NAAC GRADE A+
ACCREDITED UNIVERSITY

REVA UNIVERSITY
Bengaluru, India

School of Mechanical Engineering

B.Tech Mechanical Engineering

HANDBOOK 2024-28

RUKMINI EDUCATIONAL
Charitable Trust

www.reva.edu.in

REVA UNIVERSITY
Bengaluru, India

SCHOOL OF MECHANICAL ENGINEERING

HAND BOOK

B. Tech. in Mechanical Engineering

2024 Scheme

Applicable for 2024-28 Batch

Rukmini Knowledge Park, Kattigenahalli
Yelahanka, Bengaluru - 560 064
Karnataka, India
Phone No: +91-90211 90211, +91 80 4696 6966

CONTENTS

Chancellor's Message

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

- Nelson Mandela.

At REVA University, we are firm believers in this truth.
The power of education lies not only in the acquisition of knowledge but in its ability to transform lives, communities, and nations. As the world rapidly evolves, driven by technological advancements and global interconnectedness, education remains the catalyst for progress, innovation, and positive change.

Today, we live in an era where knowledge is no longer confined to books or classrooms. Information is accessible at the touch of a button, and opportunities for learning abound in every corner of the world. Yet, the true essence of education lies beyond the mere accumulation of information. It is about cultivating critical thinking, fostering creativity, and empowering individuals to contribute meaningfully to society. At REVA University, we are committed to nurturing seekers of knowledge who aspire to make a difference in the world.

Guided by our founding philosophy of "Knowledge is Power," we strive to create an environment where intellectual curiosity is encouraged, and dreams are transformed into reality. India is a land of immense talent and potential, and it is our duty as educators to provide the spark that ignites this potential. Through the transformative power of education, we aim to shape future leaders who possess not only technical proficiency but also strong ethical values and a commitment to social responsibility.

A university is more than just a place of learning; it is a place of growth, exploration, and transformation. Our faculty, with their expertise and dedication, are at the heart of this transformation. They are more than teachers; they are mentors who guide students on their journey of self-discovery and academic excellence. Our student-centric, transformational approach ensures that every learner is given the opportunity to explore their full potential and exceed their own expectations.

At REVA University, we take great pride in our state-of-the-art infrastructure and facilities, designed to provide an inspiring and conducive environment for both academic and extracurricular pursuits. Our campus is a vibrant space where students are encouraged to challenge their minds, develop their skills, and grow as individuals.

As we move forward, I am reminded of the words of Benjamin Disraeli: "A university should be a place of light, of liberty, and of learning." This vision continues to inspire us at REVA University, where we work as a team to create a brighter future for our students and our society.

I invite you to join us on this journey of enlightenment, growth, and transformation. Together, let us lay the foundation for a future built on values, wisdom, and knowledge.

Dr. P. Shyama Raju
Chancellor
REVA University

Pro Chancellor's Message

REVA University has emerged as a premier destination for higher education across diverse fields such as engineering, science, commerce, management, architecture, law, arts, and humanities. Our commitment to excellence in education is reinforced by the adoption of cutting-edge technologies and innovative teaching methods that ensure our students are equipped for the future.

The integration of modern tools and ICT-based technologies is at the core of our academic philosophy. We focus on digital learning, project-based learning, and personalized learning experiences that cater to individual student needs. By harnessing the power of advanced technologies such as AI-powered learning platforms, data analytics, and virtual/augmented reality, we are able to offer dynamic, interactive educational experiences that transcend traditional classroom boundaries. This technological transformation enables us to deliver STEM education more effectively while providing our faculty with ongoing professional development to stay at the forefront of teaching innovations.

Our programs are meticulously designed after a thorough analysis of current industry needs and trends, with a focus on knowledge assimilation, practical application, and global employability. We recognize the importance of preparing students not just for today's job market but for a rapidly changing future where automation, artificial intelligence, and data-driven decision-making will play pivotal roles. To meet these demands, we emphasize hands-on learning, skill development, and innovation, ensuring that our students are well-prepared to thrive in their respective fields.

At REVA University, we have implemented the Choice Based Credit System and Continuous Assessment Grading Pattern (CBCS – CAGP) in all our programs. This system provides students with the flexibility to choose subjects that align with their interests while developing essential skills. CBCS courses integrate knowledge on local, regional, national, and global issues, fostering a comprehensive understanding of the world and enabling students to become entrepreneurial and employable in a competitive global marketplace. Furthermore, students are offered a variety of value-added courses to enhance their skillsets, ensuring they are equipped to navigate the evolving demands of their chosen careers.

The future of the engineering profession, and indeed many other fields, will be shaped by dramatic technological and societal changes. The rise of automation, sustainability concerns, and increased globalization will create both opportunities and challenges for the next generation of professionals. REVA University is fully prepared to meet these challenges head-on. Through state-of-the-art laboratories, research centers, and partnerships with premier industries and academic institutions, we are committed to creating talented professionals and leaders who can navigate these future transformations.

Our growth and success have been built on a foundation of excellence in curriculum design, student-centric teaching methods, and hands-on learning practices. I extend my gratitude to our students, parents, faculty, staff, and well-wishers for their contributions in helping REVA University become a next-generation, globally recognized education hub.

Mr. Umesh S. Raju
Pro Chancellor
REVA University

Vice Chancellor's Message

The last two decades have seen remarkable growth in higher education in India and across the globe. The move towards interdisciplinary studies and interactive learning has 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 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 a higher teaching-learning environment and research. The main objective of the University is to provide higher education of global standards and hence, all the programmes are designed to meet international standards. Highly experienced and qualified faculty members, continuously engaged in the maintenance and enhancement of a student-centric learning environment through innovative pedagogy, form the backbone of the University. All the programmes 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.

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 commitment to providing premium quality education accessible to all and an environment for the growth of overall personality development leading to generating "GLOBAL PROFESSIONALS".

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

Rukmini Educational Charitable Trust

In October 2005, the long-standing dream of Smt. Rukmini Shyama Raju to educate the youth became a reality with the establishment of Rukmini Educational Charitable Trust (RECT). The RECT is a Charitable Trust to promote, establish, and conduct developmental activities in the fields of Arts, Commerce, Engineering, Environmental Science, Management, Science & Technology, Law, Architecture, Performing Arts, and others.

To meet this aim, the Trust has set up the REVA Group of Educational Institutions comprising REVA Institute of Technology and Management, REVA Institute of Science and Management, REVA Institute of Management Studies, REVA Institute of Education, REVA First Grade College, REVA Independent PU College Kattigenahalli, REVA Independent PU College-Ganganagar, and REVA Independent PU College Sanjaynagar, and REVA University. Through these institutions, the Trust seeks to fulfil its vision of providing world-class education and creating abundant opportunities for the youth to excel in academics.

Every great human enterprise is powered by the vision of extraordinary individuals and is sustained by the people who derive their motivation from the founders. Dr. P. Shyama Raju, the Chairman of the Trust, is a developer and builder of repute, a captain of the industry in his own right, and the Chairman & Managing Director of the DivyaSree Group of companies. The other trustees are Shri Bhaskar N Raju, and Smt Arathi B. Raju, Shri. Umesh. S. Raju and Smt. Tanisha U. Raju.

The Rukmini Educational Charitable Trust is driven by the purpose of nurturing students who are in pursuit of quality education and excellence. REVA, today, is a family of 10 institutions providing education from pre-university to post-graduation and providing research and resource support to PhD degree aspirants.

About REVA University

REVA University is a State Private University established in Karnataka State under the Government of Karnataka Act No. 13 in the year 2012 in Bengaluru, the IT capital of India. REVA University, recognised by the University Grants Commission (UGC) and approved by the All India Council for Technical Education (AICTE), has an A+ grade from NAAC. The University has a sprawling green campus spread over 43 acres of land.

The University has a DIAMOND Band ranking from QS I Gauge. As per QS Asian University Rankings, it is ranked 47th among all the private Universities of India and 6th among all private universities of Karnataka. In less than a decade, REVA University, Bengaluru, has established itself as a Global University in education by earning recognition as a forward-thinking institution across all disciplines.

The University currently offers 38 full-time undergraduate Programmes, 33 full-time postgraduate programmes, 20 Ph.D. programmes, and certification and diploma programmes. The University offers programmes under the faculty of Engineering, Architecture, Science and Technology, Commerce, Management Studies, Law, Arts & Humanities, and Performing Arts & Indic Studies. REVA offers some of the trending fields of study as undergraduate courses in Sports Science (B. Sc.), Agricultural Engineering (B. Tech), and Aerospace Engineering (B. Tech) which are full-time application-based programmes with a unique blend of theory and practical components.

With state-of-the-art infrastructure, the University has created a vibrant academic environment conducive to higher learning and research. This includes 200 smart classrooms that support blended learning, real-industry-like labs that foster on-the-job learning in students, a tech-enabled library with over 1 lakh collections of books, and most importantly, modern pedagogy. REVA currently has numerous students on campus from around the country. The campus has exclusive Halls of Residence which provides comfortable accommodation for boys and girls, apart from catering to the needs of all cuisine and ensuring adequate amenities are provided to make their stay an extended home.

In its mission to become a social impact university, REVA University has initiated several Corporate Social Responsibility initiatives. Jagruti, Abhivriddhi, Vanamahotsava, Education on Wheels, and Pragna are a few of the several projects in REVA. REVA has now moved on to become a Social Impact University and has aligned with the United Nations Sustainable Development Goals. Through these initiatives, REVA aspires to become an innovative University by developing a social connection with leadership qualities, ethical and moral values, research culture, and innovative skills through higher education of global standards.

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

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 in 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
Bengaluru, India

ACADEMIC REGULATIONS

B. Tech., Degree Programs
(Applicable for the programs offered from 2024-25)

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

THESE ACADEMIC REGULATIONS ARE UNDER CHOICE BASED CREDIT SYSTEM AND CONTINUOUS ASSESSMENT GRADING PATTERN (CBCS-CAGP)

1. Title and Commencement:

1.1 These Regulations shall be called **"REVA University Academic Regulations – B. Tech., Degree Program for the batch of students admitted for AY 2024-25 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 for the admitted batch during AY 2024-25 under respective schools.

SL No.	Name of the School	Name of the Program
1	School of Civil Engineering	B Tech in Civil Engineering
2	School of Computing and Information Technology	B Tech in Computer Science and Engineering (Artificial Intelligence and Machine Learning)
		B Tech in 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 (Internet of Things and Cyber Security 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 Engineering
		B Tech in Electronics and Computer Engineering
		B Tech in Robotics and Artificial Intelligence
6	School of Mechanical Engineering	B Tech in Mechanical Engineering
		B Tech in Mechatronics Engineering
		B.Tech in Aerospace Engineering
7	Department of Agricultural Engineering	B Tech in Agricultural 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, "Signals and Systems" in B. Tech., Electronics and Communication Engg are the 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, an Interactive session including discussions, self-study, desk work, seminar presentations, and other methods to deepen understanding.
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 follows:

4.2.1 Foundation Course (FC): The foundation Course is basic course which should be completed successfully as a part of graduate degree program irrespective of the program of study.

4.2.2 Professional Core Course (also known as Hard Core (HC) Course): The **Professional Core** 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.

4.2.3 Professional Elective Course (also known as Soft Core (SC) Course): Professional Elective course 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.

4.2.4 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.**

4.2.5 Audit Course (also known as Non-Credit Course /Mandatory 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.

4.2.6 Project Work / Dissertation: Project work / Dissertation work is a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problems to solve a multivariable or complex engineering problems. The project will be conducted in two phases, phase-I, 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.

4.2.7 Skill Development Course (SDC): It is a practice based course introduced in first year, second year and third year that lead to advanced job skills as per current industry/societal requirements to enhance high employability index of graduates. It may also lead to a certificate, diploma and advanced diploma, etc.

4.2.8 Emerging Technology Course (ETC): This course is introduced in the first year, focusing on the latest advancements and innovations in technology. It aims to equip students with cutting-edge knowledge and skills relevant to emerging fields.

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)	A. FOR GENERAL MERIT CANDIDATES: A candidate who has Passed in 2nd PUC / 12 Std / Equivalent Examination with English as one of the Language and obtained a Minimum of 45% of Marks in aggregate in Physics and Mathematics as compulsory subjects along with Chemistry / Bio Technology / Biology / Computer Science / Electronics as optional subjects in the qualifying examination is eligible to pursue in under graduate programs (BE).

