representing various parts of India as well a few students from overseas 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.

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 Curriculum Caters to and has relevance to Local, Regional, National, Global developmental needs. Maximum number of courses are integrated with cross cutting issues with relevant to Professional ethics, Gender, Human Values, Environment and Sustainability.

The 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

RUKMINI EDUCATIONAL CHARITABLE TRUST

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

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

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

ABOUT REVA UNIVERSITY

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

REVA University located in between Kempegowda International Airport and Bangalore city, has a sprawling green campus spread over 50 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 41 Undergraduate Programmes, 31 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, EMC2, VMware, SAP, Apollo etc, to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreign universities also facilitates students to study some of the programs partly in REVA University and partly in foreign university.

The University has also given greater importance to quality in education, research, administration and all activities of the university. Therefore, it has established an independent Internal Quality division headed by a senior professor as Dean of Internal Quality. The division works on planning, designing and developing different quality tools, implementing them and monitoring the implementation of these quality tools. It concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms. To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat Ratna Prof. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr. Balaram, Former Director IISc., and noted Scientist, Dr. V S

Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of Defense Dr. Sathish Reddy, Scientific Advisor, Ministry of Defense, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

REVA organizes various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVOTSAVA conducted every year. The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions and variety of cultural events. The founders have also instituted medals and prizes for sports achievers every year. The physical education department conducts regular yoga class's every day to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

Vision of REVA University

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

Mission of REVA University

- 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 of REVA University

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

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 student chapters and clubs which are The Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE) Student Chapter, Aeronautical Society of India (AESI) Student Chapter, Fluid Power Society of India (FPSI) Student Chapter, Indian Institute of Foundrymen (IIF) Student Chapter, International Society of Automation (ISA) Student Chapter, Sustainability Club, REVA Robotics Club, The Inquisity Club, MARS 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, B.Tech Aerospace 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 of School of Mechanical Engineering

"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 of School of Mechanical Engineering

- 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 OF SCHOOL OF MECHANICAL ENGINEERING

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

Programme Overview

Mechanical Engineering is a discipline of engineering that applies the principles of physics and materials science for design, analysis, prototyping, manufacturing, and maintenance of mechanical systems. Mechanical engineering deals with inter conversion of thermal and mechanical power and the design, production, and operation of machines and tools. It is one of the oldest and broadest engineering disciplines.

The mechanical engineering field requires an understanding of core concepts including mechanics, kinematics, thermodynamics, materials science, and structural analysis. Mechanical engineers use these core principles along with tools like computer-aided engineering and product lifecycle management to design and analyze manufacturing plants, industrial equipment and machinery, heating and cooling systems, transport systems, aircraft, watercraft, robotics, medical devices and more.

Mechanical Engineering science emerged in the 19th century as a result of developments in the field of physics. The field has continually evolved to incorporate advancements in technology. Mechanical engineers today are pursuing developments in fields such as composites, mechatronics and micro and nano technology. Mechanical Engineering overlaps with aerospace engineering, civil engineering, electrical engineering, petroleum engineering and chemical engineering to varying amounts.

There is tremendous scope for mechanical engineers in automobile engineering, cement industry, steel, power sector, hydraulics, manufacturing plants, drilling and mining industry, petroleum, aeronautical, biotechnology and many more. Nowadays they are also increasingly needed in the environmental and bio-medical fields. There are exciting times ahead for mechanical engineers as transport technologies like hyper loop, electric vehicles, flying cars, drone technologies, intelligent system like robots and additive manufacturing including 3D printing are gaining importance.

A beginner in Mechanical Engineering can opt for various job openings such as: Design Engineer, CAE Analyst, Shop Floor Engineer, Production Planning, Quality Assurance, Maintenance Engineer, Safety Engineer, Production Supervisor/Engineer, R&D Trainee etc.

The School of Mechanical Engineering at REVA UNIVERSITY offers B. Tech., Mechanical Engineering–an undergraduate programme to create motivated, innovative, creative and thinking graduates to fill the roles of Mechanical Engineers who can conceptualize, design, analyse, develop and produce Mechanical Systems to meet the modern day requirements.

The B. Tech., in Mechanical Engineering curriculum developed by the faculty at the School of Mechanical Engineering, is outcome based and it comprises required theoretical concepts and practical skills in the domain. By undergoing this programme, students develop critical, innovative, creative thinking and

problem solving abilities for a smooth transition from academic to real-life work environment. In addition, students are trained in interdisciplinary topics and attitudinal skills to enhance their scope. The above mentioned features of the programme, advanced teaching and learning resources, and experience of the faculty members with their strong connections with manufacturing sector makes this programme unique.

Program Educational Objectives (PEO's)

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

PEO1: Design, develop, maintain and improve mechanical engineering systems with highest quality, economically feasible and socially acceptable.

PEO2: Exhibit analytical, computational and experimental skills to address the challenges faced in mechanical and allied engineering streams.

PEO3: Exhibit professionalism, ethical attitude, team spirit and communication skill and pursue lifelong learning to achieve career goals, organizational goals and societal goals.

Program Outcomes (POs)

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

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, to solve mechanical engineering problems.

PO2: 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.

PO3: 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.

PO4: 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

PO5: 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.

PO6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

PO9: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: 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.

PO11: 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.

PO12: 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 Mechanical Engineering will be able to:

PSO1: Demonstrate mechanical and interdisciplinary knowledge to analyse, design and manufacture products to address the needs of the society for sustainable growth.

PSO2: Use state of the art tools and techniques to conceptualize, design and develop new products, sustenance of legacy products, processes, systems and services.

PSO3: Communicate effectively as well as to adopt a realistic, practical, systematic and innovative approach to problem solving as a team.

REVA University Academic Regulations

B. Tech., 4 years Degree Programs

(Applicable for the programs offered from 2022-23 Batch)

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

1. Title and Commencement:

1.1 These Regulations shall be called **"REVA University Academic Regulations – B. Tech., Degree Program 2022-23 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 2022-23 under respective schools.

SL No.	Name of the School	Name of the Program
1	School of Civil Engineering	B Tech in Civil Engineering
		B Tech in Agriculture Engineering
2	School of Computing and Information Technology	B Tech Computer Science and Engineering (AI and ML)
		B Tech Computer Science and Information Technology
		B Tech in Information Science and Engineering
		B Tech in Computer Science and Systems Engineering
3	School of Computer Science and Engineering	B Tech in Computer Science and Engineering
		B Tech in Artificial Intelligence and Data Science
		B Tech in Computer Science and Engineering (IoT,and Cybersecurity including Block chain Technology)
4	School of Electrical and Electronics Engineering	B Tech in Electrical and Electronics Engineering
5	School of Electronics and Communication Engineering	B Tech in Electronics and Communication Engineer
		B Tech in Electronics and Computer Engineering
		B Tech in Robotics and Automation
6	School of Mechanical Engineering	B Tech in Mechanical Engineering
		B Tech in Mechatronics Engineering
		B.Tech in Aerospace Engineering

3. Duration and Medium of Instructions:

3.1 Duration: The duration of the B 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 and project, listed under a program; 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, T and P, 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 such as laboratory experiments, field studies, case studies, project based learning or course end projects and self-study courses that equip students to acquire the required skill component.

4.2 Classification of Courses

Courses offered are classified as: Core Courses, Foundation course, Open Elective Courses, Project work/Dissertation, Skill development courses, etc.

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 Mandatory Non Credit Course (MC): These courses are mandatory for students joining B.Tech. Program and students have to successfully complete these courses before the completion of degree.

4.2.7 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, consists of literature survey, problem identification, formulation and methodology. In Phase-II , student should complete the project work by designing or creating an innovative process or development of product as an outcome. A project work is carried out as minor project in 3rd year and major project in 4th year with appropriate credits allocated.

4.2.8 Skill Development Course: It is a practice based course introduced in first year, second year and third year that lead to a certificate, diploma and advanced diploma, respectively.

4.3 "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)	3 Years (6 Semesters)	A. Passed Minimum THREE years / TWO years (Lateral Entry) Diploma examination with at least 45% marks (40% marks in case of candidates belonging to reserved category) in ANY branch of Engineering and Technology. B. Passed B. Sc Degree from a recognized University as defined by UGC, with at least 45% marks (40% in case of candidates belonging to SC/ST category) and passed XII standard with mathematics as a subject.

Sl. No.	Program	Duration	Eligibility
			C. Provided that in case of students belonging to B. Sc. Stream, shall clear the subjects of Engineering Graphics / Engineering Drawing and Engineering Mechanics of the first year Engineering program along with the second year subjects. D. Provided further that, the students belonging to B. Sc. Stream shall be considered only after filling the seats in this category with students belonging to the Diploma stream. E. Provided further that student, who have passed Diploma in Engineering & Technology from an AICTE approved Institution or B. Sc., Degree from a recognized University as defined by UGC, shall also be eligible for admission to the first year Engineering Degree courses subject to vacancies in the first year class in case the vacancies at lateral entry are exhausted. However the admissions shall be based strictly on the eligibility criteria as mentioned in A, B, D, and E above. F. Passed D.Voc. Stream in the same or allied sector. (The Universities will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme)
3	Bachelor of Technology (B Tech)		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.

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 = 14 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 Courses of Study:

Different **Courses 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. Skill Development Course (SDC)

g. Mandatory Non Credit Course (MC)

h. Project Work / Dissertation: A project work is carried out as minor project in 3rd year and major project in 4th year with appropriate credits allocated. These are defined under Section 4.2.7 of this regulation.

8. Credits and Credit Distribution

8.1 A candidate has to earn 168 credits for successful completion of B Tech degree with the distribution of credits for different courses with the credit distribution given in the scheme of study.

8.2 The concerned BOS based on the credits distribution 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

8.3 Foundation Course (FC), Hard Core (HC) or Soft Core (SC), Open Elective (OE) Skill Development Course (SDC).

8.4 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, as per AICTE, the credit distribution for various category of courses given below.

Sl. No.	Course Category	Abbreviation (AICTE)	Abbreviation (REVA)	Suggested breakup of credits (AICTE)	Credit breakup (REVA)
1	Humanities and Social Sciences including Management courses (HSMC)	HSMC	FC	12	9
2	Basic Science Courses	BSC	FC	25	20
3	Engineering Science courses including workshop, drawing, basics of electrical /mechanical /computer etc	ESC	FC	24	29
4	Professional core courses	PCC	HC	48	58
5	Professional Elective courses relevant to chosen specialization /branch	PEC	SC	18	15
6	Open subjects – Electives from other technical and /or emerging subjects	OE	OE	18	12
7	Project work, seminar and internship in industry or elsewhere	PROJ	HC	15	19
8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Knowledge Tradition]	MC	MC	-	-

9	Skill Development Courses (SDC)	-	SDC		06
TOTAL CREDITS				**160**	**168**

8.5 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.A candidate can enrol for a maximum of 26 credits and a minimum of 16 credits per Semester. However, he / she may not successfully earn a maximum of 26 credits per semester. This maximum of 26 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 168 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.

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 166 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 166 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. Continuous Internal Assessment (CIA); 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 CIA shall comprise of:

Internal Assessment Test	40 Marks

Assignments / Seminars / Model Making / Integrated Lab / Project Based Learning / Quizzes, etc.	10 Marks

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

- 1st test is conducted for 20 marks during **8th week** of the Semester;
- 2nd test is conducted for 20 marks during **15th 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 50% of the total syllabus**;
- Question paper of the **2nd test should be based on remaining 50 % of the total syllabus**;
- An assignment must be designed to cover the entire syllabus

9.6 There shall be two Assignment / Project Based Learning / Field Visit / Quiz test carrying 10 marks covering the entire syllabus.

9.7 SEE for 50 marks practical exam shall be held in the 16th and 17th week of the semester.

9.8 SEE for 50 marks theory exam shall be held in the 18th 19th and 20th week of the semester and it should cover entire syllabus.

9.9 Internal test paper is set for a maximum of 40 marks to be answered in 1.5 hours duration (for 1 credit course, exam is conducted for 25 marks with a duration of 1 hour). A test paper can have 5 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 4 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 questions.

9.10 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 (internal BoE members) to bring the quality and uniformity in the question paper.

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

9.12 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. 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.

9.13 Internal assessment marks must be decided well before the commencement of SEE.

9.14 SEE theory question 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 to 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 (question papers have to be set to test the course outcomes).

9.15 There shall be minimum 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 question paper sets shall be scrutinized by the Board of Examiners (BoE). It shall be responsibility of the BOE 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 examiners for each paper. However, there shall be moderation by one of the senior examiners, either internal or external.

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:

a. 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.

b. 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

c. 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 (for theory courses having Credits >=2).

Summary of Internal Assessment and Evaluation Schedule

Sl. No.	Type of Assessment	When	Syllabus Covered	Max Marks	Scaled down to	Date by which the process must be completed
1	Test-1	During 8th week	First 50%	40	20	9th week

2	Test -2	During 15th Week	Remaining 50%	40	20	16th Week
3	Assignment / Quiz - 1	Every week till Test-1	First 50%	10	05	9th Week
4	Assignment / Quiz - 2	Every week during Test-1 and Test-2	Remaining 50%	10	05	16th Week
5	SEE	18th to 20th Week	100%	100	50	20th Week

9.27 Summary of Internal Assessment, Semester End Examination and Evaluation Schedule is provided in the table given below (for theory courses having Credit 1).

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 8th week	First 50%	25	12.5	8th week
2	Test -2	During 15th Week	Remaining 50%	25	12.5	15th Week
5	SEE	18th to 20th Week	100%	50	25	20th Week

10 Assessment of Students Performance in Practical Courses

Lab courses are of two types: integrated labs and separate labs.

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 Assessment of lab courses

10.1.1 Assessment of Separate lab course

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 internal lab test to be conducted after completion of all the experiments before last working day of the semester	20 marks
	Total	**50 marks**

10.1.2Assessment of integrated lab course

The 10 marks meant for Internal Assessment (IA) of the performance in carrying out integrated lab course shall further be allocated as under

i	Conduction of regular practical / experiments throughout the semester	05 marks
ii	Maintenance of lab records and performance of internal lab test to be conducted after completion of all the experiments before last working day of the semester	05 marks
	Total	**10 marks**

10.2 The 50 marks meant for Semester End Examination (SEE) in case of separate lab course shall be allocated as under:

i	Conduction of practical (experiment)	30 marks
ii	Write up about the experiment/tabulation/results/inference	10 marks
iii	Viva Voce	10 marks
	Total	**50 marks**

Note: No Separate SEE for integrated lab course

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

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

For >= 2 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 credit courses

i	IA (Performance of internal test to be conducted after completion of entire syllabus)	25 marks
iii	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. Evaluation of mandatory courses: Students should maintain minimum of 75% attendance to appear for SEE of Mandatory course. The SEE should be conducted in MCQ pattern and students should get minimum pass grade to obtain the degree. There is no internal assessment

13. Evaluation of **Skill Development Courses:** The concerned BoS shall recommend to conduct test/demo/viva-voce/MCQ to test the student knowledge.

14. 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
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 ith course and Gi is the grade point scored by the student in the ith course.

Illustration for Computation of SGPA and CGPA

Illustration No. 1

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit x Grade)
Course 1	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	21	6.83	21 x 6.83 = 143.43
2	23	7.29	23 x 7.29 = 167.67
3	22	8.11	22 x 8.11 = 178.42
4	24	7.40	24 x 7.40 = 177.6
5	22	8.29	22 x 8.29 = 182.38
6	24	8.58	24 x 8.58 = 205.92
7	22	9.12	22 x 9.12 = 200.64
8	10	9.25	10 x 9.25 =92.50
Cumulative	**168**		**1348.56**

Thus,

$$CGPA = \frac{21\times6.83+23\times7.29+22\times8.11+24\times7.40+22\times8.29+24\times8.58+22\times9.12+10\times9.25}{168} = \frac{1346.58}{168} = 8.02$$

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 8.02 x 10=80.2

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

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

e. 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).**

f. 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.

14.2 Attendance Requirement

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

14.2.2. 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.

14.2.3. 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.

. 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.

18. 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

19. Provision for Supplementary Examination

In case a candidate fails to secure a minimum of 30% (15 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.

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

The student who has failed in courses worth of 12 credits or less in odd and even semesters together shall move to next semester of succeeding year(s) of study till 8th 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 12 credits in 1st and 2nd semester together shall move to the 3rd semester of the succeeding year.

Case 2: A student who has failed in a maximum of 12 credits from semester 1 to 4 together shall move to the 5th semester of the succeeding year.

Case 3: A students who has failed in a maximum of 12 credits from semester 1 to 6 together shall move to the 7th semester of the succeeding year.

21. Re-evaluation of Answer Scripts and Announcement of Re-evaluation Results

After declaration of the results of programs within next 10 days, if any candidate wishes to apply for Photocopy/Revaluation (only theory courses), s/he shall apply to the Controller of Examinations, by paying the prescribed fees notified by the University from time to time. The photocopies of the said answer books shall be made available within next TEN working days after the last date prescribed for receipt of the application at the Office of the Controller of Examinations. Photocopies will not be issued for practical/drawing/audit courses.

22. Results of Re-Evaluation will be announced within TWENTY working days (except for third evaluation).

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 Mechanical Engineering

Curriculum Structure for B. Tech Mechanical Engineering Program

SEMESTER-1 (Cycle-1)

Sl. No	Course Code	Title of the Course	HC/ FC/ SC/ OE/ MC/ SDC	Credit Pattern				Contact Hours / Week	Examination			Course category (As per AICTE)
				L	T	P	Total Credit		CIE Marks	SEE Marks	Total Marks	
1	B22AS0102	Differential Equations and Linear Algebra	FC	3	0	0	3	3	50	50	100	BSC
2	B22AS0107	Applied Physics	FC	3	0	0	3	3	50	50	100	BSC
3	B22EN0102	Introduction to Accounting	FC	1	0	0	1	1	25	25	50	HSMC
4	B22CS0104	Introduction to Data Science	HC	2	0	0	2	2	50	50	100	ESC
5	B22EE0101	Basics of Electrical and Electronics Engineering	HC	3	0	0	3	3	50	50	100	ESC
6	B22ED0101	Elements of Civil Engineering and Mechanics	HC	3	0	0	3	3	50	50	100	ESC
7	B22ME0101	Computer Aided Engineering Drawing	HC	2	0	1	3	4	50	50	100	ESC
8	B22CS0108	Data Science Lab	HC	0	0	1	1	2	25	25	50	ESC
9	B22EE0102	Basics of Electrical and Electronics Engineering Lab	HC	0	0	1	1	2	25	25	50	ESC
10	B22AS0108	Applied Physics Lab	FC	0	0	1	1	2	25	25	50	BSC
TOTAL				**17**	**0**	**4**	**21**	**25**	**400**	**400**	**800**	
TOTAL SEMESTER CREDITS				**21**								
TOTAL CUMULATIVE CREDITS				**21**								
TOTAL CONTACT HOURS				**25**								
TOTAL MARKS				**800**								

Nomenclature: **L:** Lecture, **T:** Tutorial, **P:** Practical/Practice/Hands-on, **HC**: Hard Core, **SC**: Soft Core, **FC**: Foundation Core, **OE**: Open Elective, **SDC:** Skill Development Course, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Examination, **BSC**: Basic Science Course, **HSMC**: Humanities, Social science and Management Course, **ESC**: Engineering Science Course, **PCC**: Program Core Course, **PEC**: Professional Elective Course, **MC**: Mandatory Course, **PROJ**: Project work/Internship

***Note*:** SDC-1 will be hands-on based skill enhancement course that create expertise in the domain of respective engineering branch

SEMESTER-2 (Cycle-2)

Sl. No	Course Code	Title of the Course	HC / FC /SC /OE /MC	Credit Pattern				Contact Hours / Week	Examination			Course category (As per AICTE)
				L	T	P	Total Credit		CIE Marks	SEE Marks	Total Marks	
1	B22AS0202	Vector Calculus and Partial Differential Equations	FC	3	0	0	3	3	50	50	100	BSC
2	B22AS0204	Applied Chemistry	FC	3	0	0	3	3	50	50	100	BSC
3	B22AH0103	Communication Skills	FC	0	0	1	1	2	25	25	50	HSMC
4	B22CI0104	Programming with C	HC	3	0	0	3	3	50	50	100	ESC
5	B22ME0103	Elements of Mechanical Engineering	HC	3	0	0	3	3	50	50	100	ESC
6	B22EN0101	IoT and Applications	HC	1	0	1	2	3	50	50	100	ESC
7	B22ME0102	Design Thinking	HC	1	0	1	2	3	50	50	100	ESC
8	B22CI0108	Programming with C Lab	HC	0	0	1	1	2	25	25	50	ESC
9	B22ME0104	Engineering Workshop	HC	0	0	1	1	2	25	25	50	ESC
10	B22AS0206	Applied Chemistry Lab	FC	0	0	1	1	2	25	25	50	BSC
11	B22ER0201	Skill Development Course	SDC	0	0	2	2	4	50	50	100	ESC
12	B22AS0208	Tree Plantation in Tropical Region: Benefits and Strategic Planning	FC	1	0	0	1	1	25	25	50	HSMC
TOTAL				**15**	**0**	**8**	**23**	**31**	**475**	**470**	**950**	
TOTAL SEMESTER CREDITS				**23**								
TOTAL CUMULATIVE CREDITS				**44**								
TOTAL CONTACT HOURS				**30**								
TOTAL MARKS				**950**								

SEMESTER-3 (Cycle-1)

Sl. No	Course Code	Title of the Course	HC / FC /SC /OE /MC	Credit Pattern				Contact Hours / Week	Examination			Course category (As per AICTE)
				L	T	P	Total Credit		CIE Marks	SEE Marks	Total Marks	
1	B22AS0302	Laplace Transforms and Fourier Series	HC	4	0	0	4	4	50	50	100	BSC
2	B22CS0301	Professional Ethics	FC	2	0	0	2	2	50	50	100	HSMC
3	B22CI0309	Entrepreneurship	FC	1	0	0	1	1	25	25	50	HSMC
4	B22AS0304	Environmental Science	MC	0	0	0	0	2	0	50	50	BSC
5	B22ER0301	Engineering Thermodynamics	HC	2	1	0	3	4	50	50	100	PCC
6	B22ER0302	Material Science	HC	3	0	0	3	3	50	50	100	PCC
7	B22ER0303	Manufacturing Science	HC	3	0	0	3	3	50	50	100	PCC
8	B22ER0304	Mechanical Measurements and Metrology	HC	2	0	1	3	4	50	50	100	PCC
9	B22ER0305	Mechanics of Solids	HC	3	0	0	3	3	50	50	100	PCC
10	B22ER0306	Manufacturing Technology Lab	HC	0	0	1	1	2	25	25	50	PCC
11	B22ER0307	Material Testing Lab	HC	0	0	1	1	2	25	25	50	PCC
12	B22ER0308	Soft Skill -1	HC	0	0	1	1	2	25	25	50	PCC
TOTAL				**20**	**1**	**4**	**25**	**32**	**450**	**500**	**950**	
TOTAL SEMESTER CREDITS				**25**								
TOTAL CUMULATIVE CREDITS				**69**								
TOTAL CONTACT HOURS				**33**								
TOTAL MARKS				**950**								

SEMESTER-4 (Cycle-2)

Sl. No	Course Code	Title of the Course	HC / FC /SC /OE /MC	Credit Pattern				Contact Hours / Week	Examination			Course category (As per AICTE)
				L	T	P	Total Credit		CIE Marks	SEE Marks	Total Marks	
1	B22AS0403	Probability and Sampling Theory	HC	4	0	0	4	4	50	50	100	BSC
2	B22EE0301	Universal Human Values	FC	2	0	0	2	2	50	50	100	HSMC
3	B22EN0308	Technical Documentation	FC	1	0	0	1	1	25	25	50	HSMC
4	B22MEM301	Indian Constitution	MC	0	0	0	0	2	0	50	50	HSMC
5	B22ER0401	Kinematics and Dynamics of Machines	HC	3	0	0	3	3	50	50	100	PCC
6	B22ER0402	Thermal Engineering Systems	HC	1	1	0	2	3	50	50	100	PCC
7	B22ER0403	Computer Aided Machine Drawing	HC	1	0	2	3	5	50	50	100	PCC
8	B22ER0404	Python Programming for Mechanical Engineers	HC	0	0	1	1	2	25	25	50	PCC
9	B22ER0405	Kinematics and Dynamics Lab	HC	0	0	1	1	2	25	25	50	PCC
10	B22ER0406	Heat Engine Lab	HC	0	0	1	1	2	25	25	50	PCC
11	B22ER0407	Skill Development Course	SDC	0	0	2	2	4	50	50	100	PCC
12	B22ER0408	Soft Skill -2	HC	0	0	1	1	2	25	25	50	PCC
TOTAL				**12**	**1**	**8**	**21**	**32**	**425**	**475**	**900**	
TOTAL SEMESTER CREDITS				**21**								
TOTAL CUMULATIVE CREDITS				**90**								
TOTAL CONTACT HOURS				**33**								
TOTAL MARKS				**900**								

SEMESTER-5

Sl. No	Course Code	Title of the Course	HC / FC /SC /OE /MC	Credit Pattern				Contact Hours / Week	Examination			Course category (As per AICTE)
				L	T	P	Total Credit		CIE Marks	SEE Marks	Total Marks	
1	B22MEO501	Smart Materials	OE	3	0	0	3	3	50	50	100	OE
2	B24ED0501	Indian Knowledge System	MC	0	0	0	0	1	0	50	50	HSMC
3	B22ER0501	Design of Machine Elements	HC	3	0	0	3	3	50	50	100	PCC
4	B22ER0502	Fluid Mechanics and Machines	HC	3	0	0	3	3	50	50	100	PCC
5	B22ER0503	Machining Science	HC	3	0	0	3	3	50	50	100	PCC
6	B22ER0504	Engineering Economics and Financial Management	HC	1	1	0	2	3	50	50	100	PCC
7	B22ERS511	Automotive Engineering	SC`	3	0	0	3	3	50	50	100	PEC
	B22ERS512	Green Energy Technology										
	B22ERS513	Fundamental of Robotics and Applications										
	B22ERS514	Quality Control Techniques										
8	B22ER0505	Skill Development Course	SDC	0	0	2	2	4	50	50	100	PCC
9	B22ER0506	Flow Analysis Using Ansys Fluent	HC	0	0	1	1	2	25	25	50	PCC
10	B22ER0507	Fluid Mechanics and Machines Lab	HC	0	0	1	1	2	25	25	50	PCC
11	B22ER0508	Machine Shop	HC	0	0	1	1	2	25	25	50	PCC
TOTAL				**16**	**1**	**5**	**22**	**29**	**425**	**475**	**900**	
TOTAL SEMESTER CREDITS				**22**								
TOTAL CUMULATIVE CREDITS				**112**								
TOTAL CONTACT HOURS				**29**								
TOTAL MARKS				**900**								

SEMESTER-6

Sl. No	Course Code	Title of the Course	HC / FC / SC / OE / MC	Credit Pattern				Contact Hours / Week	Examination			Course category (As per AICTE)
				L	T	P	Total Credit		CIE Marks	SEE Marks	Total Marks	
1	B22MEO601	Energy Technology	OE	3	0	0	3	3	50	50	100	OE
2	B22ER0601	Heat Transfer	HC	2	1	0	3	4	50	50	100	PCC
3	B22ER0602	Finite Element Methods	HC	2	1	0	3	4	50	50	100	PCC
4	B22ER0603	Design of Transmission Elements	HC	3	0	0	3	3	50	50	100	PCC
5	B22ERS611	Refrigeration and Air Conditioning	SC	3	0	0	3	3	50	50	100	PEC
	B22ERS612	Operation Research										
	B22ERS613	Additive Manufacturing										
	B22ERS614	Design for Manufacture and Assembly										
6	B22ERS621	Electric and Hybrid Vehicles	SC	3	0	0	3	3	50	50	100	PEC
	B22ERS622	Basics of HVAC and Cryogenics										
	B22ERS623	Hydraulics and Pneumatics										
	B22ERS624	Manufacturing Automation										
7	B22ER0604	Heat Transfer Lab	HC	0	0	1	1	2	25	25	50	PCC
8	B22ER0605	Computer Aided Engineering Analysis Lab	HC	0	0	1	1	2	25	25	50	PCC
9	B22ER0606	Research Based Mini Project	HC	0	0	2	2	4	50	50	100	PROJ
TOTAL				**16**	**2**	**4**	**22**	**26**	**400**	**400**	**800**	
TOTAL SEMESTER CREDITS				**22**								
TOTAL CUMULATIVE CREDITS				**134**								
TOTAL CONTACT HOURS				**26**								
TOTAL MARKS				**800**								

SEMESTER-7

Sl. No	Course Code	Title of the Course	HC / FC /SC /OE /MC	Credit Pattern				Contact Hours / Week	Examination			Course category (As per AICTE)
				L	T	P	Total Credit		CIE Marks	SEE Marks	Total Marks	
1	B22MEO701	Electric and Hybrid Vehicles	OE	3	0	0	3	3	50	50	100	OE
2	B22MEO702	Sustainable Engineering	OE	3	0	0	3	3	50	50	100	OE
3	B22ER0701	Vibrations and Noise Engineering	HC	3	0	0	3	3	50	50	100	PCC
4	B22ER0702	CAD/CAM/CIM	HC	3	0	0	3	3	50	50	100	PCC
5	B22ER0703	Mechatronics and Control Systems	HC	3	0	0	3	3	50	50	100	PCC
6	B22ERS711	Computational Fluid Dynamics	SC	3	0	0	3	3	50	50	100	PEC
	B22ERS712	Logistics and Supply Chain Management										
	B22ERS713	IoT and Machine Learning in Manufacturing										
	B22ERS714	Industry Training		0	0	3		6				
7	B22ERS721	Energy Management, Conservation and Auditing	SC	3	0	0	3	3	50	50	100	PEC
	B22ERS722	Product Life Cycle Management										
	B22ERS723	Digital Manufacturing										
	B22ERS724	Internship		0	0	3		6				
8	B22ER0704	Design Lab	HC	0	0	1	1	2	25	25	50	PCC
9	B22ER0705	CIM and Machine Learning Lab	HC	0	0	1	1	2	25	25	50	PCC
10	B22ER0706	Project Phase-1	HC	0	0	1	1	3	25	25	50	PROJ
TOTAL				**21**	**0**	**3**	**24**	**28**	**425**	**425**	**850**	
TOTAL SEMESTER CREDITS				**24**								
TOTAL CUMULATIVE CREDITS				**158**								
TOTAL CONTACT HOURS				**28**								
TOTAL MARKS				**850**								

SEMESTER-8

Sl. No	Course Code	Title of the Course	HC / FC /SC /OE /MC	Credit Pattern				Contact Hours / Week	Examination			Course category (As per AICTE)
				L	T	P	Total Credit		CIE Marks	SEE Marks	Total Marks	
1	B22ER0801	Major Project	HC	0	0	10	10	20	50	50	100	PROJ
TOTAL				**0**	**0**	**10**	**10**	**20**	**50**	**50**	**100**	
TOTAL SEMESTER CREDITS				**10**								
TOTAL CUMULATIVE CREDITS				**168**								
TOTAL CONTACT HOURS				**20**								
TOTAL MARKS				**100**								

Syllabus
1st Semester

Course Title	Differential Equations and Linear Algebra				Course Type		FC	
Course Code	B22AS0102	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**42**	**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. Solve the first order ordinary differential equations and its applications in the field of engineering.
2. Solve the higher order linear differential with constant coefficients
3. Solve the higher order linear differential equations with variable coefficients and its applications in the field of engineering.
4. Apply Different methods to solve consistent system of algebraic equations.
5. Solve the Eigen values and Eigen vectors of a square matrix
6. Diagonalization of a square matrix and canonical forms

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Solve first order ordinary differential equations and its application using different methods.	1,2,4	1
CO2	Solve Non-Homogeneous Linear Differential Equations with constant coefficients using direct method and the method of variation of parameters	1,2,4	1
CO3	Solve Non-Homogeneous Linear Differential Equations with variable coefficients	1,2,4	1
CO4	Compute the solution of system of equations by various methods	1,2,4	1
CO5	Compute the Eigen values and Eigen vectors of square matrix and to diagonalize the square matrices.	1,2,4	1
CO6	Apply the linear transformation and canonical form of matrix in Mechanical Engineering	1,2,4	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		1									3		
CO2	3	3		1									3		
CO3	3	3		1									3		
C04	3	3		1									3		
CO5	3	3		1									3		
C06	3	3		1									3		
Average	**3.0**	**3**		1									**3**		

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 $\frac{1}{M}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$ $\boldsymbol{and}$ $\frac{1}{N}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$ $\boldsymbol{only}$].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 of equations 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.

TEXT BOOKS

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

Course Title	Applied Physics				Course Type		FC	
Course Code	B22AS0107	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**42**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Applied 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 Civil and Mechanical Engineering courses by emphasizing the concepts underlying four units .1 Kinematics & Rectilinear motion, 2. Lasers and optics and its applications 3. Physical and mechanical Properties of Materials, 4. Measurements and measuring instruments. 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 Understand the Concepts of Kinematics of rectilinear and curvilinear motion.
3. To understand the characteristics, working, principle and applications of Lasers.
4. To gain the knowledge of different optical phenomena and its applications in Interference, diffraction and Polarization.
4. To understand the physical and mechanical properties of materials.
5. To recognize the measurements and their accuracy.
6. To understand design issues, practical oriented skills and problem solving challenges.

COURSEOUTCOMES (Cos)

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

CO	Course Outcomes	POs	PSOs
CO1	Explain the Concepts of Kinematics of rectilinear and curvilinear motion.	1,2	1,2,3
CO2	Explain the working, principle and applications CO2 and semiconductor lasers and also characteristics of lasers and applications.	1,2	1,2,3
CO3	Explain the phenomena of interference in thin films.	1	1,2,3
C04	Analyze the different physical and mechanical properties of materials.	1,2	1,2,3
CO5	Explain the construction and working of different of measuring instruments and Strength of Materials.	1,2	1,2,3
C06	Determine the accuracy of mechanical instruments.	1,2,7	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			✓			
C04				✓		
CO5				✓		
C06				✓		

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											1	1	1
CO2	3	2											2	2	1
CO3	3	2											1	1	1
C04	3	2											1	1	1
CO5	3	2											2	1	1
C06	3	2					1						1	2	1
Average	3	2.					1						1.3	1.3	1

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

COURSE CONTENT

Unit-1

Kinematics and Rectilinear Motion: Principles of dynamics, differential equation of rectilinear motion, D'Alemberts principle, Momentum and Impulse, Work and Energy, Impact.

Curvilinear Translation: Kinematics of Curvilinear motion, differential equations of curvilinear motion, motion of projectile, D'Alemberts principles in curvilinear motion, work and energy in curvilinear motion.

Unit-2

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 (GaAs) laser and Applications of laser-Cutting, drilling ,welding and LIDAR..

Optics: Principle of Superposition, Interference of light, Interference in thin films by reflection, determination of the wavelength of a given monochromatic light and refractive index of a liquid – Applications of Interference TIR-Optical fiber. Diffraction – Fraunhofer diffraction due to single slit, double slit and Diffraction grating (qualitative). Polarization – Polarization by double refraction – Nicol's Prism – Applications of Polarization.

Unit-3

Physical Properties of Materials: Density, Specific gravity, State Change temperatures, Coefficients of thermal expansion ,Specific Heat, Latent heat, Fluidity, Weld ability, Elasticity ,Plasticity ,Porosity, Thermal conductivity Electrical Conductivity.

Mechanical Properties Of Materials: Stress and Strain, Tensile strength, Stress-Strain- behavior, Ductile and Brittle Materials, Impact test, Toughness, Hardness test, Fatigue and fatigue test, Creep and Creep test, Fracture

Unit-4

Measurements and Measuring instruments: Introduction, Definition, Requirement of measurements, significance of measurement system, generalized measurement system, definitions and concept of accuracy, precision,

calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers. Mechanical members: Bourdon tube, Diaphragm, Bellows. Electrical members: Resistive, capacitive, piezoelectric transducers. Intermediate Modifying and Terminating Devices: Introduction, Mechanical systems, inherent problems, electrical intermediate modifying devices, Introduction to Terminating devices, Meter indicators, CRO, Measurement of frequency.

TEXT BOOKS

1. M.N. Avadhanulu and P.G. Kshirsagar , "A Text book of Engineering Physics", S. Chand & Company Ltd, 10th Revised Edition, New Delhi.
2. Gaur and Gupta, "Engineering Physics", Dhanpat Rai Publications, 8th Revised Edition 2017.

REFERENCE BOOKS

1. Resnick, Halliday and Jearl Walker, "Fundamentals of Physics", John Wiley & Sons, Inc., 11th Edition, 2018.
2. William Smith, "Foundations of Materials Science and Engineering", McGraw-Hill Science Engineering Math.
3. Beckwith Marangoni and Lienhard, "Mechanical Measurements", Pearson Education, 6th Edition, 2006.
4. R.K. Jain,"Mechanical Measurements", Khanna Publishers, 1994.
5. Anand. K. Bewoor and VinayA Kulkarni," Mechanical Measurements and Metrology", McGraw-Hill Science.
6. M.S.Vijaya, G.Rangarajan, "Material Science", Tata McGraw Hill.
7. S.Timoshenko, D.H.Young and J.V.RAo, "Engineering Mechanics", McGraw Hill.

Self-study: Units ,measurements and conversion, Introduction, The international system of units, Measurement of length , Measurement of mass , Measurement of time , Accuracy, precision of instruments and errors in measurement , Significant figures , Dimensions of physical quantities , Dimensional formulae and dimensional equations , Dimensional analysis and its applications, Conversion of CGS system into MKS and SI system.

<table>
<tr><td>Course Title</td><td colspan="4">Introduction to Accounting</td><td colspan="2">Course Type</td><td colspan="2">FC</td></tr>
<tr><td>Course Code</td><td>B22EN0102</td><td>Credits</td><td colspan="2">1</td><td colspan="2">Class</td><td colspan="2">I 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>1</td><td>1</td><td>1</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td><td colspan="2" rowspan="2"></td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>1</td><td>1</td><td>1</td><td>Theory</td><td>Practical</td><td>IA</td><td>SEE</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>14</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

The course introduces the basic framework of accounting to all students to understand accounting concepts and constraints, and help them in preparation of financial records, statements and analysis of the major financial statements.

COURSE OBJECTIVES

1. To educate students about the accounting principles and practices.
2. To orient about accounting recording and identification of income, expenses, Assets and Liabilities.
3. To get detailed knowledge of the practice of accounting in different forms of business
4. To gain the ability of using accounting information as a tool in applying solutions for managerial problems, evaluating the financial performance, and interpreting the financial structure.
5. To make students to Apply quantitative skills to analyse and solve business problems and to take advantage of business opportunities.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Acquire conceptual knowledge of basics of accounting and Identify events that need to be recorded in the accounting records.	1,2,4,11	1
CO2	Identify and analyse the reasons for the difference between cash book and pass book balances.	1,2,4,11	1
CO3	Equip with the knowledge of accounting process and preparation of final accounts.	1,2,4,11	1
CO4	Develop the ability to use accounting information to solve a variety of business problems.	1,2,4,11	1
CO5	Describe, explain, and integrate fundamental concepts underlying accounting and finance management.	1,2,4,11	1
CO6	Explain the need for the bank reconciliation statement and cash balance.	1,2,4,11	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 ARTICULATIONMATRIX

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

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

Unit-1

Introduction to Accounting and Accounting Process: Introduction, Meaning and Definition, Objectives of Accounting, Functions of Accounting, Users of Accounting information, Limitations of Accounting, Accounting Principles, Accounting Concepts and Conventions. Meaning, Process of Accounting, Kinds of Accounts, Rules, Transaction Analysis, Journal, Ledger, Balancing of Accounts, Trail Balance, Problems.

Accounting Concepts: Entity, Money Measurement, Going Concern, Accounting Period, Cost Concept, Dual Aspect, Accounting Mechanism – Single Entry and Double Entry. (Only Theory).

Unit-2

Recording of Business Transactions: Voucher and Transactions, Origin of Transactions, Source documents and Vouchers, Preparation of vouchers, Accounting equation approach, Meaning and Analysis of transactions using accounting equation, Rules of debit and credit, Capital and Revenue Transactions.

The Accounting Process Recording of Transactions: Books of original entry, Journal (Simple problems), types of subsidiary books (i) Cash book – Simple, Cashbook with bank column and Petty cashbook, (ii) Purchases book, Sales book, Purchases returns book, Sale returns book,

Ledger: Meaning, Utility, Format, Posting from journal and subsidiary books, Trial Balance, P& L Account and Balance sheet,

Bank Reconciliation Statement: Meaning, Need and Preparation, Correct cash balance, (Simple problems).

REFERENCE BOOKS

1. Tulsian, P.C. "Financial Accounting", Pearson Education, 20th Edition, 2016
2. S.N. Maheshwari, and. S. K. Maheshwari, "Financial Accounting", Vikas Publishing House, New Delhi, 5th Edition, 2012.
3. Dr. Jawaharlal, "Accounting Theory and Practices", HPH, 4th Edition, 2022.
4. Bhushan Kumar Goyal and HN Tiwari, "Financial Accounting", International Book House, 2021

Course Title	**Introduction to Data Science**				**Course Type**		**HC**	
Course Code	**B22CS0104**	**Credits**	**2**		**Class**		**I Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**2**	**2**	**2**	**28**	**0**	**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 either by using MS-Excel/Python/R.

COURSE OBJECTIVES

The objectives of this course is 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)

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

CO	Course Outcomes	POs	PSOs
CO1	Make use of the basic concepts of Data Science in developing the real-world applications.	1 to 4, 12	1,2,3
CO2	Apply the SQL commands in developing the real-world applications.	1 to 5,12	1,2,3
CO3	Build the data analytics solutions for real world problems, perform analysis, interpretation and reporting of data.	1 to 5	1, 2, 3

C04	Create the real-world AI based solutions using different machine learning algorithms	1 to 6, 12	1, 2, 3
CO5	Find modeling Error in Linear Regression	1 to 5	1, 2, 3
C06	Use statistical principles to solve mean and standard deviations for given data.	1 to 4, 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				✓		
C04						✓
CO5		✓				
C06			✓			

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	1	1
CO2	2	3	2	1	2	2						2	3	2	2
CO3	2	3	3	2	2								3	3	3
C04	3	3	3	2	2	2						2	3	3	3
CO5	2	3	2	2	2								3	3	3
C06	3	3	2	2								2	3	3	3
Average	**2.5**	**2.8**	**2.3**	**1.8**	**2.0**	**2.0**						**2.0**	**3.0**	**2.5**	**2.5**

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

COURSE CONTENT

Unit-1

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

Unit-2

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

Introduction to SQL: Basics of Structured Query Language, creation, insertion, updation, deletion, retrieval of tables by experimental demonstrations. Import SQL Database Data into Excel.