Sl. No.	Program	Duration	Eligibility
			B. FOR SC/ST & OBC (Cat-I, 2A, 2B, 3A 3B) CATEGORY CANDIDATES: A candidate who has Passed in 2nd PUC / 12 Std / Equivalent Examination with English as one of the Language and obtained a Minimum of 40% of Marks in aggregate in Physics and Mathematics as compulsory subjects along with Chemistry / Bio Technology / Biology / Computer Science / Electronics as optional subjects in the qualifying examination is eligible to pursue in under graduate pogroms (BE). C. The marks obtained by the candidate in Biotechnology/Biology/Computer Science / Electronics in the qualifying examination will be considered in the place of Chemistry in case the marks obtained in Chemistry is less for the required aggregate percentage for the pursue of determination of eligibility.
2	Bachelor of Technology (B Tech-Lateral Entry program)	3 Years (6 Semesters)	A. candidate who has passed Qualifying Examination i.e. any diploma examination or equivalent examination and obtained an aggregate minimum of 45 % (for General Merit Candidates) of marks taken together in all the subjects of the final year (i.e., fifth and six semesters) diploma examination (Q E) is eligible for admission to B E-Courses and 40% of marks in Q. E. in case of SC, ST and Backward Classes of Karnataka Candidates. 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. B. 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. C. 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. D. 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

Sl. No.	Program	Duration	Eligibility
			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. E. 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 program)
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, CIA and the remaining 4 weeks for SEE, evaluation and result declaration.

6.3 The credit hours defined as below:

In terms of credits, L refers to lecture hour (theory) credit per week, that indicate every one hour lecture per week of L amounts to 1 credit per Semester; T and P refer to tutorial hours and practice hours credit per week, that indicate every two hours of T and P per week amounts to 1 credit per Semester or a three hour session of T / P amounts to 2 credits per semester.

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

The following table describes 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
0	0	2	0:0:1	1	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 labelled as follows:

a. Foundation Course (FC)
b. Professional Core Course (Hard Core(HC))
c. Professional Elective Course (Soft Core(SC))
d. Open Elective Course (OE)
e. Skill Development Course (SDC)
f. Audit Course (Non-credit Course/ Mandatory Course) (MC)
g. 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 4.2.6 of this regulation.
h. Emerging Technology Course(ETC)

8. Credits and Credit Distribution

A candidate must earn 160 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.

8.1 The concerned BOS based on the credits distribution shall prescribe the credits to various types of courses listed in section 4.2 and shall assign title to every course thereon.

8.2 Every course including project work, practical work, field work, self-study elective should be entitled as per the list declared in section 4.2. However, as per AICTE, the credit distribution for various category of courses is given below in the table.

Sl. No.	Course Category	Abbreviation (AICTE)	Suggested breakup of credits (AICTE)	Credit breakup (REVA)
1	Humanities and Social Sciences including Management courses (HSMC)	HSMC	12	9
2	Basic Science Courses	BSC	25	19
3	Engineering Science courses including workshop, drawing, basics of electrical / mechanical /computer etc	ESC	24	23
4	Program Core Courses	PCC	48	61
5	Program Elective courses relevant to chosen specialization/branch	PEC	18	18
6	Open subjects – Electives from other technical and /or emerging subjects	OE	18	6
7	Project work, seminar and internship in industry or elsewhere	PROJ	15	18
8	Audit Courses (Mandatory Course)	MC	-	-
9	Skill Development Courses (SDC)/ETC/AEC	ETC/AEC/SDC		6
			160	160

8.3 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 enroll 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.

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

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

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

9 Assessment and Evaluation

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

i. Continuous Internal Assessment (CIA); and
ii. Semester End Examination (SEE)

9.2 Assessment and Evaluation of each Course shall be for 100 marks. The CIA and SEE of UG Engineering programs shall carry 50:50 marks respectively (i.e., 50 marks CIA; 50 marks for SEE).

9.3 The 50 marks of CIA shall comprise of:

Internal Assessment Test (IA 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** (IA 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:

- The question paper of the **1st test should be based on first 50% of the total syllabus**.

- The question paper of the **2nd test should be based on remaining 50 % of the total syllabus.**
- An assignments must be designed to cover the entire syllabus.

9.6 There shall be two Assignments / 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 during 16th and 17th week of the semester.

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

9.9 IA 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 action verbs. The questions must be set to assess the course outcomes described in the course document with the choice is given in questions.

9.10 The question papers for IAs shall be set by the internal faculty who have taught the course. If the course is taught by more than one faculty, all of them 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 faculty who have taught the course and set the test paper. After evaluation of answer booklets faculty must distribute to students. If any corrections are noticed by students, faculty have to justify the award of marks. The final marks are to be declared only after such corrections. School/Department has to take signature for the marks obtained.

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 of self-study and creative thinking. While setting assignment care should be taken such that the students will not be able to plagiarize the answer any other resources. Course faculty 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 self-study.

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

9.14 The SEE theory question paper is designed to comprehensively evaluate student's understanding and mastery of the course content. A total of 8 main questions will be crafted to cover the entire syllabus, out of which students are required to answer any 5 questions in

full. Each main question will carry a maximum of 20 marks and may include 3 to 4 sub-questions. The maximum marks for each course is 100, and the duration is 3 hours. All questions must be formulated using Bloom's action verbs to ensure alignment with cognitive learning objectives. Additionally, the questions must be meticulously crafted to assess the student outcomes detailed in the course document, ensuring thorough coverage of all the course outcomes.

9.15 There shall be minimum three sets of question papers for the SEE, of which one set along with scheme and solution 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 papers 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.

9.19 The report provided by the PAC 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 Controller of Examination and Vice chancellor.

9.21 University may decide to use available modern technologies for writing the IAs 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.

d. 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 Mapping 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 1/ Quiz - 1	Every week till Test-1	First 50%	10	05	9th Week
4	Assignment 2 / 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 8^{th} week	First 50%	25	12.5	8^{th} week
2	Test -2	During 15^{th} Week	Remaining 50%	25	12.5	15^{th} Week
5	SEE	18^{th} to 20^{th} Week	100%	50	25	20^{th} 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 of CIA is based on the performance of students in each lab experiment for a lab course that shall further be allocated as under:

i	Conduction of regular practical / experiments throughout the semester(Continuous evaluation)	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**

10.2 Assessment of integrated lab course

The 10 marks meant for CIA is based on the performance of students in each lab experiment for integrated lab course that shall further be allocated as under.

Integrated lab is evaluated and awarded marks should meet the requirement of assignment/quiz/field work component of respective theory course having integrated lab component. No separate assignment/quiz/filed work is assessed for such courses.

i	Conduction of regular practical / experiments throughout the semester (continuous evaluation)	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**

10.3 The 50 marks meant for 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

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

10.5 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 >4 credit:

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

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

i	Phase-1 presentation	50 marks
ii	Phase-II presentation	50 marks
III	SEE	100 marks
	Total	**200 marks**

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 CIA and SEE will be in terms of scores, and the sum of CIA and SEE scores will be for a maximum of 100 marks (CIA = 50 , SEE = 50) and have to secure a minimum of 40% to declare pass in the course. However, a candidate must secure a minimum of 30% (15 marks) out of 50 marks in 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:

SGPA/CGPA	Grade Point	Letter Grade	Performance	FGP Qualitative Index
9>=CGPA<=10	10	O	Outstanding	First Class with 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
<4CGPA	0	F	Not Satisfactory	Unsuccessful

a. Computation of SGPA and CGPA

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

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

Illustration for Computation of SGPA and CGPA

Illustration No. 1

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

Thus, **SGPA = 159 ÷ 19 = 8.37**

Illustration No. 2

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

	24			182

Thus, **SGPA = 182 ÷ 24 = 7.58**

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 (168) 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	20	7.29	20 x 7.29 = 145.8
3	25	8.11	25 x 8.11 = 202.75
4	25	7.40	25 x 7.40 = 185
5	22	8.29	22 x 8.29 = 182.38
6	23	8.58	23 x 8.58 = 197.34
7	14	9.12	14 x 9.12 = 127.68
8	10	9.25	10 x 9.25 =92.50
Cumulative	**160**		**1276.88**

Thus,

$$\boldsymbol{CGPA} = \frac{\mathbf{1276.88}}{\mathbf{160}} = 7.98$$

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) G	Letter Grade	Performance	FGP Qualitative Index
9 >= CGPA 10	10	O	Outstanding	Distinction
8 >= CGPA < 9	9	A+	Excellent	
7 >= CGPA < 8	8	A	Very Good	First Class
6 >= CGPA < 7	7	B+	Good	
5.5> = CGPA < 6	6	B	Above average	Second Class
> 5 CGPA < 5.5	5.5	C+	Average	
> 4 CGPA <5	5	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. Student must maintain a minimum attendance of 75% in each course (Theory and Practical) and 75% attendance in aggregate of all courses in a semester, with a provision of condonation of 10% of the attendance by the Vice-Chancellor on the specific recommendation of the Director of the School.

14.2.3. 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 65% of the classes taught.

14.2.4. Any student with less than 75% of attendance in individual courses of respective semester including practical courses / field visits etc., shall not be permitted to appear to SEE in the respective course.

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 test 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.

17.1 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., and 70% attendance in each courses 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% marks out of 50 (15 marks) in Semester End Examination (SEE) and a minimum of 40% marks (out of 100) 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/Odd semester examination results. The candidate who is unsuccessful in each course(s) shall appear for supplementary examination of odd and even semester course(s) to seek for improvement of the performance.

a. A student failed in any course is eligible to take supplementary exam under following category for each course: either to improve internal marks (IA1, IA2, and Assignment/Quiz), or to improve SEE.

b. Supplementary exam is permitted only during summer vacation (between even and odd semester break)

c. Eligibility to register for supplementary exam is that the student should have maintained pre-requisite attendance of ≥ 75% in respective semester.

d. No separate additional classes would be conducted for the students availing this facility.

e. Every student should pay the supplementary exam fee for each course as prescribed by the university.

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

Students who have failed in courses totalling 16 credits or fewer across both odd and even semesters combined will be allowed to proceed to the next semester of the following year(s) of their academic program.

For vertical progression, students must clear all the courses of first year to be eligible to take admission to third year and they have to clear all the courses till second year to be eligible to take admission to fourth year. For lateral entry students, students must clear all the courses of second year to be eligible to take admission to fourth year.

Case 1: A student who has failed in a maximum of 16 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 16 credits from semester 1 to 4 together shall move to the 5th semester of the succeeding year only if he/she successfully completes all the courses of first and second semester.

Case 3: A students who has failed in a maximum of 16 credits from semester 3 to 6 together shall move to the 7th semester of the succeeding year only if he/she successfully completes all the courses of third and Fourth semester.

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. Regarding 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.

25. For lateral entry students, the minimum credits to be earned for the award of the degree would be the credits earned in 3 years from 2nd year to 4th year.

B.Tech in Mechanical Engineering

Curriculum Structure for B. Tech Mechanical Engineering Program-2024-28

SEMESTER-1 (Chemistry Cycle)

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	B24AS0102	Differential Equations and Linear Algebra	FC	3	0	0	3	3	50	50	100	BSC
2	B24AS0204	Applied Chemistry	FC	3	0	0	3	3	50	50	100	BSC
3	B24EE0101	Basics of Electrical and Electronics Engineering	HC	3	0	0	3	3	50	50	100	ESC
4	B24CS0104	Fundamentals of Data Science	HC	2	0	0	2	2	50	50	100	ESC
5	B24ED0101	Elements of Civil Engineering and Mechanics	HC	3	0	0	3	3	50	50	100	ESC
6	B24CS0108	Fundamentals of Data Science Lab	HC	0	0	1	1	2	25	25	50	ESC
7	B24EE0102	Basics of Electrical and Electronics Lab	HC	0	0	1	1	2	25	25	50	ESC
8	B24ME0101	Computer Aided Engineering Drawing	HC	1	0	1	2	3	50	50	100	ESC
9	B24EN0102	Finance and Management	FC	1	0	0	1	1	25	25	50	HSMC
10	B24MEET01	Advanced Computing Methods	ETC	0	0	1	1	2	25	25	50	ETC
TOTAL				**16**	**0**	**4**	**20**	**24**	**400**	**400**	**800**	
TOTAL SEMESTER CREDITS				**20**								
TOTAL CUMULATIVE CREDITS				**20**								
TOTAL CONTACT HOURS				**24**								
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, **ETC**: Emerging Technology Course, **AEC**: Ability Enhancement Course.