Unit-3

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

Unit-4

Data visualization using scatter plots, charts, graphs, histograms and maps: Statistical Analysis: Descriptive statistics- Mean, Standard Deviation for Continuous Data, Frequency, Percentage for Categorical Data.

Applications of Data Science: Data science life cycle, Applications of data science with demonstration of experiments by using Microsoft Excel.

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. Kenneth N. Berk, Carey, "Data Analysis with Microsoft Excel", S. Chand & Company, 2004.
4. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Publications, 9th Edition, 2013.

REFERENCE BOOKS

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publications, 19th 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-LEARNING EXERCISES

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

<table>
<tr><td>Course Title</td><td colspan="3">Basic Electrical and Electronics Engineering</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
<tr><td>Course Code</td><td>B22EE0101</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">I 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="3">Total Number of Classes Per Semester</td><td colspan="2" rowspan="3">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td>Theory</td><td>Practical</td><td>IA</td><td>SEE</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

Basic Electrical and Electronics Engineering course 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 and to make the students familiar about the basics of Electrical Circuits.
2. Illustrate the basics of magnetic circuits and construction, working principle of DC machines, Transformers.
3. Illustrate the characteristics of Diodes and their applications.
4. Discuss the characteristics and applications of BJT's.
5. To familiarize the students about Number systems.
6. To validate the logical expressions using Boolean algebra.

COURSEOUTCOMES (Cos)

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

CO	Course Outcomes	POs	PSOs
CO1	Summarize the basics of electrical engineering terminology and the usage.	1,2	1
CO2	Apply KCL and KVL to Solve Electrical Circuits	1,2,4	1
CO3	Demonstrate the working principle of DC Machines and Transformers and provide applications of DC Machines, Transformers.	1,2,4	1
C04	Analyze the characteristics of PN junction diode, Zener diode and their application	1-2,4	1
CO5	Analyze the working principle and characteristics in three configurations of BJT	1-2	1
C06	Apply the concept of Number system and Arithmetic operations in digital system	1-2	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				✓		
C04				✓		
CO5			✓			
C06				✓		

COURSE ARTICULATIONMATRIX

CO/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1											1		
CO2	3	3		2									1		
CO3	3	2		2									1		
C04	3	3		2									1		
CO5	3	2											3		
C06	3	2											3		
Average	3	2.16		2									1.7		

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

COURSE CONTENT

Unit-1

Introduction to Electrical Engineering:

Basics of DC Circuits: Ohms law, Kirchhoff's Current Law, Kirchhoff's Voltage law, Numerical examples as applicable

Basics of AC Circuits: Sinusoidal voltage and currents, Magnitude and phase, polar and rectangular representation, RL, RC and RLC series and parallel circuits, power factor, phasor diagrams, three phase AC –types of three phase connection (star and delta), Comparison between single phase and three phase AC, Numerical examples as applicable

Unit-2

Magnetic Circuits, Motors and Transformers: Definition of magnetic circuit and basic analogy between electric and magnetic circuits, Faradays laws, permittivity, permeability, EMF, MMF equations, Reluctance, Energy and power DC Generator, DC Motors, Transformers - Principle of operation, Construction and EMF equations, types and applications, Numerical examples as applicable

Unit-3

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

Bipolar Junction Transistors (BJT) Configuration: BJT Operation, Common Base, Common Emitter and Common Collector, Characteristics, Numerical examples as applicable.

Unit-4

Digital Electronics and Number System: Introduction, Switching and Logic Levels, Digital Waveform.

Number Systems and its conversions: Decimal Number System, Binary Number System, Octal Number System, Hexadecimal Number System. Binary addition, Binary subtraction. Boolean Algebra Theorems, De Morgan's theorem.

Digital Circuits: Logic gates, Algebraic Simplification, Realization of all logic and Boolean expressions.

TEXT BOOKS

1. Nagrath I.J. and D. P. Kothari, "Basic Electrical Engineering", Tata McGraw Hill, 3rd Edition 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.

REFERENCE BOOKS

1. Theodore Wildi, "Electrical Machines, Drives, and Power Systems", Pearson Edition, 2007.
2. Hughes, "Electrical Technology", Pearson, 9th Edition, 2005.

Self-Learning Exercises

1. Build a electrical circuit using BJT as a switch
2. Identifying the practical application of Electromagnetic Induction

Course Title	Elements of Civil Engineering and Mechanics				Course Type		HC	
Course Code	B22ED0101	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**42**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course introduces the students to basic concepts of Engineering Mechanics, which are essential for all Engineers. The course familiarizes students shall be learning about mechanical interaction between bodies. That is, we will learn how different bodies apply forces on one another and how they then balance to keep each other in equilibrium, and forces and types of forces, centroid and moment of inertia Students will learn about basic concept of forces, force systems, beams, trusses, properties of geometric shapes.

COURSE OBJECTIVES

This course enables graduating students

1. To understand a broad concept of Engineering Mechanics.
2. To enable students to apply fundamentals and basic concepts of Rigid body Mechanics to solve problems of bodies in rest.
3. To enable the students to apply conditions of static equilibrium to analyze physical system of coplanar forces.
4. To analyze the civil engineering structures namely determinate beams and trusses.
5. To provide an overview of centroid and moment of inertia of plane area
6. To understand the concept of Beams and Friction in Civil Engineering

COURSEOUTCOMES (Cos)

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

CO	Course Outcomes	POs	PSOs
CO1	Understand basics of mechanics related to Particle, Continuum and Rigid body; Forces, Couple & moment of couple.	1	1, 2
CO2	Compute the resultant of system of forces in plane and space acting on bodies.	1,2,5	1, 2
CO3	Analyze civil Engineering Structures using static equilibrium conditions.	1,2,5	1, 2
C04	Compute the reactions developed at the supports of beams and member forces of trusses.	1,2,5	1, 2
CO5	Determine the centroid and moment of inertia of different geometrical shapes.	1,2,5	1, 2
C06	Solve the Engineering Problems for Beams in equilibrium condition and Friction	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					✓	
C04					✓	
CO5					✓	

C06					✓	

COURSE ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												1	1	
CO2	3	3			1								2	2	
CO3	3	3			1								2	2	
C04	3	3			1								2	2	
CO5	3	3			1								2	2	
C06	3	3			1								2	2	
Average	**3**	**3**			**1**								**1.8**	**1.8**	

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

COURSE CONTENT

Unit-1

Introduction to Civil Engineering: Scope of Civil Engineering. Effect of the infrastructural facilities on socio-economic development of a country.

Introduction to Engineering Mechanics: Basic idealizations; Force and its characteristics, Force System and its classification, Principle of superposition of forces, Principle of transmissibility of forces, Moment of a force, couple, moment of a couple, characteristics of couple, Equivalent force - couple system (theory only). Resolution of forces, Composition of forces - Definition of Resultant, Composition of coplanar -concurrent force system, Parallelogram Law of forces.

Unit-2

Analysis of Force System: Composition of coplanar - non- concurrent force system, Varignon's principle of moments; Numerical problems on composition of coplanar concurrent and non-concurrent force systems.

Equilibrium of Coplanar Forces: Definition of static equilibrium, Conditions of static equilibrium for different coplanar force systems, Concept of Free Body Diagram and Lami's theorem with problems

Unit-3

Centroid: Introduction to the concept, Centroid of plane figures, locating the centroid of rectangle, triangle and semicircle using method of integration, Centroid of composite sections; Numerical problems.

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

Unit-4

Analysis of Structures: Types of beams, loads, support and problems on beams. Plane trusses: Method of joints with numerical.

Friction: Types of friction, laws of friction, limiting friction, coefficient of friction concept of static and dynamic friction, numerical problems on impending motion on horizontal and inclined planes along with connected bodies,

TEXT BOOKS

1. T R Jagadeesh, “Elements of Civil Engineering and Engineering Mechanics”, Sapna Book House, 1st Edition, 2007.
2. BK Kolhapure, “Elements of Civil Engineering”, Eastern Book Promoters, 10th Edition, 2016.
3. M.N. Shesha Prakash and Ganesh.B. Mogaveer, “Elements of Civil Engineering and Engineering Mechanics”, PHI Learning, 3rd Revised Edition.
4. R S Khurmi, “Engineering Mechanics” S Chand and Company.

REFERENCE BOOKS

1. A. Nelson, “Engineering Mechanics-Statics and Dynamics”, Tata Mc-Graw Hill Education Private Ltd, New Delhi, 2009
2. S. S. Bhavikatti, “Elements of Civil Engineering”, New Age International Publisher, New Delhi, 3rd Edition 2009.

Course Title	Computer Aided Engineering Drawing				Course Type		HC	
Course Code	B22ME0101	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				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**3**	**4**	**4**	**28**	**28**	**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 orthographic projection of point, line, plane surfaces and solids. It also provides knowledge about representing the object in terms of 3D view and also development of the objects.

COURSE OBJECTIVES

1. To introduce the 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 for preparing engineering drawings
3. To teach the concepts and principles of orthographic projections, development of lateral surfaces and isometric projection of simple solids.
4. To communicate the concepts/ideas 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, line manually 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 solids manually and also by using CAD software.	1,2,5, 10	1
CO4	Draw sectional views of prisms, pyramids, cone and cylinder manually and also by using CAD software.	1,2,5, 10	1
CO5	Draw the development of lateral surfaces of the solids manually and also by using CAD software.	1,2, 3,5,10	1
CO6	Create isometric view of the solids manually 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.

Points, Line and Plane Surface: 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

Solids: 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 Lateral Surfaces of Solids: Parallel line method for prisms and cylinders, Radial line method for pyramids and cones.

Unit-4

Isometric Projections: 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
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	Interpretation and software skill

Sl. No	Practice	Tools and Techniques	Expected Skill /Ability
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, 1st Edition, 2017.
2. K. R. Gopalakrishna and Dr. M S Reddy, "Engineering Graphics-1", Subhas Publications, 2015.
3. Bhatt N.D., Panchal V.M and Ingle P.R, "Engineering Drawing", Charotar Publishing House Pvt. Ltd, 53rd Edition, 2019.

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/

Course Title	Data Science Lab				Course Type		HC	
Course Code	B22CS0108	Credits	1		Class		I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**-**	**28**	**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: ML algorithms, SQL and demonstration of experiments by using MS-Excel and MySQL

COURSE OBJECTIVES

The objectives of this course is to:

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

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs

CO1	Make use of the concepts of Microsoft Excel in developing the real-world applications.	1, 2, 4,10	1,2,3
CO2	Apply the SQL Queries in developing the real-world applications.	1,2, 3,9,10	2, 3
CO3	Build the solutions for real world problems, perform analysis, interpretation and reporting of data using regression algorithms.	2,3, 4, 8,9, 10	1, 2, 3
CO4	Design ER diagrams for database.	2,3, 4,8, 9, 10	1, 2, 3
CO5	Illustrate modeling in Multiple Linear Regression.	1 to 5, 8 to 10	1, 2, 3
CO6	Demonstrate the Logistic Regression to predict the Data.	1 to 5, 8 to 10	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 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

List of Experiments-Part-A

<table>
<tr><th>No</th><th>Title of the Experiment</th><th>Tools and Technics</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.
<table>
<tr><td>Hgt of Father</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 Son</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>
</table>

<table>
<tr>
<td>2</td>
<td>Using the data file DISPOSABLE INCOME AND VEHICLE SALES, perform the following:
i) Plot a scatter diagram.
ii) Determine the regression equation.
iii) Plot the regression line (hint: use MS Excel's Add Trend line feature.
iv) Compute the predicted vehicle sales for disposable income of $16,500 and of $17,900.
v) Compute the coefficient of determination and the coefficient of correlation</td>
<td>MS Excel</td>
<td>Perform prediction and visualiza- tion of data</td>
</tr>
<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.
i) Plot a scatter diagram.
ii) Determine the regression equation.
iii) Plot the regression line (hint: use MS Excel's Add Trend line feature).
iv) Compute the predicted indirect manufacturing costs for 300 machine hours and for 430 machine hours.
v) Compute the coefficient of determination and the coefficient of correlation.</td>
<td>MS Excel</td>
<td>Perform prediction and visualiza tion 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.
<table>
<tr><th>Year</th><th>Month</th><th>Interest rate</th><th>Un employment rate</th><th>Stock index price</th></tr>
<tr><td>2022</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 availed of Rs.10, 00,000during 3 years.
<table>
<tr><td>Sl.no</td><td>A</td><td>B</td></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>5.2%</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>
</table>

6	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.	SQL	Creating Tables
7	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.	SQL	Creating and retrieving Tables
8	Apply the linear regression, compare the average salaries of batsman depending on the run rate scored/ recorded in the matches. Assume your own database.	MS Excel	Apply Linear regression
9	Apply Multiple linear regression to predict the factory products which is A, B and C are independent variables and cost dependent variable.	MS Excel	Apply Linear regression
10	Logistic Regression-case study	MS Excel	Apply Logistic regression
11	Design the ER diagram and create schema of the REVA library Management system.	Entity Relationship	Entity Relationship
12	Design the ER diagram and create schema for Hospital Management system.	Entity Relationship	Schema design

PART-B: Projects

No	Title of the Experiment	Tools and Technics	Expected Skill/Ability
1	Big Mart sales forecasting	MS Excel	Apply Linearregression
2	Bangalore crime analysis	MS Excel	Apply Linearregression

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 International Journal on Data Science and Analytics
3. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=8254253 IEEE Magazine on Big data and Analytics

Course Title	Basic Electrical and Electronics Engineering Lab				Course Type		HC	
Course Code	B22EE0102	Credits	1		Class		I Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW

Basic Electrical & Electronics Engineering lab covers the concept of various types of electrical apparatus, tools and conduction of experiments to Analyze, Design of KCL & KVL, two-way switch or staircase wiring, Determination of VI characteristics Zener Diode, Silicon Diode, Half Wave rectifier using Diode, study& analyses of Lead & lag component, verification of logic gates.

COURSE OBJECTIVES

1. To establish a broad concept of various types of electrical apparatus, tools and instrumentation.
2. To provide hands on experience with electrical apparatus and electrical safety norms.
3. To train students to read and understand schematics so as to make electrical connection for different appliances.
4. To train students in collecting and interpreting experimental data.
5. To enhance written skills of students.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Use appropriate electrical tools for electrical connections and repair of electrical equipment's.	1,2,4,5,9,10	1
CO2	Recognize various symbols in a schematic and make connection as per the schematic	1,2,9,10	1
CO3	Systematically follow various safety procedures.	4,5,9,10	1
CO4	Make use of various measuring instruments to collect experimental data	2,4,9,10	1
CO5	Relate experimental results with theoretical analysis.	2,3,9,10	1
CO6	Demonstrate the ability to critically evaluate the performance of electrical appliances.	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 ARTICULATIONMATRIX

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

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

List of Experiments

Sl. No.	Name of the Practice Session	Tools and Techniques	Expected Skill /Ability
1.	To verify KCL and KVL	Measuring instruments(Ammeter, Multimeter, CRO) and design equations	Design and circuit debugging. Working in a team
2.	Testing of Lead & Lag networks by using R-C components.	Measuring instruments (Ammeter, Multimeter, CRO) and design equations	Design and circuit debugging. Working in a team
3.	Two-way switch/ staircase wiring. 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.	Study and analysis the Characteristics: light sensor and temperature sensor	Sensor kit	Characteristics of sensors
5.	Study and analysis of V-I Characteristics of Zener PN Junction diodes (Both Forward and Reverse Characteristics).	VI characteristics of Zener Diode kit	VI characteristics of Zener Diode
6.	Study and analysis of V-I Characteristics of SCR	Measuring instruments (Ammeter, Multimeter, CRO) and design equations	Design and circuit debugging. Working in a team
7.	Design half wave, Full wave-center tap and Bridge rectifier with and without capacitive filter and measure efficiency and ripple factor.	Rectifier kit	Determine the efficiency, Voltage regulation, ripple factor of rectifiers
8.	Design of Clippers and clampers with reference voltages	Measuring instruments (Ammeter, Multimeter, CRO) and design equations	Design and circuit debugging. Working in a team
9.	Study and analysis of input output characteristic of CE configuration of BJT.	Characteristics of BJT in Common Emitter Configuration	Input & Output Characteristics of BJT
10.	Verification of basic logic gates using discrete components	Trainer kit	Universal gates will be realized using basic gates

Demo:

1. To Study the importance of Earthing during accidental shorting of line wire and the body of equipment.
2. To study the Importance and mechanism of MCB.

TEXT BOOKS

1. Nagrath I.J. and D. P. Kothari, "Basic Electrical Engineering", Tata McGraw Hill, 3rd Edition 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.

REFERENCE BOOKS

1. Theodore Wildi, "Electrical Machines, Drives, and Power Systems", Pearson, 5th Edition, 2007.
2. Hughes, "Electrical Technology", Pearson, International Students 9th Edition 2005.

SWAYAM/NPTEL/MOOCs

1. https://nptel.ac.in/courses/108108076
2. https://nptel.ac.in/courses/108101091
3. https://www.udemy.com/course/basic-electrical-engineering-part-1

<table>
<tr><td>Course Title</td><td colspan="4">Applied Physics Lab</td><td colspan="2">Course Type</td><td colspan="2">FC</td></tr>
<tr><td>Course Code</td><td>B22AS0108</td><td>Credits</td><td colspan="2">1</td><td colspan="2">Class</td><td colspan="2">I 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>Tutorial</td><td>0</td><td>0</td><td>0</td><td colspan="2" rowspan="2"></td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td></tr>
<tr><td>Total</td><td>1</td><td>2</td><td>2</td><td>0</td><td>28</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OBJECTIVES

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

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Apply the knowledge of Physics to find the values and compare the results with theoretical calculations.	1, 2, 9,10	1,2,3
CO2	Find the physical properties of given materials.	1,2,9,10	2, 3
CO3	Find the mechanical properties of given materials.	1,2,3,9,10	1, 2, 3
CO4	Usage of different instruments and real time applications in engineering studies.	1,2, 9, 10	1, 2, 3
CO5	Find the errors in the measuring instruments.	1,2,3,9,10	1, 2, 3
CO6	Understand the concept of physical and mechanical properties of a material and its measuring instruments.	1,9,10	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 ARTICULATIONMATRIX

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

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

List of Experiments

Sl. No	Title of the Experiment	Tools and Technics	Expected Skill/Ability
1	Determination of acceleration due to gravity by Bar pendulum.	Metal bar, stop clock	Understand the theory, principle and perform the experiment, collect the data and interpret the results.
2	Determination of Young's Modulus by Single cantilever.	Cantilever set up and stop clock	Understand the theory, principle and perform the experiment, collect the data and interpret the results to estimate the Value of the material.
3	Determination of Moment of Inertia and Rigidity Modulus by Static Torsion method.	Torsion set up, metal plates, screw gauge and stop clock	Understand the theory, principle and perform the experiment, collect the data and interpret the results to estimate the Value of the material.
4	Determination of Tensile Strength of mild steel.	Steel rod, weights	Understand the theory, principle and perform the experiment, collect the data and interpret the results to estimate the Value of the material and compare with standard values.
5	Determination of Viscosity of Liquid by Poiscuille method.	Capillary tube with bottle, stop clock, measuring jar.	Understand the theory, principle and perform the experiment, collect the data and interpret the results.
6	Determination of Metacentric height of floating body.	Metacentric expt set up with fluid chamber	Understand the theory, principle and perform the experiment, determine the value of Metacentric height.

Sl. No	Title of the Experiment	Tools and Technics	Expected Skill/Ability
7	Determination of Viscosity of given liquid using falling ball method	Glass tube, fluid, steel balls with different radius, screw gauge	Understand the theory, principle and perform the experiment, collect the data and interpret the results.
8	Determination of surface tension of water by Capillary rise method.	Capillary tube, glass beaker, travelling microscope.	Understand the theory, principle and perform the experiment, collect the data and interpret the results to estimate the Value of the fluid and compare with standard values.
9	Study the Characteristics of CE mode Transistor amplifier.	NPN transistor kit, connecting wires	Understand the theory and perform the experiment, collect the data and draw the input, output and transfer characteristics of given transistor.
10	Calibration of Pressure gauges.	Pressure gauges set up	Understand the theory and perform the experiment, collect the data and interpret the results to know the calibration in gauges.
11	Study the I-V Characteristics of Photodiode.	Photo diode, light source, circuit board and wires	Understand the theory, circuit connection and perform the experiment, collect the data and interpret the results to know the photo response of a diode.

REFERENCE BOOKS

1. G.L.Souires, “Practical Physics”, Cambridge University, UK, 4th Edition, 2001.
2. D. Chattopadhyay, P. C. Rakshit and B. Saha, “An Advanced Course in Practical Physics”, Books & Allied Ltd., Calcutta, 2nd Edition, 1990.

2nd Semester

Course Title	Vector Calculus and Partial Differential Equations				Course Type		FC	
Course Code	B22AS0202	Credits	3		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**42**	**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):

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

CO	Course Outcomes	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	Solve partial differential equations with one or more independent variables	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
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.

TEXT BOOKS

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

Course Title	**Applied Chemistry**				**Course Type**		**FC**	
Course Code	**B22AS0204**	**Credits**	**3**		**Class**		**II semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**42**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Applied chemistry covers very relevant topics compatible with 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.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	List the properties of water and describe various methods employed in water treatment.	1,6	1
CO2	Analyze the metal stability (corrosion resistance) under different environmental conditions.	1,2,7	1
CO3	Identify and compare the materials best suited materials for construction of battery, fuel cells and Photovoltaic Cell.	1,2,3,7	1
CO4	Describe common use of metals and alloys, ceramics, polymers, their composition, properties and engineering applications.	1	1
CO5	Explore the modern materials and their composites for technological applications	1,2,6	1
CO6	Know the importance of advanced materials for electrochemical energy storage, conversion, and environmental remedies.	1, 7	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
CO1	3	2				1							1	
CO2	2	1					1						1	
CO3	1	2	1				1						1	
CO4	3	2											1	
CO5	2	2				1							1	
CO6	3	2					1						1	
Average	**2.33**	**1.8**	**1**			**1**	**1**						**1.0**	

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

COURSE CONTENT

Unit-1

Water Technology: Sources of water, Impurities of water, Hardness and its determination (EDTA method), Boiler Troubles and their removal, water softening methods -Lime soda (both hot lime and cold lime), Zeolite and Ion exchange, Desalination of water — Electro dialysis & Reverse osmosis method, Chemical analysis of water: chloride and fluoride estimation.

Unit-2

Concepts of Corrosion Science: Thermodynamics and Kinetics of electrochemical corrosion – Theory for corrosion, galvanic series, thermodynamics aspects of corrosion reactions, Nernst equation, dry and wet corrosion and the cell formation, potential- pH diagram (Fe and Al), kinetics of corrosion reactions, Butler-Volmer equation, polarization, passivity, immunity.

Types of corrosion – Galvanic corrosion, pitting, crevice corrosion, and intergranular corrosion.

Corrosion measurements – Weight loss method, by tafel extrapolation plots.

Corrosion control – Cathodic protection (Sacrificial anode and impressed current methods), Anodic protection

Protective coatings – Metal coatings (hot dip: tinning and galvanizing), spray techniques, role of inhibitors

Unit-3

Energy Devices: Introduction to electrochemical cells, Batteries; primary, secondary and reserve batteries, construction and working of Zn-MnO2, lead-acid, Li-ion batteries, Fuel cells; introduction, types, construction and working of PAFC and SOFC, super capacitors, photo voltaic cell

Unit-4

Modern Materials: Composition, Properties, example and applications of polymers, biomaterials, glass, composite materials, nano materials, thin films, liquid crystals.

Metals and Alloys: Stress and strain curve, mechanical properties of iron, Steel, and alloy steels (Nickel, Chromium, Tungsten).

TEXT BOOKS

1. Jain and Jain, "Engineering Chemistry", Dhanapat Rai Publications, 16th Edition, 2015.
2. SS Dara and SS Umare, "Engineering Chemistry", S. Chand Publications, 17th Edition, 2014.
3. R.V. Gadag and Nithyananda Shetty, "Engineering chemistry", Ik International Publishing House, 3rd Edition, 2014.

REFERENCE BOOKS

1. Fontana. M.G., "Corrosion Engineering", Tata McGraw Hill, 3rd Edition, 2005.
2. Charles P. Poole Jr and Frank J. Owens, "Introduction to Nanotechnology", Wiley-Interscience, 1st Edition, 2003.
3. V.R. Gowrikar, N.N. Vishwanathan and J. Sreedhar, "Polymer Chemistry", New Age International Pvt Ltd, 2021.

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/

Self –learning: Boiler corrosion and its treatment, Mechanism of scale formation in boilers, Anodic protection of corrosion control, Synthesis of Silicon and its purification, Role of stress and strain curve in understanding hardness/toughness of materials, mechanical properties of composite materials

Project Based Learning: To enhance the skill set in the integrated course, the students are advised to execute course-based design projects. Some sample projects are given below:

S. No	Suggested Projects
1.	**Chemical analysis of water for its toxic materials**: This can be done for all types of water sources available and can assess to test their drinkable condition
2.	**Estimation of COD level of water**: To test its toxicity level, polluted by organic compounds

3.	**Corrosion studies:** This can be done corrosion immunity of materials in different acids and bases.
4.	**Analysis of scale and sludge:** Collect the scale and sludge samples for sample analysis by various analytical technical, following proper protocol

Course Title	**Communication Skills**				**Course Type**		**FC**	
Course Code	B22AH0103	Credits	1		Class		**II Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Practical	1	2	2				
	Total	**1**	**2**	**2**	**0**	**28**	**50%**	**50%**

COURSE OVERVIEW

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

COURSE OBJECTIVES

The Course objectives are to

1. Develop basic communication skills in English.
2. Emphasize the development of speaking skills amongst learners of Engineering and Technology
3. Impart the knowledge about the use of electronic media such as the internet and supplement the learning materials used in the classroom.
4. Inculcate the habit of reading and writing leading to effective and efficient communication.

COURSE OUTCOMES: (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Demonstrate speaking ability with clarity, confidence, and comprehension and communicate with one or many listeners using appropriate communicative strategies (Speaking Skills).	10	
CO2	Develop the ability to write cohesively, coherently, and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic (Writing skills).	10	
CO3	Make use of reading different genres of texts by adopting various reading strategies (Reading Skills).	10	
CO4	Take part in interviews confidently and develop accurate writing skills.	10	

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	✓	✓				

COURSE ARTICULATION MATRIX

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

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

COURSE CONTENT

Unit -1

Functional English: Language as a Tool of Communication, - Effective Communication-Modes of Communication-Email communication - Giving Instructions.

Unit -2

Interpersonal Skills: Traits of good Listener types of Listening-- Formal letters (Accepting/ inviting/ declining); Personal letters (Inviting your friend to a function, congratulating someone for his / her success, thanking one's friends/relatives, - Process descriptions (general/specific).

Unit-3

Multitasking Skills: Types of Speaking- Paralinguistic Features-Types of paragraphs (cause and effect / compare and contrast / narrative / analytical); Report Writing (Feasibility/ Project report - report format – recommendations / suggestions, PPT).

Unit - 4

Persuasive Skills: Reading and Interpretation- SQ3R- Making inference from the reading passage; predicting the content of a reading passage, - Different types of Essay Writing, applying for a job; Writing a cover letter with résumé / CV.

Text Books:

1. Thorpe, Edgar and Showick Thorpe" Objective English", Pearson Education, 2013.
2. Dixson, Robert J. "Everyday Dialogues in English", Prentice Hall India Pvt Ltd., 1988.
3. Turton, Nigel D. "ABC of Common Errors", Mac Millan Publishers, 1995.
4. Ashraf Rizvi, "Effective Technical Communication" ,McGraw-Hill Education (India) Pvt. LTD., New Delhi, 2018.

Reference Books:

1. Bansal, R.K. and J.B. Harrison, "Spoken English", Orient Blackswan, 2013.
2 .Raman, Meenakshi and Sangeeta Sharma, "Technical Communication", Oxford University Press, 2015.
3. Samson, T. (ed.),"Innovate with English", Cambridge University Press, 2010.

Course Title	Programming with C				Course Type		HC	
Course Code	B22CI0104	Credits	3		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**42**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Algorithms and flowcharts are the fundamental tools for problem solving which can be used by the computers. The computer programs can be developed using algorithms and flowcharts to provide solutions to problems. C Language is a general-purpose, structured and procedure oriented programming language. It is one of the most popular computer languages today because of its structure and higher-level abstraction C. This course introduces algorithms, flowcharts and various C Programming language constructs for the development of real world applications.

COURSE OBJECTIVES

1. Explain algorithms, flowcharts and different programming constructs of C to be used for Development of applications.
2. Illustrate the use of iterative statements and conditional Statements for solving the real world problems.
3. Demonstrate the use of functions with parameter passing mechanisms for solving the real world problems.
4. Discuss the use of structures, unions, pointers and file operations for solving the real world Problems.
5. Learn new algorithms and technologies in C Programming and apply for suitable application development.
6. Develop solutions by using C Programming to the complex problems, either individually or as a part of team and report the results.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Identify the programming constructs of C language to solve a given problem.	1-3	1
CO2	Apply the concepts of matrices to develop data processing and analysis solutions in various application domains.	1-5	1
CO3	Develop text processing based applications using string operations.	1-3,5	2
CO4	Create solutions for real world problems using Pointers, Union, Structures and file operations.	1-5	2
CO5	Use algorithms and technologies in C Programming for suitable application development	1-5	2
CO6	Develop solutions by using C Programming to the complex problems, either individually or as a part of the team and report the results	1-5,9	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	2	1	3										3		
CO2	1	3	2	2	2								3		
CO3	2	2	2		1									3	
CO4	3	3	3	1	1									3	
CO5	3	3	3	2	2									3	
CO6	3	3	3	2	2				3					3	
Average	**2.3**	**2.5**	**2.7**	**1.8**	**1.6**				**3.0**				**3.0**	**3.0**	

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

COURSE CONTENT

Unit-1

Algorithm: Definition, Purpose of writing an algorithm, Rules for writing an algorithm, Advantage of writing algorithm and examples.

Flowchart: Definition, Notations used to write a flow chart, Advantage and disadvantages of writing the flowchart and examples.

Introduction to "C": Introduction to GitHub, Structure of C program with example, C language & its features, C tokens, data types in C, variables, constants, input and output functions

Unit –2

Operators and Expressions: Unary operator, assignment operator, arithmetic operator, relational operators, logical operators &bitwise operator, conditional operator, increment and decrement operator, special operator.

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

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

Iterative Statements (loops): while loop, do-while, for loop, differences between while, do-while and for loop.

Unit -3

Arrays: one dimensional array, two dimensional array, Linear and binary search and bubble sorting.

Functions: Structure of a function, types of functions, parameter passing mechanisms, Command line arguments.

Strings: String operations with and without using inbuilt string functions.

Unit -4

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

Pointers: Introduction to pointers.

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

TEXT BOOKS

1. B.W. Kernighan and D.M. Ritchie, "C Programming Language", Prentice Hall Software Series, 2nd Edition, 2005.
2. Herbert Schildt, "C: The Complete Reference", Tata McGraw Hill, 4th Edition, 2000.
3. B.S. Anami, S.A. Angadi and S. S. Manvi, "Computer Concepts and C Programming: A Holistic Approach", PHI, 2nd Edition 2008.

REFERENCE BOOKS

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

JOURNALS/MAGAZINES

1. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=6294 (IEEE Journal/Magazine on IT Professional)
2. https://ieeexplore.ieee.org/document/1267572 (IEEE Computing in Science and Engineering)

SWAYAM/NPTEL/MOOCs

1. https://online courses.nptel.ac.in/noc20_cs06/preview (Problem Solving through Programming in C)
2. https://www.edx.org/course/c-programming-getting-started (C Programming Getting started)
3. https://www.coursera.org/specializations/c-programming (Introduction to C programming)

SELF-LEARNINGEXERCISES

1. Fundamentals of computer graphics: output primitives–Line, Circle and Ellipse drawing algorithms- Attributes of output primitives.
2. Inline Assembly Language Program: Simple inline assembly, Extended Assembly Syntax Microsoft C Compiler.

Course Title	Elements of Mechanical Engineering				Course Type		HC	
Course Code	B22ME0103	Credits	3		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**42**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

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
5. To acquire a basic understanding role of Mechanical Engineering in the industry and society.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Evaluate the properties of steam and performance parameters of IC engines.	1, 2	1,2
CO2	Describe the working principle of boilers, turbines, refrigeration and air conditioning systems	1	1
CO3	Classify the engineering materials and discuss the concept of casting, CNC machine, laser engraving and 3D printing technology.	1	1
CO4	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	1,2
CO5	Discuss the application of machine elements and Calculate the speed ratio of belt drives and Gear Drives.	1,2	1,2
CO6	Describe the need of mechatronics approach in industry and application of robots.	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	1											1		
CO2	2												1		
CO3	2												1		
CO4	3	1											1	1	
CO5	3	1											1	1	
CO6	1												1		
Average	2.3	1											1	1	

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

COURSE CONTENT

Unit-1

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

Unit-2

Prime Movers: Types and working principle of turbines, IC Engines, numerical on IC engines.

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

Unit-3

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, laser engraving and 3D printing.

Unit-4

Machine Elements: Types and applications of springs, belt drives, gear drives and chain drives, numerical on belt drives and gear trains.

Introduction to Mechatronics and Robotics: Need of Mechatronics in industries, measurement system, open and closed loop control system, Robot anatomy, applications of Robotics.

TEXT BOOKS

1. K R Gopala Krishna, Sudheer Gopala Krishna and S C Sharma, “Elements of Mechanical Engineering”, Subhash Publishers, 13th Edition, 2015.
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.
2. William Bolton, “Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering”, Pearson, 2015.
3. K. K. Appukuttan, “Introduction to Mechatronics”, Oxford University Press, 2007.

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.

Course Title	IoT and Applications				Course Type		HC	
Course Code	B22EN0101	Credits	2		Class		II Semester	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	1	1	1				
	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Practical	1	2	2				
	Total	**2**	**3**	**3**	**14**	**28**	**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 OBJECTIVE

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 component of IoT architecture	1,2,3,4,5	1,2
CO2	Interpret various Applications of IoT	1,2,3,4,5	1,2
CO3	Identify IoT development boards, sensors & actuator	1,2,3,4,5	1,2
CO4	Identify communication technologies, protocols, and cloud services	1,2,3,4,5,9,10	1,2
CO5	Demonstrate the interfacing of sensors & actuators to IoT board	1,2,3,4,5,9,10	1,2
CO6	Develop simple IoT projects and modules	1,2,3,4,5,9,10	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	2	1	1	1								3	3	
CO2	2	3	1	1	1								3	3	
CO3	3	2	1	1	3								2	2	
CO4	3	2	1	1	3				2	2		2	1	1	
CO5	3	1	2	1	2				2	2		2	2	1	
CO6	3	2	2	1	2				2	2	2	2	1	1	
Average	**2.8**	**2.0**	**1.3**	**1.0**	**2.0**				**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**1.8**	

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

COURSE CONTENT

THEORY

Unit-1

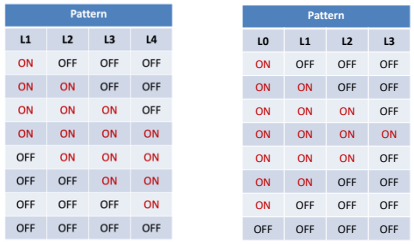
IoT Basics: Previous technologies before IoT, Introduction to IoT, How IoT works, Components of IoT Infrastructure, Basic elements of general IoT Architecture, Characteristics of IoT, benefits and challenges of IoT, Applications of IoT.

Unit-2

IoT Enabling Technologies

IoT Development Boards: Arduino, Add-on ESP module, Node MCU, Raspberry Pi; Sensors and Actuators: Temperature Sensor, PIR Sensor, Ultrasonic senor; Communication Technologies: Bluetooth, ZigBee, LoRa, WiFi, **Cellular; Protocols:** HTTP, MQTT, CoAP; IoT Cloud Platforms: Arduino Cloud, Thing Speak, Blink Cloud

PRACTICE:

Sl. No.	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	Part-A		
	Introduction to Arduino Board & getting stared with Arduino IDE software	Hardware & software	Identifications of various parts of Arduino Board &
1	Write a program to blink an LED a) Infinite number of times with ON & OFF duration of 1 sec b) infinite number of times with ON time duration 2 sec and OFF time duration 0.5 sec c) Only 3 times with ON and OFF duration 2 sec	Arduino UNO, Arduino IDE, LED's	Arduino coding
2	Write a program to blink 4 LED in the given pattern  Pattern L1 L2 L3 L4 ON OFF OFF OFF ON ON OFF OFF ON ON ON OFF ON ON ON ON OFF ON ON ON OFF OFF ON ON OFF OFF OFF ON OFF OFF OFF OFF Pattern L0 L1 L2 L3 ON OFF OFF OFF ON ON OFF OFF ON ON ON OFF ON ON ON ON ON ON ON OFF ON ON OFF OFF ON OFF OFF OFF OFF OFF OFF OFF	Arduino UNO, Arduino IDE, LED's	Arduino coding, Looping structure

3	Write a program to blink an LED with different times and duration using the concept of user defined function	Arduino UNO, Arduino IDE, LED's	Arduino coding, user define function
4	Write a program to interface motion sensor and display its status using g LED. If motion is detected it turn on LED otherwise keeps the turn off the LED.	Arduino UNO, Arduino IDE, LED, PIR sensor	Interface PIR sensor
5	a) Write a program to increase and decrease the brightness of LED. b) Write a program to control the brightness of LED using Potentiometer	Arduino UNO, Arduino IDE, LED, Potentiometer	
6	a) Write a program to interface LDR to Arduino board and display the voltage across LDR on serial monitor b) Write a program to control the brightness of LED based on the intensity of light on LDR	Arduino UNO, Arduino IDE, LED, LDR	Interface LDR sensor
7	a) Write a program to interface temperature sensor and display the values on the serial monitor b) Write a program display range of temperature on LCD	Arduino UNO, Arduino IDE, LCD, Temperature sensor	Interface Temperature sensor
8	Write a program to interface ultrasonic sensor and display the distance from an object.	Arduino UNO, Arduino IDE, Ultrasonic sensor	Interface Ultrasonic sensor
Challenging Experiments			
9	a) Introduction to ESP module & programming using Arduino IDE software b) Write a program to demonstrates how to use Wifi module ESP8266-01 to blink LED (with simple LED)	ESP8266 Arduino Uno, LED, Arduino IDE	Interface of LED to ESP Module, Program ESP using Arduino IDE
10	Write a program to demonstrate how ESP8266 can be used as an HTTP client and HTTP server to control and monitor the status of an LED	ESP8266, Arduino Uno, LED, Arduino IDE	Understand about Client Server Model
11	Write a program demonstrate how ESP8266 can be used as HTTP Webserver and get commands from the client (mobile/Laptop) directly.	ESP8266, Arduino Uno, LED, Arduino IDE	Understand about Client Server model, Create Webserver
12	Write a program to demonstrate how to implement Publisher/Subscriber method (MQTT) to control and monitor the ESP8266 GPIO2 LED	ESP8266, Arduino Uno, LED, Arduino IDE	Understand about Publisher/Subscriber Model
13	Write a program to demonstrate how ESP8266 can be used to log sensor data into thinkspeak cloud.	ESP8266, Arduino Uno, LED, Arduino IDE, ThingSpeak Cloud Service	Connect to cloud and storing data.
Part-B (Case Study/ Projects - Sample Topics)			

1. IoT based Automated Table Lamp 2. IoT based Light Dimmer and Speed Controller 3. IoT based Energy Monitor and Over Current Cut-off 4. IoT based Smart Home Controller Using Blynk 5. IoT based Motion Detector Using Cayenne 6. IoT based Air Pollution Meter 7. IoT based Smart Camera 8. IoT based Pet Feeder 9. IoT based Electronic Door Opener 10. IoT based Underground Cable Fault Detector 11. IoT based Air & Sound Pollution Monitoring System 12. IoT based Weather Reporting System 13. IoT based Toll Booth Manager System 14. IoT based Heart Attack Detection & Heart Rate Monitor 15. IoT based Person/Wheelchair Fall Detection	17. IoT based Patient Health Monitoring 18. IoT based Garbage Monitoring System 19. IoT based Liquid Level Monitoring System 20. IoT based Biometric Attendance System 21. IoT based Irrigation Monitoring & Controller System 22. IoT based Gas Pipe Leakage Detector 23. IoT based Alcohol & Health Monitoring System 24. IoT based Streetlight Controller System 25. IoT based Traffic Signal Monitoring & Controller System 26. IoT based Fire Department Alerting System 27. IoT based Antenna Positioning System 28. IoT based Garbage Monitoring with Weight Sensing 29. IoT based Colour Based Product Sorting Machine 30. IoT based Smart Mirror with News & Temperature 31. IoT based Car Parking System 32. IoT based Automatic Vehicle Accident Detection and Rescue System

TEXTBOOKS

1. Vijay Madisetti and Arshdeep Bahga , “Internet of Things: A Hands-On- Approach”, 2nd Edition ,2014.

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

Course Title	**Design Thinking**				**Course Type**		**Hard Core**	
Course Code	**B22ME0102**	**Credits**	**2**		**Class**		**II Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practice	IA	SEE
	Total	**2**	**3**	**3**	**14**	**28**	**50 %**	**50 %**

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	Course Outcomes	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, 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.	1,8,9,10,12	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	2							2	2		2	3	2	
CO2	1	3							2	3		2		2	
CO3	1								3	2		3	1	2	
CO4	1	2							3	2		2	1	2	
CO5	2		3		2				3	3		2	2	3	
CO6	2							1	3	2		2	2	3	
Average	1.6	2.3	3		2			1	2.6	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.

Tutorials:

Sl. No	Name of the Topic	Tools and Techniques	Expected Skill /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 problem identified in the teams formed	Visualization	Develop ability to understand other's 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

<table>
<tr><td>Course Title</td><td colspan="4">Programming with C Lab</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
<tr><td>Course Code</td><td>B22CI0108</td><td>Credits</td><td colspan="2">1</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">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>Tutorial</td><td>0</td><td>0</td><td>0</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</td><td>Theory</td><td>Practical</td><td>IA</td><td>SEE</td></tr>
<tr><td>Total</td><td>1</td><td>2</td><td>2</td><td>0</td><td>28</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

Algorithms and flowcharts are the fundamental tools for problem solving which can be used by the computers. The computer programs can be developed using algorithms and flowcharts to provide solutions to problems. C Language is a general-purpose, structured and procedure oriented programming language. It is one of the most popular computer languages today because of its structure and higher-level abstraction C. This course introduces algorithms, flowcharts and various C Programming language constructs for the development of real world applications.