SEMESTER-2 (Physics Cycle)

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	B24AS0205	Vector Calculus and Partial Differential Equations	FC	3	0	0	3	3	50	50	100	BSC
2	B24AS0107	Applied Physics	FC	3	0	0	3	3	50	50	100	BSC
3	B24ME0103	Elements of Mechanical Engineering	HC	3	0	0	3	3	50	50	100	ESC
4	B24CI0104	Programming with C	HC	3	0	0	3	3	50	50	100	ESC
5	B24EN0101	Internet of Things	HC	1	0	1	2	3	50	50	100	ESC
6	B24AS0109	Applied Physics Lab	FC	0	0	1	1	2	25	25	50	ESC
7	B24CI0108	Programming with C Lab	HC	0	0	1	1	2	25	25	50	ESC
8	B24ME0102	Innovation and Entrepreneurship	FC	1	0	1	2	3	50	50	100	HSMC
9	B24ME0104	Basic Mechanical Engineering Lab	HC	0	0	1	1	2	25	25	50	ESC
10	B24AH0103	Communicative English	FC	0	0	1	1	2	25	25	50	HSMC
11	B24ERET02	3D Printing Technologies	ETC	1	0	0	1	1	25	25	50	ETC
TOTAL				**15**	**0**	**6**	**21**	**27**	**400**	**400**	**800**	
TOTAL SEMESTER CREDITS				**21**								
TOTAL CUMULATIVE CREDITS				**41**								
TOTAL CONTACT HOURS				**27**								
TOTAL MARKS				**800**								

SEMESTER-3 (Cycle-1)

Sl. No	Course Code	Title of the Course	HC / FC / MC / ETC/ Project	Credit Pattern				Contact Hours / Week	Examination			Course category (As per AICTE)
				L	T	P	Total Credit		CIE Marks	SEE Marks	Total Marks	
1	B24AS0302	Laplace Transforms and Fourier Series	FC	3	0	0	3	3	50	50	100	BSC
2	B24CI0309	Introduction to Design Thinking	FC	1	0	1	2	3	50	50	50	HSMC
3	B24MEM301	Indian Constitution and Cyber Law	MC	0	0	0	0	2	0	50	50	HSMC
4	B24ER0301	Thermodynamics	HC	2	1	0	3	4	50	50	100	PCC
5	B24ER0302	Material Science and Characterization Techniques	HC	3	0	0	3	3	50	50	100	PCC
6	B24ER0303	Manufacturing Technology	HC	3	0	0	3	3	50	50	100	PCC
7	B24ER0304	Strength of Materials	HC	3	0	0	3	3	50	50	100	PCC
8	B24ER0305	Computer Aided Machine Drawing	HC	0	0	2	2	4	50	50	100	PCC
9	B24ER0306	Manufacturing Technology Lab	HC	0	0	1	1	2	25	25	50	PCC
10	B24ER0307	Material Testing Lab	HC	0	0	1	1	2	25	25	50	PCC
11	B24ER0308	Course Based Project-1	HC	0	0	1	1	2	25	25	50	PROJ
12	B24ER0309	Soft Skill -1	AEC	0	0	1	1	2	25	25	50	PCC
TOTAL				**15**	**1**	**7**	**23**	**33**	**425**	**475**	**900**	
TOTAL SEMESTER CREDITS				**23**								
TOTAL CUMULATIVE CREDITS				**64**								
TOTAL CONTACT HOURS				**33**								
TOTAL MARKS				**900**								

SEMESTER-4 (Cycle-2)

Sl. No	Course Code	Title of the Course	HC / FC / SC/MC /AEC	Credit Pattern				Contact Hours / Week	Examination			Course category (As per AICTE)
				L	T	P	Total Credit		CIE Marks	SEE Marks	Total Marks	
1	B24AS0403	Probability and Sampling Theory	FC	3	0	0	3	3	50	50	100	BSC
2	B24CS0301	Professional Ethics	FC	1	0	0	1	1	25	25	50	HSMC
3	B24EE0301	Universal Human Values	FC	1	0	0	1	1	25	25	50	HSMC
4	B24AS0304	Environmental Science	MC	0	0	0	0	2	0	50	50	BSC
5	B24ER0401	Kinematics and Dynamics of Machines	HC	2	1	0	3	4	50	50	100	PCC
6	B24ER0402	Thermal Engineering Systems	HC	3	0	0	3	3	50	50	100	PCC
7	B24ER0403	Measurements and Instrumentation	HC	2	0	1	3	4	50	50	100	PCC
8	B24ER0404	Industrial Engineering and Industry 4.0	HC	3	0	0	3	3	50	50	100	PCC
9	B24ERS411	Geometric Dimensioning and Tolerance	SC	2	1	0	3	4	50	50	100	PEC
	B24ERS412	Operations and Supply chain Management		3	0	0	3	3	50	50	100	PEC
	B24ERS413	Automotive Engineering		3	0	0	3	3	50	50	100	PEC
	B24ERS414	Fundamentals of Aerospace Engineering		3	0	0	3	3	50	50	100	PEC
10	B24ER0405	Kinematics and Dynamics Lab	HC	0	0	1	1	2	25	25	50	PCC
11	B24ER0406	Heat Engine Lab	HC	0	0	1	1	2	25	25	50	PCC
12	B24ER0407	Course Based Project-2	HC	0	0	1	1	2	25	25	50	PROJ
13	B24ER0408	Soft Skill -2	AEC	0	0	1	1	2	25	25	50	PCC
TOTAL				**18**	**1**	**5**	**24**	**33**	**450**	**500**	**950**	
TOTAL SEMESTER CREDITS				**24**								
TOTAL CUMULATIVE CREDITS				**88**								
TOTAL CONTACT HOURS				**33**								
TOTAL MARKS				**900**								

SEMESTER-5

Sl. No	Course Code	Title of the Course	HC / FC / SC / OE / MC / /AEC	Credit Pattern				Contact Hours / Week	Examination			Course category (As per AICTE)
				L	T	P	Total Credit		CIE Marks	SEE Marks	Total Marks	
1	B24MEO501	Smart Materials and Intelligent Mechanical Systems	OE	3	0	0	3	3	50	50	100	OE
2	B24ED0501	Indian Knowledge Systems	MC	0	0	0	0	2	0	50	50	HSMC
3	B24ER0501	Machine Design-1	HC	2	1	0	3	4	50	50	100	PCC
4	B24ER0502	Fluid Mechanics and Machines	HC	3	0	0	3	3	50	50	100	PCC
5	B24ER0503	Automation Technologies for Manufacturing	HC	3	0	0	3	3	50	50	100	PCC
6	B24ER0504	Engineering Economics and Financial Markets	HC	3	0	0	3	3	50	50	100	PCC
7	B24ER0505	Energy Technology	HC	3	0	0	3	3	50	50	100	PCC
8	B24ERS511	Design for Manufacturing and Assembly	SC`	3	0	0	3	3	50	50	100	PEC
	B24ERS512	Digital Quality Control										
	B24ERS513	Green Fuels										
	B24ERS514	Basics of Aerodynamics										
9	B24ER0506	Fluid Mechanics and Machines Lab	HC	0	0	1	1	2	25	25	50	PCC
10	B24ER0507	Automation and HP Lab	HC	0	0	1	1	2	25	25	50	PCC
11	B24ER0508	Soft Skill -3	AEC	0	0	1	1	2	25	25	50	PCC
TOTAL				**20**	**1**	**3**	**24**	**30**	**425**	**475**	**900**	
TOTAL SEMESTER CREDITS				**24**								
TOTAL CUMULATIVE CREDITS				**112**								
TOTAL CONTACT HOURS				**30**								
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	B24MEO601	Energy Technology	OE	3	0	0	3	3	50	50	100	OE
2	B24ER0601	Heat Transfer	HC	2	1	0	3	4	50	50	100	PCC
3	B24ER0602	Finite Element Methods	HC	1	1	0	2	3	50	50	100	PCC
4	B24ER0603	Machine Design-2	HC	2	1	0	3	4	50	50	100	PCC
5	B24ER0604	Mechatronics and Control Systems	HC	3	0	0	3	3	50	50	100	PCC
6	B24ERS611	Advanced Engineering Materials	SC	3	0	0	3	3	50	50	100	PEC
	B24ERS612	Additive and Digital Manufacturing										
	B24ERS613	Basics of HVAC and Cryogenics										
	B24ERS614	Aircraft Structures										
7	B24ERS621	Electric and Hybrid Vehicles	SC	3	0	0	3	3	50	50	100	PEC
	B24ERS622	Operation Research with AI										
	B24ERS623	Refrigeration and Air Conditioning										
	B24ERS624	Propulsion Systems										
8	B24ER0605	Heat Transfer Lab	HC	0	0	1	1	2	25	25	50	PCC
9	B24ER0606	Computer Aided Engineering Analysis Lab	HC	0	0	1	1	2	25	25	50	PCC
10	B24ER0607	Research Based Mini Project	HC	0	0	1	1	2	25	25	50	PROJ
TOTAL				**17**	**3**	**3**	**23**	**29**	**425**	**425**	**850**	

TOTAL SEMESTER CREDITS	**23**
TOTAL CUMULATIVE CREDITS	**135**
TOTAL CONTACT HOURS	**29**
TOTAL MARKS	**850**

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	B24ER0701	CAD/CAM/CIM	HC	2	1	0	3	4	50	50	100	PCC
2	B24ER0702	Introduction to Vibration and Noise Engineering	HC	2	0	1	3	4	50	50	100	PCC
3	B24ERS711	Robotics and Applications	SC	3	0	0	3	3	50	50	100	PEC
	B24ERS712	IOT and ML for Industry 4.O										
	B24ERS713	Automotive Air Conditioning										
	B24ERS714	Aircraft Maintenance										
	B24ERS715	Industry Training		0	0	3		6				
4	B24ERS721	Sustainable Engineering	SC	3	0	0	3	3	50	50	100	PEC
	B24ERS722	Advanced Manufacturing Process										
	B24ERS723	Computational Fluid Dynamics										
	B24ERS724	Aircraft Transportation Systems										
	B24ERS725	Internship		0	0	3		6				
5	B24ER0703	CIM and Machine Learning Lab	HC	0	0	1	1	2	25	25	50	PCC
6	B24ER0704	Capstone Project Phase-1	HC	0	0	2	2	4	50	50	100	PROJ
TOTAL				**10**	**1**	**4**	**15**	**20**	**275**	**275**	**550**	
TOTAL SEMESTER CREDITS				**14**								
TOTAL CUMULATIVE CREDITS				**150**								
TOTAL CONTACT HOURS				**20**								
TOTAL MARKS				**550**								

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	B24ER0801	**Capstone 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				**160**								
TOTAL CONTACT HOURS				**20**								
TOTAL MARKS				**100**								

1st Semester

Course Title	Differential Equations and Linear Algebra				Course Type		FC	
Course Code	B24AS0102	Credit	3		Class		I Semester	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

This course is applied mathematics, which is useful for engineering students and it covers various methods of solving differential equations of first and higher order, linear algebra and linear transformation, solving linear system of equations and determining Eigen values and Eigen vectors along with applications to engineering problems.

COURSE OBJECTIVES:

The objectives of this course are:

1. To solve the first order ordinary differential equations and its applications in the field of engineering.
2. To solve the linear differential equations with constant coefficients
3. To solve the linear differential equations with variable coefficients and its applications in the field of engineering.
4. Different methods to solve consistent system of algebraic equations.
5. To solve the Eigen values and Eigen vectors of a square matrix.
6. To diagonalize of a square matrix and canonical forms.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Apply various methods of solving first order ordinary differential equations to solve engineering problems related to Heat transfer and execute the same using MATLAB.	1,2,5	1
CO2	Apply method of variation of parameters to solve Linear Differential Equations having constant coefficients and problems on elastic bending of beams and execute the same using MATLAB.	1,2,5	1
CO3	Classify Linear Differential Equations with variable coefficients and employ to analyse problems on stress distribution and execute the same using MATLAB.	1,2,5	1
CO4	Compute the solution of system of equations by various methods to solve engineering problems using finite element analysis and execute the same using MATLAB.	1,2,5	1
CO5	Compute the Eigen values and Eigen vectors of square matrix and to diagonalize the square matrices to determine natural frequencies of two DOF systems and execute the same using MATLAB.	1,2,5	1
CO6	Solve linear transformation and to find canonical form of matrix and execute the same using MATLAB.	1,2,5	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES:

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

COURSE ARTICULATION MATRIX:

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

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

COURSE CONTENTS:

Differential equations of first order and first degree- Bernoulli's equation, Exact Differential Equations, Equation reducible to exact [IF for the case of $\frac{1}{M}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$ ***and*** $\frac{1}{N}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$ ***only***].Orthogonal trajectories (both Cartesian and polar form**).** Analytical solutions are compared with the computational techniques-MATLAB. *Engineering applications-Heat transfer.

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. Analytical solutions are compared with the computational techniques-MATLAB. *Engineering applications-Elastic bending of beams and stress distribution in aircraft components.

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. Analytical solutions are compared with the computational techniques-MATLAB. *Engineering applications-Finite element analysis.

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. Analytical solutions are compared with the computational techniques-MATLAB.*Engineering applications-Natural frequencies of two DOF systems.

Self-learning Component:

1. https://youtu.be/9h_Q-R6sXbM?si=PxQdP3yT08yLwZGq
2. https://youtu.be/NBcGLLU90fM?si=Cwsr7hchT2SYflOa

TEXTBOOKS:

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

REFERENCE BOOKS:

1. P.V. O’Neil, “Advanced Engineering Mathematics”, Cengage Learning, 7th Edition, 2012.
2. Potter and Goldberg, “Mathematical Methods”, Printice Hall of India Pvt. Ltd, 2nd Edition, 2000.

Course Title	**Applied Chemistry**				**Course Type**		**FC**	
Course Code	**B24AS0204**	**Credit**	**3**		**Class**		**I Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

Applied chemistry covers very relevant topics compatible with engineering students and makes them aware of importance of various aspects of basic science in engineering. The subject of applied chemistry covers area of water technology, corrosion science and electroplating, clean-green energy storage and conversion device technologies, and materials for engineering applications. Further, the course focuses on the chemistry of functional materials for various engineering applications. The 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 sustainable energy, conversion and storage devices and advanced materials in engineering applications. The subject deals with various engineering materials, their properties and applications in the field of mechanical and civil engineering.

COURSE OBJECTIVES:

The objectives of the course are to:

1. Provide knowledge on the significance of water treatment and its purification.
2. Illustrate engineering aspects of corrosion and its controlling methods.
3. Understand the structural concepts of energy devices and their current scenario.
4. Identify and select advanced materials and sensors for engineering applications.

COURSE OUTCOMES (COs):

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

COs	**Course Outcomes**	**POs**	**PSOs**
CO1	Apply the knowledge of various methods employed in water treatment for irrigation and industrial applications.	1, 7	1
CO2	Identify the type of corrosion and solve the problem of corrosion by using	1,5	1
CO3	Demonstrate the principles and uses of clean-green energy storage and conversion device technologies.	1, 7	1
CO4	Apply knowledge of electroplating and electroless plating in memory device, aerospace, and coating applications.	1, 2	1
CO5	Analyze the importance of polymeric materials and liquid crystals in display technology, as well as materials used in different sensors applications.	1, 2	1
CO6	Comprehend the practical uses of nanomaterials, biomaterials and composite materials employed in diverse fields.	1, 2	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES:

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

COURSE ARTICULATION MATRIX:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3						2						1		
CO2	1				1								1		
CO3	1						3						1		
CO4	1	1											1		
CO5	2	1											1		
CO6	2	1											1		
Avg.	**1.6**	**1**			**1**		**2.5**						**1**		

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

COURSE COTENTS:

Water Technology: Hardness & its determination (EDTA method), boiler troubles & their removal, water softening methods - lime soda, zeolite & ion exchange, desalination of water - electro dialysis & reverse osmosis method, types and engineering aspects of polymeric membranes in water purification (ultra-filtration, micro-filtration and nano-filtration), solar water treatment.

Corrosion Science and Electroplating: Definition, wet corrosion (electrochemical attack) and its mechanism, factors affecting corrosion(pH, areas of anode and cathode, polarization, nature of corrosion product), pH-potential concept in corrosion studies (Pourbiax diagrams); Al, and Fe, corrosion control methods-protective coatings; metallic coatings (anodic and cathodic coatings), cathodic protection, electroplating and electroless plating and their theory, difference between electroplating and electroless plating, application of copper electroless plating in PCB fabrication.

Clean-Green Energy Storage and Conversion Device Technologies Batteries: Classification of battery, construction and working of primary (Zn-MnO2) and secondary batteries (Li-ion batteries, Mg2+-ion, Al3+-ion batteries) and applications

Supercapacitors - Charge accumulation mechanisms in EDLC, pseudo- and hybrid capacitors, and applications.

Fuel cells: Thermodynamics of fuel cells, classification (SOFC, alkaline fuel cell) and engineering applications

Photo Voltaic Cells: Production of polycrystalline and single crystalline silicon, defects in semiconductors (schotky, frenkel, and line defects), doping mechanism, construction and role of semiconductors in designing in PV cells and their applications. Materials for Engineering Applications
Liquid crystals: Classification (thermo and lyotropic), working principle and applications Sensors - Types (fluid sensors, temperature sensors), mechanism and their applications. Biocompatible materials - Examples and their applications **Nanomaterials:** Classification, properties (hardness, surface area, magnetic and thermal), engineering applications of fullerenes, nanotubes and graphene.
P**olymers**: Polymerization techniques, polymer composite materials, types of reinforcements and matrices, properties and applications of KEVLAR, carbon fibre, glass fibre, and boron fibre.

Case study:

1. Importance and analysis of water quality in drinking and agricultural applications.
2. Corrosion studies of iron, different grades of stainless steel by chemical and electrochemical methods.
3. Choice and analysis of battery materials for e-vehicles.
4. Choice and employ photovoltaic cell for waste water treatment.
5. Comparison of properties of different polymer composite with metal oxides.
6. Study on nanocomposites for civil and aerospace applications.

TEXT BOOKS:

1. R.V.Gadag and Nithyananda shetty N, "Engineering Chemistry" Ik International Publishing house, 3rd Edition, 2014.
2. B. Siva Shankar, "Engineering Chemistry", Tata Mc Graw Hill Publishing Limited, 3rd Edition, 2015.
3. S. S. Dara, Mukkanti, "Text of Engineering Chemistry", S. Chand & Co, New Delhi, 12th Edition, 2006.
4. C. V. Agarwal, C. P. Murthy, A. Naidu, "Chemistry of Engineering Materials", Wiley India, 5th Edition, 2013.

REFERENCE BOOKS:

1. R. P. Mani, K. N. Mishra, "Chemistry of Engineering Materials", Cengage Learning, 3rd Edition, 2015.
2. P. C. Jain, Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company, 17th Edition, 2015.
3. Devender Singh, Balraj Deshwal, Satish Kumar Vats, "Comprehensive Engineering Chemistry", Dreamtech Press, 2020.

Self-Learning Component: Nature of membranes for water treatment, corrosion inhibitors, reserve batteries and classification of polymers.

Course Title	**Basics of Electrical and Electronics Engineering**				**Course Type**		**Hard Core**	
Course Code	**B24EE0101**	**Credit**	**3**		**Class**		**I Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

This course introduces the basic concepts of electrical as well as electronics engineering. This course provides the knowledge of electrical power generation through hydro, thermal, wind and solar energy sources. Provides the basic knowledge of smart grid and electric vehicle systems. It also helps the students to understand applications of semiconductor devices such as Diodes and BJT along with their characteristics and applications. This course provides better understanding of digital electronics.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Explain and to make the students familiar about the basics of electrical circuits.
2. Illustrate the basics of magnetic circuits, DC machines, transformers and domestic protection system
3. Illustrate the characteristics of semiconductor devices and their applications

COURSE OUTCOMES (COs):

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

COs	Course Outcomes	POs	PSOs
CO1	Explain and apply Ohm's Law, Kirchhoff's Current Law (KCL), and Kirchhoff's Voltage Law (KVL) in DC circuit analysis.	1,2	1
CO2	Analyze RL, RC, and RLC circuits in series and parallel configurations and interpret phasor diagrams for single phase and 3-phase ac systems.	1,2	1
CO3	Understand the working of Hydroelectric power plant, thermal power plant, wind and solar power plants and grid integration of solar power plants.	1,2,7	1,3
CO4	Familiarize with components of smart grid and electric vehicle.	1,2,7	1,3
CO5	Describe the operation and characteristics of semiconductor diodes, Zener diodes, bipolar junction transistors (BJTs) and their applications.	1,2	1
CO6	Apply Principles and theorems of Digital Electronics to simplify the logic expressions, converting between number systems and designing logic circuits using basic gates.	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		
CO2	3	3											1		
CO3	3	2					2						1		1
CO4	2	2					2						1		1
CO5	3	3											1		
CO6	3	2											1		
Avg.	2.8	2.5					2						1		1

COURSE CONTENT

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. 3-phase circuits- Star and Delta connections.

Electrical Power Generation: An Overview of generation, transmission and distribution system. Hydro Electric Power plant- Layout, working, factors for selection of site, classification, merits and de merits. Thermal Power Plant- Layout, working, merits and demerits, Wind power plant- General layout, working, factors for site selection, merits and demerits, Solar Power Plant- General arrangement and operation, Basic concepts of on-grid PV systems, merits and de merits.

Smart Grid: Introduction, components of smart grid, comparison between conventional and smart grid.

Electrical Vehicle: Schematic of Electric Vehicle, Classification.

Semiconductor Diodes and Transistors: Semiconductor Diodes: 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. Transistors: Bipolar junction Transistors BJT configuration: BJT Operation, Common Base, Common Emitter and Common Collector, Characteristics, Numerical examples as applicable.

Digital Electronics and Number System: Introduction, Switching and Logic Levels. Number Systems and its conversions: Decimal Number System, Binary Number System, Hexadecimal Number System, Binary addition, Binary subtraction. Boolean Algebra Theorems, DeMorgan's theorem. Digital Circuits: Logic gates, Algebraic Simplification, Realization of all logic and Boolean expressions. Realization of basic gates using universal gates.

Self Learning Component: Hybrid Electric Vehicle.

TEXT BOOKS:

1. Nagrath I.J. and D. P. Kothari, "Basic Electrical and Electronics Engineering", Tata McGraw Hill, 2nd Edition 2020.
2. Hayt and Kimberly, "Engineering Circuit Analysis", Tata McGraw Hill, 8th Edition, 2013.
3. Manish Goel and Gaurav Guptha," Electrical power generation" Laxmi publications Pvt Limited, 1st Edition, 2011.
3. Kulshreshtha D.C., "Basic Electrical Engineering", Tata McGraw Hill, 2nd Edition, 2019.
4. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5th Edition, 2008.
5. James D. Halderman and Curt Ward, "Electric and Hybrid Electric Vehicles" Pearson Education, 1st Edition, 2022.
6. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu and Akihiko Yokoyama, "Smart Grid: Technology and Applications" Wiley, 1st Edition, 2012

REFERENCE BOOKS:

1. Hughes, "Electrical Technology", Pearson, International Students 9th Edition, 2005.
2. Robert L. Boylestad and Louis Nashelsky, "Introduction to Electricity, Electronics and Electromagnetics" Prentice Hall, 5th Edition, 2001.
3. Leonard Grigby, "Electrical Power Generation Transmission and Distribution", CRC Press, 3rd Edition, 2018.
4. S.S. Bhatti Rahul Malhotra, "Textbook of Digital Electronics", I K International Publishing House, 0th Edition, 2011
5. Florian Skopik, Erich Wenger, "Smart Grid Security: Innovative Solutions for a Modernized Grid" Syngress, 1st Edition, 2015.

Additional Material:

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

Course Title	Fundamentals of Data Science			Course Type	Hard Core
Course Code	B24CS0104	Credit	2	Class	I semester

Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	2	2	2				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	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 OBJECTIVE (S):

The objectives of this course are to:

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

COURSE OUTCOMES (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
CO4	Demonstrate visualization of Data using python libraries	1 to 5, 8 to 10	1,2, 3
CO5	Find modeling Error in Linear Regression.	1 to 5	1, 2, 3
CO6	Use statistical principles to solve mean and standard deviations for given data.	1 to 4, 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	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

CO4	3	3	3	2	2			2	2	2			3	3	3
CO5	2	3	2	2	2								3	3	3
CO6	3	3	2	2								2	3	3	3
Avg.	**2.5**	**2.8**	**2.3**	**1.8**	**2**	**2**		**2**	**2**	**2**		**2**	**3**	**2.5**	**2.5**

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

COURSE CONTENT:

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.

Introduction to Data Science: What is Data Science? Applications of Data Science, Data science life cycle, Tools for data science, definition of AI, types of machine learning (ML), list of ML algorithms for classification, clustering, and feature selection.

Probability theory, bayes theorem, bayes probability; Cartesian plane, equations of lines, graphs; exponents.

Introduction to SQL: SQL Commands experimental demonstrations-DDL, DML, DCL, TCL, DQL, Import SQL Database Data into Excel.

Data Relationship Methods: Introduction to Correlation, 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.

Introduction to Statistics and Python: Statistical Analysis: Descriptive statistics- Mean, Standard Deviation for Continuous Data, Frequency, Percentage for Categorical Data.