COURSE OBJECTIVES

1. Explain algorithms, flowcharts and different programming constructs of C to be used for Development of applications.
2. Illustrate the use of iterative statements and conditional Statements for solving the real world problems.
3. Demonstrate the use of functions with parameter passing mechanisms for solving the real world problems.
4. Discuss the use of structures, unions, pointers and file operations for solving the real world Problems.
5. Learn new algorithms and technologies in C Programming and apply for suitable application development.
6. Develop solutions by using C Programming to the complex problems, either individually or as a part of team and report the results.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Identify the programming constructs of C language to solve a given problem.	1-3	1
CO2	Apply the concepts of matrices to develop data processing and analysis solutions in various application domains.	1-5	1
CO3	Develop text processing based applications using string operations.	1-3,5	2,3

CO4	Create solutions for real world problems using Pointers, Union, Structures and file operations.	1-5	2,3
CO5	Use algorithms and technologies in C Programming for suitable application development	1-5	2,3
CO6	Develop solutions by using C Programming to the complex problems, either individually or as a part of the team and report the results	1-5, 9, 10	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 ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	3						3	3			3		
CO2	1	3	2	2	2				3	3			3		
CO3	2	2	2		1				3	3				3	3
CO4	3	3	3	1	1				3	3				3	3
CO5	3	3	3	2	2				3	3					
CO6	3	3	3	2	2				3	3			3	3	2
Average	**2.3**	**2.5**	**2.7**	**1.8**	**1.6**				**3.0**	**3.0**			**3.0**	**3.0**	**2.7**

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

PRACTICE

No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
	PART A:		
1	Consider Loan applications in a bank consisting of various customer details such as Name, Organization, salary and loan amount applied. Segregate the loan applications based on income (low: <=5 lpa, medium: >5lpa <10lpa and high:>10lpa)	Condition checking	Apply if-else and switch
	Two files DATA1 and DATA2 contain sorted lists of integers. Write a C program to merge the contents of two files into a third file DATA i.e., the contents of the first file followed by those of the second are placed in the third file. Display the contents of DATA.	Files operations	Apply File concepts
2	Statistical measures are used for data analysis and interpretation. Develop program to determine the mean and stand deviation of data stored in an array.	Statistical Computing	Use Array and loops

	Consider the details of Airline passengers such as Name, PAN-No., Mobile-no, Email-id, Source, Destination, Seat-No and Air-Fare. Develop a program to read the details of airline passengers, store them in the structure "Airline" and List details of all the passengers who travelled From "Bengaluru to London".	Search technique	Apply Structures
3	Assume that Mr. Peterson shopped N items at Big Market and his Cart comprises of name of the item, cost of the item per UNIT and quantity. Read the details of shopping and store them in the structure "Shop". Compute the total amount spent on shopping at Big Market and also find out the item with minimum and maximum cost.	Statistical measure	Apply Structure and if then else
	b. Write a C program to define a structure named Student with name and DOB, where DOB in turn is a structure with day, month and year. Read the details of student and store them in the structure "Student". Display name and date of birth of students using the concept of nested structures.	Nested Structures	Apply Nested Structures
4	Consider a set of N students with SRN, name, and marks scored in 8 subjects. Read the details of students and store them in the structure "Student_Marks". Compute total marks and average marks of each student and display them with suitable headings.	Average computation and visualization	Apply Structure, Array and Loops
	b. Create the structure "Book" with book_id, title, author_name and price. Write a C program to pass a structure as a function argument and print the book details.	Functions	Passing structures to function
5	Assume that Ms. Jassica shopped N items at Amazon and the Cart comprises of name of the item, cost of the item per UNIT and quantity. Arrange the items in the increasing order of cost of the item per UNIT.	Sorting	Apply sorting the contents of structure.
6	Write a C program to compute the monthly pay of "N" employees using each employee's name, Basic_Pay, DA and HRA. The DA and HRA are 80% and 30% of the Basic_Pay respectively. Gross-salary is computed by adding DA and HRA to Basic_Pay. Store all the details in an array of structures and print the name and gross salary of each employee.	Reading and storing data	Use structures for reading and storing data
7	Consider the details of "N" Faculty members consisting of Name, EMP-ID,name of the school, address and salary. Create a file to store the above details. Retrieve the contents of the file to perform following operations: (i) Display the details of the faculty based on salary range entered. (ii) Display the details of the faculty based on the EMP-ID entered.	File operations	Create file, store data and display details.
8	Write a C program to determine whether the character entered is a capital letter, a small case letter, a digit or a special symbol using if else and switch case.	String operations	Apply string functions
PART B:			

	Project 1: Address Contact List with the following modules: User Add User(Name, Address, Primary contact number, secondary contact number, E-mail ID) Delete User Search for User Edit Find and replace the user name Edit the contact (Phone Number) details. Edit the Address of the user Report List of users based on the starting letter of their names. List of users based on first 2 digits of their mobile number. List of users based on the domain name of their E-mail ID.		
1	Develop a program in C to create the structure "Contact" with the fields, user name, address, mobile, phone1 and email_id. Read the data into the structure "Contact" and store them in the file "Contact.txt".	Structures and Files	Develop the program using Structures and Files
2	Develop a program in C to open contact list from the file "Contact.txt" in read mode and delete contact details of the person based on name of the person by searching his/her details. Display the updated list.	String, File and Linear Search	Develop the program using String and File
3	Develop a program in C to input the string,"Str1" (which can be either a mobile no. or name of the user) and search for it in the file, "Contact.txt" and display the details if it is found else display an error.	String, File and Linear Search	Develop the program using String and File
4	Develop a program in C to input the name of the user into the string, "Str1" , search for it in the file "Contact.txt" and replace the content of "Str1" with the new data if found.	String, File and Linear Search	Develop the program using String, File and apply linear search
5	Develop a program in C to input the phone number of user into the string, "Str1", search for it in the file "Contact.txt" and edit it with new data if found and save the same.	String, File and Linear Search	Develop the program using String, File and apply linear search
6	Develop a program in C to input the address of the user and search for the same in the file, "Contact.txt" and edit the address with new address and save the same.	String, File and Linear Search	Develop the program using String, File and apply linear search
7	Develop a program in C to input a letter into "Letter", compare it with the details stored in "Contact.txt" and then display the list of the users whose name begin with "Letter ".	File operations	Develop the program using file
8	Develop a program in C to input first two digits of a mobile number into "Mobile", search for the same in "Contact.txt" and display the details of all the users whose mobile number begin with "Mobile".	File operations	Develop the program using file
9	Develop a program in C to input a domain name of email-id and search for the same in the file, "contact.txt" and list the details of the users whose email-id matches with the given domain name.	File operations	Develop the program using file

TEXT BOOKS

1. B.W. Kernighan and D.M. Ritchie, "C Programming Language", Prentice Hall Software Series, 2nd Edition, 2005.
2. Herbert Schildt, “C: The Complete Reference”, Tata McGraw Hill, 4th Edition, 2000.
3. B.S. Anami, S.A. Angadi and S. S. Manvi, “Computer Concepts and C Programming: A Holistic Approach”, PHI, 2nd Edition 2008.

REFERENCE BOOKS

1. Balaguruswamy,”Programming in ANSI C”, Tata McGraw Hill, 4th Edition 2008.
2. Donald Hearn and Pauline Baker, “Computer Graphics C Version”, Pearson Education, 2nd Edition, 2004.

Course Title	Engineering Workshop				Course Type		Hard Core	
Course Code	B22ME0104	Credits	1		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW

Workshop practice provides the basic working knowledge of the production and properties of different materials used in the industry. It also explains the use of different tools, equipment’s, machinery and techniques of manufacturing, which ultimately facilitate shaping of these materials into various usable forms. Also to provide the basic knowledge on working and function of two wheeler and four wheeler vehicle engine and power transmission system.

COURSE OBJECTIVES

1. To make student familiar with automobile engine terminology and to have visualization of shape, size and working of engine parts.
2. To introduce the use of tools and instrument and their selection for carrying out the fitting, sheet metal work and welding work.
2. To introduce the processes used of convert of raw material in to product.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Visualise the parts of two wheeler engine and analyse the sequence of parts connected and their functional relationship.	1, 2, 9	1
CO2	Identify and explain the function of the major components of engine and power transmission system of Toyota Innova and Toyota Fortuner cars	1,2,9	1,2
CO3	Prepare the fitting model as per the given engineering drawing by using appropriate fitting tools.	1, 2, 9	1
CO4	Develop the simple sheet metal models as per drawing specification using sheet metal tools.	1,2,3,9	1,2
CO5	Demonstrate the working and application of laser engraving, 3D printing and welding processes.	1, 9	1,2
CO6	Draw the layout of workshop and prepare a technical document about the process to be followed in engineering workshop.	1,10	1

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	2	1							2				1		
CO2	2	1							2				1	1	
CO3	2	1							2				1		
CO4	2	1	1						2				1	1	
CO5	2								2				1	1	
CO6	2									3			1		
Average	**2**	**1**	**1**						**2**	**3**			**1**	**1**	

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

Part-A

1. Dismantling and Assembly of 2-Wheeler (2–stroke) Engine Parts.
2. Identification of parts of an engine of Toyota Innova and Toyota Fortuner
3. Calculation of Speed ratio of belt, chain and gear drives.
4. Study of Power train of Bicycle, 2-Wheeler and 4-Wheeler.
5. Demonstration of laser engraving process and 3D printing process.

Part-B

1. Study of Fitting tools and preparation of fitting models.
2. Study of sheet metal tools and development of pen stand and funnel
3. Hands on training on welding.
4. Study of power tools.

TEXT BOOKS

1. K.R. Gopalkrishna, “Elements of Mechanical Engineering”, Subhash Publishers, 12th Edition, 2012.
2. SKH Chowdhary, AKH Chowdhary and Nirjhar Roy, “The Elements of Workshop Technology - Vol I & II”, Media Promotors and publisher, 11th Edition, 2001.

REFERENCE BOOKS

1. David A. Crolla, “Automotive Engineering-Powertrain, Chassis System and Vehicle Body”, Butterworth-Heinemann is an imprint of Elsevier, 1st Edition, 2009.
2. R.S.Parmar, “Welding Processes and Technology”, Khanna Publishers, New Delhi, 2003.

JOURNALS/MAGAZINES

1. International Journal of Machine Tools and Manufacture
2. https://www.shutterstock.com/search/disassembled-bike-engine
3. https://pdfcoffee.com/ex5-assembly-and-disassembly-of-ic-engine-parts-pdf-free.html

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/cours

Course Title	Applied Chemistry Lab				Course Type		FC	
Course Code	B22AS0206	Credits	1		Class		II Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW

Engineering chemistry LAB covers very relevant experiment which is related to the topics compatible with ME students and make them aware of importance of various aspects of basic science in engineering. The practice gives insights on areas of light and matter interaction, optical properties of materials, clean energy, electrical conduction in solutions, corrosion phenomenon and control which is widely an interdisciplinary subject of discussion. Further the course focus on the chemistry of engineering materials, and various applications. This area of science is very much interdisciplinary in its nature and gives a platform for students to strengthen their engineering knowledge to enlighten on the importance of science which very essential for research in engineering stream.

COURSE OBJECTIVES

The Engineering chemistry lab course is designed to fulfil the following objective;

1. Provide basic knowledge and experimental required for engineering students to understand its importance of Science in technology.
2. Provide the basic knowledge and experimental skill on Interaction of light and matter to know the electronic transitions in materials and storage and conversion devices.
3. Corrosion and metal finishing, explains the phenomenon of corrosion and its Prevention. It also covers the importance of metal finishing in various industries and fabrication of PCB.
4. Electrochemical methods will be used to fabricate materials as thin films and various sensing techniques for lab analysis
5. Preparation of semiconducting and conducting materials, polymers and understand their commercial significance.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Estimate the amount of metal ions present by interaction of light source.	1,2,9,10	1
CO2	Demonstrate the electrolytic process in electrochemical cell for the purpose of energy storage and energy conversion devices.	1,2,9,10	1
CO3	Describe the corrosion phenomenon and list out various precautions to be taken in the selection of materials in controlling corrosion.	1,2,9,10	1
CO4	Preparation of commercially important polymers, nano materials, composite materials and their applications	1,2,3,9,10	1
CO5	Analyze various water quality parameters in daily life suitable for portability.	1,2,8	1

CO6	Preparation of thin film and bulk solid state conductors and semiconductors relevant to device applications	1,2,3,9,10	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 ARTICULATIONMATRIX

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

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

Part-A: List of Experiments

No	Title of the Experiment	Tools and Technics	Expected Skill/Ability
1	Verification of Beer-Lambert's Law by detection of Copper by spectroscopy.	Calorimeter, Visible spectroscopy, cuvettes	Understand the theory of interaction of light with matter and the electronic transitions in material and experimentally verify the Beer Lambert law and quantify the amount of substance
2	Estimation of Iron by Potentiometric sensor.	Potentiometer, electrodes, reference electrodes	Understand the theory of potential changes and measure and interpret the potential changes associated with change in chemical composition. This is relevant in electrochemical energy storage and conversion devices like batteries, capacitors, fuel cells
3	Estimation of concentration of acid mixture by Conductometric sensor.	Conductometer, conducting electrolytes	Understand the theory and perform the experiment, Interpret the ionic conductivity in the solution. Measure the conductance of ionically conducting liquid materials

No	Title of the Experiment	Tools and Technics	Expected Skill/Ability
4	Determination of pH/pKa of solutions using glass membrane electrode sensor.	pH meter, glass electrodes, pH sensing electrochemical cell setup	Understand the electrochemical theory, perform the experiment to sense and evaluate the pH of the give solution. Interpret the importance of pH in engineering materials and their application
5	Faraday's law verification by using Electrodeposition of Cu/Ni/Zn on stainless steel.	DC power supply units, Electrochemical cells, different coating substrate	Understand the theory of soft electrochemical deposition of thin films and perform the experiment on deposition different conductive substrates
6	Determination of Viscosity of organic Liquids by Ostwald's Viscometer	Ostwald Viscometer	Understand the theory of viscosity and perform the experiment to estimate viscosity of different fluids.
7	Evaluation of Dissolved Oxygen by Winkler's method and hence assessment of quality of water.	Winkler's method, Iodometric technique	Understand the theory and perform the experiment, collect the data and interpret dissolved oxygen content in industrial and domestic effluents
8	Estimation of Calcium/Iron/Silica in Portland Cement.	Indicators,	Understand the theory and composition of cement and perform the experiment, to estimate the important constituents of cement
9	Estimation of total hardness of Water by Complexometric Method Using EDTA	Hard water, Complexing agents	Understand the theory and perform the experiment to understand and interpret water quality. Devise the easy method for removing the hardness causing agent through complexometry
10	Determination of Alkalinity of Water Sample	Different alkaline water, variable composition, Mixed indicators	Understand the theory and perform the experiment to estimate the alkalinity of the industry feed water. Understand the need neutral water, adverse effects of alkaline water
11	Determination of percentage of iron in corrosion products.	Corrosion products, compositions analysis	A better understanding the mechanism of corrosion. Able to perform experiment to estimate the extent of corrosion and quantify the amount of corroded products
12	Synthesis of Conducting Polyaniline from aniline by Chemical method.	Simple oxidation method.	A better understanding of conducting polymers and their relevant applications in devices

PART-B: Projects

No	Title of the Experiment	Tools and Technics	Expected Skill/Ability
1	Flame photometric determination of metal ions in corroded products, water and engineering materials	Flame Photometer	To demonstrate the extent of metal ions dissolved from the substrate of different engineering materials.

2	pH and Potentiometric sensor	pH meter, Potentiometer	To demonstrate the effect of pH on engineering materials and the potential changes with change in chemical composition
3	Assembly of energy storage devices	Batteries, DC power supply units	To assemble and perform cell voltage and discharge experiments

REFERENCE BOOKS

1. V R Gowariker, N V Viswanathan and Jayadev Sreedhar, "Polymer Science", Wiley eastern ltd, 4th Edition, 2021.
2. Sudha Rani and S.K. Bashin, "Laboratory Manual on Engineering Chemistry", Dhanpat Rai Publishing Company, 3rd Edition, 2012.
3. J. Mendham," Vogel's Quantitative Chemical Analysis", Parsons, 6th Edition, 2009.

JOURNALS/MAGAZINES

1. https://pubs.acs.org/doi/abs/10.1021/acs.jchemed.5b00118
2. https://www.youtube.com/watch?v=7yuXjGdQRzM
3. https://www.youtube.com/watch?v=g5z6EaT46iA
4. https://www.youtube.com/watch?v=-GS6uoFf3qQ

Course Title	**Tree Plantation in Tropical Region: Benefits and Strategic Planning**				**Course Type**		**FC**	
Course Code	**B22AS0208**	**Credits**	**1**		**Class**		**II Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**1**	**1**	**1**	**14**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course introduces significance of trees that provide us with a great many ecosystem services, including air quality improvement, energy conservation, storm water interception, and atmospheric carbon dioxide reduction. These benefits must be weighed against the costs of maintaining trees, including planting, pruning, irrigation, administration, pest control, liability, clean-up, and removal.

Students are expected to involve in planting a tree and nurturing till the completion of their degree program. Successful maintenance of tree is considered to be one of the eligibility criterions for the award of university degree. This course is a part of "**REVA Vanamahotsava – One Student, One Tree"**

COURSE OBJECTIVES

The Course objectives are to

1. Develop basic understanding of role of trees in climate change
2. Emphasize on the selection and placing a tree for maximum benefit to environment
3. Involve in planting a tree and nurture till the completion of the degree program
4. Generate experiential report on the tree plantation process involved

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Interpret the possible key benefits of trees arresting climate change and global warming	7,9	

CO2	Develop the ability to identify the type of a tree to be planted in urban areas, agricultural fields and forestry areas	7,9	
CO3	Make use of reading different literature on climate change and global warming by adopting various reading strategies (Reading Skills)	7,9	
CO4	Take part in planting a tree and nurturing it and Generate report on tree plantation process involved	7,9	

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				√		

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						
CO4							3		3						
Average							3		3						

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

COURSE CONTENT

Unit-1

Introduction: The tropical region, Benefits and costs of urban and community forests

Unit-2

General Guidelines for Selecting and Placing Trees Guidelines for Energy Savings, Guidelines for Reducing Carbon Dioxide, Guidelines for Reducing Storm water Runoff, Guidelines for Improving Air Quality Benefits, Guidelines for Avoiding Conflicts with Infrastructure, Guidelines for Maximizing Long-Term Benefits, Trees for Hurricane-Prone Areas

Activity based learning: Every student has to thoroughly understand the significance of planting a tree, identify type of tree and place to be planted, plant a tree and nurture till the completion of the degree.

TEXT BOOKS

1. Kelaine E. Vargas, E. Gregory McPherson, James R. Simpson, Paula J. Peper, Shelley L. Gardner, and Qingfu Xiao, "Tropical community tree guide: Benefits, Costs and Strategic Planting", U.S. Department of Agriculture, Forest Service Pacific Southwest Research Station Albany, California, 2008

REFERENCE BOOKS

1. Peter Wohlleben, "The Heartbeat of Trees", Penguin Books, 2021
2. Daniel Chamovitz, "What a Plant Knows: A Field Guide to the Senses", 2020

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.

Additional guidelines for Tree Plantation in Tropical Region: Benefits and Strategic Planning course

Since this course is aimed as a special drive to restore climate change and arresting global warming, following guidelines have been framed to conduct this course as activity-based learning to build greener nation through student community. Successful implementation of this drive meets one of the very important Sustainable Development Goals (SDG's) of UN Envision 2030 on Climate Change and Global warming. This is also one of the requirements in NEP 2020 and UGC/AICTE.

1. Classes will be conducted by the nominated faculty (one hour per week) as per the syllabus.
2. Flipped classes, field experiences, group discussions and seminars can be used by the faculty so as to engage the students through student centric learning mechanisms
3. Students should be involved into understanding cause and effects of climate change, types of pollutions, and environmental hazards
4. Quizzes and debates on climate change and global warming can be arranged for each section
5. Students should plant the suitable tree and nurture
6. "Team Vanamahotsava" – A Central assistance team from REVA University will support for identifying trees, place and organizing plantation drives.
7. Regular progress review is planned to be monitored by digital system – an advanced version of current progress monitoring App.
8. School Directors are responsible to oversee all the arrangements and progress monitoring of this drive.
9. Frequent school level and university level branding shall be arranged to give awareness of this noble drive among all the stake holders such as parents, alumni, industry and academic partners, government sectors, NGO's, ministries, and the society.
10. Regular plant maintenance drive can be planned by "Team Vanamahotsava". However, planting a tree and its nurture responsibility solely rests on individual students.
11. Successful maintenance of tree is considered to be one of the eligibility criterions for the award of university degree.

3rd Semester

Course Title	Laplace Transforms and Fourier Series				Course Type		FC	
Course Code	B22AS0302	Credits	4		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number ofClasses Per Semester		Assessment in Weightage	
	Theory	4	4	4				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**4**	**4**	**4**	**52**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

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.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	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'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										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

COURSE CONTENT

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 2π 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.

REFERENCE BOOKS

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	**Professional Ethics**				**Course Type**		**FC**	
Course Code	**B22CS0301**	**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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**2**	**2**	**2**	**26**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

The course enables e the students to imbibe and internalize the Values and Ethical Behaviors in the personal and Professional lives.

COURSE OBJECTIVE S:

1. Understand the professional Rules of conduct for Engineers.
2. Appreciate codes of conduct, professional Rules of conduct.

3. Recognize the conflict of interest and Develop strategies
4. Understand the importance of communication with all stakeholders.
5. Apply practical strategies for handling ethical dilemmas.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Understanding basic purpose of profession, professional ethics and various moral and social issues.	8,9,10	
CO2	Awareness of professional rights and responsibilities of a Engineer, safety and risk benefit analysis of a Engineer	8,9,10	
CO3	Acquiring knowledge of various roles of Engineer In applying ethical principles at various professional levels	8,9,10	
CO4	Professional Ethical values and contemporary issues	8,9,10	
CO5	Apply practical strategies for handling ethical dilemmas	8,9,10	
CO6	Appreciate codes of conduct, professional Rules of conduct	8,9,10	

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	2					
CO2								3	2	2					
CO3								3	2	2					
CO4								3	2	2					
CO5								3	2	2					
CO6								3	2	2					
Average								**3**	**2**	**2**					

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

COURSE CONTENT

Unit – 1

Introduction to Professional Ethics: Basic Concepts, Governing Ethics, Personal & Professional Ethics, Ethical Dilemmas, Life Skills, Emotional Intelligence, Thoughts of Ethics, Value Education, Dimensions of Ethics, Profession and professionalism, Professional Associations, Professional Risks, Professional Accountabilities, Professional Success, Ethics and Profession.

Unit – 2

Basic Theories: Basic Ethical Principles, Moral Developments, Deontology, Utilitarianism, Virtue Theory, Rights Theory, Casuist Theory, Moral Absolution, Moral Rationalism, Moral Pluralism, Ethical Egoism, Feminist Consequentialism, Moral Issues, Moral Dilemmas, Moral Autonomy.

Unit – 3

Professional Practices in Engineering: Professions and Norms of Professional Conduct, Norms of Professional Conduct vs. Profession; Responsibilities, Obligations and Moral Values in Professional Ethics, Professional codes of ethics, the limits of predictability and responsibilities of the engineering profession.

Unit – 4

Work Place Rights & Responsibilities: Ethics in changing domains of Research, Engineers and Managers; Organizational Complaint Procedure, difference of Professional Judgment within the Nuclear Regulatory Commission (NRC), the Hanford Nuclear Reservation.

TEXT BOOKS:

1. R. Subramanian, "Professional Ethics", Oxford University Press, 2015.
2. Caroline Whitbeck, "Ethics in Engineering Practice and Research", Cambridge University Press, 2nd Edition,2015.

REFERENCE BOOKS:

1. Charles E Harris, Jr. Michael S Pritchard and Michael J Rabins, "Engineering Ethics, Concepts Cases", Cengage learning, 4th Edition, 2015.
2. Manuel G Velasquez, "Business Ethics concepts & Cases", PHI, 6th Edition, 2008.

Evaluation pattern:

1. Internal Assessment-1 will be conducted as a MCQ test for 20 Marks which covers Unit-1 and Unit-2 of the syllabus. This exam will be conducted during IA-1 examinations slot and 5 marks will be assigned to the first assignment
2. Internal Assessment-2 will be conducted as a MCQ test for 20 Marks which covers Unit-3 and Unit-4 of the syllabus. This exam will be conducted during IA-2 examinations slot and 5 marks will be assigned to the second assignment.
3. Semester End Exam will be conducted as a MCQ exam for 50 Marks which covers unit-1 to unit-4. This exam will be conducted during semester end examination slot.

<table>
<tr><td>Course Title</td><td colspan="4">Entrepreneurship</td><td colspan="2">Course Type</td><td colspan="2">FC</td></tr>
<tr><td>Course Code</td><td>B22CI0309</td><td>Credits</td><td colspan="2">1</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>1</td><td>1</td><td>1</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td><td colspan="2" rowspan="2"></td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>1</td><td>1</td><td>1</td><td>Theory</td><td>Practical</td><td>IA</td><td>SEE</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>13</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

NEN Ignite is an entrepreneurship program based on experiential learning that aims to support startups' founders through a structured pathway from Idea Discovery to Pitch Deck. A 14 weeks classroom/digital, highly experiential and practice based entrepreneurship training Course, by Wadhawani Foundation and will be delivered by Wadhawani Foundation facilitators / NEN Trained Entrepreneurship Faculty

COURSE OBJECTIVES

1. Discover an entrepreneurial opportunity
2. Articulate a compelling value proposition
3. Build a sustainable business model and business plan
4. Create and validate an MVP with potential customers
5. Select an appropriate Go-to-Market Strategy
6. Pitch the business idea to different stakeholders

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Identify the different aspects that can impact their business	3,9,10,11	1
CO2	Acquire in-depth knowledge about tools to build any business idea	3,9,10,11	1
CO3	Acquire in-depth knowledge about the different growth tools to grow their business.	3,9,10,11	1
CO4	Create a financial plan for their business	3,9,10,11	1
CO5	Create a pitch deck for their business and present it to different stakeholders	3,9,10,11	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			√			

COURSE ARTICULATION MATRIX

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

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

COURSE CONTENT

Unit-1

Introduction to Entrepreneurship: Entrepreneurs; entrepreneurial personality and intentions - characteristics, traits and behavioural; entrepreneurial challenges. Taking product or service ideas to creating value: Why should one choose to become an entrepreneur, Entrepreneurial mind-set, Intrapreneurship.

Orientation for WE Ignite program, Ice Breaking session, self-work Instructions and timelines Platform Demo Introduction to Ignite program flow and milestones , Introduction to Entrepreneurship and Human centred Approach to Design Thinking , Are you enterprising?. 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

100 Rupee Venture: Debrief of Group Activity- Presentation and Sharing Learning Experience

Unit-2

Entrepreneurial Opportunities: Opportunities. Discovery/ creation, Pattern identification and recognition for venture creation: prototype and exemplar model, reverse engineering. Problem Identification and Opportunity Discovery.

Entrepreneurial Process and Decision Making: Entrepreneurial ecosystem, Ideation, development and exploitation of opportunities; Negotiation, decision making process and approaches, Effectuation and Causation

Customer and Markets: Customer Discovery: Exploring Customer Personas & Market Estimation for your Ideas, Create a compelling value proposition & Competitive Advantage.

Unit-3

Build your Minimum Viable Product: Building a MVP that customers Love

Crafting business models and Lean Start-ups: Introduction to business models; Creating value propositions-conventional industry logic, value innovation logic; customer focused innovation; building and analysing business models; Business model canvas, Introduction to lean start-ups, Business Pitching

Business Model: Developing strong business models Create and present your Lean Canvas

Financial Feasibility: Introduction to Business plan and its components; Basics of Finance.

Unit-4

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

Go To market Strategy: Getting products to market: Channels & Strategies; Managing growth and Targeting Scale: Understand the Unit economics for your venture; Funding Strategy: Securing funding for your Startup and Preparing for pitch.

TEXT BOOKS

1. Wadhwani Foundation Curriculum 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. Drucker F Peter: "Innovation and Entrepreneurship", 1985.Heinemann, London.
3. Doanld F Kuratko & Richard M Hodgeth, "Entrepreneurship in the New Millennium", South Western, India Edition.
4. Robert D. Hisrich,"Cengage Learning Entrepreneurship", 9th Edition.
5. Kuratko and Hodgetts, "Entrepreneurship- Theory, Process & Practice", Thompson South-Western Publication
6. Thomas N. Duening, Robert D. Hisrich and Michael A. Lechter, "Technology Entrepreneurship Taking Innovation to the Marketplace", Elsevier

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/

<table>
<tr><td>Course Title</td><td colspan="3">Environmental Science</td><td colspan="3">Course Type</td><td colspan="2">MC</td></tr>
<tr><td>Course Code</td><td>B22AS0304</td><td>Credits</td><td colspan="2">0</td><td colspan="3">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="3" 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>2</td><td>2</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td><td>Theory</td><td colspan="2">Practical</td><td>IA</td><td>SEE</td></tr>
<tr><td>Total</td><td>0</td><td>2</td><td>2</td><td>26</td><td colspan="2">0</td><td>0</td><td>100 %</td></tr>
</table>

COURSE OVERVIEW

Environmental Science is focused on a holistic understanding of earth systems in order to learn from the past, comprehend the present and influence the future. It is the study of how physical, chemical and biological processes maintain and interact with life, and includes the study of how humans affect nature. As environmental science is at

the cross-roads of the natural sciences, it provides an enriching alternative to a single-subject honors degree, and can open the door to an exciting range of career options. This approach enables us to tackle necessary problems, such as ensuring that human needs are met in a sustainable way, so that everyone has access to clean water and air, and the resources required for agriculture and industrial activity.

COURSE OBJECTIVES

1. Familiar with current and emerging environmental engineering and global issues, and have an understanding of ethical and societal responsibilities.
2. Recognize the need for engaging in life-long learning.
3. Study 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, analyse and execute favourable environmental conditions and the role of individual, government and NGO in environmental protection.	7,9,10	1
CO2	List the causes, effects & remedial measures of environmental pollution, degradation & find ways to overcome them by suggesting the pollution controlled products.	7,9,10	1
CO3	Get motivation to find new renewable energy resources with high efficiency through active research and innovation.	7,9,10	1
CO4	Critically analyze the ecological imbalances and provide recommendations to protect the environment.	7,9,10	1
CO5	Explore the condition of environmental degradation and waste management techniques and take promising measures to make our environment eco-friendly.	7,9,10	1
CO6	Identify new methodologies for conservation of our natural resources and ecosystem.	7,9,10	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							2		2	2			1		

CO2							2		2	2			1		
CO3							3		2	2			1		
CO4							3		2	2			1		
CO5							2		2	2			1		
CO6							3		2	2			1		
Average							**2.5**		**2**	**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.

Unit-2

Environmental Pollution: Definition, sources and types, Pollutant-Definition & classification, Concepts of air pollution, water 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, Bio-medical waste and Electronic waste (E-Waste).

Unit-3

Energy: Conventional/Non-renewable sources – Fossil fuels based (Coal, petroleum & natural gas), nuclear energy, Non-conventional/renewable sources – Solar, wind, hydro, biogas, biomass, 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. Forest wealth - Importances, Deforestation-Causes, effects and controlling measures

Unit-4

Ecology - Definition, branches, objectives and classification, Concept of an ecosystem – Structure and functions, Components of ecosystem-abiotic and biotic.

Levels of Biological Diversity: Genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns and global biodiversity hot spots. India as a mega-biodiversity nation; Endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity.

Field Work: Visit to waste water/sewage treatment plant (STP) and biogas plant at REVA university campus, and/or Visit 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. https://www.classcentral.com/course/swayam-environmental-studies-14042.
2. https://www.edx.org/course/introduction-to-environmental-science-2?index=product&search_index=product&webview=false&campaign=Introduction+to+Environmental+Science&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Flearn%2Fenvironmental-science.
3. https://www.coursera.org/specializations/environmental-science?action=enroll.

Examination Pattern

The course is Mandatory course, as per the regulations 2023-24, no IA tests or assignments for the course evaluation. Semester End Examination question paper is of MCQ pattern set for maximum marks of 50.

Course Title	**Engineering Thermodynamics**				**Course Type**		**Hard Core**	
Course Code	**B22ER0301**	**Credits**	**3**		**Class**		**III Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Tutorial	1	2	2				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**4**	**4**	**52**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

The primary purpose of the course Engineering Thermodynamics is to provide the students with knowledge about fundamentals of thermodynamics which includes thermodynamic systems and processes. Thermodynamic laws with application and expose to various thermodynamic cycles. Understand the properties of the gases and pure substances to analyze the processes. Further the course exposé the students to working of the devices like compressors and refrigeration systems.

COURSE OBJECTIVES

1. To enable the students to understand the basic concepts of thermodynamics.
2. To acquire the knowledge about first and second law of thermodynamics to analyse the practical applications.
3. To gain the concepts about ideal gases, real gases and pre substances to solve numerical on practical applications.
4. To identify and analyse performance of thermal devices like compressors, steam turbines, refrigerators and air conditioners.

COURSE OUTCOMES (COs)

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

CO	**Course Outcomes**	**POs**	**PSOs**
CO1	Apply fundamental concepts of thermodynamics to identify systems to solve numerical on temperature measurements.	1,2	1,2

CO2	Apply fundamental concepts of thermodynamics to solve numerical on Work and Heat.	1,2	1,2
CO3	Analyze the systems using first and second law of thermodynamics and to solve numerical on practical applications.	1,2	1,2
CO4	Analyze the thermodynamic cycles involved in systems.	1,2	1,2,3
CO5	Solve the numerical on thermodynamic processes by applying the concept of ideal gases	1,2	1.2,3
CO6	Apply fundamental concepts of thermodynamics for analysis of Pure substances	1,2	1,2

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 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	
CO3	3	3											3	3	
CO4	3	3											3	3	1
CO5	3	3											3	3	1
CO6	3	3											3	3	
Average	**3**	**3**											**3**	**3**	**1**

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

COURSE CONTENT

Unit-1

Introduction: Thermodynamic systems, microscopic and macroscopic study, Thermodynamic equilibrium, state, processes and cycles, Zeroth law of thermodynamics and thermodynamic temperature scales.

Work and Heat: Mechanics Definition of Work and limitations, Thermodynamic definition of work, Displacement work, expressions for displacement work in various processes with p-v diagrams. Work as path function, Electrical work, Paddle wheel work and flow work. Heat: definitions, units, sign convention, specific heats, heat is a path function. Comparison between work and heat. Simple numerical, demo on effect of heat on material using simulation software/animation video.

Unit-2

First Law of Thermodynamics: first law for a closed system undergoing cyclic and non-cyclic process, first law applied for open system- steady flow engineering devices

Second Law of Thermodynamics: Introduction to second law; Qualitative difference between heat and work; Cyclic heat engine; Thermal energy reservoirs; Kelvin-Plank statement and Clausius statement of second law of thermodynamics; Refrigerator and heat pump, equivalence of both statements; PMM II; Reversibility and irreversibility, causes of irreversibility; Carnot cycle, Reversed heat engine; Carnot's theorem, corollary of Carnot's theorem; Absolute thermodynamic temperature scale; Numerical

Unit-3

Entropy: Introduction to entropy; Clausius Theorem; Prove entropy as property of system; of Clausius Inequality; Temperature-Entropy diagram, representation of Carnot cycle on T-S diagram; Principle of increase of Entropy and applications The T-ds equations; Equations for change in entropy during thermodynamic processes; Numerical.

Ideal Gases: Definition, gas constant, perfect and semi perfect gases, Evaluation of heat, work, and change in internal energy, enthalpy and entropy for various quasi-static processes.

Unit-4

Pure substance: P-T and P-V diagrams; triple point and critical points, sub cooled liquid, saturated liquid, mixture of saturated liquid and vapour; saturated vapour and superheated vapour states of a pure substance with water as example; Enthalpy and entropy of change of phase (Latent heat); dryness fraction, T-S and h-s diagrams, representation of various processes on these diagrams; throttling calorimeter, separating and throttling calorimeter. Numerical.

CASE STUDIES

1. Applications related to temperature measurements, first and second law of thermodynamics
2. Applications related to Entropy, Ideal gases and pure substances.

TEXT BOOKS

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.

REFERENCE BOOKS

1. Yunus A. Cengel, "Thermodynamics: An Engineering Approach", McGraw - Hill Education, 9th Edition, 2019.
2. S Domkundwar, C P Kothandaraman, Domkundwar, "A course in Thermal Engineering", Dhanpat Rai Publication, New Delhi India, 6th Edition, 2009,
3. Gordon J. Van Wylan & Richard E Sonntagg, "Fundamentals of Thermodynamics", Wiley Eastern Ltd, 7th Edition, 2009.

JOURNALS/MAGAZINES:

1. https://www.sciencedirect.com/journal/the-journal-of-chemical- thermodynamics

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112/105/112105123/
2. https://www.coursera.org/courses?query=thermodynamics

Course Title	**Material Science**				**Course Type**		**Hard Core**	
Course Code	**B22ER0302**	**Credit**	**3**		**Class**		**III semester**	
Course Structure	TLP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	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 scienceis 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 OBJECTIVE:

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, defects, and diffusion.	1,2	1,2
CO2	Discuss the properties of ductile and brittle materials, identify various phases of metals and alloys through appropriate phase diagrams and will be able to identify homogeneous and heterogeneous nucleation.	1,2	1,2
CO3	Calculate different composition of the alloy, identify different phases and forms of iron, select suitable heat treatment process based on material properties and will be to provide a suitable method to change the properties of materials.	1,2	1,2
CO4	Check the hardenability of alloy by conducting the Jominy-end quench test, identify the different precipitation sequence in age hardening of Al-Cu alloy.	1,2	1,2
CO5	Adopt different engineering materials for different applications	1	1,2
CO6	Choose the suitable characterization techniques for analysis of surface topography, composition and precipitates of metals and alloys	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											3	1	
CO2	3	3											3	1	
CO3	3	2											3	1	
CO4	2	1											3	1	
CO5	3												3	1	
CO6	3	3			1								3	1	

Average	2.8	2.2			1								3	1	

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, atomic packing factor. Simple numerical. **Defects and diffusion in solids:** Point, linear, planar and volume defects, edge and screw dislocations, grain boundaries, twin and stacking faults. Diffusion: Diffusion mechanisms, Fick's first law and simple numerical.

Unit-2

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.

Phase diagrams: Isomorphous and eutectic binary phase diagrams, Hume rothery rules, Gibbs phase rule, lever rule, microstructure development in eutectic phase diagram. Simple numerical on phase diagrams and Gibbs phase rule, Solidification of metals and alloys, nucleation and growth phenomena, heterogeneous and homogeneous nucleation.

Unit-3

Iron-carbon system: Fe-Fe3C diagram, invariant reactions and different phases. Time temperature transformation (TTT diagrams), continuous cooling transformation (CCT) diagrams, hardenability, Jominy-end quench test.

Heat Treatment: Fundamentals of heat treatment, Annealing, types of annealing, normalizing, spheroidising, hardening, tempering, austempering, martempering, homogenization and age hardening of Al-Cu alloy. Carburizing, cyaniding and nitriding.

Unit-4

Engineering materials: Polymers: classification, properties and applications of polymers. Ceramics: classification of ceramics, applications of ceramics and types of glasses. Composite Materials: classification of composite materials based on matrix and reinforcement, matrix and fiber materials, selection of materials for engineering application, introduction to sustainable materials.

Characterization Techniques: working principle of optical, scanning and transmission electron Microscope, Fundamentals of X-ray diffraction, Bragg's law, X-ray diffraction pattern of crystalline and amorphous material.

TEXT BOOKS

1. R. Balasubramaniam," Callister's Materials Science and Engineering", Wiley, 2nd Edition, 2014.
2. Raghavan V, "Materials Science and Engineering - A First Course", Prentice Hall India Learning Private Limited, 6th Edition, 2015.

REFERENCE BOOKS

1. James F. Shackelford, "Introduction to Materials Science for Engineers", Pearson Education, 8th Edition, 2020.
2. Donald R Askeland, Pradeep P Fulay and Wendelin J Wright, "The Science and Engineering of Materials", Wadsworth Publishing Co Inc., 6th Edition, 2010.
3. Ashok Rajan, T.V. Sharma and C.P. Sharma, "Heat Treatment – Principles & Techniques", Prentice Hall of India, 2nd Edition, 2011.
4. B.D. Cullit, "Elements of X-ray Diffraction", Pearson, 3rd Edition, 2001.

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	Manufacturing Science				Course Type		Hard Core	
Course Code	B22ER0303	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Manufacturing Science is a basic course of Mechanical Engineering discipline. It focuses on overall view of mechanical engineering areas of manufacturing streams. The course is designed to understand basic concept like molding, casting, welding, metal forming, sheet metal and non-conventional machining manufacturing process and special moulding process. The students are exposed to the molding and joining process like Soldering, Brazing and Welding and various joining process. Students are introduced to the non-conventional machining methods working principles and applications.

COURSE OBJECTIVES

1. To enable the students understand the basic concepts of moulding and the sequence of processes involved in the preparation of green sand mould and sand test.
2. To teach students how to select the metal forming processes.
3. To teach students how to perform simple welding operations using Arc.
4. To understand the use of non-conventional machining processes.
5. To help students acquire knowledge about the behaviour and manufacturing properties of all engineering materials and basic concept of foundry and casting processes.
6. To demonstrate and give hands on training on the moulding and welding process.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Describe the concepts of moulding and working principle involved in casting process.	1	1,2
CO2	Understand various methods of special moulding process involved in manufacturing of superalloys.	1	1,2
CO3	Understand the different metal forming process, types, applications, solve the numerical on forging and extrusion.	1	1,2
CO4	Compare the various metal joining process for engineering applications.	1	1,2
CO5	Identify suitable welding process for different engineering materials.	1	1,2
CO6	Identify the suitable non-conventional machining process for aerospace and engineering applications.	1, 5	1,2

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 ARTICULATIONMATRIX

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

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

COURSE CONTENT

Unit-1

Metal Casting Processes: Casting Terminology, Pattern, Types of Patterns, Pattern allowances, Moulds, Moulding Tools & Machines, Core, Core Making, Sand Moulding methods, fluxing, Inoculation, Inspection and repairing of castings. Melting furnaces, Defects in casting.