Python basics, Strings, Lists, Tuples, Sets, Dictionaries, Introduction to python libraries, Numpy, Matplotlib, Pandas, Scikit-Learn, Implementation of ML.

Self Learning Component:

1. Relational database management system.
2. Advanced MS-Excel and JMP (SAS) tool

TEXT BOOKS:

1. B.S. Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 43rd Edition, 2015.
2. Ramakrishnan and Gehrke, “Database Management systems”, McGraw Hill Publications, 3rdEdition, 2003.
3. Kenneth N. Berk, Carey, “Data Analysis with Microsoft Excel”, S. Chand & Company, 2004.
4. Joel Grus,”Data science from scratch - First principles with Python”, Shroff/O'Reilly, 2015.

REFERENCE BOOKS:

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

JOURNALS/MAGAZINES:

1. https://www.journals.elsevier.com/computational-statistics-and-data-analysis
2. https://www.springer.com/journal/41060International Journal on Data Science and Analytics

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

SWAYAMNPTEL/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 Universityhttps: //www.edx.org/course/subject/data-science
4. https://onlinecourses.nptel.ac.in/noc19_cs60/preview
5. "Mastering Data Analysis in Excel" - https://www.coursera.org/learn/analytics-excel.

Course Title	**Elements of Civil Engineering and Mechanics**				**Course Type**		**Hard Core**	
Course Code	**B24ED0101**	**Credit**	**3**		**Class**		**I semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW

This course serves as an introductory exploration into the diverse realms of Civil Engineering, covering fundamental fields. Students will delve into the significance of infrastructure, understanding its types and the pivotal role, emphasis is placed on classifying roads based on their functions and comparing the characteristics of flexible and rigid pavements. Introduction to engineering mechanics entails grasping basic idealizations like particle, continuum, and rigid body mechanics, along with the principles governing force systems, moments, and equilibrium. Analysis of force systems, both concurrent and non-concurrent, is thoroughly explored, incorporating concepts like centroids, moments of inertia, and support reactions. The course concludes with a detailed examination of friction, encompassing its types, laws, and numerical applications related to impending motion on various surfaces. Through this comprehensive overview, students are equipped with foundational knowledge essential for further specialization and practical application in the field of Civil Engineering.

COURSE OBJECTIVE (S):

This course enables graduating students able to

1. Understand the fundamental principles and scope of various fields within Civil Engineering.
2. Analyze the significance of infrastructure in societal development and the role of civil engineers in its design and implementation.
3. Apply principles of engineering mechanics to analyze forces, moments, and equilibrium in various structural systems.
4. Utilize geometric concepts such as centroids and moments of inertia to analyze the stability and structural integrity of engineering components.
5. Understand the principles of structural analysis by exploring different types of loads, supports, s and moments on beams.
6. Evaluate the effects of friction on the motion of objects and surfaces, and friction laws to solve practical engineering problems.

COURSE OUT COMES (COs)

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

CO	**Course Outcomes**	**POs**	**PSOs**

CO1	Describe the roles and applications Civil Engineering, covering fundamental fields	1,2	2
CO2	Understanding of different types of infrastructure, identify the role of civil engineers in infrastructural development, and assess the socio-economic impacts of infrastructural facilities on a country.	1,2,5	2,4
CO3	Demonstrate proficiency in identifying and classifying force systems, concurrent and non-concurrent force systems	1,2,3,4,5	2,4
CO4	Determine centroids of plane figures, calculate moments of inertia for basic shapes and composite sections.	1,2,3,4,5	2,4
CO5	Analyse given scenarios to determine the appropriate methods for calculating support reactions and moments on beams.	1,2,3,4,5	2,4
CO6	Apply friction laws to calculate friction, and solving problems related to impending motion on horizontal and inclined planes.	1,2,3,4,5	2,4

BLOOM'S LEVEL OF THE COURSE OUTCOME

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

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3											1		
CO2	3	3			1								3		1
CO3	3	3	1	1	3								3		3
CO4	3	3	2	1	3								3		3
CO5	3	3	2	1	3								3		2
C06	3	3	1	1	3								3		3
Avg.	**3**	**3**	**1.5**	**1**	**2.6**								**2.7**		**2.4**

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

COURSE CONTENT:

Introduction to Civil Engineering Scope of different fields of Civil Engineering - Surveying, Building Materials, Construction Technology, Geotechnical Engineering, Structural Engineering, Hydraulics, Water Resources and Irrigation Engineering, Transportation Engineering, Environmental Engineering.
Infrastructure: Types of infrastructure, Role of Civil Engineer in the Infrastructural Development, Effect of the infrastructural facilities unsocial-economic development of a country.
Roads: Classification of Roads and their functions, Comparison of Flexible and Rigid Pavements (Advantages and Limitations). **Dams:** Different types of Dams.
Introduction to Engineering Mechanics: Basic idealizations - Particle, Continuum and Rigid body; Force and its characteristics, Classification of force systems, Principle of physical independence,

superposition, transmissibility of forces, Moment of a force, Couple, Moment of a couple, Characteristics of couple, Equivalent force - Couple system.

Analysis of Concurrent Force Systems- Concepts: Resultants and Equilibrium Composition of forces - Definition of Resultant; Composition of coplanar -concurrent force system, Parallelogram Law of forces, Principle of resolved parts; Numerical problems.

Analysis of Non-Concurrent Force Systems- Composition of coplanar - non-concurrent force system, Varignon's principle of moments; Numerical problems. Definition of Equilibrant; Conditions of static equilibrium for different force systems, Lami's theorem; Numerical problems.

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.

Analysis of structures: Types of Loads and Supports, Numerical problems on support reactions with Point load and uniformly distributed and uniformly varying loads and Moments problems on beams.

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. B K 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 and N. Khurmi "Engineering Mechanics" S Chand Publishing, 22nd Edition, 2018.

REFERENCE BOOKS:

1. 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.
3. Dr. P.N. Modi and S.M. Seth, "Hydraulics and Fluid Mechanics Including Hydraulics Machines", Standard Book House Since 1960, 23rd Edition, 2022.

<table>
<tr><td>Course Title</td><td colspan="3">Fundamentals of Data Science Lab</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B24CS0108</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>LTP</td><td>Credits</td><td>Contact Hours</td><td>Workload</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Lecture</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</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 DESCRIPTION:

Data Science is an interdisciplinary, problem-solving oriented subject that is used to apply scientific techniques to practical problems. The course orients on preparation of datasets and programming of

data analysis tasks. This course covers the topics: ML algorithms, SQL and demonstration of experiments by using MS-Excel and MySQL and Python.

COURSE OBJECTIVE (S):

The objectives of this course are 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 to 5, 8 to 10	1,2,3
CO2	Apply the SQL Queries in developing the real-world applications.	1 to 5, 8 to 10	2, 3
CO3	Build the solutions for real world problems, perform analysis, interpretation and reporting of data using regression algorithms.	1 to 5, 8 to 10	1, 2, 3
C04	Design ER diagrams for database.	1 to 5, 8 to 10	1, 2, 3
CO5	Use Excel to solve Multiple Linear Regression.	1 to 5, 8 to 10	1, 2, 3
CO6	Demonstrate visualization of Data using python libraries	1 to 5, 8 to 10	1,2, 3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO	Bloom's Level					
	Remember (L1)	**Understand (L2)**	**Apply(L3)**	**Analyze(L4)**	**Evaluate(L5)**	**Create(L6)**
CO1			✓			
CO2			✓			
CO3				✓		
C04						✓
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	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
Avg.	**2.8**	**2.8**	**2.5**	**2.0**	**2.0**			**1.0**	**3.0**	**3.0**			**3.0**	**3.0**	**3.0**

Practice:

No	Title of the Experiment	Tools and Technics	Expected Skill/Ability

<table>
<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 And JMP Tool</td><td>Create and perform operations on Excel data set by applying Linear regression</td></tr>
<tr><td>2</td><td>Using the data file DISPOSABLE INCOME AND VEHICLE SALES, perform the following:
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 And JMP Tool</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 And JMP Tool</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>ar</th><th>nth</th><th>erest rate</th><th>Un employment rate</th><th>ck index price</th></tr><tr><td>22</td><td></td><td>5</td><td></td><td>64</td></tr></table></td><td>MS Excel And JMP Tool</td><td>Perform prediction and visualization of data</td></tr>
</table>

<table>
<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><th>Sl.no</th><th>A</th><th>B</th></tr>
<tr><td>1</td><td>Principal</td><td>Rs.10,00,000</td></tr>
<tr><td>2</td><td>Annual interest rate</td><td>5.2%</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 And JMP Tool</td><td>Create Excel data and perform EMI estimator</td></tr>
<tr><td>6</td><td>Create a supplier database of 10 records with SUPPLIER_ID as primary key, SUPPLIER_NAME, PRODUCTS, QUANTITY, ADDRESS, CITY, PHONE_NO and PINCODE, Where SUPPLIER_NAME, PRODUCTS, QUANTITY and PHONE_NO should not be NULL.</td><td>SQL</td><td>Creating Tables</td></tr>
<tr><td>7</td><td>Create the customer database of a big Market with CUSTOMER_ ID as primary key, CUSTOMER_NAME, PHONE_NO, EMAIL_ID, ADDRESS, CITY and PIN_ CODE. Store at least twenty customer’s details where CUSTOMER_NAME and PHONE_NO are mandatory and display the customer data in alphabetical order.</td><td>SQL</td><td>Creating and retrieving Tables</td></tr>
<tr><td>8</td><td>Apply the linear regression, compare the average salaries of batsman depending on the run rate scored/ recorded in the matches. Assume your own database.</td><td>MS Excel And JMP Tool</td><td>Apply Linear regression</td></tr>
<tr><td>9</td><td>Apply Multiple linear regression to predict the factory products which is A, B and C are independent variables and cost dependent variable.</td><td>MS Excel And JMP Tool</td><td>Apply Linear regression</td></tr>
<tr><td>10</td><td>Logistic Regression-case study using Kaggle Database</td><td>MS Excel And JMP Tool</td><td>Apply Logistic regression</td></tr>
<tr><td>11</td><td>Design the ER diagram and create schema of the REVA library Management system.</td><td>Entity Relationship</td><td>Entity Relationship</td></tr>
<tr><td>12</td><td>Perform Exploratory Data Analysis to predict customer churn in telecommunications company using Python libraries such as Pandas, and Matplotlib to aid in this process.
(Use datasets from Kaggle/NCBI.)</td><td>Jupyter/Colab - Python</td><td>Apply Exploratory Data Analysis</td></tr>
<tr><td>13</td><td>“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.</td><td>Jupyter/Colab - Python</td><td>Create and perform operations on list.</td></tr>
<tr><td>14</td><td>“TUPLE1” and “TUPLE2” are two tuples that contain “N” values of different data types read using the user defined function “READ” with the help of input() function. Elements of “TUPLE1” and “TUPLE2” are to be read one at a time and the “larger” value among them should be placed into “TUPLE3”. Display all tuples.</td><td>Jupyter/Colab - Python</td><td>Create and perform operations on Tuples.</td></tr>
</table>

PART_B: Projects

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

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 and 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		Hard Core	
Course Code	B24EE0102	Credit	1		Class		I Semester	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	1	2	2				
	Total	1	2	2	0	28	50%	50%

COURSE OVERVIEW:

Basic Electrical and 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:

The objectives of this course are to:

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

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Use appropriate electrical tools for electrical connections and repair of equipment's	1,2,4,5	1
CO2	Recognize various symbols in a schematic and make connection as per circuit diagram	1,2,9,10	1
CO3	List out 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	Analyse the results obtained from experiments.	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 ARTICULATION MATRIX:

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

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

COURSE CONTENT

S. No.	Name of the Experiment
1	To verify KCL and KVL for the given circuit both practically and theoretically.
2	Simulation of RL and RC circuit using PSIM and power factor Calculation.
3	Staircase wiring circuit layout for multi storage building
4	To study and verify series and parallel circuits.
5	Study and analysis of Voltage regulator using Zener Diode
6	Demonstration of Clamper circuit with reference voltage
7	Design half wave, Full wave-centre tap and Bridge rectifier with and without capacitive filter and measure efficiency and ripple factor.
8	Demonstration of Clippers with reference voltages
9	Study and analysis of input output Characteristics of CE configuration of BJT.