Casting Cleaning: Fettling, shot blasting, Finishing and heat treatment of casting.

Special molding Process: Shell mould, Investment casting, gravity die casting, Plaster mould casting, Ceramic mould casting, die casting, Centrifugal casting, Die-casting processes.

Unit-2

Metal Forming Processes: Hot working & Cold working of metals, Forging Machines, forging operations, Rolling, Types of Rolling mills, rolling operations, Extrusion, Extrusion processes, Rod, wire and tube drawing, Bending, Principle and types of Deep drawing, Principle and Types of Sheet metal forming operations such as squeezing, spinning, peen, stretch forming and super plastic forming.

Unit-3

Fabrication Processes: Classification of welding, Electric Arc Welding Equipment, TIG & MIG Welding processes, Gas Welding, Equipment, Processes, Resistance welding, Types of Resistance welding, Soldering and Brazing, Adhesive bonding, Welding Inspection, Defects, Causes & Remedies.

Unit-4

Non Traditional Machining: Introduction, Need, classification, Electro-Discharge Machining, Electro-Chemical Machining, Laser Beam Machining, Abrasive Jet Machining, Water jet Cutting, Ultrasonic Machining, High Velocity Forming of Metals, Explosive Fabrication, Hydro forming, Electro-hydraulic Forming, Magnetic pulse Forming, Electron Beam Machining

CASE STUDIES

1. Heat generation in metal cutting and factors influencing the same
2. Prepare brief report on significance of die casting in aerospace application.
3. Study the characteristics of casting process and machining process, also list the characteristics of cast components and machined components.
4. Prepare a report showing the application and suitability of Gas welding and Electric arc welding.

TEXT BOOKS

1. P.N.Rao, “Manufacturing Technology: Foundry, Forming and Welding”, Tata McGraw Hill Volume 1, 4th Edition 2017
2. Ghosh and Mallick A. K., “Manufacturing Science”. Affiliated East-West Press Pvt. Ltd., 2010.

REFERENCE BOOKS

1. Ghosh and Mallick A. K., “Manufacturing Science”. Affiliated East-West Press Pvt. Ltd., 2010

2. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. II, 2010, Media promoters and publishers private limited, Mumbai.

JOURNALS/MAGAZINES

1. International Journal of Machine Tools and Manufacture
2. International Journal of Scientific & Engineering Research
3. Machining: Fundamentals and Recent Advances

SWAYAM/NPTEL/MOOCs

1. Machining Science: https://onlinecourses.nptel.ac.in/noc23_me02/preview
2. Introduction to Abrasive Machining and Finishing Processes: https://onlinecourses.nptel.ac.in/noc23_me21/preview

Course Title	Mechanical Measurement and Metrology				Course Type		Hard Core	
Course Code	B22ER0304	Credits	3		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	2	2	2				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**3**	**4**	**4**	**26**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

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, surface roughness and Nano measurement.
4. To explore the various aspects regarding the force, torque, strain & temperature measurement.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	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 and record the measurements.	1, 9, 10	1
CO2	Describe the need of limit system and working of different types of comparators.	1	1
CO3	Enumerate the pressure, speed surface roughness measurement and Nano Measurements	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 calliper and record the measurements.	1,2, 9, 10	2
CO6	Demonstrate the measurement of cutting forces, thread components, angular components and record the measurements.	1, 2, 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								3	3			3	2	
CO2	3												3	2	
CO3	3												3	2	
CO4	2												3	2	
CO5	2	1							3	3			2	3	
CO6	1	1							3	3			2	3	
Average	**2.2**	**1**							**3**	**3**			**2.7**	**2.3**	

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

COURSE CONTENT
THEORY

Unit-1

Introduction to Metrology: 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

Pressure Measurements: principle, Bridgeman gauge, McLeod gauge, Pirani gauge.

Speed Measurement: Mechanical counters**, c**ontact and non-contact type measurement.

Surface Roughness: Introduction, surface texture symbols and specifications, Tomlinson surface meter.

Advances in Metrology: Precision Instrumentation based on Laser Principle, Coordinate measuring machines.

Optical Measuring Techniques: Tool Maker's Microscope, Profile Projector.

Unit-4

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: strain gauge, electrical strain gauge, mechanical strain gauge, preparation & mounting of strain gauges.

PRACTICE:

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /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 calliper, 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

TEXT BOOKS

1. R.K. Jain, Engineering Metrology, Khanna Publishers, 1994.
2. I.C.Gupta, Engineering Metrology, Dhanpath Rai Publications, 2018.

REFERENCE BOOKS

1. Beckwith Marangoni and Lienhard, Mechanical Measurements, Pearson Education, 6th Edition, 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, 2013.

SWAYAM/NPTEL/MOOCs:

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

Course Title	Mechanics of Solids				Course Type		Hard Core	
Course Code	B22ER0305	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Mechanics of solids is a fundamental subject needed primarily for the students of Mechanical sciences. As the engineering design of different components, structures etc. used in practice are done using different kinds of materials, it is essential to understand the basic behavior of such materials. The objective of the present course is

to make the students acquainted with the concept of load resultant, consequences and how different kinds of loadings can be withstood by different kinds of members with some specific materials. The course contents are prepared, explaining the fundamentals in a simple and lucid manner so that the students can grasp the basics of the application of loading system and its consequence in a deformable body.

COURSE OBJECTIVES

1. To understand the basic concepts of the stresses and strains for different materials and strength of structural elements.
2. To analyse and understand principal stresses due to the combination of two dimensional stresses on an element.
3. To evaluate the behavior of torsional members, thick & thin cylinders, columns and beams.
4. To draw the SFD & BMD for different types of beams.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Apply the concepts of elasticity to determine stresses in structural members subjected to different types of loading and identify the type of load acting on the member.	1,2	1,2
CO2	Formulate the relationships between loads, member forces and deformations and material stresses and strains in structural members under axial loading.	1,2	1,2
CO3	Analyze the principal stresses in structural member's subjected to biaxial loading and draw Mohr's circle.	1,2	1.2,3
CO4	Analyze the bending stresses and Draw the SFD and BMD of beams subjected to UDL and Concentrated load.	1,2	1,2,3
CO5	Analyze the stresses in thick and thin cylinder subjected to internal pressure and structural members subjected to torsion.	1,2	1,2,3
CO6	Apply Euler's theory and Rankine-Gordon's formula to analyze the behavior of columns under different loads and end conditions.	1,2	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											3	3	
CO2	3	3											3	3	
CO3	3	3											3	3	1
CO4	3	3											3	3	1
CO5	3	3											3	3	1
CO6	3	3											3	3	1
Average	**3**	**3**											**3**	**3**	**1**

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

COURSE CONTENT

Unit-1

Stress and Strain: Concept of stress, types of stresses, concept of strain, types of strain, Hooke's law, Stress-strain diagrams for ductile and brittle materials, deformation of bars subjected to constant and variable loads, stepped bars, Principle of superposition, numerical, demo on failure of material using ansys software /animation video.

Elastic Constants: Poisson's ratio**,** volumetric strain**,** Young's modulus, Rigidity modulus and bulk modulus, relation between Young's modulus & rigidity modulus, Young's modulus & bulk modulus and relation between E,G&K, Numerical. Thermal stresses.

Unit-2

Compound stresses: Two-dimensional stress system, transformation of 2D stress system, principal stresses and planes, maximum, minimum shear stresses, and their planes. Numerical. Mohr's circle for plane stress, numerical.

Thick and Thin Cylinders: Hoop and longitudinal stresses in thin cylinders subjected to internal pressure, Stresses in thick cylinders, Lame's Theorem, Numerical.

Unit-3

Bending of Beams: Pure and non-uniform bending, Derivation of bending equation, section modulus for various beam cross sections, numerical on bending of beams, demo on bending of beams using ansys software /animation video.

Shear Force and Bending Moment Diagram: Types of beams and loads, Different types of supports, Relation between load, shear force and bending moment, Numerical on SFD and BMD for cantilever and simply supported beams subjected to various loading and boundary conditions.

Unit-4

Columns: Definition, Long and short columns, slenderness ratio, Assumptions, Derivation of Euler's crippling load for columns with different end conditions**,** Limitations of Euler's theory**,** Rankine-Gordon's formula, numerical.

Torsion: Derivation of torsion equation, Numerical on torsion of solid and hollow shafts

CASE STUDIES

1. Develop a Python Programming for obtaining shear force and bending moment diagram of beams subjected to concentrated loads, uniform loads, varying loads and externally applied moments.
2. Prepare comparison report on suitability of following materials with respect to their properties and application: Mild Steel, Cast Iron and Aluminum.

TEXT BOOKS

1. S. H. Crandall et al., "An Introduction to Mechanics of Solids (In SI Units)", McGraw-Hill. 3rd Edition, 2017.
2. F. P. Beer, E. R. Johnston (Jr.), J.T. DeWolf, D.F. Mazurek and S. Sanghi, "Mechanics of Materials", McGraw Hill, 7th edition, 2017.
3. R.C. Hibbeler, "Mechanics of Materials", Pearson, 10th Edition, 2016.

REFERENCE BOOKS

1. S.S.Bhavikatti," Strength of materials", Vikas publishing House, 5th Edition, 2022.
2. U.C.Jindal, "Strength of materials", Pearson, 1st Edition, 2012.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/mechanics-of-materials

SWAYAM/NPTEL/MOOCs

1. https://nptel.ac.in/courses/112107146
2. https://www.udemy.com/course/strengthofmaterials/

Course Title	Manufacturing Technology Lab				Course Type		Hard Core	
Course Code	B22ER0306	Credits	1		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**26**	**50%**	**50%**

COURSE OVERVIEW

Sand casting is one of the oldest and most economical processes for creating metal parts and structures. Controlling the structure and properties of green sands and cores is of great necessity to produce the metal parts and structures with high quality. Manufacturing Technology Lab is a place where castings are produced on a large scale. The students will be conducting experiments in the laboratory pertaining to testing of molding sand, preparation of moulds using cope and drag with patterns or without pattern

COURSE OBJECTIVE (S)

The objectives of this course are to:

1. The course will introduce desirable properties of moulding sand and establish its relevance in preparing the sand old.
2. To introduce the experimental procedure in determining the GFN, Permeability, Strength of mould, moisture & clay content in sand sample, core hardness and mould hardness.
3. To bring in the effect of clay and water content on the various properties of moulding sand.
4. To give students hands on practice in preparing the sand moulds (Cope & Drag box) using single piece, split pattern and without using pattern.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Describe general properties of moulding sand, the influence of Grain fineness of the silica sand used in the preparation of the mould	1,2,3,8,9	1,2
CO2	Determine the compression and shear of a moulding sand for different proportion of clay. the percentage of clay & moisture content for a given sand	1,2,3,8,9	1,2
CO3	Determine the tensile strength of a moulding sand for different proportion of clay. the percentage of clay & moisture content for a given sand	1,2,3,8,9	1,2
CO4	Determine the permeability of a moulding sand for different proportion of clay. the percentage of clay & moisture content for a given sand	1,2,3,8,9	1,2
CO5	Develop a sand mould using with or without patterns	1,2,3,8,9	1,2
CO6	Demonstrate the various skills of casting	1,2,3,8,9	1,2

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	2	1	1					-	3	3			3	3	
CO2	3	2	1					1	3	3			3	1	
CO3	3	2	1					1	3	3			3	2	
CO4	2	1	1						3	3			2	2	
CO5	2	1	1						3	3			3	3	
CO6	3	2	1					1	3	3			3	1	

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

Part-A

Preparation of sand specimens and conduction of the following tests:

a) Compression, Shear and Tensile tests on Universal Sand Testing Machine.

b) Permeability test

c) Core hardness & Mould hardness tests.

d) Sieve Analysis to find Grain Fineness number of Base Sand

e) Clay content determination in Base Sand

Part-B

a) Study of foundry tools.

b) Preparation of moulds using two moulding boxes using patterns or without patterns.(Split pattern, Match plate pattern and Core boxes).

c) Preparation of one casting (Aluminum or cast iron-Demonstration only)

TEXT BOOKS

1. Dr.K.Radhakrishna “Manufacturing Process-I”, Sapna Book House, 5th Revised Edition 2009.

2. P.N.Rao, “Manufacturing Technology: Foundry Forming and Welding”, Tata McGraw Hill, 3rd Edition,2003.

REFERENCE BOOKS

1. Roy A Lindberg, “Process and Materials of Manufacturing”, Pearson Education, 4th Edition, 2006.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/science/article/abs/pii/B9780128197264000946
2. https://www.sciencedirect.com/science/article/abs/pii/B9780081020630000059

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc23_me48/preview
2. https://www.edx.org/course/fundamentals-of-manufacturing-processes

SELF-LEARNINGEXERCISES:

1. Manufacturing Processes
2. Metal Forming Processes
3. Foundry Practices

Course Title	Material Testing Lab				Course Type		Hard Core	
Course Code	B22ER0307	Credits	1		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

This course deals with objective is to give a broad understanding of common materials related to mechanical engineering with an emphasis on the fundamentals of structure-property-application relationships. Which provides ideas on the practical knowledge of test several properties of material like ductility, surface roughness, malleability, and hardenability etc.The practical work enables the students to gain expertise and confidence in manufacturing activities.

COURSE OBJECTIVES

1. To understand the characteristics and behavior of engineering materials used for structures and machines.
2. To select materials based on their properties and their proper use for a particular facility under prevailing loads and environmental conditions.
3. To Predict component behavior using experimental test results and engineering formulae.
4. Students will have exposure to practical applications including writing of a technical report related to each experiment.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Evaluate microstructure of different materials using the metallurgical microscope.	1,2, 9, 10	1,2
CO2	Determine the impact strength of a material using Izod and Charpy tests.	1,2, 9, 10	1,2
CO3	Identify defects using non-destructive testing methods.	1,2, 9, 10	1,2
CO4	Determine the elastic properties of materials using UTM and torsion testing machine.	1,2, 9, 10	1,2,3
CO5	Evaluate surface properties of materials using wear test and determine the hardness of material using different hardness test method.	1,2, 9, 10	1,2,3
CO6	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 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 ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3							1	1			1	2	
CO2	3	2							1	1			2	1	
CO3	2	3							1	1			2	1	
CO4	3	2							1	1			2	1	1
CO5	3	2							2	1			2	1	1
CO6	3	2							2	2			2	2	
Average	**2.6**	**2.3**							**1.3**	**1.1**			**1.8**	**1.3**	**1**

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

Part-A

1. Preparation of specimen for Metallographic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.
2. Determining the impact strength of a given material using Charpy & Izod tests.
3. Estimating the Hardness of different Engineering materials using Brinell, Rockwell and Vickers's Hardness test.
4. Non-destructive test experiments like ultrasonic flaw detection, magnetic crack detection, dye penetration testing, to study the defects of cast and welded specimens.

Part-B

1. Determine the density of given composite materials.
2. To conduct Tensile, shear and compression tests of metallic and non-metallic specimens using Universal Testing Machine.
3. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.
4. To carry out torsion test on metallic specimen.
5. Bending Test on nonmetallic specimens.

TEXT BOOKS

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. Journal of Materials Science.
2. Journal of Materials Engineering and Performance

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/cours

4th Semester

Course Title	Probability and Sampling Theory				Course Type		FC	
Course Code	B22AS0403	Credits	4		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	4	4	4				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**4**	**4**	**4**	**52**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

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.

COURSE OBJECTIVES

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.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	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'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											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

COURSE CONTENT

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 conditiona 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.

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.

REFERENCE BOOKS

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	**Universal Human Values**				**Course Type**		**FC**	
Course Code	**B22EE0301**	**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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**2**	**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

COURSE OUTCOMES (COs)

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

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Course Outcomes	POs	PSOs
CO1	Understand the significance of value inputs in a classroom and start applying them in their life and profession.	6,7,8,	1
CO2	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.	6,7,8,	1
CO3	Understand the role of a human being in ensuring harmony in society and nature.	6,7,8	1
CO4	Demonstrate the role of human being in the abetment of pollution	6,7,8	1
CO5	Describe appropriate technologies for the safety and security of the society as responsible human being.	6,7,8	1
CO6	Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.	6,7,8	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	2	1					1		
CO2						3	2	1					1		
CO3						3	2	1					1		
CO4						3	2	1					1		
CO5						3	2	1					1		
CO6						3	2	1					1		
Average						**3**	**2**	**1**					**1**		

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

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

Evaluation pattern:

Internal Assessment-1 will be conducted as a MCQ test for 20 Marks which covers Unit-1 and Unit-2 of the syllabus. This exam will be conducted during IA-1 examinations slot and 5 marks will be assigned to the first assignment

Internal Assessment-2 will be conducted as a MCQ test for 20 Marks which covers Unit-3 and Unit-4 of the syllabus. This exam will be conducted during IA-2 examinations slot and 5 marks will be assigned to the second assignment. Semester End Exam will be conducted as a MCQ exam for 50 Marks which covers unit-1, unit-2, unit-3 and unit-4. This exam will be conducted during semester end examination slot.

Course Title	Technical Documentation				Course Type		FC	
Course Code	B22EN0308	Credits	1		Class		IV semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**1**	**1**	**1**	**13**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Technical writing is all about strategically placing facts and figures in a sensible and user-understandable way. A structured approach encourages creating a better output, all the while considering available resources and objectives. This course focusses on various factors to improve the skills of Technical documentation.

COURSE OBJECTIVES

1. Acquire language skills
2. Develop linguistic and communicative competencies
3. Study academic subjects more effectively using the theoretical and practical components of English syllabus, and hence will develop study skills and communication skills in formal and informal situations.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Produce effective engineering documents that enable readers to access relevant information.	6,8,9,10,12	1
CO2	Learn to avoid communication problems that distract the readers, causing confusions, distrust, or misunderstanding.	6 8,9,10,12	1
CO3	Practice various verbal reasoning and grammar practice.	6,8,9,10,12	1
CO4	Search engineering information, both in traditional ways and online.	6,8,9,10,12	1
CO5	Write research/design reports with special emphasis on content and style.	6,8,9,10,12	1
CO6	Improve the art of presentations in team	6,8,9,10,12	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						1		1	2	2		2	1		
CO2						1		1	2	2		2	1		
CO3						1		1	2	2		2	1		
CO4						1		1	2	2		2	1		
CO5						1		1	2	2		2	1		
CO6						1		1	2	2		2	1		
Average						**1**		**1**	**2**	**2**		**2**	**1**		

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

COURSE CONTENT

Unit-1

Information Design and Development: Different kinds of technical documents, Information development life cycle, factors affecting information and document design, Technical Writing, Grammar and Editing- Technical writing process, forms of discourse, Writing drafts and revising, Collaborative writing, creating indexes, technical writing style and language. Basics of grammar, study of advanced grammar, editing strategies to achieve appropriate technical style.

Unit-2

Advanced Technical Communication : Introduction to advanced technical communication, Usability, Managing technical communication projects, time estimation, Single sourcing, Localization, Writing reports, project proposals, brochures, newsletters, technical articles, manuals, official notes, business letters, memos, progress reports, minutes of meetings, event report.

TEXT BOOKS

1. David F. Beer and David McMurrey,"Guide to writing as an Engineer, John Willey. New York, 2004
2. Diane Hacker, Pocket Style Manual, Bedford Publication, New York, 2003. (ISBN 0312406843)
3. Shiv Khera, You Can Win, Macmillan Books, New York, 2003.
4. Raman Sharma, Technical Communications, Oxford Publication, London, 2004.
5. Dale Jungk, Applied Writing for Technicians, McGraw Hill, New York, 2004. (ISBN: 07828357-4)
6. Sharma, R. and Mohan, K. Business Correspondence and Report Writing, TMH New Delhi 2002.
7. Xebec, Presentation Book, TMH New Delhi, 2000. (ISBN 0402213).

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.

Evaluation pattern:

Since Technical documentation is 1 credit course and asper the regulations 23-24, IA1 and IA2 will not be conducted however internal assessment marks of 25 will be awarded based on two assignments/quizzes/presentation.

Semester End Exam is for 25 Marks and evaluation is based on the Technical report prepared by the students and viva-voce. This exam will be conducted during semester end practical examination slot.

Course Title	Indian Constitution				Course Type		MC	
Course Code	B22MEM301	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 %**	**100 %**

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 state executive and elections system of India.

COURSE OBJECTIVES

1. To know about the basic structure of Indian Constitution.
2. To know the Fundamental Rights (FR's), DPSP's and Fundamental Duties (FD's) of our constitution.
3. To know about our Union Government, political structure & codes, procedures.
4. To know the State Executive & Elections system of India.
5. To learn the Amendments and Emergency Provisions, other important provisions given by the constitution

COURSE OUTCOMES (Cos)

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

CO	Course Outcomes	Pos	PSOs
CO1	Analyze the basic structure of Indian Constitution	6,8,9, 12	
CO2	Remember their Fundamental Rights, DPSP's and Fundamental Duties (FD's) of our constitution	6,8,9, 12	
CO3	Know about Indian Union Government, political structure & codes, procedures.	6,8,9, 12	
CO4	Understand our State Executive & Elections system of India	6,8,9, 12	
CO5	Understand the Amendments and Emergency Provisions, other important provisions given by the constitution	6,8,9, 12	

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		√				

COURSE ARTICULATION MATRIX

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

CO5						2		1	1			1			
Average						**2**		**1**	**1**			**1**			

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

COURSE CONTENT

Unit – 1

Indian Constitution: Necessity of the constitution, societies before and after the constitution adoption, introduction to the Indian constitution, making of the constitution, role of the constituent assembly.

Unit – 2

Salient features of India Constitution: Preamble of Indian constitution and key concepts of the preamble, fundamental rights and its restriction and limitations in different complex situations.

Unit – 3

DPSP's and Fundamental Duties: Directive Principles of State Policy (DPSP's) and its present relevance in Indian society, fundamental duties and its scope and significance in nation, union executive: parliamentary system, union executive – president, prime minister, union cabinet.

Unit – 4

Executive and Elections system of India: Parliament - LS and RS, parliamentary committees, important parliamentary terminologies, judicial system of India, supreme court of India and other courts, judicial reviews and judicial activism, state Executive and Governer, CM, state cabinet, legislature - VS & VP, election commission, elections and electoral process, amendment to constitution, and important constitutional amendments till today, emergency provisions.

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.

REFERENCES BOOKS

1. M V Pylee, "An Introduction to Constitution of India", S Chand & Company, 5th Edition.
2. Durga Das Basu, "Introduction to constitution of India", LexisNexis, 23rd Edition.

Examination Pattern:

1. Internal Assessment-1 and 2 question paper shall be set of 25 questions, each of the 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The average of IA1 and IA2 marks obtained by the student will be final IA marks.
2. Semester End Examinations (SEE) SEE paper shall be set of 50 questions, each of the 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The marks will be scaled down to 25 Marks. The time allotted for SEE is 01 hour.

Course Title	**Kinematics and Dynamics of Machines**				**Course Type**		**Hard Core**	
Course Code	**B22ER0401**	**Credits**	**3**		**Class**		**IV Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

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, aero plane, 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 and acceleration of mechanism, different tooth forms, mesh, and their arrangements.
4. To examine the gyroscopic effect in aero plane, ship, two-wheeler, and four-wheeler vehicle.
5. To explain the working principle, 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	Understand different mechanisms, its inversions, perform the velocity and acceleration analysis of parts of mechanism.	1,2	1,2
CO2	Determine degrees of freedom for different planar mechanisms and understand the types of motion for a kinematic mechanism.	1,2	1,2
CO3	Understand the different terminologies of gear and the arrangement of different gears to transmit motion	1	1.2
CO4	Develop the various cam profile based on the follower motions and types of followers.	1,2,3	1,2
CO5	Analyze the balancing of rotating and reciprocating masses of engine.	1,2	1,2
CO6	Evaluate the performance of governor and analyze the gyroscopic effect on aero plane, two and four wheelers.	1,2	1,2

BLOOM'S LEVELOF 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 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												3	1	
CO4	3	2	1										2	1	
CO5	3	2											1	2	
CO6	3	2											1	2	
Average	**3**	**2**	**1**										**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.

Unit-2

Gears and Gear Trains: Classification & terminology, law of gearing, tooth forms & comparisons, Systems of gear teeth, 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 in same plane and in different planes.

Balancing of Reciprocating Masses: Derivation of primary and secondary force in reciprocating members, balancing of inline cylinder engine.

Unit-4

Governors: Introduction, Difference between flywheel and governor, Principle of mechanical governor, Types of governors and terminologies of a porter governor, Derivation and numerical related to height, speed and other parameters of governor

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

CASE STUDIES

1. Kinematic analysis of the press mechanism using MSC Adams
2. Analyze the forces acting on a drive shaft of the automobile and determine the position of unknown mass for complete dynamic balance
3. Draw the variation of motion for the spring used in opening and closing of inlet valves in an IC Engine
4. Calculate the length of different links for an automobile steering rod for correct steering mechanism
5. Analyze the stability of a 2 wheeler for driving in a circular track of radius 500mm

TEXT BOOKS

1. RK Bansal, "Theory of Machines", Lakshmi Publications, 6th Edition, 2016.
2. VP Singh, "Theory of Machine", Dhanpat Rai &Co, New Delhi, India, 5th Edition, 2017.

REFERENCE BOOKS

1. Joseph E Shigley, "Theory of Machine and Mechanisms Si Edition", Oxford University, 4th Edition, 2019.
2. PL Ballaney, "Theory of Machines and Mechanisms", Khanna Publication, New Delhi India, 25th Edition, 2018,

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/search?qs=kinematics

SWAYAM/NPTEL/MOOCs

1. https://onlinecourses.nptel.ac.in/noc23_me118/preview
2. https://www.coursera.org/learn/physics-101-forces-kinematics

Course Title	Thermal Engineering Systems				Course Type		Hard Core	
Course Code	B22ER0402	Credits	2		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Tutorial	1	2	2				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**2**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Thermal Engineering Systems plays an important role in design of many mechanical, electrical and electronics system. The course deals with combustion thermodynamics, Internal Combustions engines, air standard cycles, rankine cycle, refrigeration and psychometry. Further the course exposé the students to working of the systems like air conditioning systems, gas turbines and jet propulsions.

COURSE OBJECTIVES

1. To understand the basic definitions, concepts of chemical reactions involved in combustion process.
2. To study the classification, testing and performance evaluation of IC Engines.
3. To study the various aspects of energy conversion in the gas and vapor power cycles.
4. To gain the knowledge about basic definitions and concepts of refrigeration, psychometry and air-conditioning systems.
5. To evaluate the performance parameters of gas turbine and Jet Propulsion systems.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Analyze the combustion processes using thermodynamic principles.	1,2	1,2
CO2	Evaluate the performance parameters of I.C Engines.	1,2	1,2
CO3	Apply the knowledge of thermodynamics in the analysis of air standard and vapor power cycles.	1,2	1,2
CO4	Apply the concept of refrigeration and psychometry principles to evaluate the performance of air-conditioning systems.	1,2	1,2
CO5	Compute the thermal performance parameters and suggest the suitable method to improve thermal efficiency of gas turbine.	1,2	1,2
CO6	Understand the working principles of jet propulsion systems.	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	2											3	3	
CO2	3	3											3	2	
CO3	3	3											3	2	
CO4	3	2											3	2	
CO5	3	2											3	2	
CO6	3												3	1	
Average	**3**	**2.4**											**3**	**2**	

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

COURSE CONTENT

Unit-1

Combustion Thermodynamics: Theoretical (Stoichiometric) air for combustion of fuels, Excess air, balancing of combustion equations, Exhaust gas analysis, A/F ratio, Enthalpy of formation, enthalpy and internal energy of combustion. Combustion efficiency, Simple numerical.

I.C. Engines: Classification of IC engines, Performance analysis of I.C Engines, heat balance sheet, Morse test**,** Simple numerical.

Unit-2

Gas Power Cycles: Air standard assumptions, Air-standard Otto, Diesel and dual Cycles- PV and TS diagrams, description, thermal efficiencies (Derivation only for Otto cycle) and MEP, Simple numerical.

Vapor Power Cycle: Thermodynamic analysis of simple Rankine cycle, methods to improve cycle performance-Regeneration (open feed water) and reheating, numerical only on Rankine cycle.

Unit-3

Refrigeration: Vapor compression refrigeration system-description, refrigerating effect, Capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties, Vapor absorption refrigeration system (No numerical on refrigeration)

Psychometrics: Psychometric properties of Air, Psychometric Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of two moist air streams, Simple numerical.

Air Conditioning Systems: Summer air conditioning, winter air conditioning, Simple numerical.

Unit-4

Gas Turbines: Classification of Gas turbines, Gas turbine (Brayton) cycle - description and analysis of open cycle gas turbine, Derivations of equations for efficiency, work ratio and Pressure ratio for maximum power output; actual gas turbine cycles, Simple numerical, Methods to improve thermal efficiency of gas turbines

Jet Propulsion: Introduction to the principles of jet propulsion, Turbojet and turboprop engines & their processes, Principle of rocket propulsion.

CASE STUDIES

1. Develop a python programming for analyzing (drawing PV diagram) of the diesel cycle.
2. Prepare a brief report on specifications of latest IC engines used latest in modern vehicles.
3. Prepare a report on cooling load and specifications of air-conditioning systems used in offices or residential places.
4. Prepare a report on any thermal power station by mentioning the following details: Make and specifications, type and of number of turbines, capacity of power generation, working principle, operating conditions and applications.

TEXT BOOKS

1. P.K. Nag “Engineering Thermodynamics” Tata McGraw Hill, 6th Edition 2018.
2. Ganesan V, “Gas Turbines Tata McGraw Hill, 3rd Edition, 2010.
3. Domkundwar and Arora, “Power Plant Engineering” Dhanpat Rai & Co, 5th Edition, 2010.

REFERENCE BOOKS

1. Saravanamuttoo, H.I.H., Rogers, G.F.C. and Cohen, H., "Gas Turbine Theory" Pearson Education Limited, 5th Edition 2013.
2. Rajput R.K, Thermal Engineering. Lakshmi publications, 10th Edition, 2020.
3. R.B.Mathur and R.P.Sharma, "Internal Combustion Engines", Dhanpat Rai & Sons, 2nd Edition, 2018.
4. Yunus A. Cenegal and Michael A. Boles, "Thermodynamics -An Engineering Approach", Tata McGraw-Hill, 9th Edition, 2019.
5. Mahesh M Rathore, "Thermal Engineering", Tata McGraw-Hill, Prentice-hall of India Pvt. Ltd, 1st Edition, 2010.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/international-journal-of-heat-and-mass-transfer
2. American Institute of Aeronautics and Astronautics (https://www.aiaa.org/)
3. https://journals.sagepub.com/home/jer

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/courses/112/105/112105123/

<table>
<tr><td>`</td><td colspan="4">Computer Aided Machine Drawing</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B22ER0403</td><td>Credits</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">IV 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>Theory</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td><td colspan="2" rowspan="2"></td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Practice</td><td>2</td><td>4</td><td>4</td></tr>
<tr><td>Total</td><td>3</td><td>5</td><td>5</td><td>Theory</td><td>Practical</td><td>IA</td><td>SEE</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>13</td><td>52</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

The students of mechanical engineering program are mainly involved in drafting, manufacturing, inspection and planning activities (such as preparing process plans, preparing bill of materials, etc.) in industries. For all such activities, reference document is the drawing of component/assembly to be manufactured. In this context, it is of utmost important to prepare, read and interpret component drawings correctly for production of components and assemblies accurately and precisely. The industrial practices of drafting are also important for the students to make them aware of drafting practices, symbols, codes, norms and standards generally used in industries. Development of sketching ability also strengthens effective engineering communication & presentation. Now a days the market driven economy demands frequent changes in product design to suit the customer needs. With the introduction of computers the task of incorporating frequent changes as per requirement is becoming simpler. This course has been introduced at B.Tech level in order to develop the skills in student so that they can generate various production drawings as required in industry using various CAD software.

COURSE OBJECTIVES

1. To understand drawing and develop the capacity to represent any matter/object and to impart knowledge of machine component and its conversion into 2D drawing.
2. To develop the ability to apply Limits, Fits, and Dimensional Tolerances, as well as Geometric Tolerances to components and assemblies on Engineering Drawings.
3. To create awareness about the Riveted joints and coupling/joints with their empirical relations.
4. To develop an ability to Create Solid Models of machine components.

Able to apply these skills to the solution of a variety of practical problems and be able to employ their knowledge to solve more complicated problems.

5. To develop an ability to Create assembly models of simple machine Parts. The student should be prepared to

continue the study of computer aided machine drawing through further subjects/projects in further years of engineering.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Visualize and formulate detail drawing of a given object.	1,2,5,10	1,2,1
CO2	Design and sketch the orthographic view of square headed and hexagonal headed bolt and nut assembly as per BIS.	1,2,10	1,2,1
CO3	Design and sketch single and double riveted butt joints as per stated conditions.	1,2,3,10	1,2,1
CO4	Design and sketch details and assembly of cotter joint and knuckle joint	1,2,3,10	1,2,1
CO5	Design and sketch details and assembly of universal coupling.	1,2,3, 10	1,2,1
CO6	Create 2-D, 3-D models and assemble the parts of mechanical systems by using standard CAD software with manufacturing considerations.	1,2,3,5,10	1,2,1

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 ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			2					2		1	3	1	1
CO2	3	2	2							2			3	1	1
CO3	3	2	2							2			3	1	1
CO4	3	1	2							2			2	1	1
CO5	3	2	2							3			3	1	1
CO6	3	2	3		3					3		1	3	1	1
Average	**3.0**	**1.8**	**2.2**		**2.2**					**2.3**		**1**	**2.8**	**1.0**	**1.0**

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

COURSE CONTENT

THEORY

Unit-1

Introduction to GD&T: Limits, fits and tolerances, Rule of G D & T, datum and its application, form tolerances and its applications, tolerance stack up analysis of simple machine part.

Orthographic Views: Conversion of pictorial views into orthographic projections of simple machine. (Bureau of Indian Standards conventions are to be followed for the drawings).

Unit-2

Fasteners: Orthographic projection of Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly).

Riveted Joints: Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets).

Unit-3

Joints: Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.

Unit-4

Assembly Drawings: Bushed bearing, Universal coupling, Machine Vice, Butterfly valve, Preparation of Bill of materials and tolerance data sheet.

PRACTICE

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Apply GD & T principles on simple machine parts	GD&T, Machine parts	Hands on Experience
2.	Draw orthographic projection of machine components	Drawing tools and CAD Software	Hands on Experience
3.	Draw orthographic projection of Hexagonal Headed bolt and nut assembly.	Drawing tools and CAD Software	Hands on Experience
4.	Orthographic projection of Bolts (Square Head)	Drawing tools and CAD Software	Hands on Experience
5	Draw orthographic projection of riveted joints	Drawing tools and CAD Software	Creative Thinking
6	Draw orthographic projection of joints for connecting two shafts like Cotter or Knuckle Joint, universal coupling.	Drawing tools and CAD Software	Creative Thinking
7	Assemble the parts of MACHINE VICE and Draw the following orthographic views. a) Front view with full section b) Top View	Drawing tools and CAD Software	Hands on experience & Creative Thinking
8	Assemble the parts of BUSHED BEARING and Draw the following orthographic views. a) Front view with full section b) Top View	Drawing tools and CAD Software	Hands on experience & Creative Thinking
9	Assemble the parts of UNIVERSIAL COUPLING and Draw the following orthographic views. a) Front view with full section b) Top View	Drawing tools and CAD Software	Hands on experience & Creative Thinking
10	Assemble the parts of BUTTERFLY VALVE and Draw the following orthographic views. a) Front view with full section b) Top View	Drawing tools and CAD Software	Hands of experience & Creative Thinking

TEXT BOOKS

1. K R Gopala Krishna, “Machine Drawing”, Subhas Stores, 2005.
2. N. D. Bhatt and V.M. Panchal, “Machine Drawing”, Charotar Publishing House, 2014
3. Sham Tickoo , “CAD for Engineers and Designers”, Dream Tech, 2005.

REFERENCE BOOKS

1. Ajeet Singh, Machine Drawing Includes AutoCAD, Tata McGraw-Hill, 2012.
2. P S Gill, “Machine Drawing”, Kataria & Sons, 2009
3. P I Vargheese and K C John, “Machine Drawing”, VIP Publishers, 2011.
4. Dr. Alex Krulikowski, “Fundamentals of Geometric Dimensioning and Tolerancing”, University of Michigan, Third Edition, 2014.

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/cours

<table>
<tr><td>Course Title</td><td colspan="4">Python Programming for Mechanical Engineers</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B22ER0404</td><td>Credits</td><td colspan="2">1</td><td colspan="2">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 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>Tutorial</td><td>0</td><td>0</td><td>0</td><td colspan="2" rowspan="2"></td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Practice</td><td>1</td><td>2</td><td>2</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>

COURSE OVERVIEW:

Python Programming for Mechanical Engineers is a simple yet powerful programming language. Its simple syntax makes Python easy to learn. Also, this language integrates well with all types of programming models, such as imperative, object-oriented, and procedural. Python has efficient high-level data structures. It is used in mechanical engineering in the areas of mechanics, machine design and thermodynamics. 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 mechanical and interdisciplinary problems apart from any general problems leading to automation.

COURSE OBJECTIVE (S):

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 NumPy and Matplotlib library package.
4. Discuss the file and Data Virtualization concepts pertaining to mechanical engineering problems.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Make use of language constructs to solve real world problems using python programming.	1- 4, 8, 9, 12	1

CO2	Develop programs for text processing and other application domains by making use of regular expressions.	1-3, 5,9,12	2
CO3	Apply features of NumPy package to develop computationally intensive programming to analyze and interpret the data.	1- 5, 9, 12	3
CO4	Apply the features of Matplotlib library to develop computationally intensive programming to analyze and interpret the data.	1,4,5,9,12	1-3
CO5	Learn new tools and technologies in the python and apply for suitable application development.	12	1,2
CO6	Develop solutions in the python to the mechanical engineering problems, and prepare the report and results with proper analysis and interpretation.	5, 9, 10	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	1	1	2				1	1			1	3		
CO2	3	2	3		2				1			1		3	
CO3	3	1	2	1	2				1			1			3
CO4	3			2	2				1			1	3	3	3
CO5												1	2	2	
CO6					2				1	1				2	2
Average	**3**	**1.3**	**2**	**1.6**	**2**			**1**	**1**	**1**		**1**	**2.7**	**2.5**	**2.7**

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

Part-A

1. "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.
2. A string containing multiple words is to be read from the user one at a time, after reading perform following operations. Convert all the strings to uppercase and display split the words of a string using space as the separation character and display.
3. 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%.

4. 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: Get the details of “CAR” object from user and store into Array of objects Display the details of “CAR” object based on “COMPANY”, “MODEL” and “PRICE”.
5. 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 “Airline” with the above attributes and perform the following operations: Get the details of “Airline” object from user and store into Array of objects List details of all the passengers who travelled From “Bengaluru to London”.List details of all the passengers who travelled From “Chicago to Beijing” on 10th of Feb, 2024.

Part-B

1. Write the Python Programs to obtain Shear Force and Bending Moment Diagrams of beams.
2. Plotting a Stress Strain Curve for ductile and brittle materials using Python and Matplotlib
3. Write the Python Programs on Von Misses Failure Theory Plot.
4. Analyse the Diesel Cycle with python Program.

TEXT BOOKS

1. Mark Pilgrim, “Dive into Python 3”, A Press Special Edition, 2nd Edition, 2015.
2. Travis E. Oliphant, “Guide to NumPy”, Trelgol Publishers, 2006.

REFERENCE BOOKS

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”, 3rd Edition, CENAGE Learning.
5. Wesley J. Chun, “Core Python Programming”, 2nd Edition, Prentice Hall.
6. Steve Holden and David Beazley, “Python Web Programming”, New Riders, 2002.
7. Springer, Kent D. Lee, “Python Programming Fundamentals”, 2nd Edition.
8. John V. Guttag, “Introduction to Computation and Programming using Python”, MIT Press, 2016.

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

SELF-LEARNINGEXERCISES:

1. Explore PYTHON library for IOT programming
2. More exploration on GitHub
3. Data Visualization packages
4. C modules interface

Course Title	Kinematics and Dynamics lab				Course Type		Hard Core	
Course Code	B22ER0405	Credits	1		Class		IV Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

This course deals with the validation of velocity and acceleration of 4 bar mechanism, single slider crank chain, and double slider crank chain. It also aims at evaluating the performance of CAM and follower mechanism based on the type of motion and follower. It helps students in analyzing, controlling and balancing the rotating masses of engines. This course also aims at learning the stability and direction control for precise control of motion of machines.

COURSE OBJECTIVES

1. To analyze and simulate velocity and acceleration of simple mechanisms using CAE tool
2. To evaluate the performance of cam and follower based on the type of motion using CAE tool
3. To analyze the position of different masses in the same or different plane for complete balance of engines
4. To introduce the application of gyroscope in determining the stability of vehicle moving in curved path.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Apply the concepts of kinematics to analyse the velocity and acceleration of mechanisms	1,2, 9	1,2
CO2	Use CAE tool in order to model and validate the velocity and acceleration of mechanisms.	1,2,5, 9	1,2
CO3	Evaluate the performance characteristics of a porter governor and document the work.	1,2, 9	1,2
CO4	Determine the stability ,direction of motion for a gyroscopic couple	1,2,9	1,2
CO5	Examine the balancing of engine and document the results.	1,2,9	1,2
CO6	Understand the position and motion of cam and follower based on different motion types and prepare report	1,2,5,9,10	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	1			2				2				3	3	1
CO2	3	2			2				3				3	3	1
CO3	3	2			2				2				2	3	1

CO4	2	2							2				3	3	
CO5	3	2							2				3	2	
CO6	3	2							2	3			3	3	
Average	**2.7**	**1.8**			**2**				**2.2**	**3**			**2.8**	**2.8**	**1**

Part-A

1. Analysis of Four bar mechanism – 2 problems each.
2. Analysis of single slider crank mechanism – 2 problems each.
3. Analysis of double slider crank mechanism- 2 problems each
4. Analysis of cam and follower mechanism

Part-B

1. To determine the magnitude, position of unknown rotating masses using balancing machine.
2. To determine the power, effort, controlling force and sensitiveness of the porter governor.
3. To determine gyroscopic couple, angle of precision for a rotating disc experimentally.

TEXTBOOKS

1. S S Rattan, "Theory of Machines", Tata Mc Graw Hill Education Private Limited New Delhi 2017
2. Joseph E Shigley, "Theory of Machines and Mechanisms", Oxford Higher Education International Version, 2014

REFERENCE BOOKS

1. VP Singh, "Theory of Machines", Dhanpat Rai Publishing, 2022
2. Dr R.K.Bansal, "Theory of Machines", Lakshmi Publications Bangalore. 2017

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	**Heat Engine Lab**				**Course Type**		**Hard Core**	
Course Code	**B22ER0406**	**Credits**	**1**		**Class**		**IV Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Heat engine lab deals with the conduction of experiments to find the properties of fuel such as flash point, fire point, Calorific value, Viscosity, and they are to find the alternate fuels for IC engine. This course also deals with evaluation of performance parameters of IC Engines and enable the students to have hands on experience to conduct performance test on IC engines. The experiments are carried out to determine the performance of Centrifugal blower and reciprocating air compressor. The practical work enables the students to gain expertise and become familiar to automobile sector.

COURSE OBJECTIVES

1. To understand of fuel properties using measuring devices.
2. To determine calorific value of fuels and other characteristics.
3. To give the students hands on practice to evaluate performance of petrol and diesel engines.
4. To understand the performance characteristics of reciprocating air compressor and centrifugal blower.

5. The students will be able to find the performance parameters of a two-wheeler electric vehicle

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Evaluate the flash and fire point, Viscosity of the given petroleum products by using suitable apparatus and suggest the suitable lubricant for stated engine conditions.	1,2,9	1
CO2	Identify and explain the different parts of multicylinder engine and Electric vehicle.	1,9	1,2
CO3	Estimate the amount of heat energy content in a given sample of fuel.	1,2,9	1,2
CO4	Evaluate the frictional power in a multi cylinder engine by Morse test	1,2,9	1,2
CO5	Conduct experiments, interpret, and analyze the result of IC engine and 2-wheel electric vehicle performance and document the results in the form of technical report.	1,2,3,9,10	1,2,3
CO6	Conduct experiments, interpret the data, analyze the Centrifugal and reciprocating power absorbing machines and document the results in the form of technical report.	1,2,3,9,10	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	2	1							1				2		
CO2	2		1						1				3	2	1
CO3	3	2	1						1				3	2	1
CO4	3		1						1				3	2	1
CO5	3	3	1						3	3			3	2	1
CO6	3	3	1						3	3			3	2	1
Average	**2.6**	**2.4**	**1**						**1.6**	**3**			**2.8**	**2**	**1**

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

Part-A

1. Determination of Viscosity of a lubricating oil using Redwoods Viscometers.
2. Determination of Calorific value of gaseous fuels.
3. Determination of Flash point and Fire point of lubricating oil using Cleveland's (Open Cup) Apparatus.
4. Identify and describe the working of parts of Toyota Fortuner car.

Part-B

1. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio.
   a. Four stroke diesel Engine
   b. Four stroke petrol Engine
   c. Multi cylinder petrol Engine (Morse test)

d. Variable compression ratio Engine.

2. Performance test on two stage Reciprocating air compressor.
3. Performance test on Centrifugal air blower
4. Performance test on Vapor compression refrigeration.
5. Performance test on Air conditioning system (Open cycle and closed cycle).
6. Performance test on a two/four wheeler electric vehicle.

TEXT BOOK

1. P.K. Nag "Engineering Thermodynamics" Tata McGraw Hill, 6th Edition 2018.

REFERENCE BOOKS

1. R.B.Mathur and R.P.Sharma, "Internal Combustion Engines", Dhanpat Rai Publication, 2002.
2. Yunus A. Cenegal and Michael A. Boles, "Thermodynamics -An Engineering Approach", Tata McGraw-Hill Publication, 2002.
3. Mahesh M Rathore, "Thermal Engineering", Tata McGraw-Hill, Prentice-hall of India Pvt. Ltd.

JOURNALS/MAGAZINES

1. International Journal of Heat and Mass Transfer
2. American Institute of Aeronautics and Astronautics

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/cours

5th Semester

Course Title	Smart Materials				Course Type		Open Elective	
Course Code	B22MEO501	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	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, Biomimetics and 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 and shape 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 smart actuators 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)

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

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 of smart composites.	1, 2, 3	2
CO4	Recognize the smart structures, self sensing and energy harvesting materials.	1, 2	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
CO6	Examine the relevant methods and techniques of advances in Sensing applications of smart sensors of structural health monitoring.	1, 2,5	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	2	
CO5	3	2											1	2	2
CO6	3	2			1								1	2	2
Average	**3**	**2**	**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, 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.

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	**Indian Knowledge System**				**Course Type**		**MC**	
Course Code	**B24ED0501**	**Credit**	**0**		**Class**		**V Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	1	1				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	**0**	**1**	**1**	**14**	**0**	**0%**	**100%**

COURSE OVERVIEW:

The Indian Knowledge Systems comprise of Jnan, Vignan, and Jeevan Darshan that have evolved out of experience, observation, experimentation, and rigorous analysis. This tradition of validating and putting into practice has impacted our education, arts, administration, law, justice, health, manufacturing, and commerce. This has influenced classical and other languages of Bharat, that were transmitted through textual, oral, and artistic traditions. “Knowledge of India” in this sense includes knowledge from ancient India and, its successes and challenges, and a sense of India’s future aspirations specific to education, health, environment and indeed all aspects of life.

COURSE OBJECTIVES:

The objectives of this course are:

1. To provide a roadmap for systemic study of Indian knowledge system
2. To introduce students to the science and technological advancements related to Indian tradition.
3. To help students understand the Indian architecture, fine arts and agricultural system.
4. To help learners understand India’s rich legacies influence on the world heritage

COURSE OUTCOMES (COs):

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

CO	**Course Outcomes**	**POs**	**PSOs**
CO1	Gain conceptual understanding of Indian culture and traditions.	6,8,10	
CO2	Appreciate the science and technological advancements in ancient India.	6,8,10	
CO3	Describe various ancient theories related to health, well- being and mindfulness	6,8,10	

CO4	Comprehend the Indian architecture, town planning, art and music.	6,8,10	
CO5	Understand India as a land united by cultural diversity.	6,8,10	

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					
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

COURSE CONTENT:

Introduction to IKS: Bharatavarsha-A Land of Rare Natural Endowments: Largest cultivable area in the world. Protected and nurtured by Himalayas. The Sindhu-Ganga plain and great coastal plains. The great rivers of India-Abundant rains, sunshine and warmth, vegetation, animals and mineral wealth. Most populous country in the world. India's prosperity held the world in thrall. Splendid geographical isolation of India and the uniqueness of Indian culture.

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

Foundational literatures: Vedas, Ramayana, Mahabharata and the Puranas

Contribution of ancient India to Mathematics, Astronomy and Health Science

Development of Science in Ancient India: Mathematics, Astronomy and Health Science.

Mathematics: Numbers, fractions and geometry in the Vedas. Decimal nomenclature of numbers in the Vedas Zero and Infinity Simple constructions from Sulba-sutras.Science- Kanad, Varahamihira, Nagarjuna. Important texts of Indian mathematics Brief introduction to the development of algebra, trigonometry and calculus.

Astronomy: Ancient records of the observation of the motion of celestial bodies in the Vedic corpus. Sun, Moon, Nakshatra & Graha. Astronomy as the science of determination of time, place and direction by observing the motion of the celestial bodies. The motion of the Sun and Moon. Motion of equinoxes and solstices Elements of Indian calendar systems as followed in different regions of India.

Health Science: Vedic foundations of Ayurveda. Ayurveda is concerned both with maintenance of good health and treatment of diseases. Basic concepts of Ayurveda. The three Gunas and Three Doshas, Pancha-mahabhuta and Sapta-dhatu. The importance of Agni (digestion). Six Rasas and their relation to Doshas Ayurvedic view of the cause

of diseases. Dinacharya or daily regimen for the maintenance of good health, Ritucharya or seasonal regimen Important Texts of Ayurveda Selected extracts from Astängahrdaya (selections from Sätrasthana) and Susruta-Samhita (sections on plastic surgery, cataract surgery and anal fistula).

TEXT BOOKS:

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 and 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
6. D. M. Bose, S. N. Sen and B. V Subbarayappa, Eds, "A Concise History of Science in India", Universities Press, 2nd Edition, 2010.
8. Dharampal, "Indian Science and Technology in the Eighteenth Century: Some Contemporary European Accounts", Dharampal Classics Series, Rashtrotthana Sahitya, Bengaluru, 2021.
10. JK. Bajaj and M. D Srinivas, "Indian Economy and Polity in Eighteenth Century Chengalpattu" J. K. Bajaj Edition, Indian Economy and Polity, Centre for Policy Studies, Chennai, 1995,
11.Mandayam Doddamane Srinivas Jitendra Bajaj, "Annam Bahu Kurvita: Recollecting the Indian Discipline of Growing and Sharing Food in Plenty" Centre for Policy Studies, 1996.

Course Title	**Design of Machine Elements**				**Course Type**		**Hard Core**	
Course Code	**B22ER0501**	**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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**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. This course covers theories of failure, shafts design, riveted and bolted joints, power screws and impact strength

COURSE OBJECTIVES

1. To understand the concept of normal, shear and torsional stress, codes and standards in the engineering in relevance to mechanical engineering.
2. To know the concept of static & impact strength in machine elements and theories of failure.
3. To understand the fatigue failure.
4. To explain the design procedure of design of shafts.
5. To introduce the concept of safe design of riveted and bolted joints in industry applications.

COURSE OUTCOMES (COs)

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

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 by applying theories of failure.	1,2	1,2
CO2	Evaluate the effect of impact load and Apply the Soderberg's criterion to design the machine element subjected to fatigue load.	1,2,3,5	1,2
CO3	Analyze the effect of stress concentration for various machine elements subjected to axial, bending and torsional load.	1,2	1,2

CO4	Design machine elements like Shafts as per ASME Standard, Knuckle and Cotter joints ISO standards for desired conditions.	1,2,3,6,8	1,2
CO5	Compute the efficiency of temporary and permanent joints as per ISO standards.	1,6, 8	1,2
CO6	Design the Fasteners and Power screws for different applications as per ISO standards.	1,2,3,6,8	1,2

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 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	3		1								3	3	
CO3	3	3											3	3	
CO4	3	2	2			1		2					3	3	
CO5	3					1		2					3	3	
CO6	3	2	2			1		2					3	3	
Average	**3**	**2.4**	**2.3**		**1**	**1**		**2**					**3**	**3**	

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

COURSE CONTENT

Unit-1

Introduction: Definitions: normal, shear, biaxial and triaxial stresses, Stress tensor, Principal stresses. Stress-strain diagrams for ductile and brittle materials, Failure of brittle materials, Failure of ductile materials, Factor of Safety Design considerations: Codes and Standards.

Design for Static Strength: Static loads subjected to Axial, Bending and torsion loads.

Theories of Failure: Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory, Stress concentration, Determination of stress concentration factor, simple numerical.

Unit – 2

Impact Strength: Introduction, Impact stresses due to axial loading, Simple numerical.

Design for Fatigue Strength: Introduction- S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, Endurance limit modifying factors, size effect, surface effect, Stress concentration effects, Goodman's and Soderberg's relationship, Simple numerical.

Unit – 3

Design of Shafts: Materials for shaft, Torsion of shafts, Design of solid and hollow shafts for strength and rigidity design of shafts for combined bending and axial loads.

Design of Temporary Joints: knuckle joint and cotter joint.

Threaded Fasteners: Stresses in threaded fasteners, Effect of initial tension, Design of threaded fasteners under static.

Unit – 4

Riveted Joints: Types, rivet materials, failures of riveted joints, Joint efficiency, simple numerical.

Welded Joints: Types, strength of butt and fillet welds.

Power Screws: Mechanics of power screw, Stresses in power screws, efficiency and self-locking, simple numerical.

CASE STUDIES

1. A 32-inch LED TV is decided to be mounted on a clamp. Identify the number of bolts and the profile of clamp which must withstand the maximum load on the branded TV.
2. Analyze the stress patterns on a clamping plate used to connect the shaft of 100mm diameter.
3. A pedestal fan is to cool the room of 10x8 size. Determine the forces and stresses induced in the rotating shaft and check for safety of the fan.
4. A centrifuge is rotating at 1000rpm to separate butter from curd. Determine the stresses induced.
5. Design a member to absorb an impact load of 80 kN falling with a velocity of 25 m/s.
6. Design the bolt of an excavator which is used to lift the debris from the ground of 150 m depth.
7. Identify and suggest the type of riveting for making boiler surface and the diameter of the rivet.

TEXT BOOKS

1. Joseph E Shigley and Charles R. Mischke, "Mechanical Engineering Design", McGraw Hill International, 6th Edition 2009.
2. V.B. Bhandari, "Design of Machine Elements", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4th Edition 2017.
3. Dr. P C Sharma and Dr. D K Aggarwal, "Machine Design", S. K. Kataria & Sons, 13th Edition, 2017.

DATA HAND BOOKS

1. K. Lingaigh, "Machine Design Databook", McGraw Hill Education, 2nd Edition 2017.
2. K.Mahadevan and B.Reddy, "Design Data Hand Book", CBS Publisher, 4th Edition, 2018.

REFERENCE BOOKS

1. Robert L. Norton, "Machine Design", Pearson Education Asia, 2001.
2. M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, "Design of Machine Elements", Pearson Education, 2006.
3. Hall, Holowenko, Laughlin (Schaum's Outlines series), "Machine Design", Adapted by S.K. Somani, Tata Mc Graw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/topics/engineering/design of machine elements
2. https://link.springer.com/book/10.1007/978-3-319-06086-6 SWAYAM/NPTEL/MOOCs:
3. https://onlinecourses.nptel.ac.in 2. https://nptel.ac.in/courses

<table>
<tr><td>Course Title</td><td colspan="4">Fluid Mechanics and Machines</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B22ER0502</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>Tutorial</td><td>0</td><td>0</td><td>0</td><td colspan="2" rowspan="2"></td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Practice</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>Theory</td><td>Tutorial</td><td>IA</td><td>SEE</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

Fluid Mechanics and Machines aim to deal with the behavior of fluids under rest and in motion. The course deals with types of fluids, properties of fluids, fluid statics, pressure measurement, fluid kinematics, and fluid dynamics. This course also emphasizes the basic fluid mechanics principles and energy transfer in a hydraulic machine along with their performances. The course also highlights the viscous flow and forces over immersed bodies.

COURSE OBJECTIVES

1. Acquire a basic Knowledge of the properties of fluids, fluid statics and fluid kinematics.
2. To expose to the fluid dynamics to solve problems on engineering applications.
3. To describe the significance of major and minor losses of fluid flow through pipes.
4. To discuss the viscous flow parameters and flow over the immersed bodies.
5. To analyze the velocity components and energy transfer in fluid machines.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Use the knowledge of fluid properties and apply the basic laws of fluid to analyze fluid statics and kinematics.	1,2	1,2
CO2	Apply the principles of fluid dynamics and dimensional analysis techniques for solving the fluid flow problems.	1,2,5	1,2
CO3	Evaluate the major and minor losses the fluid flow through pipes.	1,2	1,2
CO4	Apply the fundamental concepts of fluid mechanics for analyzing the viscous flow through pipes and around immersed bodies.	1,2	1,2
CO5	Apply the fundamental concepts of energy conversion principles to analyze fluid flow through generalized turbomachines.	1,2	1,2
CO6	Evaluate the performance parameters of power absorbing and power generating turbomachines.	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			2								3	2	
CO3	3	3											3	2	
CO4	3	3											3	2	
CO5	3	3											3	2	
CO6	3	3											3	2	
Average	**3**	**2.7**			**2**								**3**	**2**	

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

COURSE CONTENT

Unit-1

Introduction: Definition of a fluid, types of fluids, Properties of fluids, Newton's law of viscosity, Numerical on viscosity.

Fluid Statics: Pascal's law, Hydrostatic law, Manometers- simple and differential manometers.

Fluid Kinematics: Types of fluid flow, three-dimensional continuity equation in Cartesian co-ordinate system, introduction to velocity and acceleration of fluid flow.

Unit-2

Fluid Dynamics: Euler's equation of motion along stream line, Bernoulli's equation and its limitations, Applications of Bernoulli's theorem, numerical, introduction to flow measuring devices.

Dimensional Analysis: Dimensional Homogeneity, Methods of dimensional analysis- Rayleigh's method, Buckingham - π theorem, Numerical, Discussion on Similitude and Model studies.

Unit-3

Flow through pipes: Classification of Frictional losses for fluid flow through the pipe, Darcy-Weisbach and Chezy's equations, Numerical. Discussion on minor loses in pipes, hydraulic gradient line and total energy line.

Viscous flow: Reynolds Number, Laminar flow through circular pipes, Hagen – Poiseuille equation. (No-derivation), Numerical.

Flow over immersed bodies: Introduction, Lift and drag forces, Coefficient of lift and drag forces, Numerical.

Unit-4

Energy Exchange in Fluid machines: Fluid flow through a generalized turbomachine, Euler's turbine equation with components of energy transfer.

Centrifugal Pumps: Layout **of** centrifugal pump, types of heads and efficiencies of centrifugal pump, work done on the Centrifugal Pump, numerical, Pumps in series and parallel, minimum starting speed, NPSH.

Hydraulic Turbines: Classification, efficiencies of hydraulic turbines. Pelton turbine - velocity triangles, design parameters, Francis turbine - velocity triangles, design parameters, Kaplan- velocity triangles, design parameters. Numerical.

CASE STUDIES

1. Develop a CFD analysis for the flow-measuring devices.
2. Conduct the experiment to determine the coefficient of friction for fluid flow through pipes of different diameters and compute the same using MAT lab code.
3. Prepare a report on pumps used in Agricultural fields/ Industries by mentioning the following details: Make and specifications, operating conditions, construction, working principle, and applications.
4. Prepare a report on any Mini or Macro hydroelectric power stations by mentioning the following details: Make and specifications, type and of number of turbines, capacity of power generation, working principle, operating conditions and applications.

TEXT BOOKS

1. Dr. Bansal, "A Text Book of Fluid Mechanics and Hydraulic Machines", R.K.Lakshmi Publications Pvt. Ltd, 9th Edition, 2018.
2. An Introduction to Energy Conversion, Volume III, Turbo machinery V. Kadambi and Manohar Prasad New Age International Publishers, Reprint, 2008

REFERENCE BOOKS

1. Yunus A. Cengel and John M.Cimbala, "Fluid Mechanics (SI Units)", Tata McGraw Hill, 4th Edition, 2019.
2. Pijush.K.Kundu, "Fluid Mechanics", Taylor & Francis, 3rd Edition, 2015.
3. M. S. Govindegowda and A. M. Nagaraj, "Turbo machines", M. M. Publications, 7th Edition, 2012.

JOURNALS/MAGAZINES

1. https://www.cambridge.org/core/journals/journal-of-fluid-mechanics

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc22_me31/preview
2. https://www.my-mooc.com/en/categorie/mechanical-engineering

Course Title	Machining Process				Course Type		Hard Core	
Course Code	B22ER0503	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course would encompass a comprehensive study of metal cutting and machine tools. The students will go through the fundamentals and principles of metal cutting to practical applications through multiple labs using lathes, milling machines, grinding machines, and drill bits, Computer Numerical Control etc. Tool geometry, chip formation, cutting force calculations and measurement, tool wear and other aspects will be given due attention.

COURSE OBJECTIVES

1. To familiarize the student with tool nomenclature and cutting forces & principles of Machine tools.
2. To incorporate the concepts of various machining operations to prepare a model using lathe as per dimensions
3. To give exposure of various machines used for manufacturing of metal components.
4. To incorporate the suitable super finishing process to produce the intricate components and CNC technology
5. To help students acquire knowledge about theory of metal cutting, mechanism of machining and analyze process parameters influence.
6. To explain and demonstrate the different instruments for linear and angular measurements.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Analyze forces acting on the cutting tool in orthogonal and oblique cutting and various process parameters to improve the cutting tool life	1,2	1,2,3
CO2	Describe various machining process used for machining of components.	1	1,2,3
CO3	Explain various machines used for manufacturing of metal components	1	1,2,3
CO4	Identify the cutting tools required for different machining processes along with its principles.	1,2	1,2
CO5	Demonstrate the cutting forces induced during the metal cutting operations and understand the influence of process parameters.	1,2	1,2
CO6	Compare the application of conventional machines, CNC machine and nontraditional machines.	1,2	1,2

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 ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											3	3	1
CO2	2												2	2	1
CO3	2												3	2	1
CO4	3	2											3	1	
CO5	3	2											3	2	1
CO6	3	2											3	2	1
Average	**2.7**	**2.0**											**2.8**	**2.0**	**1.0**

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

COURSE CONTENT

Unit-1

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

Unit-2

Principles of Machine Tools: Kinematics of machine tools, speed transmission from motor to spindle, speed reversal mechanism, mechanism for feed motion.

Lathe: Working principle and specifications of lathe, center lathe and its components, lathe operations, Constructional features of turret and capstan lathe.

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

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

Unit-3

Milling: Principle of working, Classification of Milling machines, construction and working of Horizontal and vertical milling machines. Milling operations, methods of indexing, simple and compound indexing, numerical on simple indexing.

Grinding: Working principle, constructional features of Cylindrical, Center less and Surface grinding machines, Types of abrasives, bonding process, marking of grinding wheels. Dressing and truing of grinding wheels.

Unit-4

Lapping: Principle of Lapping, Lapping methods, Advantages and limitations of lapping.

Honing: Principle of honing, Types of honing machines, Advantages, limitations and applications of honing.

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

CNC Machines: Overview, types, construction, tool and work holding devices, feedback devices, part programming, examples.

Introduction Non Traditional Machining: Importance of NTM, Classification, Need and comparison between conventional and non- conventional machining process**.**

CASE STUDIES

1. Do a literature on metal cutting tool life and prepare a report on methods/precautions to be followed to enhance the tool life.
2. Prepare document stating the materials used for manufacturing the metal cutting tools and desirable properties of cutting tool materials.
3. Why industries are moving from conventional machines to CNC machines-A detailed report.

TEXT BOOKS

1. R.K Jain, “Production Technology”, Khanna Publications, 2003.
2. P N Rao, “Manufacturing Technology”, McGraw-Hill Education, (Volume II), 2018
3. Kalpakjian, Serope, “Manufacturing Engineering and Technology”, Addison –Wesley publishing co., New York
4. Pandey and Shan, “Modern Machining Process”, Tata McGraw Hill, 2000.

REFERENCE BOOKS

1. Hajra Choudhury, “Workshop Technology Vol-II”, Media Promoters & Publishers Pvt. Ltd. 2004
2. Amitabh Ghosh and Mallik, “Manufacturing Science”, affiliated East West Press, 2003
3. G.C Sen & Bhattacharya, “Principle of Machine Tools”, Tata McGraw Hill, New Delhi.

JOURNALS/MAGAZINES

1. International Journal of Machine Tools and Manufacture
2. Journal of Manufacturing Processes

SWAYAM/NPTEL/MOOCs:

1. https://www.coursera.org/browse/physical-science-and-engineering/mechanical-engineering
2. https://onlinecourses.nptel.ac.in/noc21_me04/preview

Course Title	Engineering Economics and Financial Management				Course Type		Hard Core	
Course Code	B22ER0504	Credits	2		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	1	1	1				
	Tutorial	1	2	2				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**2**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

This subject explores the importance of economics in industries. Engineering economics is an interdisciplinary subject in which the financial aspect of the industrial product and investment interest rates are discussed. The course emphasizes evaluating interest rates and comparing alternatives using PW, AW, FW and Internal rate of return. This subject also deals with the evaluation of selling price and depreciation and the introduction into the Stock market.

COURSE OBJECTIVE:

1. To Study principles and techniques of economic evaluation in different fields of Engineering
2. To know the assessment procedure for the evaluation of alternatives.
3. To calculate interest under various conditions.
4. To learn the 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	Analyze the cash flow diagram and interest rates.	1,2,11	1,2
CO2	Discuss the time value of money and ash flow diagram.	1,2,11	1,2
CO3	Demonstrate to convert different cash flows into Present worth, Future worth and Annual equivalent worth	1,2,11	1,2
CO4	Calculate the rate of return, depreciation charges and income taxes	1,2,11	1,2
CO5	Compare the alternatives using different compound interest factors	1,2,11	1,2
CO6	Understand Share market, stock trading, and derivatives.	1,11,12	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 ARTICULATIONMATRIX

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

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

COURSE CONTENT

Unit-1

Introduction to Engineering Economy: Introduction to Indian Economy, Basic terminologies used in the economy, Engineering Decision- Makers, Engineering and Economics, Problem-solving and Decision making, Intuition and Analysis, Tactics and Strategy. Law of demand and supply, Interest and Interest factors: Interest rate, Cash – flow diagrams, Exercises with 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, and Simple Exercises.

Unit-2

Evaluation of Projects and Depreciation: Annual worth method, and internal rate of return method. Numerical covering all the above methods 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 costs involved). Introduction, Scope of Finance, and Finance Functions, Statements of Financial Information: Source of financial information, financial statements, Balance sheet, Profit and Loss Account, the relation between Balance sheet and Profit and Loss account. Simple Numerical

Unit-4

Introduction to Indian Financial Market: Investment Basics, Securities: Regulator, Participants. Primary Market: Issue of Shares, Foreign Capital Issuance. Secondary Market: Stock Exchange, Stock trading, Equity Investment, debt Investment. Derivatives, Depository, Mutual Funds, Clearing and settlement and redressal.

CASE STUDIES

1. Liquidity Analysis of Asian Paints Limited.
2. Fast Tracking Indian Economy: A Challenge Task Ahead.
3. Economics of Apple, Inc.s iPhone
4. Taiwan - Inside the Miracle: A Development Success Story
4. BRICS and Beyond: Impact on Indian Business

TEXT BOOKS

1. Riggs J.L., “Engineering Economy”, McGraw Hill, 2002.

2. Thuesen H.G. “Engineering Economy”, PHI, 2002.

REFERENCE BOOKS:

1. Tarachand, “Engineering Economy”, 2000.Schaum's Series Feedback Control Systems, 2001.
2. O P Khanna, “Industrial Engineering and Management”, Dhanpat Rai & Sons. 2000.
3. Prasanna Chandra, “Financial Management”, TMH, 7th Edition, 2004.
4. IM Pandey “Financial Management”, Vikas Pub. House, 2002.

JOURNALS/MAGAZINES

1. Journal of Financial Economics.
2. Journal of Accounting and Economics.
3. Journal of Financial and Quantitative Analysis.
4. Journal of Banking and Finance.
5. Journal of Money, Credit and Banking.
6. Journal of International Money and Finance.

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/110105121
2. https://nptel.ac.in/courses/110105035

Course Title	Automotive Engineering				Course Type		Soft Core	
Course Code	B22ERS511	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course deals with the components used in automotive like, engine transmission system, braking system and fuel supply system. It emphasizes on emissions emitting from various types of vehicles, emission norms and methods of controlling emissions. This course explores the necessity of cooling and lubricating system, the advance ignition systems, steering and brake system to control the vehicles.

COURSE OBJECTIVES

1. To know layout and arrangement of principal parts of an automobile.
2. To understand the working of transmission and brake systems.
3. To comprehend operation and working of steering and suspension systems.
4. To know the automobile emissions and its effects on environment.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Describe the functions of different parts of engine.	1	1
CO2	Understand the working of transmission and braking systems.	1	1
CO3	Discuss the working of steering, suspension systems and their applications.	1	1
CO4	Analyze the causes of automobile emissions, its effects on environment and methods to reduce the emissions.	1, 2, 6, 7	1
CO5	Illustrate the construction and working of transmission systems and their Components.	1	1
CO6	Recognize the different types of suspension systems, Steering systems, braking Systems and describe their working principles.	1, 2	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
O1	3												1		
CO2	3												1		
CO3	3												1		
CO4	3	1				1	1						1		
CO5	3												1		
CO6	3	1											1		
Average	**3**	**1**				**1**	**1**						**1**		

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

COURSE CONTENT

Unit-1

Engine Components: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for SI Engine and CI Engines.

Cooling and Lubrication: Cooling requirements, Types of cooling- Thermos siphon system, Forced circulation water cooling system, Water pump, Radiator, Significance of lubrication, Splash and Forced feed system.

Unit-2

Transmission Systems: Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints. Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

Brakes: Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock – Braking systems, purpose and operation of antilock-braking system.

Unit-3

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

Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system.

Ignition System: Battery Ignition system, Magneto Ignition system, electronic Ignition system.

Unit-4

Superchargers and Turbochargers: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag.

Automotive Emission Control Systems: Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, controlling crankcase emissions, controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter.

Emission Standards: Euro norms, Bharat Stage norms, motor vehicle act.

CASE STUDIES

1. Prepare literature survey report on Next generation Tesla cars credibility in Indian road system.
2. Prepare literature survey report on compare the efficiency of existing EV (Electric Vehicles) with conventional automotive vehicles.
3. Prepare report on How to overcome existing EV (Electric Vehicles) vehicle battery system problems.
4. Prepare report on Next-generation low carbon vehicles
5. Prepare report on Future of Automotive Industry with integration of software development.
6. Prepare report on Existing EV s and their comparative analysis.

TEXT BOOK:

1. Kirpal Singh, "Automobile Engineering", Volume 1&2, The World Book Depot, 14th Edition, 2021.
2. R.B. Gupta "Automobile Engineering", Aman Book Stall, 1st Edition, 2014.

REFERENCE BOOKS:

1. William.H.Crouse, "Automotive Mechanics", McGraw-Hill, 10th Edition, 2006.
2. Mathur and Sharma "Internal Combustion Engines", Dhanpat Rai Publications, 8th Edition, 2016.
3. V Ganesan, "Internal Combustion Engines", McGraw-Hill, 4th Edition, 2012.
4. John B Heywood, "Internal Combustion Engine Fundamentals", McGraw Hill, 2nd Edition, 2018.

JOURNALS/MAGAZINES

1. https://www.springer.com/journal/International Journal of Automotive Technology
2. https://www.sae.org/publications/magazines/automotive-engineering
3. https://www.resurchify.com/impact/category/Automotive-Engineering

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/Fundamentals of Automotive Systems

Course Title	**Green Energy Technology**				**Course Type**		**Soft Core**	
Course Code	**B22ERS512**	**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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course explores the concept of thermal energy conversion and introduces the different types of fuels used for steam and nuclear power plants. This course introduces to renewable energy resources like hydro, solar, wind, tidal, geothermal and bio mass energy.Further the course deals with conversion of electrical energy through fuel cells and battery technology. This course helps the students to know the different types of power plants to generate electricity, its components, material handling systems, benefits, limitations and applications and it creates the interest in the students to select this field as a career in their future.

COURSE OBJECTIVES

1. To understand the different energy resources available in the nature.
2. To gain the knowledge about steam and nuclear power plant.
3. To enhance the knowledge about renewable energy sources and energy conversion process.
4. To explore the knowledge on fuel cells and battery technology.

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 energy resources available in the nature and conversion of steam energy in to electrical energy using steam and nuclear power plant.	1,2,6,7	1
CO2	Analyze the water resources for the generation of electricity using hydel plants.	1,2, 6,7	1
CO3	Describe the energy conversion from solar, hydrogen energy resources and its applications.	1,6,7	1
CO4	Discuss the principles of energy conversion of wind, ocean, and geothermal energy systems.	1,7	1
CO5	Elaborate the main characteristics of biomass energy source and construction factors of biogas digesters.	1,6,7	1
CO6	Discuss the working principle and application of fuel cells and battery technology.	1, 6	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						3		
CO2	3	2				2	2						3		
CO3	3					2	2						3		
CO4	3					2	2						3		
CO5	3					2	2						3		
CO6	3					2	2						3		
Average	**3**	**2**				**2**	**2**						**3**		

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

COURSE CONTENT

Unit-1

Introduction to Energy System: types of energy resources, Review of energy scenario in India, Different Types of Fuels used for steam power plant, general Layout of steam power plant, Equipment for preparation of pulverized Coal-Bowl mill, unitsystem and bin system.

Draught System: Chimneys- natural, forced, induced and balanced draft, Cooling towers and Ponds.

Nuclear Power plant: Fuels used in Nuclear power plant, general Layout of the Plant, Advantages, disadvantages and nuclear waste disposal methods, Case studies.

Unit-2

Hydro-Electric Energy: General layout of hydel power plants, classification of hydel plants, Hydrographs, flow duration curve (numerical on hydrograph and flow duration curve), Case studies.

Solar Energy and Applications: Solar radiation - Availability- Measurement Advantages, disadvantages and Applications of solar energy source,

Hydrogen Energy: Introduction to hydrogen energy, methods of hydrogen production (electrolysis and thermo-chemical method).

Unit-3

Wind Energy: Wind energy - General considerations - classification of wind power plants –Working of Horizontal and vertical axis wind turbine.

Tidal Power: classification and working of different systems, advantages and disadvantages tidal power plants.

Ocean Thermal Energy Conversion (OTEC) Power generation –working principle, Advantages, disadvantages and Applications of OTEC.

Geothermal Energy Conversion: Availability - working principle, Advantages, disadvantages.

Unit-4

Biomass Energy Sources: Photosynthesis process, Energy through fermentation -Ethanol Production from sugarcane, Biomass characteristics. Factors affecting biogas yield, biogas digester (floating gasholder and fixed dome type with working principle and diagram).

Fuel Cells & Battery Technology: Introduction, types, working principle, applications of fuel cells and Batteries.

CASE STUDIES

1. Case study on renewable energy resources energy power plants
2. Case study on non-renewable energy resources energy power plants

TEXT BOOKS

1. P.K Nag, “Power Plant Engineering”, 3rd Ed. Tata McGraw Hill, 2nd Edition 2001.
2. B H Khan, “Non-conventional energy resources”, McGraw Hill Education, 3rd Edition, 2017.
3. G.D. Rai, “Non-Conventional Energy Sources”, Khanna Publishers, 2011.
4. Mehrdad Ehsani, “Modern Electric, Hybrid electric and Fuel Cell Vehicles”, CRC Press, 3rd Edition, 2019.

REFERENCE BOOKS

1. Duncan Richardson, “Plant Equipment & Maintenance Engineering Handbook”, McGraw Hill Professional, 2013.
2. R.K. Rajput, “Power Plant Engineering”, Laxmi Publications, 5th Edition, 2016.
3. Bahman Zohuri and Patrick McDaniel, “Thermodynamics In Nuclear Power Plant Systems”, Springer, 2016.
4. A.R. Jha, “Next-Generation Batteries and Fuel Cells for Commercial, Military, and Space Applications”, CRC Press Inc; 1st Edition 2012.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/search?qs=nuclear%20power%20plant
2. https://www.journals.elsevier.com/international-journal-of-hydrogen-energy
3. https://www.sciencedirect.com/search?qs=fuel%20cells
4. https://www.researchgate.net/publication/369942210_Fuel_Cell_Electric_Vehicle_Modeling_Using_HybridBatteryFuel_Cell_Vehicle_Modeling_Tool_HBFCMT

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

Course Title	Fundamental of Robotics and Applications				Course Type		Soft Core	
Course Code	B22ERS513	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course deals with the basics of robots and its construction, operation, transformation along application of forward and inverse kinematics to industrial robots. Also this course discusses about types of end effector used for different application and discuss about programming and industrial, non-industrial applications of robots as well as the machine-vision systems.

COURSE OBJECTIVES

1. To identify the types of industrial robots along with its specifications.
2. To apply forward and inverse kinematics concepts to industrial robots.
3. To attain knowledge of robot programming and along with machine vision.
4. To understand Industrial and non-industrial application of robots with its limitations.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Understand the fundamentals of robotic systems and their terminologies.	1	1,2,3
CO2	Analyze direct kinematics of various manipulator configurations.	1,2	1,2,3
CO3	Design manipulator configuration and end-effector for industrial applications.	1,2,3	1,2,3
CO4	Develop the part programs for various robotic applications.	1,2,3	1,2,3
CO5	Understand the role of robot for the various industrial & Non industrial applications.	1	1,2,3
CO6	Analyze the inverse kinematics of 3R manipulator.	1,2	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	2
CO2	3	3	1										3	1	3
CO3	3	2											3	1	3

CO4	2	1											3	1	2
CO5	3	2	1										3	1	2
CO6	3	1	1										3	1	3
Average	2.8	1.8	1										3	1	2

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

COURSE CONTENT

Unit-1

Introduction: Fundamental laws of robotics, brief history of robotics, classification of robots, robot evaluation-resolution, repeatability and accuracy of robot, numerical.

Components of Robots and Structure of Robots: Types of joints, representation of joint, degrees of freedom and workspace.

Configuration of Robots: Cartesian, cylindrical, spherical, and articulate.

Unit-2

Spatial Description: Description of position and orientation of a rigid body, Types of Frames, Euler angle representation for XYZ, XYZ frames.

Transformations: Translation, Rotation, scaling (numerical with real applications), homogeneous representation of transformations, properties of rotation matrices and combined transformations (numerical with real applications).

D-H convention: forward kinematics, implementation of d-h convention and obtaining transformation matrices for 3r manipulator, SCARA manipulator, puma 560 manipulator. Inverse kinematics, inverse kinematics of 3r manipulator.

Unit-3

Robot End Effectors: Types of end effectors, mechanical gripper, types of mechanical grippers, magnetic gripper, vacuum gripper, adhesive gripper, other special grippers.

Robot Programming: Methods of programming, lead through programming methods, three levels of robot programming, teach by showing, explicit robot programming language, task level programming language, requirements of robot programming language, world modelling, motion specifications, flow of execution, programming environment, sensor integration, AML and VAL. Simple example, programming with graphics.

Unit-4

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.

Non-Industrial Applications: home sector, health care, agriculture, entertainment, research and military applications.

Case Studies

1. Design and simulation of different types of robot like ABB, KUKA, FANUC robots models using Robot Simulation Software.
2. Robot Applications, Industrial and non-industrial application, mobile application, limitations and future application of robot.

TEXT BOOKS

1. Saeed B. Niku, “Introduction to Robotics: Analysis, Systems, Applications”, Pearson Education India, 2nd Edition, PHI, 2003.
2. Ganesh S Hegde, “Industrial Robotics”, University Science Press, 2nd Edition, 2009.

REFERENCE BOOKS

1. M.P. Groover, “Industrial Robotics – Technology, Programming and Applications”, TATA McGraw-Hill Education Pvt Ltd, USA, 3rd Edition, 2008.
2. Ramesh Jam, Rangachari Kasturi, Brain G. Schunck, “Machine Vision”, TATA McGraw-Hill Education Pvt. Ltd, 2nd Edition, 1991.

3. Yoremkoren, “Robotics for Engineers”, TATA McGraw-Hill Education Pvt Ltd, USA, 2nd Edition 1987.
4. P.A. Janaki Raman, “Robotics and Image Processing”, Tata McGraw-Hill Education Pvt Ltd, 2nd Edition, 2001.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/robotics-and-autonomous-systems
2. https://www.sciencedirect.com/journal/robotics

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc21_me76/preview

<table>
<tr><td>Course Title</td><td colspan="4">Quality Control Techniques</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B22ERS514</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 emphasis a balanced blend of the statistical quality control concepts and hands-on training in the methods, standards and guidelines currently being used for industrial quality control. It is essential activity involves intermittent or continuous manual or automated inspection of parameters to collect data and analyze it using statistical quality control techniques and other quality control techniques to interpret quality of raw materials, work in process and final products. Based on above need, this course has been designed to provide the necessary knowledge and skills in Quality control techniques and enable a practicing engineer to gain a firm grasp of statistical quality control methods and enable him/her to not only analyze and improve existing quality control processes, but also design and implement new quality control processes in industrial settings.

COURSE OBJECTIVES

1. To understand the basic concepts of quality control and other statistical methods for monitoring quality.
2. To learn various available Quality control tools and techniques and economical design issues associated with the quality monitoring.
3. To demonstrate the ability to design and implement these tools.
4. Develop strategies for conducting design of experiments in process improvements.
5. Perform Reliability evaluation of Mechanical, Electrical, Electronics and Software Technology Systems.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Demonstrate the use of quality control techniques for enhancement of quality technology and management.	1,2	1,2
CO2	Use modern statistical methods to examine for process quality control and improvement.	1,2,9	1,2
CO3	Construct variables and attributes control chart and interpret their state of statistical control.	1,2,9	1,2
CO4	Perform analysis of process capability and its index.	1,2	1,2
CO5	Analyze the various parameters of operating characteristics curve using sampling techniques and reliability aspects of production processes.	1,2,9,	1,2
CO6	Demonstrate the ability to conduct experiments using DOE techniques and ability to use of ISO standards and other latest quality techniques.	1,2,3,5,9	1,2

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 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							2				1	3	
CO3	3	3							2				1	3	
CO4	3	3							2				1	3	
CO5	3	3											1	3	
CO6	3	3	1		1				2				1	3	
Average	**3**	**2.67**	**1**		**1**				**2**				**1**	**2.8**	

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

COURSE CONTENT

Unit-1

Introduction: Introduction to Quality, Definition of Quality, Dimensions of Quality, Cost of Quality, Quality control Techniques, Fundamentals of Total Quality Management, TQM framework, Quality Gurus, Benefits and Obstacles of TQM

Statistical Process Control: Introduction to SPC, Data types, Measure of central tendency and dispersion-numericals, causes of variation in quality. Statistical basis of control charts, Basic principles of control charts, choice of control limits, sample size and sampling frequency, rational sub groups.

Unit-2

Control Charts for Variable and Attribute Data: Controls charts for mean and Range(X-bar and R-Charts), Controls chart for fraction non- conforming (p, np, 100p charts), Control chart for non-conformities (c and u charts). Analysis of patterns of control charts.

Process capability: Methods of estimating process capability, Process capability indices- Cp and Cpk

Unit-3

Acceptance Sampling: Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – Operating Characteristics (O.C.) curves – producer's Risk and Consumer's Risk. AQL, LTPD, AOQL concepts- standard sampling plans for AQL and LTPD- uses of standard sampling plans.

Reliability and Life Testing: Definition of reliability, Failure models of components, Failure rate analysis, Bath Tub Curve, common failure rate curve, types of failure, MTBF, MTTR, and Availability. Reliability evaluation in simple cases of exponential failures in series, parallel and series-parallel device configurations. Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy.

Unit-4

Experimental Design for Process Improvement: General model of a process, Examples of designed experiments in process improvement, Principles of experimentation, Guidelines for designing experiments, Completely randomized designs (CRD), Randomized block designs (RBD), Factorial experiments

Quality Assurance and Six Sigma: Quality assurance, ISO 9000, 14000 standards, ISO certification process.
Design for Six Sigma: Introduction to Six sigma, 7 quality tools .Overview of DMAIC methodology, DFSS, DMADV Methods.