10	Realization of basic gates using universal gates

Demo Experiments:

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 Education, 6th Edition, 2013.
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

Course Title	**Computer Aided Engineering Drawing**				**Course Type**		**Hard Core**	
Course Code	**B24ME0101**	**Credit**	**2**		**Class**		**I Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	1	1	1				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	1	2	2				
	Total	**2**	**3**	**3**	**14**	**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:

The objectives of this course are to:

1. Introduce the concepts like dimensioning, conventions and standards of engineering drawings in order to become professionally efficient.
2. Enable students to learn about the software tool for preparing engineering drawings
3. Teach the concepts and principles of orthographic projections, development of lateral surfaces and isometric projection of simple solids.
4. Communicate the concepts/ideas through the language of technical drawing and sketching.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Apply orthographic projection principles to represent points accurately in multiple views with or without aid of CAD software, ensuring consistency and clarity in engineering drawings.	1,2,5,10	1
CO2	Apply orthographic projection principles to draw the projection of line accurately with or without aid of CAD software, ensuring consistency and clarity in engineering drawings.		
CO3	Develop a thorough understanding of the principles of projection, including how plane surfaces are projected onto projection planes in orthographic projection with or without aid of CAD software	1,2,5, 10	1
CO4	Learn how to visualize the shape, size, and features of solids in three dimensions and accurately represent them in orthographic projection drawings with or without aid of CAD software	1,2,5, 10	1
CO5	Develop a solid conceptual understanding of the development of lateral surfaces of solids such as prisms, pyramids, cylinders and cones with aid of computer, including the principles of unfolding or unwrapping the surfaces.	1,2,5, 10	1
CO6	Create isometric drawing of solids and combined solids and learn how to visualize and represent the individual components of the combined solid and assemble them into a coherent isometric projection using CAD software.	1,2, 3,5,10	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES:

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

COURSE ARTICULATION MATRIX:

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

THEORY:

Introduction – Geometrical constructions, engineering drawing standards, Introduction to CAD Software, Orthographic projection of points in first and third Quadrant only.
Orthographic projection of straight lines inclined to both horizontal and vertical planes.
Orthographic projection of regular plane surfaces -surface is inclined to both HP and VP.
Projections of Solids: Orthographic projection of regular solids like prisms, pyramids, cone and cylinder when the axis is inclined to both HP and VP.
Development of Lateral Surfaces of Solids: Parallel line method for prisms and cylinders, Radial line method for pyramids and cones
Isometric Drawing: Concept of isometric drawing and isometric projection, Isometric drawing of simple solid and combined solids (only 2 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	Analysing and software skill
3.	Draw the projection of straight lines locating in first quadrant	Solid Edge Software	Draw the views of the line and software skill
4.	Draw the projection of triangular and square lamina inclined to both HP and VP	Solid Edge Software	Analysing and software skill
5.	Draw the projection of rectangular and pentagonal lamina inclined to both HP and VP	Solid Edge Software	Analysing and software skill
6.	Draw the projection of hexagonal and circular lamina inclined to both HP and VP	Solid Edge Software	Analysing and software skill
7.	Draw the projection of prisms inclined to both HP and VP	Solid Edge Software	Interpretation and software skill
8.	Draw the projection of pyramids inclined to both HP and VP	Solid Edge Software	Analysing and software skill
9	Drawing development diagram of lateral surface of prisms.	Solid Edge Software	Analysing and Software Skill
10	Drawing development diagram of lateral surface of pyramids	Solid Edge Software	Analysing and Software Skill
11	Draw the isometric drawing of two co-axial solids	Solid Edge Software	Creative and Software Skill
12	Draw the isometric drawing of two co-axial solids	Solid Edge Software	Creative and Software Skill
13	Draw the isometric drawing of two co-axial solids	Solid Edge Software	Creative 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	Finance and Management				Course Type		FC	
Course Code	B24EN0102	Credit	1		Class		I Semester	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	1	1	1				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	1	1	1	**14**	**0**	**50%**	**50%**

COURSE OVERVIEW:

This course provides an introduction to the fundamentals of finance and management principles essential for understanding business operations and decision-making processes. It covers key concepts in finance such as the time value of money, financial markets, and institutions, along with principles of management including planning, organizing, leading and controlling.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the concept of finance and its various applications in both personal and business contexts.
2. Evaluate various financial instruments, markets, and investment opportunities to make informed investment decisions.
3. Develop the ability to analyze financial situations using time value of money principles.
4. Apply management theories and techniques to effectively lead teams, manage conflicts, and enhance organizational performance.
5. Examine Henri Fayol's fourteen principles of management and their relevance to contemporary organizational practices.

COURSE OUTCOMES (COs):

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

CO	Course outcomes	POs	PSO
C01	Understand how financial principles influence everyday choices, such as savings, investment, and expenditure.	9,10,11,12	1
C02	Understand the role of financial intermediaries such as banks, investment banks, and stock exchanges.	9,10,11,12	1
CO3	Understand Frederick Taylor's scientific management theory and its emphasis on efficiency and productivity.	9,10,11,12	1
CO4	Identify the functions of management: planning, organizing, leading, and controlling.	9,10,11,12	1
C05	Understand theories of motivation and their application to employee behavior.	9,10,11,12	1
CO6	Develop effective communication skills and decision-making abilities essential for managerial roles, including interpersonal communication, conflict resolution, and problem-solving.	9,10,11,12	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES:

CO	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
C01	✓	✓				

C02	✓	✓				
CO3		✓				
CO4			✓			
CO5		✓				
CO6			✓			

COURSE CONTENTS:

Introduction to Finance: Overview of Finance Definition and Scope of Finance Importance of Finance in Business and Personal Decision Making Goals of Financial Management Financial Markets and Institutions: Personal Financial Planning. Reading Understanding financial statements. Time Value of Money Concepts: Future Value, Present Value, Discounting Calculating Future Value and Present Value of Cash Flows Applications of Time Value of Money in Financial Decision Making Financial Markets and Institutions Types of Financial Markets: Money Market, Capital Market, Primary Market, Secondary Market Financial Instruments: Stocks, Bonds, Derivatives Role of Central Banks and Regulatory Bodies in Financial markets Principles of management.

Principles of Management: Management: Introduction- Meaning, nature and characteristics of management Definition of management Evolution of management thought Scope and Functions of management (Planning, Organizing, Leading, and Controlling). Management as a science art or profession. Management and administration. Levels of management (Top, Middle, Front-line). Principles of management- Fayols principles of management. Taylor's Scientific Management Theory- Taylor's Principles of Management, Maslow's theory of Hierarchy of Human Needs, Douglas McGregor's Theory X and Theory Y- Hertzberg Two Factor Theory of Motivation - Leadership Styles, Social responsibilities of Management. Porter's Five Force Model, BCG Matrix and PESTLE analysis.

Self Learning Component:

1. Study Future Value, Present Value, and Discounting concepts through online tutorials or videos.
2. Investigate examples of companies demonstrating social responsibility and their impact on stakeholders.
3. Explore how each financial instrument is traded and valued in the market.
4. Reflect on personal leadership qualities and areas for development.

TEXT BOOKS:

1. Ravi M. Kishore, "TAXMANN's Financial Management", Taxmann Publications Pvt. Ltd., 2020.
2. Dr. P.N. Reddy, N. Mukund Sharma and Prof. H.R. Appannaiah, "Management Accounting", Himalaya Publishing House, 5th Edition, 2012.

REFERENCE BOOKS

1. Prasanna Chandra, "Financial Management: Theory & Practice", McGraw-Hill Education, 11th Edition, 2019.
2. Richard L. Daft, "Management", South Western Educational Publishing, 11th Edition, 2013.

Course Title	**Advanced Computing Methods**				**Course Type**		**ETC**	
Course Code	B24MEET01	**Credits**	**1**		**Class**		**I Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	1	2	2				
	Total	**1**	**2**	**2**	**0**	**28**	**50%**	**50%**

COURSE OVERVIEW:

This course delves into the intricacies of employing MATLAB and Python for advanced computing tasks, elevating students' proficiency from basic to sophisticated levels. It explores a spectrum of computational methods crucial in various domains of engineering. Through hands-on activities and theoretical insights, students navigate basic coding, optimize computational processes, and apply MATLAB's and Python capabilities for solving problems.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the advanced computing methods using MATLAB and Python.
2. Explore advanced techniques for data analysis and visualization in both languages.
3. Understand the case studies of advanced computing using MATLAB
4. Understand the basic concepts of python programming.
5. Explore advanced data manipulation and analysis using Python libraries.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Apply MATLAB to carry out computations related to matrices.	1,2	1,2
CO2	Apply MATLAB to plot, visualize and analyze the 2D and 3D graphs.	1,2	1,2
CO3	Apply parallel computing toolbox for advanced computing.	1,2,5	1,2
CO4	Solve the advanced computing problems using python programming	1,2	1,2
CO5	Analyze the complex data manipulation and analysis tasks using NumPy library	1,2,5	1,2
CO6	Plot and visualize the data using Matplotlib library	1,2,5	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 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	3											2	2	
CO3	3	3			3								3	2	
CO4	3	2											2	2	
CO5	3	3			3								3	2	
CO6	3	3			3								2	2	
Avg	**3**	**2.66**			**3**								**2.5**	**2**	

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

COURSE CONTENTS:

Introduction to MATLAB, History, Capabilities, Operators and Special Characters, Special variables and Constants, Syntax for Trigonometric functions, Creating Matrices and related operations, Plotting (2D

and 3D Plots), Interpolation functions, Parallel computing toolbox. Case studies on advanced computing using MATLAB.
Introduction and review of basic python programming concepts, Basics of advanced data structures (lists, tuples, dictionaries, sets), Python NumPy arrays and operations, Linear algebra with NumPy, Data Visualization with Matplotlib.
Case study on exploratory data analysis using python libraries (NumPy and Matplotlib).

TEXT BOOKS:

1. Peter I. Kattan,"MATLAB for Beginners: A Gentle Approach", Petra Books, 2nd Edition, 2022.
2. Dr. Niranjan H and Siva.S, Manual on "Mechanical Engineers and MATLAB", School of Mechanical Engineering, REVA University, Bengaluru
3. Mark Pilgrim, "Dive into Python 3", Apress Special Edition, 2nd Edition, 20l5.
4. Travis E. Oliphant, "Guide to NumPy", Trelgol Publishers, 2006.

REFERENCE BOOKS:

1. Simin Nasseri, "Solving Mechanical Engineering Problems with MATLAB", Linus Learning, 2016.
2. J. Srinivas and R. V Dukkipati, Solving Engineering Mechanics Problems with MATLAB, New Age International (P) Limited, 2009.
3. Mark Lutz, "Learning Python", Oreilly, 2003.
4. John M. Zelle, "PYTHON Programming: An Introduction to Computer Science", Franklin, Beedle & Associates. 2004

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

2nd Semester

Course Title	Vector Calculus and Partial Differential Equations				Course Type		FC	
Course Code	B24AS0205	Credit	3		Class		II semester	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	3	3	3				
	Tutorial	-0	0	0	Theory	Practical	CIE	SEE
	Practical	-0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

This course is applied mathematics, which is useful for engineering students and it covers partial derivatives, multiple integrals, vector calculus, vector differentiation to flow problems, vector integration, formation of partial differential equations and various methods to find the solution with applications to engineering problems.

COURSE OBJECTIVE:

The objectives of this course are to:

1. Determine partial derivatives and its applications.
2. Evaluate multiple integrals over a region, changing the order of integration and polar coordinates.
3. Learn concepts of vector differentiation and its applications.
4. Study Vector integration and curvilinear coordinate systems
5. Study Homogeneous and non- homogeneous partial differential equations.
6. Study various methods to solve partial differential equations.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Apply the concept of partial derivatives and multiple integrals to design and analyze beams and execute the same using MATLAB.	1,2,5	1
CO2	Solve double and triple integrals over a region to analyze the properties of plane (2D) and solids (3D) and execute the same using MATLAB.	1,2,5	1
CO3	Analyze vector functions and vector differential operators to understand the concepts in fluid dynamics and execute the same using MATLAB.	1,2,5	1
CO4	Evaluate line integrals, surface, and volume integrals to determine moment of inertia of objects and execute the same using MATLAB.	1,2,5	1
CO5	Evaluate the solution of homogeneous and non- homogeneous partial differential equations to analyse the solutions of heat and wave equations and execute the same using MATLAB.	1,2,5	1
CO6	Apply various methods to solve partial differential equations having one or more independent variables and execute the same using MATLAB.	1,2,5	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES:

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

CO4			√			
CO5			√			
CO6			√			

COURSE ARTICULATION MATRIX:

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3			3								3		
CO2	3	3			3								3		
CO3	3	3			2								3		
CO4	3	2			3								3		
CO5	3	3			2								3		
CO6	3	2			2								3		
Avg.	**3**	**2.6**			**2.5**								**3**		

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

COURSE CONTENTS: THEORY:

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. Analytical solutions are compared with the computational techniques-MATLAB, *Engineering applications- to design and analyse beams.