Simulation on Statistical tool (only for Assignment)

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Construction and interpretation of statistical control charts a. X-bar & R-chart b. X-bar & s-chart c. np-chart d. p-chart e. c-chart f. u-chart	Minitab software	Hands on Experience
2.	Single sample inspection plan: Construction and interpretation of OC, AQL, LTPD, ASN, ATI, AOQ, AOQL curves	Minitab software	Hands on Experience
3.	Calculation of process capability	Minitab software	Hands on Experience

CASE STUDIES

1. Application of SQC in packaging Industry
2. Implementation of TQM & Six Sigma in various automobile and manufacturing sector-A case study review.
3. Assessing the Quality of product using SQC Maps: A Case study
4. Implementation of ISO standard in MSME'S/SME'S: A case study

TEXT BOOKS

1. Grant, Eugene .L, "Statistical Quality Control", McGraw-Hill, 7th Edition, 2006.
2. L.S.Srinath, "Reliability Engineering", Affiliated East west press, 4th Edition, 2009.
3. Mahajan, "Statistical Quality Control", Dhanpat Rai, 2016.

REFERENCE BOOKS

1. Monohar Mahajan, "Statistical Quality Control", Dhanpat Rai & Sons, 2001.
2. R.C.Gupta, "Statistical Quality Control", Khanna Publishers, 6th Edition, India, 2003.
3. Besterfield D.H Quality Control, New Jersey, Prentice Hall, 1993.
4. Sharma S.C., "Inspection Quality Control and Reliability", Khanna Publishers, 2002.

JOURNALS/MAGAZINES

1. IEEE Transactions on Industrial Informatics
2. International journal of Production Research
3. Journal of Industrial Information Integration
4. International Journal of Production Research
5. International Journal of Production Economics
6. Journal of Manufacturing Technology Management
7. Journal of Product Innovation Management
8. Reliability Engineering & System Safety

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/110105088
2. https://www.udemy.com/course/statistical-quality-control-sqc/
3. https://www.udemy.com/course/mastering-statistical-quality-control-with-minitab/

Course Title	Flow Analysis Using Ansys Fluent				Course Type		Hard Core	
Course Code	B22ER0506	Credits	1		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW:

This course provides practical knowledge related to Ansys-Fluent and demonstrates the concept for real-time applications in the Mechanical engineering domain. It is intended to cater to the needs of budding mechanical engineers in fluid flow applications. Ansys-Fluent uses numerical analysis and algorithms to solve and analyse problems of fluid flow and focuses on research culture in Fluid kinematics and dynamics.

COURSE OBJECTIVES:

1. To provide the knowledge to understand the basics of Ansys-fluent.
2. To analyse the fluid flow over a flat plate and through the circular pipe.
3. To provide knowledge for fluid flow over the immersed bodies using Ansys-Fluent.
4. To analyse the Aerodynamic properties of various geometries.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Explain fundamental concepts of computational fluid dynamics.	1,2,5	1,2
CO2	Build the CAD model, analyse the flow of fluid over a flat plate, through circular pipe and document the results in the form of the technical report.	1,2,3,5,9,10	1,2,3
CO3	Build the CAD model, analyze the flow measuring devices and document the results in the form of technical report.	1,2,3,5,9,10	1,2,3
CO4	Investigate the behaviour of flow around different structured objects and document the results in the form of technical report.	1,2,3,5,9,10	1,2,3
CO5	Validate the Aerodynamic properties for flow over cylinder and document the results in the form of technical report.	1,2,3,5,9,10	1,2,3
CO6	Estimate the Aerodynamic properties for flow over Symmetrical Aero foil and document the results in the form of technical report.	1,2,3,5,9,10	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	1			2				2	1			3	3	
CO2	3	2	2		3				2	1			3	2	2
CO3	3	2	2		3				2	1			3	2	2
CO4	3	2	2		3				2	1			3	2	2
CO5	3	2	2		3				2	1			3	2	2
CO6	3	3	3		3				2	1			3	3	3
Average	**3**	**2**	**2.2**		**2.8**				**2**	**1**			**3**	**2.2**	**2.2**

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

Theory

Basics of Computational Fluid Dynamics

Fluid properties, Types of fluids, classification of Fluid flows, Introduction to CFD, Capabilities of CFD, Discussion on Continuity, Momentum and Energy Governing equations, Basic discretization method, Finite Control Volume method, Initial and Boundary conditions, Discussion on Turbulent fluid flow models and Basics of Ansys Fluent- Preprocessor, Processor, and post-processor.

Practice

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1	Analysis of Flow over a flat plate	Ansys-Fluent	Hands on Experience
2	Analysis of Flow through circular pipe	Ansys-Fluent	Hands on Experience
3	Analysis of Flow through Venturi meter and orifice meter	Ansys-Fluent	Hands on Experience
4	Estimation of minor losses in flow domain in a circular pipe	Ansys-Fluent	Hands on Experience
5	Analysis of Convergent –Divergent Nozzle for different Divergence angle	Ansys-Fluent	Hands on Experience
6	Flow over a cylinder	Ansys-Fluent	Hands on Experience
7	Flow over a symmetrical Aero foil	Ansys-Fluent	Hands on Experience

TEXT BOOKS

1. J. D Anderson, "Fundamental of Computational fluid dynamics", McGraw-Hill Publications, 6th Edition, 1995.
2. Jiyuan Tu "Computational fluid Dynamics – A practical approach "Elsevier publication, 3rd Edition, 2018.

REFERENCE BOOKS

1. K. Muralidhar, T. Sundarajan "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2nd Edition, 2003.
2. Suhas V Patankar, "Numerical Heat Transfer and Fluid Flow", 1st Edition, CRC Press, 2018.

JOURNALS/MAGAZINES

1. International Journal of Computational Fluid Dynamics, Taylor and Francis.
2. Progress in Computational Fluid Dynamics, An International Journal, Inderscience Publishers.

SWAYAM/NPTEL/MOOCs:

1. Computational Fluid Dynamics, by Prof. Suman Chakraborty, IIT Kharagpur (https://onlinecourses.nptel.ac.in/noc21_me126/preview)
2. Foundation of Computational Fluid Dynamics, by Prof. Vengadesan, IIT Madras https://onlinecourses.nptel.ac.in/noc20_me64/preview)

Course Title	Fluid Mechanics and Machines Lab				Course Type		Hard Core	
Course Code	B22ER0507	Credits	1		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Fluid Machines Lab is focused on the applications of theoretical concept learned from the Fluid mechanics and machines course. The students will be conducting experiments in the laboratory pertaining to determination of losses of fluid flow through pipe, calibration of flow measuring devices, performance testing of Hydraulic turbines, Centrifugal Pumps and Reciprocating pumps.

COURSE OBJECTIVES

1. The course will impart practical knowledge in verification of principles of fluid flow.
2. To introduce various fluid flow measuring devices and determine discharge.
3. To introduce the experimental procedure in conducting the performance testing of various fluid machineries.
4. To understand the performance characteristics of various fluid machineries.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Describe various properties of fluid for analyzing fluid flow applications.	1	1
CO2	Determine the energy losses for fluid flowing through pipe and pipe fittings and document the results in the form of technical report.	1,2,3,9,10	1,2,3
CO3	Determine the discharge for fluid flow through pipes and open channel and document the results in the form of technical report.	1,2,3,9,10	1,2,3
CO4	Compute the coefficient of impact for a jet striking the vanes and document the results in the form of technical report.	1,2,3,9,10	1,2,3
CO5	Conduct experiments, interpret the data, analyze the Centrifugal and reciprocating power absorbing machines and document the results in the form of technical report.	1,2,3,9,10	1,2,3
CO6	Conduct experiments, interpret the data, analyze the hydraulic power generating machines and document the results in the form of technical report.	1,2,3,9,10	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									1			2		
CO2	3	2	1						3	2			3	2	1
CO3	3	2	1						3	2			3	2	1
CO4	3	2	1						3	2			3	2	1
CO5	3	3	1						3	3			3	2	1
CO6	3	3	1						3	3			3	2	1
Average	**3**	**2.4**	**1**						**3**	**2.2**			**2.8**	**2**	**1**

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

Part-A

1. Determination of friction factor and Reynold's number for the fluid flowing through pipes.
2. Determination of minor losses for fluid flow through pipe fittings.
3. Calibration of Veturimeter, Orifice meter, flow nozzle and V notch.
4. Determination of force developed by impact of jets on vanes.

Part-B

1. Performance test on Single stage Centrifugal pump to draw Main and Operating characteristic curves.
2. Performance test on Multi- stage Centrifugal pump to draw Main and Operating characteristic curves.
3. Performance test on Reciprocating pump to draw Main and Operating characteristic curves.
4. Performance test on Pelton turbine to draw Main and Operating characteristic curves.
5. Performance test on Francis turbine to draw Main and Operating characteristic curves.
6. Performance test on Kaplan turbine to draw Main and Operating characteristic curves.

TEXT BOOKS

1. Dr. Bansal, "Fluid Mechanics and Machinery", R.K.Lakshmi Publications, 11th Edition, 2022.
2. Jagadish Lal, "Fluid Mechanics and Hydraulic Machines", Metropolitan Book Company, 4th Edition 2012.

REFERENCE BOOKS

1. Yunus A. Cengel and John M.Cimbala, "Fluid Mechanics (SI Units)", Tata McGraw Hill, 4th Edition, 2019.
2. Pijush.K.Kundu, "Fluid Mechanics", Taylor & Francis, 3rd Edition, 2015.

JOURNALS/MAGAZINES

1. https://www.cambridge.org/core/journals/journal-of-fluid-mechanics

SWAYAM/NPTEL/MOOCs

1. https://onlinecourses.nptel.ac.in/noc22_me31/preview
2. https://www.my-mooc.com/en/categorie/mechanical-engineering

Course Title	Machine Shop				Course Type		Hard Core	
Course Code	B22ER0508	Credits	1		Class		V Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

The Machine Shop Laboratory provides hands-on experience with the basic machining techniques and using various types of equipment in manufacturing environments .It is also aimed at providing an introduction to the Know-how common machining processes used in industries for manufacturing parts by removal of material in a controlled environment. The students will go through the fundamentals and principles of metal cutting using lathe, milling machine, shaping machines and also CNC milling and CNC Lathe machines

COURSE OBJECTIVES

1. To impart practical and working knowledge of Machine Tools and operations.
2. To develop machining skills with appropriate selection of tools.
3. To give exposure to analyze the speed, feed and depth of cut and workmanship.
4. To give students hands on practice in preparing lathe models, milling and shaping models.
5. To give exposure to advanced machining process like CNC milling and CNC lathe machines

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Demonstrate practical and working knowledge of Machine Tools and operations.	1,9	1
CO2	Perform turning, facing, knurling, thread cutting, tapering, eccentric, turning and allied operations using lathe.	1,9	1

CO3	Perform plain shaping and groove cutting using shaping machine.	1,9	1
CO4	Perform gear cutting operation by using suitable indexing method using milling machine.	1,9	1
CO5	Select cutting parameters like cutting speed, feed, depth of cut and tooling for various machining operations.	1,9	1
CO6	Identify the sequence of operation, prepare a model as per given profile using CNC Lathe and CNC milling machine.	1,5, 9,10	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	2								2				1		
CO2	3								2				2		
CO3	3								2				2		
CO4	3								2				2		
CO5	3								2				2		
CO6	3				1				2	1			2	1	
Average	**2.8**				**1**				**2**	**1**			**1.8**	**1**	

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

Part-A

1. Introduction to Lathe machine and to establish the cutting speed, feed, depth of cut.
2. Preparation of Facing and Turning model
3. Establishing Taper turning and Step turning models
4. Preparing Model involving thread cutting and knurling operations
5. Producing cylindrical hole and chamfer operations in the given model

Part-B

1. Involute Gear cutting using milling machine and universal dividing head
2. Cutting V-Groove/Rectangular shapes by using Shaping Machine.
3. Demo on eccentric turning.
4. Demo of model preparation on CNC lathe
5. Demo of Preparation on CNC Milling Machine

TEXT BOOKS

1. R.K Jain, "Production Technology", Khanna Publications, 2003.
2. P N Rao, "Manufacturing Technology", McGraw-Hill Education, (Volume II), 2018
3. Kalpakjian, Serope, "Manufacturing Engineering and Technology", Addison –Wesley publishing co., New York

REFERENCE BOOKS

1. Hajra Choudhury, “Workshop Technology Vol-II”, Media Promoters & Publishers Pvt. Ltd. 2004
2. Amitabh Ghosh and Mallik, “Manufacturing Science”, affiliated East West Press, 2003
3. G.C Sen & Bhattacharya, “Principle of Machine Tools”, Tata McGraw hill, New Delhi.

JOURNALS/MAGAZINES

1. International Journal of Machine Tools and Manufacture
2. Journal of Manufacturing Processes

SWAYAM/NPTEL/MOOCs

1. https://www.coursera.org/browse/physical-science-and-engineering/mechanical-engineering
2. https://onlinecourses.nptel.ac.in/noc21_me04/preview

6th Semester

Course Title	Energy Technology				Course Type		Open Elective	
Course Code	B22MEO601	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 and introduces the different types of fuels used for steam and nuclear power plants. This course introduces to renewable energy resources like hydro, solar, wind, tidal, geothermal and bio mass energy.Further the course deals with conversion of electrical energy through fuel cells and battery technology. This course helps the students to know the different types of power plants to generate electricity, its components, material handling systems, benefits, limitations and applications and it creates the interest in the students to select this field as a career in their future.

COURSE OBJECTIVES

1. To understand the different energy resources available in the nature.
2. To gain the knowledge about steam and nuclear power plant.
3. To enhance the knowledge about renewable energy sources and energy conversion process.
4. To explore the knowledge on fuel cells and battery technology.

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 energy resources available in the nature and conversion of steam energy in to electrical energy using steam and nuclear power plant.	1,6,7	1
CO2	Analyze the water resources for the generation of electricity using hydel plants	1,2,6,7	1
CO3	Describe the energy conversion from solar, hydrogen energy resources and its applications.	1,6,7	1
CO4	Discuss the principles of energy conversion of wind, ocean, and geothermal energy systems.	1,7	1
CO5	Elaborate the main characteristics of biomass energy source and construction factors of biogas digesters.	1,6,7	1
CO6	Explain the fundamentals of fuel cells and battery technology.	1,6	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						3		
CO2	3	2				2	2						3		
CO3	3					2	2						3		
CO4	3						2						3		
CO5	3					2	2						3		
CO6	3					2							3		
Average	**3**	**2**				**2**	**2**						**3**		

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

COURSE CONTENT

Unit-1

Introduction to Energy System: Types of energy resources, review of energy scenario in India, different types of fuels used for steam power plant, general layout of steam power plant, equipment for preparation of pulverized coal-bowl mill, unitsystem and bin system.

Draught System: Chimneys: Natural, forced, induced and balanced draft, Cooling towers and Ponds.

Nuclear Power Plant: Fuels used in nuclear power plant, general layout of the plant, advantages, disadvantages and nuclear waste disposal methods, case studies.

Unit-2

Hydro-Electric Energy: General layout of hydel power plants, classification of hydel plants, Hydrographs, flow duration curve (numerical on hydrograph and flow duration curve), Case studies.

Solar Energy and Applications: Solar radiation - Availability- Measurement Advantages, disadvantages and Applications of solar energy source,

Hydrogen Energy: Introduction to hydrogen energy, methods of hydrogen production (electrolysis and thermo-chemical method).

Unit-3

Wind Energy: Wind energy - General considerations - classification of wind power plants –Working of Horizontal and vertical axis wind turbine.

Tidal Power: classification and working of different systems, advantages and disadvantages tidal power plants.

Ocean Thermal Energy Conversion (OTEC) Power generation –working principle, Advantages, disadvantages and Applications of OTEC.

Geothermal Energy Conversion: Availability - working principle, Advantages, disadvantages.

Unit-4

Biomass Energy Sources: Photosynthesis process, Energythrough fermentation -Ethanol Production from sugarcane, Biomass characteristics. Factors affecting biogas yield, biogas digester (floating gasholder and fixed dome type with working principle and diagram).

Fuel Cells and Battery Technology: Introduction, types, working principle, applications of fuel cells and Batteries.

CASE STUDIES

1. Case study on renewable energy resources energy power plants
2. Case study on non-renewable energy resources energy power plants

TEXT BOOKS

1. P.K Nag, “Power Plant Engineering”, 3rd Ed. Tata McGraw Hill, 2nd Edition 2001.

2. B H Khan, “Non-conventional energy resources”, McGraw Hill Education, 3rd Edition, 2017.
3. G.D. Rai, “Non-Conventional Energy Sources”, Khanna Publishers, 2011.
4. Mehrdad Ehsani, “Modern Electric, Hybrid electric and Fuel Cell Vehicles”, CRC Press, 3rd Edition, 2019.

REFERENCE BOOKS

1. Duncan Richardson, “Plant Equipment & Maintenance Engineering Handbook”, McGraw Hill Professional, 2013.
2. R.K. Rajput, “Power Plant Engineering”, Laxmi Publications; Fifth edition, 2016.
3 .Bahman Zohuri and Patrick McDaniel, “Thermodynamics in Nuclear Power Plant Systems”, Springer, 2016.
4. A.R. Jha, “Next-Generation Batteries and Fuel Cells for Commercial, Military, and Space Applications”, CRC Press Inc; 1st Edition 2012.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/search?qs=nuclear%20power%20plant
2. https://www.journals.elsevier.com/international-journal-of-hydrogen-energy
3. https://www.sciencedirect.com/search?qs=fuel%20cells
4. https://www.researchgate.net/publication/369942210_Fuel_Cell_Electric_Vehicle_Modeling_Using_HybridBatteryFuel_Cell_Vehicle_Modeling_Tool_HBFCMT

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

Course Title	**Heat Transfer**				**Course Type**		**Hard Core**	
Course Code	**B22ER0601**	**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				
	Tutorial	1	2	2				
	Practice	0	0	0	Theory	Tutorial	IA	SEE
	Total	**3**	**4**	**4**	**26**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Heat Transfer deals with the study the modes of heat transfer and their governing equations. It provides the knowledge on heat transfer through composite wall, cylinders, and spherical surfaces including insulation under steady state condition. It also focuses on how the heat transfer rate can be enhanced by providing fins and applications of heat transfer for analysis of types of Heat Exchangers and unsteady state of heat transfer.

COURSE OBJECTIVES

1. To understand the basic modes of heat transfer and their governing equations.
2. To study the heat transfer processes through composite structures under steady and unsteady state.
3. To analyze conduction, convention and radiation heat transfer processes.
4. To learn the effect of insulation and design of heat exchangers.

COURSE OUTCOMES (COs)

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

CO	**Course Outcomes**	**POs**	**PSOs**
CO1	Understand the three modes of heat transfer and thermal management in electronics systems.	1	1
CO2	Analyze the combined mode of heat transfer through composite structure like composite wall, cylinder and sphere with and without insulation.	1,2	1,2
CO3	Solve the numerical on fins by choosing appropriate fin condition.	1	1,2

CO4	Apply Lumped system and Heisler chart analysis to interpret transient heat conduction phenomenon.	1,2	1,2
CO5	Apply free and forced convection concept to analyze convective heat transfer.	1,2	1,2
CO6	Design heat exchangers using LMTD and Effectiveness-NTU method.	1,2,3	1,2

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 ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3											2		
CO2	3	3											3	2	
CO3	3												3	2	
CO4	3	3											3	2	
CO5	3	3											2	2	
CO6	3	3											3	2	
Average	**3**	**3**											**2.67**	**2**	

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

COURSE CONTENT

Unit-1

Introduction to Heat transfer: Modes and Basic governing laws of heat transfer, Boundary conditions, Thermal contact resistance, Overall heat transfer coefficient, 3-D heat conduction equation in Cartesian co-ordinates, Discussion on 3-D conduction equation in Cylindrical & Spherical coordinates, 1-D steady state heat conduction without heat generation (plane wall, cylinders & spheres), Thermal Resistances concept, heat transfer through composite structures. Critical thickness of insulation on spheres and cylinders. Numerical on composite structures and critical thickness.

Unit-2

Fins: Introduction to fins, Discussion on governing equations for different conditions of fins, effectiveness & efficiency of fin, Numerical.

1-D Transient Conduction: Lumped system Analysis, Use of Heisler's charts for transient conduction in plane slab, long cylinder, and sphere. Numerical examples, Introduction to Numerical analysis of Heat conduction

Unit-3

Natural Convection: Application of dimensional analysis for free convection, various correlations used for free convection heat transfer, physical significance of Grashoff, Raleigh number, Numerical.

Convection Heat Transfer: Hydrodynamic and thermal boundary layer over a flat plate and Flow through duct, critical Reynolds number

Forced Convection: Application of dimensional analysis for forced convection, various correlations used for forced convection heat transfer, physical significance of Reynolds, Prandtl, Stanton, Nusselt numbers, Numerical.

Unit-4

Heat Exchangers: Classification, Overall heat transfer coefficient, fouling and fouling factors, LMTD method of analysis, Discussion on effectiveness-NTU(No derivation) method of analysis of heat exchangers, Numerical.

Radiation Heat Transfer: Thermal radiation, definitions of various terms, Laws of black body radiation-Stefan Boltzmann, Wein's displacement law, Kirchhoff's law, Planck's law, Black body concept, Discussion on radiation shape factor, Discussion on heat exchange between two gray bodies (Infinite parallel planes), Discussion on effect of radiation shields, Numerical.

Thermal Management in Electronics: heat is generation in electronic circuits, types of thermal management

CASE STUDIES

1. Application of heat transfer through composite wall to calculate heating or cooling load of residential and Industrial building.
2. Applications of transient heat transfer analysis for design of microwave and egg boiler.
3. Study of various heat exchangers used in automobile vehicles, residential and industrial applications.

TEXT BOOKS

1. Ozisik, "Heat transfer-A basic approach", Tata McGraw Hill, 1st Edition, 1985.
2. R K Rajput, "A Textbook of Heat and Mass Transfer", S Chand Publications, 7th Edition, 2019.

REFERENCE BOOKS

1. Yunus A-Cengel, "Heat and Mass Transfer", Tata McGraw hill, 6th Edition, 2020.
2. Frenk P.Incropera and DavidP.Dewitt, "Principles of Heat and Mass transfer", John Wiley and sons, 6th Edition, 2018.
3. Mahesh M Rathore, "Heat and Mass Transfer", Laxmi publications, 3rd Edition, 2016.

JOURNALS/MAGAZINES

1. The Journal of Heat Transfer, ASME.
2. International Journal of Heat and Mass Transfer, Elsevier.

SWAYAM/NPTEL/MOOCs

1. Heat Transfer, By Prof. Ganesh Viswanathan, IIT Bombay, https://onlinecourses.nptel.ac.in/noc20_ch12/preview
2. Heat Transfer, By Prof. Sunando Dasgupta, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc19_ch23/preview

Course Title	**Finite Element Methods**				**Course Type**		**Hard core**	
Course Code	**B22ER0602**	**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				
	Tutorial	1	2	2				
	Practice	0	0	0	Theory	Tutorial	IA	SEE
	Total	**3**	**4**	**4**	**26**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

Finite Element Analysis is a numerical method used to analyze and solve engineering problems in which the behavior of structures, machines, and systems is described by partial differential equations. Finite Element Analysis breaks down the complex problem into smaller, more manageable elements, then solves the equations for each element and combines the results to obtain an approximate solution for the entire problem.

COURSE OBJECTIVES

1. To understand the basic principles of FEA, including the mathematical and physical foundations.
2. To develop skills in using FEA software to solve engineering problems.
3. To learn how to choose appropriate element types and meshing strategies for different types of problems.
4. To understand the limitations and assumptions of FEA and how to interpret and validate the results of an analysis.
5. To develop the ability to apply FEA to solve real-world engineering problems and to identify the appropriate approach to use for a given problem.
6. To learn best practices for FEA analysis, including model preparation, solution techniques, and post-processing.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Understand the principles of FEA, including the mathematical and physical foundations, steps involved and ability to choose appropriate element types.	1,2	1,2
CO2	Derive elemental stiffness matrix for bar, beam and truss.	1,2	1,2
CO3	Develop finite element solutions for bars, trusses, and beams 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.	1,2,12	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	2	
CO2	3	1											3	3	
CO3	3	3	2		1							1	3	2	1
CO4	3	3	2										3	3	1
CO5	3	3	2										3	2	1
CO6	3	3										1	3	3	1
Average	**3**	**2.66**	**2**		**1**							**1**	**3**	**2.5**	**1**

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

COURSE CONTENT

Unit-1

Introduction: Introduction to FEM, Steps involved in FEM, Phases of FEM, Engineering applications, Advantages, Disadvantages, List of commercial FEM Packages.

Discretization: Types of elements used in FEM, Shape and behavior, Choice of element types, size and number of elements, Location of nodes, Node and Element numbering, coordinate systems, Mesh quality parameters and Convergence criteria.

Unit- 2

Interpolation polynomials: 1D Linear, quadratic and cubic. Simplex, complex, and multiplex elements. 2D PASCAL's triangle CST elements, 1D linear shape functions in NCS, and Jacobian for triangular element.

Solution of 1-D Bars: Derivation of element stiffness matrix for 1D element, properties of stiffness matrix numerical on bars on the uniform, stepped, and tapered cross-sections to analyze displacements, reactions and stresses by using penalty and elimination approaches.

Unit-3

Introduction: Types of trusses, Derivation of stiffness matrix, Numerical 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 quadrilateral element, quadratic rectangular element, Numerical integration: 1 and 2 gauss point for 1D case.

Unit-4

Beams: Derive Hermite shape functions for beam element, Derivation of stiffness matrix using Hermite shape functions, Numerical on beams carrying concentrated & UDL loads.

Heat transfer: Steady-state heat transfer, 1D heat conduction governing equation, Boundary condition, Numerical on heat conduction and convection in composite walls, and pin fins.

CASE STUDIES

1 Analysis of a Truss Bridge.
2 Analysis of a Pressure Vessel.
3 Analysis of an Aircraft Wing.
4 Stress Analysis of the truck chassis.
5 Structural dynamic analysis of storage frames.

TEXT BOOKS

1. J. N. Reddy, "Introduction to Finite Element Method", McGraw Hill, 4th Edition, 2020.
2. Tirupathi. R. Chandrapatla, Ashok. D. Belegundu, "Finite Elements in Engineering", Pearson Education India, 4th Edition, 2015.

REFERENCE BOOKS

1. S. S. Bhavikatti, "Finite Element Analysis", New Age International publishers, 3rd Edition, 2015.
2. David Hutton, "Fundamentals of Finite Element Analysis", McGraw Hill Education, 2017.
3. Robert D. Cook, "Concepts and Applications of Finite Element Analysis", Wiley, 4th Edition, 2009

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

<table>
<tr><td>Course Title</td><td colspan="3">Design of Transmission Elements</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B22ER0603</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>Tutorial</td><td>0</td><td>0</td><td>0</td><td colspan="2" rowspan="2"></td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Practice</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>Theory</td><td>Practical</td><td>IA</td><td>SEE</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

Design of transmission elements deals with the basics of design concepts Involved in curved beams, springs, clutches and brakes. It provides the students with fundamental skills of engineering, and the ability to apply the theories of science to practice. This course would help to fill the gap the knowledge at graduation and step into producing the detailed design of gears & bearings in Industries.

COURSE OBJECTIVES

1. To enable students to design important machine elements such as springs, brakes, curved beams, flexible power transmission elements such as belts and ropes.
2. To enable students to design different gears such as spur gear, helical gear and bevel gear.
3. To help students in understanding and selection of ball and roller bearings from the standard design catalogue.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Solve for stresses in curved beams and design the springs subjected to static axial load as per SAE standards.	1,2,3,6,8	1,2
CO2	Design belt drives used in mechanical power transmission as per SAE standards.	1,2,3,6,8	1,2
CO3	Design clutches and brakes for automotive applications as per SAE standards.	1,2,3,6,8	1,2
CO4	Design spur and helical gears subjected to static, dynamic and wear load conditions as per AGMA standards.	1,2,3,6,8	1,2
CO5	Design bevel gear for different load conditions as per AGMA standards and recommend appropriate solution.	1,2,3,6,8	1,2
CO6	Design ball bearings subjected to cyclic loads and speeds as per the series-2 Indian Standards	1,2,3,6,8	1,2

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 ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1			1		2					3	3	
CO2	2	2	3			1		2					3	3	
CO3	3	3	3			1		2					3	3	
CO4	2	3	3			1		2					3	2	
CO5	2	2	3			1		2					2	3	
CO6	2	3	1			1		2					3	3	
Average	**2.16**	**2.66**	**2.33**			**1**		**2**					**2.83**	**2.83**	

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

COURSE CONTENT

Unit-1

Design of Belts Introduction to transmission systems, Selection, and design of Flat & V-belts for different applications.

Curved Beams: Stresses in curved beams of circular and rectangular cross sections used in crane hook and open circular ring.

Unit-2

Clutches and Brakes: Design of single plate and multi plate clutch, Design of Block / Shoe brakes (Single Shoe Brake only), Band brakes - Simple Band brakes, Self-locking of brakes, Heat generation in Brakes.

Design of Springs: Types of springs - stresses in helical springs of circular section subjected to static axial loading. Leaf Springs: Stresses in leaf springs and simple problems.

Unit-3

Design of Spur Gears: Definitions, stresses in gear tooth: Lewis's equation and form factor, Design for strength, Dynamic load and wear load.

Design of Helical Gears: Definitions, formative number of teeth (Without derivation), Design based on strength, dynamic and wear loads.

Unit-4

Design of Bevel Gears: Definitions, formative number of teeth, Design based on strength, dynamic and wear loads.

Bearings: Bearing Life, equivalent bearing load, selection of bearings, Bearings for cyclic loads and speeds for ball bearing.

CASE STUDIES

1. Design a spring to withstand the weight of an elevator which varies from 800N to 1200N force and operating 8 Hrs /day.
2. Design a crane hook to lift the load of 8000N from a mine of depth 800m.
3. Design a clutch for a 150 cc bike by considering all the factors into consideration.
4. Design a gear of sugarcane crusher by considering all the factors into consideration.
5. Design a bearing for front suspension of a 350 cc bike.

DESIGN DATA HAND BOOKS

1. Lingaiah K, "Machine Design Databook", McGraw Hill Education, 2nd Edition, Vol1 & 2, 2017
2. Balaveera K Reddy and K Mahadevan, "Design Data Hand Book for Mechanical Engineers", CBS Publisher, 4th Edition, 2018.

TEXT BOOKS

1. Richard G Budynas and J Keith Nisbett, " Shiegly's Mechanical Engineering Design", McGraw Hill Education, 11th Edition, 2020.
2. V. B. Bhandari, "Design of Machine Elements" Tata McGraw Hill Publishing Company Ltd., 3rd Edition 2017.

REFERENCE BOOKS

1. Robert L. Norton, "Machine Design- An Integrated Approach", Pearson Education, 5th Edition, 2018.
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, 10th Printing, 2015.

JOURNALS/MAGAZINES

1. Clutches and Brakes: Design and Selection - 2nd Edition - William C. (routledge.com)
2. 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)

Course Title	**Refrigeration and Air Conditioning**				**Course Type**		**Soft Core**	
Course Code	**B22ERS611**	**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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Tutorial	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course provides the knowledge on refrigeration and air conditioning systems. Understand the concept of various thermodynamic cycles used for producing cooling effect. It gives information about components and working fluids used in refrigeration systems. It also provides knowledge on estimation of the cooling or heating load to select the capacity of the plant. This course enlightens the uses of refrigeration and air conditioning in various real time applications. This course provides basic knowledge to work in R&AC industries.

COURSE OBJECTIVES

1. To understand principles of refrigeration and refrigeration cycles and systems.
2. To acquire the knowledge on refrigerants, their effects and components used in R&AC systems.
3. To understand principles of psychometry and develop the skills to estimate cooling load and heating load for summer and winter air conditioning
4. To gain the knowledge on how refrigeration and air conditioning will be useful in domestic and commercial applications.
5. To expose the students to field of refrigeration and air conditioning, so that they can get opportunities to work in R&AC industries.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Explain working principle of refrigeration and air conditioning systems.	1	1,
CO2	Summarize the application of refrigerants and working of components used in refrigeration and air-conditioning systems.	1,7	1,2
CO3	Evaluate the performance of vapour compression, vapour absorption and air refrigeration systems.	1,2	1,2
CO4	Design summer and winter air conditioning systems based on cooling and heating loads.	1,2,3	1,2,3
CO5	Demonstrate the knowledge on construction and working of water coolers and air conditioning systems used in food storage, automotive vehicles, hospitals and theaters.	1	1,2
CO6	Discuss cryogenic concepts used for liquefaction of air and oxygen.	1	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 ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												3		
CO2	2	1					1						2	1	
CO3	3	2											3	1	
CO4	3	3	2										3	1	1
CO5	3	2											3	1	
CO6	3	1											2		
Average	**2.67**	**1.8**	**2**				**1**						**2.6**	**1**	**1**

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

COURSE CONTENT

Unit-1

Refrigeration Cycles: Methods of refrigeration, Vapour compression refrigeration cycle and actual vapour compression cycle, Air refrigeration cycle, Aircraft refrigeration system- simple and boot strap system with performance analysis. Vapour absorption systems-COP of the system, simple Ammonia-water vapour absorption system, Lithium bromide refrigeration system, three fluid vapour absorption systems, and simple numerical on vapour compression refrigeration system.

Unit-2

Refrigerants: Refrigerant classification, Designation, Refrigerant properties, Oil Compatibility – Environmental Impact- ozone layer depletion, global warming, Alternate refrigerants, Refrigerant absorbent combinations for vapor absorption system.

Refrigeration Components: Reciprocating Open & Hermetic type, Screw Compressors and Scroll Compressors, Condensers-types, Evaporators-types, chillers-types, Expansion devices-capillary tube- automatic expansion valve - thermostatic expansion valve- Low side-high side float, low pressure and high pressure cut outs, solenoid valves.

Unit-3

Design of Air conditioning Systems: Review of Moist air properties-various psychometric process, Summer and Winter Air-conditioning, Cooling load calculations-comfort chart-SHF-GRSHF-ERSHF, cooling load estimate, Cooling load calculation using HVAC Design software

Unit-4

Air-conditioning Systems and Components: Different Air-Conditioning Systems-Central – Station Air-Conditioning System, Unitary Air-Conditioning System, Window Air-Conditioner and Packaged Air-Conditioner, Air handling system- ducts and its arrangements, room air distribution- supply air outlets.

Application of Refrigeration and Air Conditioning: Domestic refrigerator-construction- working and maintenance, Water coolers-storage type, Cold storage plants, Dessert cooler, Air conditioning systems for automobiles-car-bus-truck container, Air conditioning system in hospitals, Air conditioning system in theaters, Introduction to cryogenics-liquefaction of air and oxygen.

CASE STUDIES

1. Cooling Load calculations of the residential and industrial buildings using HVAC software.
2. Detail study of Air conditioning systems installed in hospitals.
3. Study of Air conditioning system installed in theaters/auditoriums.

TEXT BOOKS

1. Arora, C. P., “Refrigeration and Air Conditioning”, Tata McGraw Hill, New Delhi, 4th Edition, 2021
2. W.F.Stocker and J.W.Jones “Refrigeration & Air Conditioning”, McGraw Hill Book Company, 2nd Edition, 2014.

REFERENCE BOOKS

1 Manohar Prasad, “Refrigeration and Air conditioning”, New Age International (P) Ltd, New Delhi,3rd Edition, 2021
2. Ananthanarayanan.P.N, “Basic Refrigeration and Air Conditioning”, Tata McGraw Hill, 4th Edition, 2013
3. Roy J. Dossat,”Principles of Refrigeration”, Pearson Education Asia, 5th Edition, 2001
4. R S Khurmi and J K Gupta, “A Text Book on “Refrigeration and Air conditioning”, S Chand Publication., New Delhi, 5th Revised Edition, 2020.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/international-journal-of-refrigeration
2. https://www.journals.elsevier.com/international-journal-of-refrigeration

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112105129

2. https://nptel.ac.in/courses/112105128

Course Title	Operation Research				Course Type		Soft core	
Course Code	B22ERS612	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Optimization is the most important sub area of the discipline Operations Research. Optimization problems arise in all walks of human activity- particularly in engineering, business, finance and economics. Operations research aims to achieve the best performance under the given circumstances. Optimization also involves comparing and narrowing down potential options. Simulation – Involves creating models or replicas to test and test solutions before applying them. 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 model real life optimization problems as Linear Programming (Optimization) Problems and subsequently educate the student to solve these models with the help of the available methods.

COURSE OBJECTIVES

1. To understand the fundamentals of OR, Formulation of an LPP and determine the optimal solution for a LPP Problem
2. To understand applications of LPP in solving transportation, assignment and travelling salesman problem.
3. To analyze the waiting line model for real world applications.
4. To determine the project completion time by using PERT and CPM.
5. To know the scheduling of machines in the shop floor by using Johnson's algorithm.
6. To discuss the conflict between the two players in a game and determine the best strategy for the play.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Develop mathematical model for LPP and solve graphically for the optimal product mix and iterative method.	1,2,3	1,2
CO2	Formulate and obtain optimal solution for the transportation and assignment models.	1,2,4,5	1,2
CO3	Analyze networks using PERT and CPM techniques to improve decision making and objective analysis of decision problems.	1,3,5, 9	1.2
CO4	Discuss and solve the various waiting line problems.	1	1,2
CO5	Identify the importance of sequencing of jobs and recognize patterns that make the environment more understandable and predictable.	1, 5	1,2
CO6	Distinguish different game situation from a pure individual's decision problem and to explain/Solve concepts of players, strategies, payoffs, rationality and equilibrium.	1, 5	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 ARTICULATIONMATRIX

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

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

COURSE CONTENT

Unit-1

Introduction to Operation Research: Definition, Scope of OR, OR Models, Characteristics and phases of OR. Advantages and limitation of OR. Mathematical formulation of LPP, Assumptions in LPP. Graphical solutions of LPP, Convex and non-convex sets.

Linear Programming Problem: Slack, surplus and Artificial variables, Simplex method & BIG-M, Special cases - unbounded solution, multiple optimal solution, infeasible solution & degeneracy.

Unit-2

Transportation Model: Formulation of transportation model, Determination of IBFS using different methods- Different methods to VAM Technique & optimality by Modi (U-V) method. Balanced and unbalanced transportation Problem, Degeneracy in transportation problems and resolving degeneracy, maximization of transportation problem.

Application of Transportation Problem: Assignment model, Hungarian Method, Formulation of the assignment model (Minimization and Maximization), Balanced and unbalanced model, travelling salesman problem.

Unit-3

Network analysis: PERT & CPM Techniques. Project scheduling, Basic terminology used in project network, network construction, time estimates, determination of critical path and its durations, Floats, Variance under probabilistic models, prediction of project completion date.

Waiting Line Model: Queue system and characteristics of queuing models, Kendall's notation, classification of the queue. The M/m/1 :∞/FCFS queuing system, Numerical.

Unit-4

Game Theory: Introduction, Definition, strategy, Formulation of games, pay off matrix, Maximin and minimax criteria, Saddle point, Types of games. Solution of game with and without saddle point, Graphical solution of 2 X n game & M X 2 game. Dominance property for rectangular game i.e., M x N game.

Sequencing: Johnson's algorithm, Assumptions in sequencing, n jobs to 2 machines, n jobs on 3 machines, n jobs on m machines, 2 jobs on n machines, graphical solution priority rules.

CASE STUDIES

Implementation of OR Models to realistic problems - practical cases, by using TORA, WinQSB.

1. Product / Production Mix Problem
2. Transportation Model
3. Assignment Model / Travelling Salesman Model
4. Project Scheduling - PERT and CPM

TEXT BOOKS

1. Prem kumar Gupta and D.S.Hira, "Operations Research", S.Chand Publication, 7th Edition, 2022.
2. S.D.Sharma, "Operations Research: Theory Methods and Applications", Kedarnath Ramanth & co., 2020.

REFERENCE BOOKS

1. Hiller and Liberman, "Introduction to Operation Research", Tata McGraw hill.
2. Taha.H.A, "Operation Research and Introduction", Pearson Education Edition.
3. Ravindran, "Engineering Optimization: Methods and Application", John Wiley and Son's Publication, 2nd Edition, 2006.
4. Kalavathy, "Operation Research", Vikas Publications, 2019.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/european-journal-of-operational-research
2. https://www.theorsociety.com/publications/journals/jors/
3. https://www.inderscience.com/jhome.php?jcode=ijor

SWAYAM/NPTEL/MOOCs

1. https://onlinecourses.nptel.ac.in/noc19_ma29/preview
2. https://www.coursera.org/learn/operations-research-theory
3. https://onlinecourses.swayam2.ac.in/cec20_ma10/preview

Course Title	**Additive Manufacturing**				**Course Type**		**Soft core**	
Course Code	**B22ERS613**	**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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

This course introduces the basic fundamentals of rapid manufacturing (RM), its fabrication methodology, different techniques of part fabrication, materials and various areas of defects and improvements in RM. The course also introduces the preprocessing, processing and post processing (CIM Scenario) steps to build the part and concept of reverse engineering.

COURSE OBJECTIVES

1. To learn the fundamentals of Rapid prototyping and related concepts to understand the various materials used in the techniques.
2. To extent product life time by adding necessary features and eliminating redundant features early in the design.
3. To impart the knowledge of additive manufacturing fundamentals and practical knowledge on various 3D printing technologies.
4. To understand the concept of preprocessing and post processing methods to be followed for the additive manufacturing
5. Able to design and print 3D components using various printing tools by minimize sustaining engineering changes

COURSE OUTCOMES (COs)

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

CO	**Course Outcomes**	**POs**	**PSOs**

CO1	Develop the ability to understand the concepts, capabilities and limitations of additive technologies and their varied applications evolved in manufacturing scenario.	1,2	1,2,3
CO2	Visualize, design and print 3D components using various software and 3D printing tools by Identifying suitable process and process parameters	1,2,3	1,2,3
CO3	Recognize the post processing concept for additive Manufacturing	1,2	1,2,3
CO4	Illustrate the process of concept modeler - three dimensional printing.	1,2,3	1,2,3
CO5	Examine and identify the errors in STL files and implement a suitable repair algorithm.	1,2,3	1,2,3
CO6	Implement suitable shrinkage compensation and identify appropriate orientation of parts for different layering techniques. .	1,2	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 ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2											3	1	1
CO2	3	2	1										3	1	1
CO3	2	2											3	1	1
CO4	3	3	2										3	1	1
CO5	3	2	1										3	1	1
CO6	2	2											3	1	1
Average	**2.5**	**2.2**	**1.3**										**3**	**1**	**1**

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

COURSE CONTENT

Unit-1

Introduction and SLA: Definition of RP, Prototypes, Types of prototypes, roles of prototypes, Need for the compression in product development, Impact of Rapid prototyping in product development, history of RP systems, Survey of applications, industry and classification of RP systems, Basic methodology of RP, Benefits and limitations.

Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.

Unit-2

Solid Ground Curing: Principle of operation, Machine details, Applications

Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications.

Fusion Deposition Modeling: Principle, Process parameter, Path generation, Applications.

Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.

Unit-3

Concept Modelers and Rapid Tooling: Introduction, types, 3D printing to 5D printing - principle of operation. Indirect and Direct rapid tooling - Aluminium filled epoxy tooling, Spray metal tooling, 3D Keltool, DMILS and Quick cast process

Software for RP: STL files, Overview of Solid view, magic's, Mimics, magic communicator, etc.. Internet based manufacturing.

Unit-4

Process Optimization: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.

Reverse Engineering: surface digitizing, Surface generation from point cloud data, surface modification – data transfer to solid models. Detail application with respect to Aerospace, medical, and automobile.

TEXT BOOKS

1. Paul F. Jacobs, "Stereo Lithography and other RP & M Technologies", SME, NY 1996.
2. Pham D.T & Dimov, S.S Verlog, "Rapid Manufacturing", S.S Verlog London 2001

REFERENCE BOOKS:

1. Terry Wohlers, "Rapid Prototyping", Wohler's Report 2000" Wohler's Association 2000.
2. Gurumurthi, "Rapid Prototyping Materials", IISc Bangalore
3. Lament wood, "Rapid Automated", Indus press New York
4. Chua, C.K., Leong, K.F., "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley and Sons Inc., 2000, Indian reprint 2019.

JOURNALS/MAGAZINES

1. https://openaccesspub.org/journal/3d-printing-and-applications/archives1.
2. https://www.emerald.com/insight/publication/issn/1355-25462.
3. https://home.liebertpub.com/publications/3d-printing-and-additive-manufacturing/621/overview

SWAYAM/NPTEL/MOOCs:

1. https://archive.nptel.ac.in/courses/112/103/112103306/
2. https://onlinecourses.nptel.ac.in/noc22_me130/preview
3. https://www.coursera.org/specializations/additive-manufacturing
4. https://www.coursera.org/specializations/3d-printing-additive-manufacturing

<table>
<tr><td>Course Title</td><td colspan="3">Design for Manufacturing and Assembly</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B22ERS614</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>Tutorial</td><td>0</td><td>0</td><td>0</td><td colspan="2" rowspan="2"></td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Practice</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>Theory</td><td>Practical</td><td>IA</td><td>SEE</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>39</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

Design for Manufacturing and Assembly course deals with introduction to DFMA and Selection of Materials Product Design for Manual Assembly and also covers design for High speed Automatic Assembly, Robot Assembly .This course covers the linking DFM with CAD and Introduction to TRIZ

COURSE OBJECTIVES

1. To enable the students to understand general design principles for manufacturability, strength and mechanical factors, mechanisms selection.

2. To Provide systematic basic knowledge for Working principle, Material, Manufacture, Design Possible solutions and Materials choice.
3. To enable the students to understand the design features to facilitate machining-drills-milling cutters, keyways, doweling procedures
4. To formulate the Identification of uneconomical design.
5. To design for economy, design for clampability, design for accessibility and modifying the design

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Discuss the DFMA and its impact on industry.	1	1,2
CO2	Apply DFMA implementation in design of manual assembly.	1,2,3	1,2
CO3	Apply DFMA implementation in design of high speed automatic assembly and robot assembly.	1,2	1,2
CO4	Apply product design rules for automation.	1,2	1,2
CO5	Create of link between CAD and DFMA, and understanding its effect.	1,2,5	1,2
CO6	Understand the importance of TRIZ and its advantages for industry.	1,5	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												3	2	
CO2	3	2	1										3	3	
CO3	3	2											3	2	
CO4	3	2											3	3	
CO5	3	2			1								3	3	
CO6	3				1								3	2	
Average	**3**	**2**	**1**		**1**								**3**	**2.5**	

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

COURSE CONTENT

Unit- 1

Introduction to DFMA and Selection of Materials: Meaning of Design for Manufacture and Assembly, how DFMA works, Advantages of Applying DFMA. During Product Design, Typical DFMA Case Studies, Overall Impact of DFMA on Industry. General Requirements for Early Materials and Process Selection, Selection of Manufacturing Processes, Process Capabilities, Selection of Materials, Primary Process/Material Selection.

Unit-2

Product Design for Manual Assembly: Introduction, General Design Guidelines for Manual Assembly, Development

of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, Weight on Handling Time, Effects of Combinations of Factors, Effect of Chamfer Design on Insertion Operations, Avoiding Jams During Assembly, Application of the DFA Methodology, Types of Manual Assembly Methods, Assembly Quality.

Unit-3

Design for High speed Automatic Assembly, Robot Assembly: Introduction, Design of Parts for High-Speed Feeding and Orienting – Example, Additional Feeding Difficulties, High-Speed Automatic Insertion, Analysis of an Assembly, General Rules for Product Design for Automation, Design of Parts for Feeding and Orienting, Product Design for Robot Assembly.

Unit-4

Linking DFM with CAD and Introduction to TRIZ: Introduction, General Considerations for Linking CAD and DFMA, Geometric Representation Schemes in CAD Systems, Design Process in a Linked CAD/DFMA Environment, Expert Design and Cost Estimating Procedures, Introduction to TRIZ.

TEXT BOOKS

1. Geoffrey Boothroyd, "Hand Book of Product Design", Marcel Dekker Inc., New Edition, 1994.
2. Harry Peck, "Design for Manufacture", Pittman Publication, 1973.
3. Robert Matousek, "Engineering Design - A systematic approach", Springer, 3rd Edition, 1963.
4. James G.Bralla, "Hand Book of Product Design for Manufacturing: A Practical Guide to Low-cost Production", McGraw-Hill Handbooks, 1986.

REFERENCE BOOKS

1. Swift K.G, "Knowledge Based Design for Manufacture", Prentice-Hall, 1987.
2. Geoffrey Boothroyd, Assembly Automation and Product Design, CRC Press, 2nd Edition, 2005.

Course Title	**Electric and Hybrid Vehicles**				**Course Type**		**Soft Core**	
Course Code	**B22ERS621**	**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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

The course is designed for students who are interested in either conducting research and development in industries related to Electric and Hybrid Vehicles, or pursuing higher studies in this field. The course provides a comprehensive understanding of the various components involved in the working of an Electric Vehicle. It also covers the basics of different electric motors, motor controllers, and control techniques, as well as the electric vehicle drivetrain, regenerative braking used in different types of hybrid vehicles. Prior knowledge of the basic working fundamentals of vehicles is recommended for students to enhance their learning experience. Additionally, the course aims to introduce students to the emerging market of retrofitting existing internal combustion engine vehicles with electric motors

COURSE OBJECTIVES

1. To provide the students with sufficient knowledge on different configurations of EHVs like series, parallel and complex hybrid architectures of automobile vehicles.
2. To enable the students to understand the concept of modern electric drive trains system and its topology, hybrid architectures and hybrid power plant specifications.

3. To help the students to understand the concept of identifying the energy storage methods, energy storage and their alternatives, energy management and control system.
4. To provide the knowledge of the various hybrid propulsion systems, different types of motors and their control parameters of 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	Generalize a clear understanding of the fundamental principles of EHV technology and its impact on social and environment.	1,6,7	1,2
CO2	Recognize different configurations of Hybrid vehicles power trains and analyze the various hybrid load tracking architectures	1,2,6,7	1,2
CO3	Analyze the challenges and opportunities associated with the widespread adoption of energy storage system for electric and hybrid vehicles like battery, fuel cell, Ultra capacitors and flywheels	1,2,6,7	1,2
CO4	Illustrate the working of different types of electrical machines and motors and analyze various motor drive topologies and control parameters used for electric vehicle application.	1,2,3,6,7	1,2,3
CO5	Evaluate the potential impact of energy control management unit with an ability to Identify various communication protocols and technologies used in vehicle networks	1,2,6,7	1,2,3
CO6	Demonstrate the various hybrid vehicular network architectures and analyze the advanced power management systems used on EHVs for optimum operations.	1,2,6,7	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					2	2						2	1	
CO2	3	2				1	1						3	1	
CO3	3	2				3	3						2	1	
CO4	3	2	1			1	1						3	1	1
CO5	3	2				1	1						2	2	1
CO6	3	2				1	1						3	2	1
Average	**3**	**2**	**1**			**1.5**	**1.5**						**2.5**	**1.3**	**1**

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

COURSE CONTENT

Unit-1

Introduction: A Brief History of EHVs, EHVs –Global scenario, Need of EHV technology, Architectures of EHVs, social and environmental importance of hybrid and electric vehicles, basics of vehicle performance, mathematical models to describe vehicle performance

Hybridization of the Automobile: Basics of the EV, Basics of the HEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV) and vehicle architectures, Solar Powered Vehicles, Hybrid Electric Vehicles System – Analysis and its Types

Unit-2

Hybrid Electric Drive-trains: Basic Architecture of Hybrid Drive Trains, 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, Electric Vehicle (EV) drivetrain Alternatives Based on Drivetrain Configuration, Electric Vehicle (EV) Drivetrain Alternatives Based on Power Source Configuration.

Unit-3

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery Parameters, Different types of Battery used in EHVs, Construction and working of Li-ion battery, State of Charging (SOC), Problems associated with battery systems in EHVs, Temperature controlling methods.

Fuel Cells: Introduction to Fuel cell technology and its working principle, Fuel Cell Characteristics, Discussion on various Fuel Cell Types, Construction and working of Hydrogen Fuel cell, challenges with Fuel Cell EV, Flywheels.

Unit-4

Electric Propulsion unit: Electric Machines and Drives in HEVs- Fundamental of Drives and Control of EV Using DC motor, Induction Motor, Permanent Magnet Motor, BLDC motor.

Control Systems for the EHV and EVs: In vehicle networks- CAN, Energy Management Strategies: Needs and classification of different energy management strategies, BMS- Battery Management System, EV Charging Technologies- Wireless power transfer (WPT) technique for EV charging.

TEXT BOOKS

1. Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 4th Edition, 2003
2. M. Ehsani, Y. Gao and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRC Press, 2nd Edition, 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”, Wiley, 3rd Edition 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”, Wiley, 4th Edition, 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	Basics of HVAC and Cryogenics				Course Type		Soft Core	
Course Code	B22ERS622	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course explores the concept of cryogenics and heating ventilation air conditioning. In this course we learn the different methods of maintaining low temperatures. Importance of low temperature maintenance, and application of cryogenics in the present world. This course also deals with the advancements in refrigeration, air conditioning and the need for HVAC. Components involved in HVAC.

COURSE OBJECTIVES

1. To understand the different technology and materials involved in low temperature cooling methods.
2. To gain the knowledge about applications of Cryogenics in the present world.
3. To enhance the knowledge in the field of Ventilation and cooling with the latest technology.
4. To explore the knowledge on HVAC calculations.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Discuss the principles of heat transfer, components used in refrigeration and air conditioning.	1	1
CO2	Elaborate the main components involved in heat transfer in buildings locality, Properties of air.	1,6,7	1
CO3	Explain the fundamentals of principles used in HVAC with sufficient evidence using different standards available.	1,2,6	1
CO4	Summarize the basic principal, materials and methods involved in cryogenics.	1	1
CO5	Understand the concept of superconductivity and its applications.	1	1
CO6	Describe the different methods used in liquefaction of different gases by different methods its applications.	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						1						3		
CO2	3					1	1						3		

CO3	3	2				1							3		
CO4	3												3		
CO5	3												3		
CO6	3	1											3		
Average	**3**	**1.5**				**1**	**1**						**3**		

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

COURSE CONTENT

Unit-1

Fundamental and scope of HVAC, Mode of heat transfer, standards refrigeration cycles, component of a/c, refrigerants and types, properties of air (DBT, %RH, WB, DPT, enthalpy).

Unit-2

Load Calculation: Orientation of Building, to read latitude of location of building, calculation of U factor for wall, glass, roof and partition, calculation of equivalent temp, difference for wall, glass, roof and partition, cooling and heat load calculation using ASHRAE Standards, calculation of sensible heat factor, ADP and Dehumidified CFM.

Unit-3

Introduction to Low Temperature Engineering: Cryogenics, principles of cryogenics, methods of production of low temperature, cryogenic fluids, superconductivity and its applications, super fluidity, low temperature properties of structural materials applications of cryogenics.

Unit-4

Liquefaction of Gases: Linde Hampson system, Claude system, Heylandt system, Critical components of liquefiers, Cryo coolers, Stirling Cryo cooler, Gifford McMahon cryo cooler, Pulse tube cryo cooler, Thermodynamic analysis of above systems.

TEXT BOOKS

1. Barron, “Cryogenic Systems”, McGraw Hill Book Co, 1966
2. James E. Brumbou and Audel, “HVAC Fundamentals”, Volume-l, Wiley Publishing, 4th Edition, 2004

REFERENCE BOOKS

1. A.Arkherov, “Theory and Design of Cryogenic Systems”, Imported Publication, 1981.
2. Klaus D Timmerchand and Thomas M Flynn, “Cryogenic Process Engineering”, Springer, 2013
3. Robert Mcdowall, “Fundamentals of HVAC Systems”, Elsevier, 1st Edition, 2007
4. Samuel C. Sugarman, “HVAC Fundamentals”, Fairmont Press, 1st Edition, 2005.
5. ASHRAE Hand Book / Volume 1& 2, 1981.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/cryogenics.
2. https://www.mdpi.com/journal/applsci/special_issues/Ventilation_Air_Conditioning
3. https://www.springer.com/journal/44189
4. https://www.ashrae.org/technical-resources/ashrae-journal

SWAYAM/NPTEL/MOOCs:

1. https://archive.nptel.ac.in/courses/112/101/112101004/

Course Title	**Hydraulics and Pneumatics**				**Course Type**		**Softcore**	
Course Code	**B22ERS623**	**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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

The Fundamental Hydraulic and Pneumatic course 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 the fluid power applications and analyze the fluid power requirement for a given application.	1,2	1,2
CO2	Identify and select the hydraulic and pneumatic systems for the various applications	1,2	1,2
CO3	Design and analyze the different hydraulic and pneumatic power circuits for the given applications.	1,2,3	1,2
CO4	Identify and select the various fluids for the fluid power applications.	1,2	1,2
CO5	Evaluate the performance of fluid power components.	1,2	1,2
CO6	Describe the application of pneumatics in automation sector.	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 ARTICULATIONMATRIX

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

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. Hydraulics circuits with IoT.
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, single acting cylinder circuit, double acting cylinder circuit and multi cylinder circuits, pneumatic logic circuits- by using OR and AND logic gates.

CASE STUDIES

1. Study on hydraulic system used in aircraft landing gear.
2. Performance evaluation of double acting hydraulic cylinder circuit using FLUIDSIM Software
3. Study on hydraulic system contamination control.

TEXT BOOKS

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education, 7th Edition, 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; 3rd 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	Manufacturing Automation				Course Type		Soft Core	
Course Code	B22ERS624	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**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. To explore the concept of automation and building blocks, Fundamentals of manufacturing.
2. To understand the manufacturing support systems of different industries.
3. To impart the knowledge of automated production, group technology and cellular manufacturing concept.
4. 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 manufacturing feasibilities between cellular and flexible manufacturing methods.	1, 2	1,2
CO4	Apply the concept of modern inspection techniques to check the quality of components.	1,5	1,2
CO5	Understand the ladder diagram to automate different process.	1,2,5	1,2
CO6	Demonstrate and analyze the pneumatic circuits for different applications.	1,2	1,2

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												2	2	
CO2	2												2	2	
CO3	3	2											2	2	
CO4	3				2								2	2	
CO5	3	2			2								2	2	
CO6	3	2											2	2	
Average	**2.8**	**2**			**2**								**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 oflean 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 IMS & 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, and their applications with various automation examples. Human Machine Interface (HMI) & Supervisory Control and Data Acquisition System (SCADA), motion controller, smart sensors, RFID technology and its application, machine vision and control applications.

CASE STUDIES

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", Prentice Hall India Learning PrivateLimited, Revised 2nd Edition 2011.
4. Nakra, B. C., "Theory and Applications of Automatic Controls", New Age InternationalPublishers, Revised 2nd Edition, 2014.
5. Morriss, S. B., "Automated Manufacturing Systems", McGraw Hill, 2006.
6. John W. Webb & Ronald A. Reis, "Programmable Logic Controllers – Principles and Applications", Pearson Education, 5th Edition,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

Course Title	Heat Transfer Lab				Course Type		Hard Core	
Course Code	B22ER0604	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	1	2	2	Theory	Practical	IA	SEE
	Tutorial	0	0	0				
	Total	**1**	**2**	**2**	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW:

Heat Transfer laboratory provides fundamental and industrial knowledge about modes of heat transfer, like conduction, convection and radiation, and their application. Concepts of heat transfer are applied in the field of Heat Exchanger design and phase change phenomenon. This course deals with the concepts of thermal conductivity, convective heat transfer coefficient, Stephen Boltzmann constant, transient heat transfer, vapor compression refrigeration and Air conditioning systems.

COURSE OBJECTIVES:

The objectives of course are to:

1. Provide knowledge on modes of heat transfer and laws governing the Heat and Mass transfer.
2. Analyze various techniques to compute the heat transfer coefficient in various heat transfer problems.
3. Conduct experiment to study variation of temperature along the length of the pin fin under forced and free Convection.
4. Carryout analysis of boiling and condensation phenomenon and design heat transfer equipment.
5. Conduct experiments related to various heat transfer processes and heat exchangers and analyze measurements data.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Describe the three modes of heat transfer and their governing equations.	1	1,2
CO2	Perform conduction heat transfer experiment to estimate thermal conductivity of metal rod, overall heat transfer coefficient of composite slab and document the results in the form of technical report	1,2,4,10	1,2
CO3	Evaluate the heat transfer coefficients in forced convection, free convection and Correlate with theoretical values and document the results in the form of technical report.	1,2,4, 9,10	1,2
CO4	Perform experiments on radiation heat transfer to determine surface emissivity and Stefan- Boltzmann's constant and document the results in the form of technical report.	1,2,4,9,10	1,2
CO5	Evaluate heat transfer coefficients in condensation, boiling, LMTD and effectiveness of heat exchangers and document the results in the form of technical report.	1,2,4,9,10	1,2
CO6	Conduct experiments, interpret the data, analyse Vapour compression refrigeration, Air conditioning system and document the results in the form of technical report.	1,2,4,9,10	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	1	
CO2	3	3		1					3	3			1	2	
CO3	3	3		1					3	3			2	1	
CO4	3	3		1					3	3			1	1	
CO5	3	3		1					3	3			1	1	
CO6	3	3		1					3	3			1	1	1
Average	**3**	**3**		**1**					**3**	**3**			**1.5**	**1.16**	**1**

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

List of Experiments

1. Determination of thermal conductivity of a metal rod.
2. Determination of overall heat transfer coefficient of composite slab.
3. Analysis of heat transfer through pin-fin.
4. Experiment on transient conduction heat transfer.
5. Estimation of heat transfer coefficient for natural convection heat transfer.
6. Estimation of heat transfer coefficient for forced convection heat transfer.
7. Determination of emissivity of a surface
8. Determination of Stefan Boltzmann constant.
9. Determination of LMDT and effectiveness in a parallel flow and counter flow heat exchangers.
10. Experiment on boiling of liquid and condensation of vapour.
11. Performance test on vapour compression refrigeration.
12. Performance test on a vapour compression air – conditioner

TEXT BOOKS

1. Tirumaleshwar, “Heat & Mass transfer”, Pearson Education, 2014.
2. Ozisik, Heat transfer-A basic approach, Tata McGraw Hill, 1985.

REFERENCE BOOKS

1. Yunus A-Cengel, “Heat transfer-A practical approach”, Tata McGraw Hill, 2nd Edition, 2002.
2. Mahesh M Rathore, “Heat and mass transfer”, Laxmi publications, 2017.
3. Frank Kreith, Raj. M. Manglik, Mark. S. Bohn, “Principles of Heat transfer”, Thomas Learning, 7th Edition, 2010.
4. Frenk P.Incropera and DavidP.Dewitt, “Fundamentals of heat and mass transfer”, John Wiley and son’s, 5th Edition, 2007.
5. R K Rajput, “Heat and Mass transfer”, S Chand Publications, 2018.

JOURNALS/MAGAZINES

1. The Journal of Heat Transfer, ASME
2. International Journal of Heat and Mass Transfer, Elsevier

SWAYAM/NPTEL/MOOCs:

1. Heat Transfer, By Prof. Ganesh Viswanathan, IIT Bombay, https:// onlinecourses.nptel.ac.in /noc20_ch12/preview
2. Heat Transfer, By Prof. Sunando Dasgupta, IIT Kharagpur, https:// online courses.nptel. ac.in/noc19_ch23/preview

Course Title	Computer Aided Engineering Analysis Lab				Course Type		Hard Core	
Course Code	B22ER0605	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				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

This course deals with the numerical simulation of field problems that are difficult to be analysed using theory of elasticity or thermodynamics principles. Also discuss the application of finite element analysis, selection of elements, mesh size and to analyse real-world structural, thermal and vibration problems using ANSYS Workbench software.

COURSE OBJECTIVES

1. To understand the different modules of ANSYS Workbench.
2. To analyze the bars, trusses and beams subjected to various loading and boundary conditions.
3. To apply FEA for thermal analysis and modal analysis
4. To demonstrate the thermal analysis of a PCB unit with CPU.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Understand the phases of FEA, various commands and modules used in ANSYS Workbench package.	1	1
CO2	Develop FEM model and Perform structural analysis of bar and truss elements using Ansys workbench and validate the solution, document the results.	1,2,3,5, 9,10,12	1,2,3
CO3	Develop FEM model and Determine the Stress concentration factor and maximum stress in a rectangular plate with a circular hole and plate with fillet using Ansys workbench and validate the solution, document the results	1,2,3,5, 9,10,12	1,2,3
CO4	Develop FEM model and analyze the Shear force and bending moment diagram for beams with different loading and boundary conditions using Ansys workbench and validate the solution, document the results.	1,2,3,5 ,9,10,12	1,2,3
CO5	Carry out modal analysis of beams and rectangular plates using Ansys workbench and validate the solution, document the results.	1,2,3,5, 9,10,12	1,2,3
CO6	Develop FEM model and Analyze the temperature distribution in a pin fin, composite wall and PCB unit, validate the solution, document the results.	1,2,3,5, 9,10,12	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 ARTICULATIONMATRIX

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

CO6	3	2	2		3				2	1		1	2	1	1
Average	**3**	**2**	**2**		**3**				**2**	**1**		**1**	**2**	**1**	**1**

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

Part-A

1. Introduction to ANSYS Workbench and FEA.
2. Structural analysis of tapered bars, composite bars and stepped bar subjected to axial load
3. Structural analysis of trusses for various boundary conditions.
4. Drawing of shear force and bending moment diagrams for cantilever, simply supported and overhanging beams subjected to point load, uniformly distributed load and moment.

Part-B

1. Determination of stress concentration factor and maximum stress in rectangular plate with central hole, rectangular plate with fillet subjected to axial load and moment.
2. Steady state thermal analysis of pin fin and composite walls subjected to different boundary conditions.
3. Modal analysis of beams and rectangular plates subjected to different boundary conditions.
4. Demonstration of thermal analysis of a PCB unit with CPU.

TEXT BOOKS

1. Xiaolin Chen, Yijun Liu, Finite Element Modeling and Simulation with ANSYS Workbench, CRC Press, 2nd Edition, 2018.
2. Sham Tickoo, "ANSYS Workbench 2019 R2: A Tutorial Approach", CADCIM Technologies, 3rd Edition, 2019.

REFERENCE BOOKS

1. Daryl. L. Logon, "A first course in Finite Element Method", Cenage Learning, 6th Edition, 2016.
2. J.N.Reddy, "Finite Element Method", Mc Graw – Hill, 4th Edition, 2018

JOURNALS/MAGAZINES

1. Finite Elements in Analysis and Design
2. International Journal for Numerical Methods in Engineering

SWAYAM/NPTEL/MOOCs

1. https://onlinecourses.nptel.ac.in/noc22_me43/preview
2. https://www.udemy.com/course/detailed-introduction-to-ansys-workbench/

Course Title	**Research Based Mini Project**				**Course Type**		**Hard Core**	
Course Code	**B22ER0606**	**Credits**	**2**		**Class**		**VI Semester**	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Tutorial	0	0	0				
	Practice	2	4	4	Theory	Practical	IA	SEE
	Total	**2**	**4**	4	**0**	**52**	**50 %**	**50 %**

COURSE OVERVIEW

Mini project is one of the integral parts of mechanical 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.

COURSE OBJECTIVES

1. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
2. To inculcate the process of self-learning and research.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	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'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		
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

COURSE CONTENT

Research based project is aim to identify the research gap though extensive literature survey on a recent trends in mechanical 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 areas and formulate the problem statement. The team submit a report prepared as per the guidelines/format of the university (one report per group).

TEXT BOOKS

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, 6th 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, 6th 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

7th Semester

Course Title	Electric and Hybrid Vehicles				Course Type		Open Elective	
Course Code	B22MEO701	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

The course is designed for students who are interested in either conducting research and development in industries related to Electric and Hybrid Vehicles, or pursuing higher studies in this field. The course provides a comprehensive understanding of the various components involved in the working of an Electric Vehicle. It also covers the basics of different electric motors, motor controllers, and control techniques, as well as the electric vehicle drivetrain, regenerative braking used in different types of hybrid vehicles. Prior knowledge of the basic working fundamentals of vehicles is recommended for students to enhance their learning experience. Additionally, the course aims to introduce students to the emerging market of retrofitting existing internal combustion engine vehicles with electric motors

COURSE OBJECTIVES

1. To provide the students with sufficient knowledge on different configurations of EHVs like series, parallel and complex hybrid architectures of automobile vehicles.
2. To enable the students to understand the concept of modern electric drive trains system and its topology, hybrid architectures and hybrid power plant specifications.
3. To help the students to understand the concept of identifying the energy storage methods, energy storage and their alternatives, energy management and control system.
4. To provide the knowledge of the various hybrid propulsion systems, different types of motors and their control parameters of 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	Generalize a clear understanding of the fundamental principles of EHV technology and its impact on social and environment.	1,6,7	1,2
CO2	Recognize different configurations of Hybrid vehicles power trains and analyze the various hybrid load tracking architectures	1,2,6,7	1,2
CO3	Analyze the challenges and opportunities associated with the widespread adoption of energy storage system for electric and hybrid vehicles like battery, fuel cell, Ultra capacitors and flywheels	1,2,6,7	1,2
CO4	Illustrate the working of different types of electrical machines and motors and analyze various motor drive topologies and control parameters used for electric vehicle application.	1,2,3,6,7	1,2,3
CO5	Evaluate the potential impact of energy control management unit with an ability to Identify various communication protocols and technologies used in vehicle networks	1,2,6,7	1,2,3
CO6	Demonstrate the various hybrid vehicular network architectures and analyze the advanced power management systems used on EHVs for optimum operations.	1,2,6,7	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					2	2						2	1	
CO2	3	2				1	1						3	1	
CO3	3	2				3	3						2	1	
CO4	3	2	1			1	1						3	1	1
CO5	3	2				1	1						2	2	1
CO6	3	2				1	1						3	2	1
Average	**3**	**2**	**1**			**1.5**	**1.5**						**2.5**	**1.3**	**1**

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

COURSE CONTENT

Unit-1

Introduction: A Brief History of EHVs, EHVs –Global scenario, Need of EHV technology, Architectures of EHVs, social and environmental importance of hybrid and electric vehicles, Basics of vehicle performance, mathematical models to describe vehicle performance

Hybridization of the Automobile: Basics of the EV, Basics of the HEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV) and vehicle architectures, Solar Powered Vehicles.

Unit-2

Hybrid Electric Drive-trains: Basic Architecture of Hybrid Drive Trains, 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, Electric Vehicle (EV) drivetrain Alternatives Based on Drivetrain Configuration, Electric Vehicle (EV) Drivetrain Alternatives Based on Power Source Configuration.

Unit-3

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery Parameters, Different types of Battery used in EHVs, Construction and working of Li-ion battery, State of Charging (SOC), Problems associated with battery systems in EHVs, Temperature controlling methods.

Fuel Cells: Introduction to Fuel cell technology and its working principle, Fuel Cell Characteristics, Discussion on various Fuel Cell Types, Construction and working of Hydrogen Fuel cell, challenges with Fuel Cell EV, Flywheels.

Unit-4

Electric Propulsion unit: Electric Machines and Drives in HEVs- Fundamental of Drives and Control of EV Using DC motor, Induction Motor, Permanent Magnet Motor, BLDC motor.

Control Systems for the EHV and EVs: In vehicle networks- CAN, Energy Management Strategies: Needs and classification of different energy management strategies, BMS- Battery Management System, EV Charging Technologies- Wireless power transfer (WPT) technique for EV charging.

TEXT BOOKS

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 4th Edition, 2003
2. M. Ehsani, Y. Gao and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press, 2nd Edition, 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", Wiley, 3rd Edition 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", Wiley, 4th Edition, 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

<table>
<tr><td>Course Title</td><td colspan="4">Sustainable Engineering</td><td colspan="2">Course Type</td><td colspan="2">Open Elective</td></tr>
<tr><td>Course Code</td><td>B22MEO702</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>Tutorial</td><td>0</td><td>0</td><td>0</td><td colspan="2" rowspan="2"></td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Practice</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 primary purpose of the course Sustainable Engineering is to introduce the students the concept of sustainability which is holistic approach that considers ecological, social and economic dimensions, recognizing that all must be considered together to find lasting prosperity.

It covers the concept of ESG, Millennium Development Goals (MDGs), Sustainable Development Goals (SDGs) & Environmental legislations in India. It emphasizes on zero waste concept, solid waste management, carbon credits, carbon foot print & carbon sequestration. It also covers environmental management standards, sustainability practices, green engineering, sustainable urbanization, sustainable cities & sustainable transport.

COURSE OBJECTIVES

1. To enable the students to understand the principles, indicators and general concept of sustainability.
2. To apprehend the local, regional and global impacts of unsustainable designs, products and processes.
3. To gain the concepts of ESG, Millennium Development Goals (MDGs), Sustainable Development Goals (SDGs) & Environmental legislations.
4. To enable the students to understand environmental management standards, sustainability practices and green engineering.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Explain the relevance and concept of sustainability, ESG, Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Environmental legislations in India.	1,6,7,12	-
CO2	Explain zero waste concept, solid waste management, carbon foot print, environmental management standards and legal provisions for environmental protection.	1, 6,7,12	-
CO3	Analyze and assess the life cycle of a product and its impact on environment.	1, 6,7,12	-
CO4	Outline the concepts related to conventional and non-conventional energy from green energy perspective.	1, 6,7,12	-
CO5	Understand and apply sustainability concepts in construction practices, designs, product development and processes across various engineering disciplines.	1, 6,7,12	-
CO6	Make a decision in applying green engineering concepts and become a lifelong practitioner of sustainability in society	1, 6,7,12	-

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 ARTICULATIONMATRIX

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

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

COURSE CONTENT

Unit-1

Introduction: Concept, evolution of the concept, Social, environmental and economic sustainability concepts, Sustainable development, Concept of ESG, Nexus between Technology and Sustainable development, Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM), Environmental legislations in India - Water Act, Air Act.

Unit-2

Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion. Carbon credits and carbon trading, carbon foot print, Carbon sequestration – Carbon capture and storage (CCS), legal provisions for environmental protection.

Unit-3

Environmental Management Standards: ISO 14000 series, Life Cycle Analysis (LCA) - Scope and Goal, Life Cycle Assessment, Bio-mimicking. Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis

Clean Technology and Energy: Energy sources: Basic concepts-Conventional and non-conventional, solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Rainwater harvesting.

Unit-4

Sustainability Practices: Sustainable Engineering Design Principles, Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanization, Sustainable cities, Sustainable transport.

CASE STUDIES

1. Assessment of Sustainability in Water Resources, Energy Resources, Food Supplies.
2. Sustainability studies of Biofuels for transportation.
3. Life Cycle Assessment (LCA) of products like Aluminum cans, PVC bottles, Cars.

TEXT BOOKS

1. Allen, D. T. and Shonnard, D. R., "Sustainability Engineering: Concepts, Design and Case Studies", Prentice Hall, 1st Edition, 2012.
2. Bradley. A.S, Adebayo A.O and Maria, P. "Engineering Applications in Sustainable Design and Development", Cengage Learning, 3rd Edition, 2015.

REFERENCE BOOKS

1. Mackenthun K.M., "Basic Concepts in Environmental Management", CRC Press, 1st Edition, 1999.
2. Ni bin Chang, "Systems Analysis for Sustainable Engineering: Theory and Applications", McGraw-Hill Professional, Illustrated Edition, 2010.
3. Malcolm Dowden, "Climate Change and Sustainable Development: Law, Policy and Practice", Estates Gazette Ltd, 1st Edition, 2008.
4. Daniel A. Vallero and Chris Brasier, "Sustainable Design: The Science of Sustainability and Green Engineering", Wiley-Blackwell, 1st Edition, 2008.

JOURNALS/MAGAZINES

1. https://www.springer.com/journal/11625
2. https://www.nature.com/natsustain/

SWAYAM/NPTEL/MOOCs

1. https://onlinecourses.nptel.ac.in/noc20_de07/preview
2. https://www.udemy.com/course/sustainabilityreporting

Course Title	**Vibrations and Noise Engineering**				**Course Type**		**Hard Core**	
Course Code	**B22ER0701**	**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				
	Tutorial	0	0	0				
	Practical	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

The course aims to deal with mechanical vibration and its effects on mechanical systems. The course defines terminology associated with mechanical vibrations; study of free and forced vibrations under un-damped and damped conditions for single degree of freedom mechanical systems. The course further deals with vibration of multi-degree of freedom mechanical systems, vibration measurement and Noise Engineering.

COURSE OBJECTIVES

1. To enable the students to understand the theoretical principles of vibration and vibration analysis techniques for the practical solution of vibration problems.

2. Formulate mathematical models of problems in vibrations using Newton's second law or energy principles.
3. To analyze the free and forced (harmonic, periodic, non-periodic) vibration analysis of single and two degree of freedom linear systems.
4. To enable the students to determine sound pressure level measurement in specified acoustic environment.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Describe the causes, effects of vibration in mechanical systems and apply basics of engineering to vibrating mechanical system and develop mathematical models to obtain their governing equations of motion and their response.	1,2,3,4	1,2
CO2	Compute the natural frequency for free and forced vibration of a single degree of freedom of un-damped and damped systems.	1,2,3	1,2
CO3	Analyze the vibratory responses of Mechanical systems for harmonic, periodic and non-periodic excitation.	1,2,3,6	1,2
CO4	Formulate the mathematical models for Two DOF mechanical vibrating system and Analyze its natural frequencies and mode shapes.	1,2,3,4	1,2
CO5	Demonstrate the Vibration measurements and its functionality.	1,2	1,2
CO6	Interpret the principles of vibration and noise reduction techniques to real life engineering problems.	1,2,3,6	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	1									3	3	
CO2	3	3	2										3	3	
CO3	3	3	2			1							3	3	
CO4	3	3	2	2									3	3	
CO5	3	3				1							3	3	
CO6	3	2	1			1							3	3	
Average	**3**	**2.8**	**1.8**	**1.5**		**1**							**3**	**3**	

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

COURSE CONTENT

Unit-1

Introduction: Types of vibrations, Definitions, Simple Harmonic Motion (S.H.M.), Work done by harmonic force

Undamped Free Vibration - Single Degree of Freedom Systems: Derivations for spring mass systems, Methods of Analysis, Natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring, numerical.

Unit-2

Damped free vibrations- Single Degree of Freedom Systems: Types of damping, Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement, numerical.

Forced vibration - Single Degree of Freedom Systems: Introduction, Analysis of forced vibration with constant harmonic excitation- magnification factor, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), force and motion transmissibility, Energy dissipated due to damping, numerical.

Unit-3

Vibration Measurements: Seismic instrument, frequency measuring instrument, whirling of shafts with and without damping, discussion of speeds above and below critical speed of shafts, numerical.

Vibration of Two Degree of Freedom Systems: Principle modes of vibrations, Normal mode and natural frequencies of systems (without damping) – Simple spring mass systems, masses on tightly stretched strings, double pendulum, torsional systems, combined rectilinear and angular systems, Undamped dynamic vibration absorber, numerical.

Unit-4

Noise Engineering: Subjective response of sound: Frequency and sound dependent human response; the decibel scale; relationship between, sound pressure level(SPL), sound power level and sound intensity scale; relationship between addition, subtraction and averaging, sound spectra and Octave band analysis; loudness; weighting networks; equivalent sound level, auditory effects of noise; hazardous noise, exposure due to machines and equipment; hearing conservation and damage risk criteria, daily noise doze.

CASE STUDIES

1. Develop python programming to for understanding the vibration of single degree freedom systems.
2. Develop python programming plot frequency response of single degree and multi Degree spring mass system.
3. Study the response of the Quarter car vibration.
4. Study the Bounce and pitch response of the vehicle (2 DOF).
5. Study the response of Mechanical system with variation of stiffness/Damping.

TEXT BOOKS

1. S. S. Rao, “Mechanical Vibrations”, Pearson Education Inc, 6th Edition, 2016.
2. S. Graham Kelly, “Fundamentals of Mechanical Vibrations “, Schaum’s outline Series, Tata McGraw Hill, New Edition, 1996.
3. W. T. Thomson, “Theory of Vibrations with Applications”, Pearson Education Inc, 5th Edition, 2008
4. C Sujatha, “Vibrations and Acoustics – Measurements and Signal”, Tata McGraw Hill, 1st Edition, 2017.

REFERENCE BOOKS

1. V. P. Singh, “Mechanical Vibrations”, Dhanpat Rai & Company, 3rd Edition, 2006.
2. Amberkar A.G, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd, 1st Edition, 2006.

JOURNALS/MAGAZINES

1. Journal of Sound and Vibration
2. Noise & Vibration Worldwide - SAGE Journals
3. Journal of Vibration and Acoustics
4. Journal of Vibration Engineering & Technologies
5. https://www.inceusa.org/publications/noise-news-international

SWAYAM/NPTEL/MOOCs

1. https://nptel.ac.in/courses/112107212 (Introduction to Mechanical Vibration)
2. https://nptel.ac.in/courses/112104194 (Basics of Noise and Its Measurements)
3. https://www.classcentral.com/course/swayam-sound-and-structural-vibration-58554
4. https://onlinecourses.nptel.ac.in/noc22_me34/preview (Sound and Structural Vibration)

<table>
<tr><td>Course Title</td><td colspan="4">CAD/CAM/CIM</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B22ER0702</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>2</td><td>2</td><td>2</td></tr>
<tr><td>Tutorial</td><td>1</td><td>3</td><td>3</td><td colspan="2" rowspan="2"></td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Practice</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>5</td><td>5</td><td>Theory</td><td>Tutorial</td><td>IA</td><td>SEE</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>26</td><td>39</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

The Course explores with the technology related to the use of digital computers to perform design activities and manufacturing activities in an organization. This course also focuses on computer technology to automate each and every function starting from market information, production processed, design activities, materials, commercial, financial required for the industry. It also deals with the reliability and performance of automated flow line involving three methods of line balancing of minimizing the total amount of idle time for a given job at a given assembly line speed.

COURSE OBJECTIVE

1. To understand the fundamentals of CAD/CAM/CIM and related concepts to understand the various modeling features and its manufacturing.
2. Introduce various concepts of the product development cycle can be reduced in the design stages and also reduction of Manufacturing Lead time.
3. To develop the skills to write NC programming.
4. To have a hands on experience on various tools used for modeling and manufacturing aspects.
5. To study about the line balancing in automated flow lines.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Apply the basic principles of CAD/ CAM to create 3D models of real-world products before they are ever manufactured.	1,2,3	1,2
CO2	Develop the manual NC part programming for given profile.	1,2,3,5	1,2
CO3	Identify the suitable type of automation for different production systems.	1,2	1,2
CO4	Criticize the mathematical model used in production system.	1,2	1,2
CO5	Analyze the various work transport system used in high volume production.	1,2	1,2
CO6	Formulate the line balancing of an automated assembly lines and understand advanced emerging technologies used in manufacturing.	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	2	
CO2	3	2	1		1								3	2	
CO3	3	2											3	2	
CO4	3	2											3	2	
CO5	3	2											3	2	
CO6	3	2											3	2	
Average	**3**	**2**	**1**		**1**								**3**	**2**	

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

COURSE CONTENT

Unit-1

Fundamentals of CAD: Definition of CAD/CAM/CIM, Product cycle and its cad / cam over laid, Design process & application of computers for design, creating the manufacturing database, Benefits of CAD/CAM/CIM, CIM Hard ware and software, Elements and activities of CIM system, Development of CIM.

Computer Graphics: Coordinate Systems, Database Structure for Graphic Modeling, functions of graphics package, Transformation of geometry, 2D transformations – Simple problems. Geometric Modeling & its types, Windowing and clipping.

Unit-2

Introduction to NC Technology Basic components of NC system, NC Coordinate system, types of NC motion control systems, advantages and applications of NC. CNC & DNC Systems: Types, advantages and its functions.

NC/CNC Programming: NC Procedure, Manual programming and computer assisted part programming, syntax formats in part programming, G & M codes, Cutter Radius Offset, Tool Length Offset, Fixed Cycles/canned cycles, Turning and milling programs. (Using CAM software demonstrate turning and milling operations).

Unit-3

Computer Integrated Manufacturing System: Introduction to CIM and Automation, types of Automation, Model of manufacturing, Information processing cycle in manufacturing, Types of Production systems, Production Concepts & its Mathematical models, Problems. Automation Strategies.

Introduction and Analysis of Automated Flow Line: High Volume Production system: Introduction, Automated flow line, Work part transport, Buffer storage and its control functions. General terminology and analysis, Analysis of Transfer line with and without storage with numerical problems.

Unit-4

Assembly and Line balancing: Types of assembly system, Minimum rational work element, cycle time. Precedence constraints and diagram, Balance delay. Methods of Line balancing – LCR/K & W / RPW method, numerical only on LCR and RPW.

Advanced Techniques in Manufacturing: Smart Manufacturing, Digital Manufacturing, Digital twin, intelligent Manufacturing, Internet of things in Manufacturing, Cloud based Manufacturing, Cloud computing for manufacturing.