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, irrotational and Solenoidal Fields. Analytical solutions are compared with the computational techniques-MATLAB, *Engineering applications-to study fluid flow around objects.

Line integral – Circulation – work, Surface integral – Flux, Green's Theorem in the Plane, Stokes Theorem, Volume Integral- Divergence Theorem, Green's Theorem. Orthogonal Curvilinear Coordinates. Analytical solutions are compared with the computational techniques-MATLAB, *Engineering Applications- work done by a variable force, to find moment of inertia of objects**.**

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. Analytical solutions are compared with the computational techniques-MATLAB. *Engineering Applications-to solve heat transfer problems.

Self-learning Component:

1. https://youtu.be/U51lQtlzvA0?si=ZBsm0LtF6UU7tSIV
2. https://youtu.be/PxCxlsl_YwY?si=4zkNfEV8XCQda697
3. https://youtu.be/rveuCHNkaC4?si=e4Z4ES26ToxUDVB1

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.

Course Title	Applied Physics				Course Type		FC	
Course Code	B24AS0107	Credits	3		Class		II semester	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practice	0	0	0				
	Total	3	3	3	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW

This course introduces the basic concepts of physics and its applications to the engineering courses by emphasizing the concepts: Measurements and measuring units, Physical and mechanical properties of materials, Lasers, and optical Fibers, sensors, and tensors. The course has basic laws, expressions and theories which help to increase the scientific knowledge to analyze upcoming technologies. The course also consists of real-time applications and numerical examples, which makes the course interesting and attractive.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Learn about the measuring systems, measurements, accuracy and precession of measuring instruments.
2. Know the basic working principles of transducers and sensors.
3. Understand the applications of Lasers, optical fibers and super conductors in modern technology.
4. Gain knowledge of working principles of different energy sources and applications.
5. Understand design issues, practically oriented skills, and problem-solving challenges.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Gain a thorough understanding of the fundamental principles and theories behind measurement systems and sensors / Transducers.	1,2	1,2
CO2	Develop the ability to select the appropriate sensor or transducer for a given application based on factors like range, accuracy, sensitivity, and environmental conditions.	1,2	1,2
CO3	Develop the ability to analyze and solve problems related to forces, moments, and the equilibrium of rigid bodies.	1, 2	1,2
C04	Explaining the principles of laser and optical fiber communication, including light propagation in optical fibers, attenuation, dispersion, and optical amplification.	1,2	1,2
C05	Exemplify the principles of superconductor and their applications.	1	1,2
CO6	Gain a thorough understanding of energy harnessing, compare energy sources and select the suitable energy resources for given application.	1,2,7	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	√	√	√	√		
C04	√	√	√	√		
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											2	2	
CO3	3	2											1	1	
CO4	3	2											1	1	
C05	3	2											2	1	
CO6	3	2					1						1	2	
Avg.	**3**	**2**					**1**						**1.3**	**1.3**	

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

COURSE CONTENT

Measurements: Introduction, requirement of measurements, significance of measurement system, generalized measurement system, concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, Errors in measurement, classification of errors. **Transducers and Sensors:** Transducers, primary and secondary transducers. Mechanical transducers: Bourdon tube, Diaphragm, Bellows. Electrical Transducers: Resistive, capacitive, piezoelectric and transducers

Intermediate Modifying and Terminating Devices: Introduction, Mechanical systems, electrical intermediate modifying devices, Introduction to Terminating devices, Meter indicators, CRO, LED and LCD display systems, pressure and thermal sensors, ultra sonic sensors, IR sensors, photodetector, MEMS, optical fiber sensors

Dynamics: Force, Newton's laws of motion, units of force system, moment, couple, torque, balancing and resulting forces, gravitational force, center of force and gravity, conditions for stability of bodies, numerical

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: Optical fiber, working principle of fibers, attenuation, amplification and applications of Optical fibers, interferometry, Polarization – Polarization by double refraction – Nicol's Prism- polarizers – Applications of Polarization.

Super conductivity: super conductors, Meissner effect, maglev vehicles and applications

Energy sources: Introduction renewable energy, solar energy, working principle of solar cells, different types of solar cells, advanced photovoltaic materials, methods of photovoltaic cells fabrication. Introduction to Windmill energy and its working principles. Turbines, hydropower, and nuclear power generation.

TEXT BOOKS:

1. Gaur and Gupta, "Engineering Physics", Dhanpat Rai Publishers", 8th revised Edition, 2017.
2. M. N. Avadhanulu and P. G. Kshirsagar, "A Textbook of Engineering Physics", S. Chand & Company Ltd, 10th revised Edition, 2019.

Reference Books:

1. R.K. Jain, "Mechanical and industrial Measurements", Khanna Publishers, 11th Edition, 1995.
2. Resnick, Halliday and Jearl Walker, "Fundamentals of Physics", John Wiley & Sons, Inc., 11th Edition, 2018.
3. Willaim Smith and Javed Hashemi, "Foundations of Materials Science and Engineering", McGraw-Hill Higher Education, 6th Edition, 2020.
4. Beckwith Marangoni and Lienhard, "Mechanical Measurements", Pearson Education, 6th Edition, 2006.
5. M.S.Vijaya, G.Rangarajan, "Material Science", Tata McGraw Hill, 4th Edition, 2004.
6. S.Timoshenko, D.H.Young and J.V.RAo, "Engineering Mechanics", McGraw Hill, 5th Edition, 2017.
7. Jenny Nelson, "The Physics of Solar Cell", Imperial College Press, 2003.

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.

Course Title	**Elements of Mechanical Engineering**				**Course Type**		**Hard Core**	
Course Code	**B24ME0103**	**Credit**	**3**		**Class**		**II Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	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:

The objectives of this course are to:

1. Develop the basic knowledge on energy resources, heat & work, steam formation, turbines, IC engines and refrigeration - air conditioning.
2. Incorporate the concept of different types of machine elements such as, gear drives, belt drives & chain drives
3. Give exposure in the field of engineering materials, manufacturing processes and testing of materials.
4. Incorporate the concepts of modern manufacturing processes like CNC, additive manufacturing and digital manufacturing technology and its applications.
5. Provide a basic understanding role of Mechanical Engineering in the industry and society.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Apply the knowledge of energy resources to analyze real-world energy challenges and propose potential solutions and understanding of the concept of sustainability in the context of energy resources.	1, 2	1,2
CO2	Develop a comprehensive understanding of the working principles and application underlying prime movers, including thermodynamics and evaluate the performance characteristics of IC engines, including power output and efficiency.	1, 2	1,2
CO3	Gain a solid understanding of the fundamental principles of thermodynamics, and heat transfer as they apply to refrigeration and air conditioning systems and familiarize various components and systems used in refrigeration and air conditioning.	1	1,2
CO4	Develop a comprehensive understanding of working mechanical drives such as gears, belts, chains, properties of materials, processing of materials and testing methods of materials.	1, 5	1
CO5	Gain a comprehensive understanding of the principles and concepts underlying Industry 4.0, including, the Internet of Things (IoT), Machine Learning (AI), 3D printing and digital technologies.	1, 5	1,2,3
CO6	Understand the applications of robotics in various fields, such as manufacturing, healthcare, agriculture, logistics, aerospace, etc and understand the concept of measurement system and control system used in robotics.	1	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES:

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

COURSE ARTICULATION MATRIX:

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

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

COURSE CONTENT:

Energy Resources: Types of energy resources: Non-renewable- thermal power plant, Concept of heat and work, Steam formation, Types of steam, Steam properties, steam turbines (impulse and reaction), numerical on steam properties.

Renewable energy: Solar P-V system, hydrogen energy through electrolysis and wind energy.

IC Engines: Fuels and properties, classification of IC engines, parts and terminology, working of 4-stroke petrol engine, numerical on IP, BP, FP and Mechanical Efficiency. Introduction to basics of electric and hybrid vehicles.
Gas Turbines: Open and closed cycle gas turbine. Hydraulic turbines: Classification and working of Pelton wheel.
Refrigeration and Air Conditioning: Principle of Refrigeration system, working of domestic refrigerator (VCR) and window air conditioner.
Machine Elements: Belt drives: Principle of open and crossed belt drive, gear drives types and chain drives, numerical on velocity ratio.
Materials: Introduction to engineering materials, basic properties and classifications.
Testing of Materials: Basics of destructive and nondestructive testing methods, working of NDT methods such as Dye penetration and Magnetic crack detection.
Manufacturing Processes: casting, Machining (lathe & drilling machine), metal joining process- Arc welding.
Introduction to Advanced Manufacturing and Industry 4.0 -CNC machines, laser engraving, additive manufacturing- classification, applications, working of FDM, Introduction to Digital manufacturing- machine learning (ML) applications, Industrial Internet of Things (IIoT), Human Machine Interface.
Robotics and Control System: Need of Automated Guided Vehicle (Retrieval/storage system) in industries, applications of Robots, measurement system, open and closed loop control system.

Self-Learning Component: Hybrid vehicles, Engineering Materials, Need of Automated Guided Vehicle.

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.
4. Baldev Raj, M. Thavasimuthu and T. Jayakumar “Practical Non-Destructive Testing” Narosa publisher, 3rd Edition 2011.
5. Madhumathy P, M Vinoth Kumar, R. Umamaheswari “Machine Learning and IoT for Intelligent Systems and Smart Applications” CRC Press publisher, 2021.

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	Programming with C				Course Type		Hard Core	
Course Code	B24CI0104	Credits	3		Class		II Semester	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Practice	0	0	0				
	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:

The objectives of this course are to:

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)

On successful completion of this course; the student shall 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	Learn new algorithms and technologies in C Programming and apply 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	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/ PO	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	3
CO4	3	3	3	1	1									3	3
CO5	3	3	3	2	2	1									
CO6	3	3	3	2	2	2			3				3	3	2
Avg.	**2.3**	**2.5**	**2.6**	**1.7**	**1.6**	**1.5**			**3**				**3**	**3**	**2.6**

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

COURSE CONTENT:

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. 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. **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, recursive functions.

Strings: string operations with and without using inbuilt string functions. **Structures & 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 & 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, 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	**Internet of Things**				**Course Type**		**Hard Core**	
Course Code	**B24EN0101**	**Credit**	**2**		**Class**		**I/II semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	1	1	1				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**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, smartphones, 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, Boards, sensors, actuators and communication protocols. The course is supported with hands on sessions that incorporates different types of sensors interfaced with IoT board to build IoT projects to solve real time problems. The case study of deployment of IoT in various applications are provided.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the fundamentals of Internet of Things.
2. Inculcate knowledge of IoT devices, Sensors and Communication Protocols in various application domains.
3. Gain expertise in interfacing of various sensors to IoT Boards, Arduino and Node MCU.
4. Discuss various applications of IoT.

COURSE OUTCOMES (COs): On successful completion of this course, the student shall be able to:

CO	**Course Outcomes**	**POs**	**PSOs**
CO1	Describe IoT architecture and Models of IOT	1,2,3,4,5	1,2
CO2	Identify and work on different IoT development boards	1,2,3,4,5	1,2
CO3	Identify communication technologies, protocols, and cloud services	1,2,3,4,5	1,2
CO4	Identify sensors & actuators and demonstrate the interfacing of sensors & actuators to IoT boards	1,2,3,4,5,9,10, 12	1,2
CO5	Interpret various Applications of IoT	1,2,3,4,5,6,9,10,12	1,2,3
CO6	Develop simple IoT projects and modules	1,2,3,4,5,9,10,11,12	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	2	1	1	1								3	3	
CO2	2	3	1	1	1								3	3	
CO3	3	2	1	1	2								2	2	
CO4	3	3	3	2	2				2	1		2	2	2	
CO5	3	2	2	1	2	2			2	1		2	2	2	1
CO6	3	2	2	1	2				2	2	2	2	2	2	2

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

CONTENT

IoT Basics and Arduino UNO Board: Introduction to IoT and its working, IoT Architecture, Models of IOT, Characteristics of IoT, Merits, demerits, futures scope and challenges of IoT, IOT Echo system, Arduino UNO board, memories, microcontroller, Basic programming of Arduino UNO board: Numeric data types, text data types, Array data types, Digital input output functions, Communication Technologies: Bluetooth, ZigBee, Wi-Fi, Cellular, IoT Enabling Technologies and Applications.