Practice in Tutorial Session

Sl. No	Title	Tools and Techniques	Expected Skill /Ability
1.	Autodesk Fusion 360 Basics	Structure of Autodesk Fusion 360	Application of Autodesk Fusion
2.	3D Modeling in Fusion 360	Familiar with Extrude, Fillet, chamfer, revolve, sweep, combine tools.	Create 3D models of real-world products before they are ever manufactured
3	3D Modeling in Fusion 360 – Creating and Modifying Solid Bodies	Familiar with Loft, Sculpt, Patch, Replace Face, Thicken	Create 3D models of real-world products before they are ever manufactured

Note:

1. After having hand on experience on 3D Modeling in Autodesk Fusion 360, student is expected to develop concept model and prepare product design of automotive components, domestic components Household products, aerospace components, etc.
2. First three to four weeks will be hands-on training on 3D Modeling in Fusion 360 will be given to students.
3. In remaining tutorial session each student is expected to develop concept and prepare a model of automotive components, household products and aerospace components. (At least one each segment).
4. Performance in tutorial session will be evaluated for 20 Marks.

TEXT BOOKS

1. M.P.Groover & Emory W.Zimmer, "CAD/CAM, Computer Aided Design and Manufacturing", Pearson India, 2nd Edition. 2007.
2. Mikell P.Groover, "Automation, Production system & Computer Integrated Manufacturing", Pearson India, 2nd Edition. 2007.

REFERENCE BOOKS

1. Ibrahim Zeid, "CAD/CAM Theory and Practice", Tata McGraw Hill, 2007.
2. P. Radha Krishnan, S. Subramanyan & V. Raju, "CAD/CAM/CIM", New Age international Publishers, 2nd Edition. 2008.
3. P. Radha Krishnan, "Computer Numerical Control Machines and CAM", New Age international Publishers, 1st Edition 2012.
4. P. N. Rao,"CAD/CAM Principles and applications", Tata McGraw Hill, 2010.

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/Computer Aided Design
2. https://www.sciencedirect.com/journal/Advancements in CAD/CAM technology: Options for practical implementation

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112102102
2. https://nptel.ac.in/courses/112104289

Course Title	Mechatronics and Control Systems				Course Type		Hard Core	
Course Code	B22ER0703	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course focuses on various aspects of mechatronics and control engineering. Over view on various sensors and transducer used for measurement and detecting the input signal for various applications. It provides information about signal conditioning devices and micro controllers to be used in mechatronics devices. It also provides knowledge on control engineering about mathematical modeling and analysis of mechanical system and electrical system. Also enable the students to understand the time response analysis and stability analysis of control system.

COURSE OBJECTIVES

1. To understand various aspects of mechatronics system
2. To acquire the knowledge on transducers, sensors and actuators
3. To understand working of signal conditioning devices and micro controllers
4. To develop the skills on mathematical modeling and analysis of system under time domain
5. To study the stability of system by using R H criteria and root locus technique.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Identify the key elements of mechatronics system and interface sensors / transducer output with microprocessor for design or controlling of the system.	1,2	1
CO2	Explain working of electrical actuators, controllers and select the desired actuator/drives/controller for the design of given mechatronics system.	1,2	1
CO3	Understand the concept of signal processing and explain the use of signal conditioning / interfacing systems and microcontrollers in the design of mechatronics systems.	1,2	1,2
CO4	Develop mathematical models and transfer function for mechanical and electrical system.	1,2,3	1,2
CO5	Perform time response analysis of first and second order system.	1,2	1,2
CO6	Examine the stability of the system using Routh's-Hurwitz Criterion and root locus plot.	1,2,5	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 ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2											3		
CO2	2	2											3		
CO3	3	2											3	2	
CO4	3	3	2										3	2	
CO5	3	3											3	2	
CO6	3	3			1								3	2	2
Average	**2.6**	**2.5**	**2**		**1**								**3**	**2**	**2**

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

COURSE CONTENT

Unit-1

Introduction to Mechatronics Systems and Actuators: Definition of mechatronics, components of mechatronics, Basic Terminologies, Open loop and Closed loop control systems, microprocessor based control systems, ATM, Washing machine, Static and dynamic characteristics of sensor, Capacitance sensor, Eddy current sensor, Hall effect sensor-Light sensors, optical encoders, Actuation System- mechanical-Electro mechanical, electrical switches, solid state switches, solenoid.

Unit-2

Drives: AC, DC, Servo motors, stepper motors, hybrid motors, BLDC motors.

Signal Conditioning Devices: amplifier, filters, multiplexers, de multiplexers, ADC, DAC.

Micro Controllers: Introduction, classification of micro controllers and its application, Arduino processor-Introduction, Architecture and application.

Unit-3

Introduction to Mechanical System Modeling: Real time applications, Transfer Functions- models of mechanical systems (translational and rotational) and electrical systems, Introduction to block diagram and signal flow graph.

Time Response Analysis: Types of inputs, first order and second order system response to step input, time response specifications and concepts of time constant, numerical problems.

Unit-4

Stability Analysis: Routh's-Hurwitz Criterion, stability analysis using root locus plots, Introduction to PI, PD and PID controllers.

CASE STUDIES

1. Mathematical modeling of shock absorber used in Indian Automobile vehicles.
2. Time response analysis of shock absorber using Matlab / Simulink software.
3. Stability analysis by constructing root locus plot using Matlab / Python Code.

TEXT BOOKS

1. Katsuhiko Ogata, "Modern Control Engineering", Pearson Education, 5th Edition, 2021.
2. W.Bolton "Mechatronics", Pearson Publications, 7th Edition, 2018.
3. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International Publishers, 6th Edition, 2017.

REFERENCE BOOKS

1 Devdas shetty and Richard A. Kolk "Mechatronics System Design" Cengage Learning, 2nd Edition, 2011.
2. B.C.Kuo, F.Golnaraghi "Automatic Control Systems", John Wiley & Sons, 9th Edition 2014.
3. Richard C Dorf & Robert H Bishop," Modern Control Systems", Prentice Hall, 13th Edition, 2016.

JOURNALS/MAGAZINES

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

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112103174
2. https://www.classcentral.com/course/swayam-mechatronics-23047
3. https://nptel.ac.in/courses/107106081
4. https://www.edx.org/course/dynamics-control-upvalenciax-dc201x-0

Course Title	Computational Fluid Dynamics				Course Type		Soft Core	
Course Code	B22ERS711	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

This course deals with an introduction to Computational Fluid Dynamics, solution of continuity, momentum, and energy equations using the finite volume method. Students are trained to use commercial CFD tools for fluid flow modelling, discretization, and solution of equations.

COURSE OBJECTIVES

1. To acquire the basic knowledge of concepts of Computational fluid dynamics.
2. To provide the students with sufficient background to understand the mathematical representation of the governing equations of fluid flow and heat transfer applications.
3. To enable the students to solve the problem using the discretization technique.
4. To analyze the techniques, skills, & engineering tools necessary for engineering practice by applying numerical methods to a "real-world" fluid-flow problems,
5. To integrate various numerical techniques in formulating a numerical solution method.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Gain the basic Knowledge of Computational Fluid Dynamics applications and discuss numerical errors.	1	1,2
CO2	Develop the CFD governing equations for fluid flow applications.	1,2,3	1,2
CO3	Analyze the fluid flow fields using discretization techniques.	1,2	1,2
CO4	Use CFD simulation techniques to solve the turbulent flow problems.	1,2,5	1,2
CO5	Solve real-world problems related fluid flow using CFD tools	1,2,5	1,2,3
CO6	Discuss the applications of advanced methods used in CFD.	1	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	2	
CO2	3	2	2										3	2	
CO3	3	2											3	2	
CO4	3	2			3								3	2	
CO5	3	2			3								3	2	1

CO6	3												3	2	1
Average	**3**	**2**	**2**		**3**								**3**	**2**	**1**

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

CONTENT

Unit-1

Introduction and Basic Governing Equations: Introduction to CFD, advantages, Limitations of CFD, applications of CFD in different fields, the future of computational fluid dynamics, Different forces acting on the fluid, Governing equations of fluid dynamics-Continuity, Momentum and energy equations in differential form, Boundary conditions-Neumann, and Dirichlet, Numerical errors -.truncation error, round off error, Discretization error, Enhancing computational fluid dynamics with machine learning.

Unit-2

CFD Techniques : Basic aspects of discretization, Discretization techniques- Finite Element Method, Finite difference method and Finite volume method, Comparison of discretization by the three methods - three-dimensional continuity equation in Cartesian coordinates, Introduction to Finite differences- – Explicit, Implicit and Crank-Nicolson methods, Stability criterion

Unit-3

Simulation Techniques: Important features of turbulent flow, Reynolds average Navier Stokes (RANS) equation, Necessity of turbulence modeling, Different types of turbulence model: discussion on - Turbulent kinetic energy and dissipation, one equation- Spalart-Allmaras, two-equation model: κ-ε model, Advantages and dis advantages, RNG κ-ε model and κ-ω model, Multiphase flow.

Unit-4

Applications of CFD: Geometry creation, meshing, grid-independent test, mesh refinement analysis, practical boundary condition, validation, and results. Convergence, accuracy, Discussion on Advanced topics in CFD - Virtual reality meets, Fluid structure interaction, Physiological Fluid Dynamics, integration of CFD with Machine learning Discussion on Practical problems using CFD tools.

TEXT BOOKS

1. J. D Anderson, “Fundamental of Computational fluid dynamics”, McGraw-Hill Publications, 6th Edition, 1995
2. Jiyuan Tu “Computational Fluid Dynamics: A practical approach”, Elsevier publication, 3rd Edition, 2018.

REFERENCE BOOKS:

1. K. Muralidhar, T. Sundarajan “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 2nd Edition, 2003.
2. Suhas V Patankar, “Numerical Heat Transfer and Fluid Flow”, CRC Press, 1st Edition, 2018.

JOURNALS/MAGAZINES

1. International Journal of Computational Fluid Dynamics, Taylor and Francis.
2. Progress in Computational Fluid Dynamics, An International Journal, Inderscience Publishers.

SWAYAM/NPTEL/MOOCs:

1. Computational Fluid Dynamics, by Prof. Suman Chakraborty, IIT Kharagpur: https://onlinecourses.nptel.ac.in/noc21_me126/preview.
2. Foundation of Computational Fluid Dynamics, by Prof. Vengadesan, IIT Madras.

Course Title	Logistics and Supply Chain Management				Course Type		Soft core	
Course Code	B22ERS712	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

The course on Supply Chain and Logistics provides a comprehensive understanding of the fundamental principles, concepts, and practices involved in managing the flow of goods, services, and information across the supply chain. It explores the strategic and operational aspects of supply chain management, emphasizing the integration of various functions and the importance of efficient logistics operations.

COURSE OBJECTIVES

1. Understand the key components, functions, and activities within a supply chain.
2. Analyze the strategic importance of supply chain management for organizations.
3. Analyze global supply chain networks and the challenges associated with international logistics.
4. Apply problem solving and analytical skills to real world supply chain and logistics scenarios.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Understand the fundamentals, key concepts, functions of Supply Chain	1,11	1,2
CO2	Analyze supply chain networks in transportation modes, distribution strategies.	1,2,11	1,2
CO3	Explore the principles and techniques of optimization of carrier selection, freight consolidation.	1,2,11	1,2
CO4	Emphasizes the importance of sustainable and ethical practices in supply chain, environmental and social responsibility.	1,2,11	1,2
CO5	Distinguish cross functional business processes in supply chains	1,2,11	1,2
CO6	Decision affecting supply chain's "plan", "deliver", "Source" and "customer management" and "make" functions.	1,2,11,12	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 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	3									1		3	3	
CO3	3	3									1		3	3	
CO4	3	3									1		3	3	
CO5	3	3									1		3	3	
CO6	3	3									1	1	3	3	

Average	**3**	**3**									**1**	**1**	**3**	**3**	

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

COURSE CONTENT

Unit-1

Introduction to Supply Chain Management: Definition and importance of supply chain management, key components of a supply chain, Supply chain integration and collaboration.

Logistics Management: Role and scope of logistics in supply chain management, Transportation management and optimization, Warehouse management and inventory control, Packaging and materials handling

Unit-2

Demand Forecasting and Inventory Management: Techniques for demand forecasting, Inventory control models and strategies, Vendor-managed inventory and Just-in-Time (JIT) systems

Transportation in Supply Chain: Modes of transportation (road, rail, air, sea), Freight rates and pricing, Route optimization and carrier selection.

Unit-3

Warehousing and Distribution: Warehouse design and layout, Order fulfilment and picking strategies, Cross-docking and distribution centres.

Information Technology in Supply Chain Management: Role of technology in supply chain operations, Warehouse management systems (WMS) and transportation management systems (TMS), Supply chain visibility and analytics

Unit-4

Global Supply Chain Management: Challenges and opportunities in international logistics**,** Customs and trade compliance**,** Global sourcing and distribution strategies

Sustainable Supply Chain Management: Environmental and social considerations in supply chain practices**,** Green logistics and reverse logistics**,** Ethical issues and corporate social responsibility, value engineering in cost management.

CASE STUDIES

1. Procter & Gamble's Collaborative Supply Chain
2. Amazon's Fulfillment Operations:
3. Walmart's Inventory Management:
4. Taiwan - Inside the Miracle: A Development Success Story
5. Zara's Fast Fashion Supply Chain

TEXTBOOKS

1. Sunil Chopra and peter, "Supply Chain Management: Strategy, Planning, and Operation", 7th Edition 2020.
2. David Simchi -LeviDesigning and Managing the Supply Chain: Concepts, Strategies, and Case Studies" 3rd Edition, 2008.

REFERENCE BOOKS:

1. F.Robert Jacobs et al "Operations and Supply Chain Management: The Core" by F. Robert Jacobs and Richard Chase, 5th Edition, 2017.
2. Alan Harrison and Remko, "Logistics Management and Strategy: Competing through the Supply Chain", 6th Edition, 2018.

JOURNALS/MAGAZINES

1. Journal of Business Logistics (JBL)**:** https://onlinelibrary.wiley.com/journal/21581592
2. Supply Chain Management: An International Journal: Supply Chain Management: An International Journal
3. International Journal of Physical Distribution & Logistics Management: International Journal of Physical Distribution & Logistics Management
4. Supply Chain Quarterly
5. Journal of Supply Chain Management

6. International Journal of Logistics Management:
7. https://www.emerald.com/insight/publication/issn/0957-4093

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/110108056
2. https://nptel.ac.in/courses/110105141

Course Title	IoT and Machine Learning in Manufacturing				Course Type		Soft Core	
Course Code	B22ERS713	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				
	Tutorial	0	0	0				
	Practice	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**39**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

Industry 4.0 concerns the transformation of industrial processes through the integration of modern technologies such as sensors, communication, and computational processing. Industrial Internet of Things (IIoT) is an application of IoT in industries to modify the various existing industrial systems. IIoT links the automation system with enterprise, planning and product lifecycle. In this course, Introduced to the series objectives and an overview of digital transformations in manufacturing in today's business world. The course also introduces machine learning, with various aspects involved in machine learning, supervised learning, and various algorithms in supervised learning. There is emphasis on implementation of optimization techniques using machine learning.

COURSE OBJECTIVES

1. To introduce basics of Internet of things.
2. To impart the knowledge of IoT and M2M for different application in Industrial Internet of things
3. To give exposure the basic theory underlying machine learning.
4. To introduce machine learning techniques for the prediction, analyze and optimization of the machining parameters.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Understand the IoT enabling technologies	1	1,2
CO2	Identify and select IoT structures for the given applications	1,2	1,2
CO3	Apply the concept of M2M for building architectural block of IoT device	1	1.2
CO4	Implement Machine learning technique for intelligent Manufacturing system	1,2,5	1,2
CO5	Apply new tools and technologies in machine learning and apply for suitable optimization problems	1,2,5	1,2
CO6	Develop machine learning algorithms for optimization of metal cutting parameters	1,2,5	1,2

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 ARTICULATIONMATRIX

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

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

COURSE CONTENT

Unit-1

Introduction to IoT: Definition – Significance of IoT, Characteristics of IoT-Physical Design of IoT – Logical Design of IoT- IoT enabling technologies, Scope–Sensors for IoT Applications–Structure of IoT– IoT Map Device.

M2M to IoT: A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies.

Unit-2

M2M to IoT-An Architectural Overview:

Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. IoT Device – Basic building blocks of an IoT Device – Exemplary Device: Raspberry Pi

IoT Platforms Design Methodology:

Introduction – IoT Design Methodology, concept of the Industrial Internet of Things – Case study IoT enables CNC Machining, Real time machine monitoring.

Unit-3

Introduction to Machine Learning: Machine Learning basics, challenges, Applications, methods of Machine Learning, performance metrics, Data preprocessing, Data Loading, Understanding data with statistics, understanding data with visualization, preparing data, data feature selection.

Unit-4

Supervised Learning – Performance metrics: accuracy, misclassification, confusion matrix, similarity/dissimilarity methods, Decision Tree, K-nearest neighbor, logistic regression, support vector machine algorithm, naive Bayes algorithm, bagging and boosting techniques: random forest algorithm.

Identification of Optimal Parameters using supervised learning techniques, Build an optimization model to study the metal cutting parameters using machine learning.

TEXT BOOKS

1. Arshadeep Bahaga, Vijay Madisetti,"Internet of things-A hands –on approach", Universities Press, 1st Edition, 2015
2. Adrian McEwen and Hakim Cassimally,"Designing the Internet of Things", Wiley, 1st Edition, 2014.
3. Russell & Norvig, "Artificial Intelligence: A Modern Approach", Prentice-Hall, 3rd Edition, 2010.
4. Tom Mitchell, "Machine Learning", McGraw-Hill, 1st Edition, 2017.

REFERENCE BOOKS

1. Dominique DGuinard and Vlad M.Trifa,"Building the Web of things with examples in Node.js and Raspberry Pi", Manning Publications Co, 2016.
2. Elaine Rich, Kevin Knight, "Artificial Intelligence", TataMcgraw Hill, 3rd Edition, 2009
3. https://www.tutorialspoint.com/machine_learning_with_python/index.htm

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/artificial-intelligence
2. https://www.jair.org/index.php/jair

SWAYAM/NPTEL/MOOCs

1. https://nptel.ac.in/courses/106105077
2. https://onlinecourses.nptel.ac.in/noc22_ge29/preview

Course Title	Industry Training				Course Type		Soft core	
Course Code	B22ERS714	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				
	Tutorial	0	0	0				
	Practice	3	3	3	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**0**	**39**	**50 %**	**50 %**

COURSE OVERVIEW

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 according to industrial requirements. Industry training bridges the gap between academic learning and real-world application, equipping students with hands-on knowledge and professional competencies necessary for career development.

COURSE OBJECTIVES

1. To gain a practice-oriented and 'hands-on' working experience in the real world and to enhance the student's learning experience.
2. To develop a right work attitude, self-confidence, interpersonal skills 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 work environment.
4. To get pre-employment training opportunities and an opportunity for the company or organization 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 undergo Industry Training (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

TEXT BOOKS

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	Energy Management, Conservation and Auditing				Course Type		Soft core	
Course Code	B22ERS721	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

General principles of Energy management and Energy management planning - Peak Demand controls, Energy management opportunities in electrical systems and HVAC systems, Reactive power management, Energy audit cogeneration system, Economic analysis of energy projects**.**

COURSE OBJECTIVES

1. To enable the students to understand the concept of energy management and energy management opportunities.
2. To understand the different methods used to control peak demand
3. To know energy auditing procedure
4. To understand the different methods used for the economic analysis of energy projects.

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 energy management and energy management adopted in different systems.	1,2,6,7	1
CO2	Summarize the basic concepts of energy resources available in the nature and conservation of energy in steam power plant, and waste heat recovery.	1,2, 6,7	1
CO3	Describe the energy conservation in HVAC systems and, energy saving opportunities in fans and Pumping systems.	1,6,7	1
CO4	Discuss the principles of energy audit, Energy audit Instruments, cogeneration-types and schemes.	1,6,7	1
CO5	Elaborate Computer aided energy management and its applications.	1,6,7	1
CO6	Use economic analysis methods for cost estimation the projects.	1,2,6,7	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	2						3		
CO2	3	2				2	2						3		
CO3	3					2	2						3		
CO4	3					2	2						3		
CO5	3					2	2						3		
CO6	3	2				2	2						3	1	
Average	**3**	**2**				**2**	**2**						**3**	**1**	

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

COURSE CONTENT

Unit-1

Introduction to Energy Management: General principles of Energy management and Energy management planning. Peak Demand controls, methodologies, Types of Industrial Loads, Optimal Load Scheduling-Case studies, energy management opportunities in lighting and motors, electrolytic process and Electric heating, case studies.

Unit-2

Energy Conservation in Steam Boilers: Types of boilers, Combustion in boilers, Performances evaluation, Feed water treatment, Blow down, Energy conservation opportunities in boiler, properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, Identifying opportunities for energy savings, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.

Unit-3

Energy Conservation in HVAC Systems: Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Classification and Advantages of Waste Heat Recovery system, analysis of waste heat recovery, energy saving opportunities in fans and pumping systems.

Energy Audit: Definition, Need, Types of energy audit, energy audit instruments, cogeneration-Types and Schemes, Optimal operation of cogeneration plants - Case study. Computer aided energy management.

Unit-4

Economic Analysis Methods: Introduction, cash flow model, time value of money, evaluation of proposals, pay-back method, average rate of return method, internal rate of return method, present value method, lifecycle costing approach, case studies.

CASE STUDIES

1. Case study on energy conservation of different thermal systems.
2. Case study on energy auditing of different thermal systems.
3. Case study on energy management of different thermal systems.

TEXT BOOKS

1. Paul O'Callaghan, Energy management, McGraw Hill Book Co. 2021
2. G.G. Rajan, Optimizing energy efficiencies in industry -, Tata McGraw Hill, Pub. Co., 2001
3. Charles M. Gottschalk, Industrial energy conservation, John Wiley & Sons, 1996.

REFERENCE BOOKS

1. Albert Thumann, William J. Younger, Handbook of Energy Audits, CRC Press, 2003.
2. D. Yogi Goswami, Frank Kreith, Energy Management and Conservation Handbook, CRC Press, 2007
3. IEEE recommended practice for energy management in industrial and commercial facilities, IEEE std 739 -1995 (Bronze book).
4 M Jayaraju and Premlet, Introduction to Energy Conservation and Management, Phasor Books, 2008
5. Wayne C. Turner, Energy management Hand Book --The Fairmount Press, Inc., 1997.

JOURNALS/MAGAZINES

1. https://www.beeindia.gov.in/content/energy-auditors
2. https://www.cpri.in ›energy efficiency and renewable energy division (ered)
3. https://www.michigan.gov/documents/cis_eo_inside_churchmanual_45636_7.pdf
4. https://www.bookstore.teri.res.in/books/9788179930922
5. https://www.sjbit.edu.in/.../eee/.../energy%20auditing%20&%20demand%20side%20

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc21_me86/preview
2. https://nptel.ac.in/courses/103107157

<table>
<tr><td>Course Title</td><td colspan="4">Product Life Cycle Management</td><td colspan="2">Course Type</td><td colspan="2">Soft core</td></tr>
<tr><td>Course Code</td><td>B22ERS722</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

Product Life Cycle Management (PLM) is the process of managing a product from ideation to retirement. It involves managing all the data and processes related to a product, from design and development to production and distribution. This course will provide the comprehensive understanding of PLM, including the five phases of product development and the four stages of PLM. Also about the evolution of PLM and its benefits, as well as product lifecycle management software and the closed loop manufacturing cycle. Additionally, the course will cover the integration of PLM with other systems such as Supply Chain Management (SCM) and Customer Relationship Management (CRM). By the end of this course, an solid understanding of PLM and its role in improving product development and streamlining manufacturing processes.

COURSE OBJECTIVES

1. To enable the students to understand the basic concepts of thermodynamics.
2. To acquire the knowledge about first and second law of thermodynamics to analyse the practical applications.
3. To gain the concepts about ideal gases, real gases and pre substances to solve numerical on practical applications.
4. To identify and analyse performance of thermal devices like compressors, steam turbines, refrigerators and air conditioners.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Integrate the various stages of PLM into engineering product categories and portfolios that will evaluate into commercial success.	1,3	1,2
CO2	Interpret the data with information &/or communicate the same for the supply chain & value supplier chain quotation to ensure sustainable development.	1,4,5	1,2
CO3	Examine Life cycle Management strategies & knowledge to develop new or appropriate engineering design solution in engineering environment.	1,3,9	1.2
CO4	Translate and implement the legal, environmental and international regulatory frame works into product design, development and manufacturing requirement.	1,2,3	1,2
CO5	Assess system for corrective and preventive action to track production, Quality issues through digital manufacturing.	1, 5	1,2

CO6	Incorporate preventive approaches concentrating on minimizing waste, hazard and risk associated with product design, development & Manufacturing.	1,5	1,2

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 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			1	2								3	3	
CO3	3		2						1				3	3	
CO4	1	2	2										3	3	
CO5	1				2								3	3	
CO6	1				2						1		3	3	
Average	**2**	**2**	**1.6**	**1**	**2**				**1**		**1**		**3**	**3**	

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

COURSE CONTENT

Unit-1

Introduction to Product Life Cycle Management: Definition, PLM life cycle Model, Thread of PLM, Need for PLM, Opportunities and Benefits of PLM, Views, components and phases of PLM, PLM feasibility study, PLM Visioning.

PLM Concepts, Processes and Workflow: Characteristics of PLM, Environment Driving PLM, PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation , Production, Support of PLM

Unit-2

Collaborative Product Development: Engineering Vaulting, Product reuse, smart parts, Engineering change Management, Bill of materials and process consistency, Digital Mock-up and prototype development, Design for Environment , Virtual testing and validation, Marketing Collateral.

Unit-3

Digital Manufacturing -PLM: Digital Manufacturing, Benefits of Digital Manufacturing, Manufacturing the First-one, Ramp-Up, Virtual Learning Curve, Manufacturing the Rest, Production Planning.

Unit-4

Developing a PLM strategy and conducting a PLM Assessment: Strategy, impact of strategy, implementing a PLM strategy, PLM initiatives to support corporate objectives, infrastructure Assessment, Assessment of current systems and Applications.

CASE STUDIES

1. https://sterlingplm.com/casestudies/sterling-plm-helps-tech-giant-use-polarion-to-achieve-process-improvements-for-faster-time-to-market/
2. https://www.superheuristics.com/product-life-cycle-of-maggi/

3. https://www.concurrent-engineering.co.uk/plm-case-study-adidas
4. https://mentormecareers.com/product-life-cycle-of-amul/

TEXT BOOKS

1. Grieves, Michael, "Product Lifecycle Management", Tata McGraw Hill publication, 1st Edition, 2006,.
2. Stark, John, "Product Life cycle Management", Volume I, Springer, 3rd Edition, 2016.
3. Stark, John, "Product Life cycle Management", Volume II, Springer, 3rd Edition, 2016.
4. Anti Saaksvuori and Ansel miImmonen, "Product Lifecycle Management", Springer Publisher, 2008.
5. Steven Haines, "The Product Manager's Desk Reference", McGraw-Hill Education, 2nd Edition, 2014

REFERENCE BOOKS

1. Yunus A. Cengel, "Thermodynamics: An Engineering Approach", McGraw - Hill Education, 9th Edition, 2019.
2. S Domkundwar, C P Kothandaraman, Domkundwar, "A course in Thermal Engineering", Dhanpat Rai Publication, New Delhi India, 6th Edition, 2009,
3. Gordon J. Van Wylan & Richard E Sonntagg, "Fundamentals of Thermodynamics", Wiley Eastern Ltd, 7th Edition, 2009.

JOURNALS/MAGAZINES

1. https://www.inderscience.com/jhome.php?jcode=ijplm
2. https://www.emerald.com/insight/content/doi/10.1108/EJM-08-2020-0594/full/html

SWAYAM/NPTEL/MOOCs

1. https://archive.nptel.ac.in/courses/110/104/110104084/
2. https://www.coursera.org/projects/the-product-life-cycle

Course Title	Digital Manufacturing				Course Type		Soft core	
Course Code	B22ERS723	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

Manufacturing refers to the processes of converting the raw materials into useful products. Digital manufacturing technologies are used to simulate and model processes so that they can be optimized, helping businesses to reduce operating costs, speed up production, and improve cohesion between different stages of the manufacturing process by more seamlessly pairing them. Digital manufacturing tools (often cloud-based) can connect and simplify processes across the production cycle to create a 'digital thread' that integrates manufacturing operations to streamline and enhance design, production, servicing, and more. The 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 advanced manufacturing techniques aligned to the industry 4.0.

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. To introduce the CAD/CAM concepts and applications.
4. To 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 achieve higher quality and productivity standards.	1	1,2
CO2	Demonstrate the knowledge on rapid manufacturing applications in tooling, biomedical etc.,	1	1,2
CO3	Enumerate and analyze 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	1,2
CO5	Discuss intelligent manufacturing system and digital enterprises.	1	1,2
CO6	Use manufacturing support systems for productivity improvement.	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 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	1											3	3	
CO4	3												3	3	
CO5	3												3	3	
CO6	3												3	2	
Average	**3**	**1**											**3**	**2.83**	

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 Applications: Online Predictive Modeling - Monitoring and Intelligent Control of production and Logistics/Supply Chain Processes - Smart Energy Management of manufacturing processes and facilities

Unit-2

Digital Design and Fabrication: Digital twins and applications , Digital process twins in manufacturing , Agile (Additive) Manufacturing Systems - an overview, Mass Customization , Smart Machine Tools - NC/CNC.DNC, Part programming types and methods(Manual part programming), Robotics and Automation (perception, manipulation, mobility, autonomy) ,Sensor networks and Devices

Unit-3

Manufacturing Support Systems: Flexible manufacturing, FMS layout, FMS planning and implementation issues, Benefits, Group Technology , Kanban System, Just-in-Time manufacturing, lean manufacturing - setup reduction, Cellular manufacturing

Unit-4

Intelligent Manufacturing Systems: Components of IMS, Tool and techniques of IMS, 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. AI & ML in Manufacturing

TEXT BOOKS

1. Kumar K, "Smart Manufacturing and Industry 4.0", Taylor & Francis, 2021.
2. Mikell P. Grover, "Automation, Production Systems and Computer Integrated Manufacturing", 4th Edition, Pearson Education, 2016.
3. Radhakrishna P, "CAD/CAM/CIM", PHI, 2020.

REFERENCE BOOKS

1. William MacDougall, "Industry 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", Wiley India Private Limited, 7th Edition, 2010.
3. Jayakrisna Kandasamy, Kamalakantha Muduli, V P Komula, Putrushottam L Meena, "Smart Manufacturing Technologies for Industry 4.0 Inteigration, Benefits and Operational Activities", 1st Edition, Routledge, Taylor and Francis, 2023.

JOURNALS/MAGAZINES

1. https://www.journals.elsevier.com/journal-of-manufacturing-processes
2. https://ojs.wiserpub.com/index.php/DMT/about
3. https://www.frontiersin.org/journals/mechanical-engineering/sections/digital-manufacturing
4. https://www.springer.com/journal/10845

SWAYAM/NPTEL/MOOCs

1. https://nptel.ac.in/courses/110106146
2. https://nptel.ac.in/courses/108103009
3. https://www.udemy.com/course/digital-manufacturing-and-industry-40-training-
4. https://www.coursera.org/specializations/digital-manufacturing-design-technology

<table>
<tr><td>Course Title</td><td colspan="4">Internship</td><td colspan="2">Course Type</td><td colspan="2">Soft core</td></tr>
<tr><td>Course Code</td><td>B22ERS724</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="3">Total Number of Classes Per Semester</td><td colspan="2" rowspan="3">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Practice</td><td>3</td><td>3</td><td>3</td><td>Theory</td><td>Practical</td><td>IA</td><td>SEE</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>3</td><td>0</td><td>39</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW

The internship in field of study is essential to 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 according to industrial requirements.

COURSE OBJECTIVES

1. To gain a practice-oriented and 'hands-on' working experience in the real world and to enhance the student's

learning experience.

2. To develop a right work attitude, self-confidence, interpersonal skills 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 work environment.
4. To get pre-employment training opportunities and an opportunity for the company or organization 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 who will get opportunity to undergo paid internship during 7th semester is permitted to register for internship pahse-1 course. 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

TEXT BOOKS

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	**Design Lab**				**Course Type**		**Hard Core**	
Course Code	**B22ER0704**	**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				
	Tutorial	0	0	0				
	Practice	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**26**	**50 %**	**50 %**

COURSE OVERVIEW

The course deals with the free and forced vibrations under un-damped and damped conditions for single degree of freedom mechanical systems. It also deals with the critical speed of a rotating shaft. This lab helps the manufacturing sector in analyzing the vibration measurement and Noise Engineering. Also study the mode shapes of cantilever beam. The course further deals with experimental stress analysis.

COURSE OBJECTIVES

1. To enable the students to understand the theoretical principles of vibration and vibration analysis techniques for the practical solution of vibration problems.
2. To analyze the free and forced (harmonic, periodic, non-periodic) vibration analysis of single degree of freedom linear systems.
3. To enable the students to determine sound pressure level measurement in specified acoustic environment.
4. To predict stress levels using the concepts of Photo elasticity.
5. To analyze the parameters (Principal Stresses and Strains) using strain rosettes.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Estimate the natural frequency for longitudinal and torsional systems and demonstrate a physical understanding of damping as well as frequencies and mode shapes of engineered systems and record the results in the form of technical report.	1, 4, 9, 10	1, 2
CO2	Compute the natural frequency for forced vibration of a single degree of freedom of un-damped systems and record the results in the form of technical report.	1, 3, 9, 10	1, 2
CO3	Compute the critical speed of rotating shaft and record the results in the form of technical report.	1, 3, 9, 10	1, 2
CO4	Predict the vibration using measuring instruments and noise reduction techniques to real time engineering problems and record the results in the form of technical report.	1, 4, 6, 9, 10	1, 2
CO5	Justify the Photo elasticity principles for stress analysis and record the results in the form of technical report.	1, 2, 9, 10	1, 2
CO6	Determine Principal stresses and strains in members subjected to combined loading using strain rosettes, compare it with theoretical values and record the results in the form of technical report.	1, 2, 9, 10	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	2			3					3	3			3	3	
CO2	2		3						3	3			3	3	
CO3	3		3						3	3			2	3	
CO4	3			3		3			3	3			3	2	
CO5	2	3							3	3			3	3	
CO6	3	3							3	3			2	3	
Average	**2.5**	**3**	**3**	**3**		**3**			**3**	**3**			**2.7**	**2.8**	

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

Part-A

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional).
2. To study the forced damped vibration of spring mass system.
3. Determination of critical speed of a rotating shaft.
4. Vibration measurements by accelerometers/ Laser Doppler/ Vibrometer/ μ-flown probes.

5. Determination of natural frequency of beam /plate by experimental model analysis.

Part-B

1. Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes.
2. Determination of Fringe constant of photo elastic material using.
   a) Circular disc subjected to diametral compression.
   b) Pure bending specimen (four point bending).
3. Determination of stress concentration using Photo elasticity for rectangular plate with a hole under tension.
4. Determination of Pressure distribution in Journal bearing.

TEXT BOOKS

1. S. S. Rao, Mechanical Vibrations, Pearson Education Inc, 6th edition, 2016.
2. S. Graham Kelly, Schaum's outline Series, Fundamentals of Mechanical Vibrations, Tata McGraw Hill.
3. W. T. Thomson, Mechanical Vibrations, Pearson Education Inc, 5th edition, 2008.
4. Sadhu Singh, "Experimental Stress Analysis", Khanna Publisher New Delhi, 2009.
5. Srinath L.S., "Experimental stress Analysis", Tata McGraw Hill, New Delhi.

REFERENCE BOOKS

1. G. K.Grover, Mechanical Vibrations, Nem Chand and Bros.
2. W. T. Thomson, Theory of Vibration with Applications, Pearson Education Inc, 5th edition, 2008.
3. V. P. Singh, Mechanical Vibrations, Dhanpat Rai & Company, 3rd edition, 2006.
4. Jindal, "Experimental stress analysis", Pearson Publishers, 2018.
5. J.Srinivas, "Stress analysis-An introduction to Experimental Techniques", Narosa Publishers, 2015.

JOURNALS/MAGAZINES

1. Journal of Sound and Vibration
2. Journal of Vibration and Acoustics
3. Journal of Vibration Engineering & Technologies
4. https://www.inceusa.org/publications/noise-news-international
5. https://www.sciencedirect.com/topics/engineering/experimental-stress-analysis
6. https://link.springer.com/book/10.1007/978-3-319-06086-6

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112107212 (Introduction to Mechanical Vibration)
2. https://www.classcentral.com/course/swayam-sound-and-structural-vibration-58554
3. https://onlinecourses.nptel.ac.in/noc22_me34/preview (Sound and Structural Vibration)
4. https://onlinecourses.nptel.ac.in/noc21_me02/preview
5. https://nptel.ac.in/courses/112106068

<table>
<tr><td>Course Title</td><td colspan="4">CIM and Machine Learning Lab</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B22ER0705</td><td>Credits</td><td colspan="2">1</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="3">Total Number of Classes Per Semester</td><td colspan="2" rowspan="3">Assessment in Weightage</td></tr>
<tr><td>Theory</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Tutorial</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>Theory</td><td>Practical</td><td>IA</td><td>SEE</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>

COURSE OVERVIEW

The main purpose of this lab is to train the students industry ready and to attain employability skills with the CNC programming of canned cycles and cutting tool path generation through CNC simulation software by using G-Codes

and M-codes. Students will get acquainted about CNC Lathe part programming for Turning, Facing, Grooving, Step turning, Taper turning, Circular interpolation, Combination of few operations followed by CNC Mill Part programming for Drilling, Peck drilling, Boring, Turning, Facing, Taper turning. The course trains the students on applying machine learning techniques using python for tool life monitoring.

COURSE OBJECTIVES

1. To train the students with CNC part programming concepts
2. To generate manual part programming – CNC Turning, milling and drilling
3. To familiarize with the various operations to be performed with syntax format based on Fanuc controller.
4. To carry out the simulation /Dry run of the given profile with various operations involved in it.
5. To familiarize with the various Machine Learning Models for tool condition monitoring.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Understand the basic concept of NC programming languages – Manual Part programming and Computer assisted part programming.	1,2,5	1,2
CO2	Analyze the various operations involved in the profile with its syntax format for machining and document the results in the form of technical report.	1,2,5,9,10	1,2
CO3	Generate the part program for the given turning, drilling and Milling profile/part geometry and document the results in the form of technical report	1,2,5,9,10	1,2
CO4	Use Canned Cycles for Drilling, Peck drilling, Boring, Turning, Taper turning, Thread cutting operations and document the results in the form of technical report	1,2,5,9,10	1,2
CO5	Familiarize with the computer numerical control software and its ability to generate the cutter tool path as per given profile in the dry run and document the results in the form of technical report.	1,2,5,9,10	1,2
CO6	Apply Machine Learning Models for tool condition monitoring using Python.	1,2,5,9,10	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	3	2			1								2	1	
CO2	2	3			3				2	2			2	2	
CO3	2	3			3				2	2			2	2	
CO4	2	3			3				2	2			2	2	
CO5	2	3			3				2	2			2	2	

CO6	3	2			1				1	1			2	1	
Average	**2.3**	**2.6**			**2.3**				**1.8**	**1.8**			**2**	**1.6**	

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

Part-A

1. Manual CNC part programming for turning and drilling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path.
2. Simulation of Turning, Drilling operations. Typical simulations to be carried out using simulation packages like: Cadem CAMLab-Pro, Master- CAM with and without canned cycle programs.
3. Simulation of milling operations. Typical simulations to be carried out using simulation packages like: Cadem, CAMLab-Pro, Master- CAM, M-Tab for with & without canned cycle programs

Part-B

1. Introduction to Machine Learning Techniques and implementation using Python.
2. Supervising of data acquired from CNC Machining.
3. Prediction of tool wear using Machine Learning Models.

TEXT BOOKS

1. M.P.Groover & Emory W.Zimmer, "CAD/CAM, Computer Aided Design and Manufacturing", Pearson India, 2nd Edition. 2007.
2. Mikell P.Groover, "Automation, Production system & Computer Integrated Manufacturing", Pearson India, 2nd edition. 2007.
3. Tom Mitchell, "Machine Learning", McGraw-Hill, 2nd Edition 2017.

REFERENCE BOOKS

1. Ibrahim Zeid, "CAD/CAM theory and practice", Tata McGraw hill. 2007.
2. P. Radha Krishnan, S. Subramanyan & V. Raju, "CAD/CAM/CIM", New Age international Publishers, 2nd Edition. 2008.
3. P. Radha Krishnan, "Computer Numerical Control Machines and CAM", New Age international Publishers, 1st Edition 2012.
4. P. N. Rao, "CAD/CAM Principles and applications", Tata McGraw hill, 2010.
5. Chris Bishop, "Neural Networks for Pattern Recognition", Oxford University Press, 1995

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/journal/Computer Aided Design
2. https://www.sciencedirect.com/journal/Advancements in CAD/CAM technology: Options for practical implementation

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112102102
2. https://nptel.ac.in/courses/112104289

Course Title	**Project Phase-1**			**Course Type**	**Hard Core**
Course Code	**B22ER0706**	**Credits**	**1**	**Class**	**VII Semester**
Course Structure	TLP	Credits	Contact Hours	Assessment in Weightage	
	Theory	0	0		
	Tutorial	0	0		
	Practice	1	2	IA	SEE
	Total	**1**	**2**	**50 %**	**50 %**

COURSE OVERVIEW

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.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	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	Propose the objectives of project work and design the project methodology.	1, 2	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 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		3										3	3	3	3
CO3	3	1											3	3	3
CO4									3				3	3	3
CO5										3			3	3	3

CO6											3		3	3	3
Average	**3**	**2**							**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 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).

TEXT BOOKS

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, 6th 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, 3rd 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, 6th 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

8th Semester

Course Title	Major Project			Course Type	Hard Core
Course Code	B22ER0801	Credits	10	Class	VIII Semester
Course Structure	TLP	Credits	Contact Hours	Assessment in Weightage	
	Theory	0	0		
	Tutorial	0	0		
	Practice	10	20	IA	SEE
	Total	**10**	**20**	**50 %**	**50 %**

COURSE OVERVIEW

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.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	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 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		√				

CO7				√		
CO8			√			

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		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 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, analysis / design / development of model and estimated project cost and submit the same in the form of a report prepared as per the guidelines/format of the university.

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1. Biswajit Mallick, "Innovative Engineering Projects", Entertinement Science and Technology Publication, Bhubaneswar, India, 1st Edition 2015.
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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