IoT Development Boards: Node MCU, Raspberry Pi; Sensors and Actuators: Temperature Sensor, PIR Sensor, Ultrasonic senor, LDR, Applications of IoT, Protocols: HTTP, MQTT, CoAP; IoT Cloud Platforms: Arduino Cloud, Thing Speak, Blink Cloud

Experiments:

Sl. No.	Name of the Practice Session	Tools and Techniques	Expected Skill /Ability
	Arduino UNO		
1	**Experiment-01** Introduction to Arduino Board & getting started with Arduino IDE software. Write a program to blink an LED: a) Infinite number of times with ON & OFF duration of 1 sec b) Only 3 times with ON and OFF duration 2 sec	Hardware & software for Arduino UNO Arduino UNO Board Arduino IDE LED	Identifications of various parts of Arduino UNO and Coding
2	**Experiment-02** 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	Interface of Potentiometer
3	**Experiment-03**	Arduino UNO Arduino IDE LED	Interface LDR sensor

	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.	LDR	
4	**Experiment-04** a) Write a program to interface temperature sensor and display the values on the serial monitor. b) Write a program to display the range of temperature on LCD.	Arduino UNO Arduino IDE LCD Temperature sensor	Interface Temperature sensor
5	**Experiment-05** Write a program to interface ultrasonic sensor and display the distance from an object.	Arduino UNO Arduino IDE Ultrasonic sensor	Interface Ultrasonic sensor
	NODU MCU		
8	**Experiment-06** Introduction to NODE MCU and Write a Program for 2-BIT COUNTER using Node MCU.	Hardware & software for NODE MCU NODE MCU Board Two LED's	Identifications of various parts of NODE MCU and Coding
9	**Experiment-07** Write a program to interface motion sensor and display its status using LED. If motion is detected, turn on LED otherwise keeps the LED off.	NODE MCU LED PIR sensor	Interface PIR sensor
10	**Experiment-08** Write a program to interface Single LED blinking using Node MCU and Bluetooth module.	Node MCU Bluetooth module LED	Connection of Bluetooth to NODE MCU
11	**Experiment-09** Write a program to control the status of LED using relay.	Node MCU Bluetooth module LED	Control of LED through Relay
12	**Experiment-10** Write a program to interface temperature sensor and display the values on Web Page/Cloud.	Node MCU Temperature Sensor LED Cloud Service	Connect to cloud and display the values

TEXTBOOKS:

1. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-On- Approach", Orient Blackswan Private Limited, 1st Edition, 2015.

REFERENCE BOOKS:

1. Raj Kamal," Internet of Things: Architecture and Design Principle", McGraw Hill McGraw Hill, Standard Edition, 2022.

Additional Material:

1. https://www.coursera.org/learn/iot
2. https://www.coursera.org/learn/interface-with-arduino
3. https://www.youtube.com/watch?v=APH6Nrar27w&list=PLYwpaL_SFmcB8fDd64B8SkJiPpEIzpCzC
4. https://www.youtube.com/watch?v=NSUj_NMV5t0&list=PLuAADu3OvBt4SUxlYPu_xJogSmVfSLZF0

Course Title	Applied Physics Lab				Course Type		FC	
Course Code	B24AS0109	Credits	1		Class		I Semester	
Course Structure	LTP	Credits	Contact Hours	Workload	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practice	1	2	2				
	Total	**1**	**2**	**2**	**0**	**28**	**50%**	**50%**

COURSE OVERVIEW:

Course Prerequisite: Basic knowledge about setting up experiments measuring various parameters

COURSE OBJECTIVES

The objectives of this course are to:

1. Make the students gain practical knowledge to co-relate with the theoretical studies.
2. 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.

COURSEOUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Apply the knowledge of Physics and conduct experiment to find acceleration due to gravity, rigidity modulus and moment of inertia, young's modulus of the materials, compare the results with theoretical values.	1, 2, 9,10	1,2
CO2	Find the Viscosity of given liquid by Poiseuille method and falling ball method, and compare results and document.	1,2,9,10	1,2
CO3	Determine the surface tension of given liquid by capillary rise method by conducting experiment in group and document the results.	1,2,9,10	1, 2
C04	Analyze the I-V characteristics of transistors and photodiodes and the related graphs by origin software and document the results.	1,2, 5, 9, 10	1, 2
CO5	Calibrate the pressure gauge by compare with standard values and prepare the calibration report.	1,2,9,10	1, 2
CO6	Understand the concept of diffraction of light and determine the wavelength of LASER source by conducting experiment and check with reported values and document.	1,2,9,10	1,2

BLOOM'SLEVELOFTHECOURSEOUTCOMES

CO#	Bloom's Level					
	Remember (L1)	**Understand (L2)**	**Apply(L3)**	**Analyze(L4)**	**Evaluate(L5)**	**Create(L6)**
CO1				√		
CO2				√		
CO3				√		
C04				√		
CO5				√		
CO6				√		

COURSE ARTICULATION MATRIX

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

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

SL. No.	Title of the Experiment	Tools and Techniques	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 Moment of Inertia of disc and Rigidity Modulus of steel wire 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.
3	Determination of Viscosity of Liquid by Poiseuille method.	Capillary tube with bottle, stop clock, measuring jar.	Understand the theory, principle and perform the experiment, collect the data, and interpret the results.
4	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.
5	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.
6	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.
7	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.
8	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.
9	Determination of wavelength of Laser by diffraction.	Laser source, grating	Understand the theory and perform the experiment, collect the data and calculate the wavelength of given laser.

10	Determination of Young's Modulus of steel scale 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.

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.
3. B.L. Worshnop and H.T. Flint, "Advanced Practical Physics", Little Hampton Book Services Ltd., 9th Edition, 1951.
4. S. L. Gupta and V. Kumar, "Practical Physics", Pragati Prakashan, 33rd Edition, 2018.
5. S.P. SINGH, "Advanced Practical Physics Vol. - I", Pragati Prakashan, 15th Edition, 2017.

Course Title	**Programming with C Lab**				**Course Type**		**HC**	
Course Code	**B24CI0108**	**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	Theory	Practical	IA	SEE
	Practice	1	2	2				
	Total	1	2	2	0	28	**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:

The objectives of this course are to:

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)

On successful completion of this course; the student shall 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	Learn new algorithms and technologies in C Programming and apply 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	2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

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

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	3										3		
CO2	1	3	2	2	2								3		
CO3	2	2	2		1									3	3
CO4	3	3	3	1	1									3	3
CO5	3	3	3	2	2	1									
CO6	3	3	3	2	2	2			3				3	3	2
Avg.	**2.3**	**2.5**	**2.6**	**1.7**	**1.6**	**1.5**			**3**				**3**	**3**	**2.6**

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

PRACTICE:

PART A:			
No	**Title of the Experiment**	**Tools and Techniques**	**Expected Skill /Ability**
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.
	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
6	a. 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:	File operations	Create file, store data and display details.

	(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.		
	b. 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 & 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, Pauline Baker, "Computer Graphics C Version", Pearson Education, 2nd Edition, 2004.

<table>
<tr><td>Course Title</td><td colspan="3">Innovation and Entrepreneurship</td><td colspan="2">Course Type</td><td colspan="2">FC</td></tr>
<tr><td>Course Code</td><td>B24ME0102</td><td>Credits</td><td colspan="2">2</td><td colspan="2">Class</td><td colspan="2">I 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 Weightage</td></tr>
<tr><td>Lecture</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 rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td>1</td><td>2</td><td>2</td></tr>
<tr><td>Total</td><td>2</td><td>3</td><td>3</td><td>14</td><td>28</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, 36-42 hours of classroom/digital, highly experiential and practice based entrepreneurship training Course, by Wadhawani Foundation and will be delivered by WF facilitators / NEN Trained Entrepreneurship Faculty.

COURSE OBJECTIVES:

The objectives of this course are to:

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 (CO'S)

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

CO	Course Outcomes	POs	PSOs
CO1	Identify the different aspects that can impact their business	3,9,10,11,12	1
CO2	Acquire in-depth knowledge about tools to build any business idea	3,9,10,11,12	1
CO3	Acquire in-depth knowledge about the different growth tools to grow their business.	3,9,10,11,12	1
CO4	Create a financial plan for their business	3,9,10,11,12	1
CO5	Create a pitch deck for their business and present it to different stakeholders	3,9,10,11,12	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						√

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	2		
CO2			2						2	2	3	2	2		
CO3			2						2	2	3	2	2		
CO4			2						2	2	3	2	2		
CO5			2						2	2	3	2	2		
Avg.			**2**						**2**	**2**	**3**	**2**	**2**		

CONTENT:

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

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

Build your MVP : 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.

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. K. Ramachandran, "Entrepreneurship Development", Tata Mc. Graw Hill, 1st Edition, 2008
2. Sangeeta Sharma, "Entrepreneurship Development" PHI Publications, 1st Edition, 2022.

REFERENCE BOOKS:

1. Baringer and Ireland, "Entrepreneurship", Pearson, 11th Edition, 2020.
2. Drucker F Peter: "Innovation and Entrepreneurship", Heinemann, London, 1985.
3. Doanld F Kuratko and Richard M Hodgeth, "Entrepreneurship in the New Millennium", India Edition - South-Western,
4. Robert D. Hisrich, "Entrepreneurship", McGraw Hill, 11th Edition, 2020.
5. Donald F. Kuratko and Richard M. Hodgetts "Entrepreneurship: Theory, Process and Practice" South-Western, 6th Edition, 2003.
6. Thomas N. Duening, Robert D. Hisrich and Michael A. Lechter, "Technology Entrepreneurship: Taking Innovation to the Marketplace", Academic Press, 2nd Edition, 2014.

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="4">Basic Mechanical Engineering Lab</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B24ME0104</td><td>Credit</td><td colspan="2">1</td><td colspan="2">Class</td><td colspan="2">I/II Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credit</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 Weightage</td></tr>
<tr><td>Lecture</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 rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</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 OVERVIEW:

Basic Mechanical Engineering Lab provides the knowledge of fundamental information of production, properties of materials and testing of materials through non-destructive technique. It also explains about the different tools, equipment's and techniques of conventional manufacturing as well as advanced manufacturing. Also it provides the information about fuels, lubricants used for IC engines, power transmission devices like belt drives,

COURSE OBJECTIVES:

The objectives of this course are to:

1. Make the students familiar with basic tools and techniques of Mechanical Engineering.
2. Give exposure of different material properties using experimental procedure
3. Introduce the concepts of manufacturing processes, automobile parts, and electronic components.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Gain a comprehensive understanding of the significance and analyze the relevance of fuel/oil properties such as calorific value, flash point, and fire point in various applications including energy production, transportation, and safety regulations.	1, 2	1, 2
CO2	Gain a comprehensive understanding of the concept of measuring density of a substance and interpret its significance in various fields such as materials science, physics and engineering.	1, 2	1, 2
CO3	Acquire a skill to interpret and analyses I-V curve solar PV panel, calibrate the load cell, detect the defects in materials using NDT method and determine the speed ratio and slip in belt drive.	1,2,5	1, 2
CO4	Develop the simple sheet metal model as per the drawing specification using sheet metal tools	1,2,3	1,2
CO5	Communicate effectively experimental procedures, results, and findings through written reports and oral presentations.	1,10	3
CO6	Demonstrate the working and applications of 3D printing, arc welding, Laser Engraving and CNC Machining and Data Acquisition for Machine Learning and IC engine Parts (Toyota Car)	1, 5	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES:

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

COURSE ARTICULATION MATRIX:

CO/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1											1	1	

CO2	3	1											1	1	
CO3	3	1			1								1	1	
CO4	3	1	1										1	1	
CO5	3									1			1		1
CO6	3	1											1	1	
Avg.	**3**	**1**	**1**		**1**					**1**			**1**	**1**	**1**

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

COURSE CONTENTS:

PART- A

1. Determination of Calorific Value of Fuel.
2. Determination of Flash and Fire Point of Lubricants and Fuel.
3. Calculation of density of Material.
4. Performance of Solar PV Panel Module plotting I-V Curve.
5. Identification of Toyota Car Parts.
6. Demonstration of 3D printing and Laser Engraving.

PART- B

1. Calibration of Load Cell.
2. Identification of defects using Magnetic Particles Test (NDT).
3. Determination of speed ratio and percentage of slip in belt drives.
4. Fabrication of Sheet Metal Model.
5. Demonstration of Arc Welding process.
6. Demonstration of CNC Machining and Data Acquisition for Machine Learning.

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. K. K. Appukuttan, “Introduction to Mechatronics”, Oxford University Press, 2007.
3. Baldev Raj, M. Thavasimuthu, T. Jayakumar “Practical Non-Destructive Testing” Narosa publisher, 3rd Edition, 2011.

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	Communicative English				Course Type		FC	
Course Code	B24AH0103	Credit	1		Class		II semester	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	1	2	2				
	Total	**1**	**2**	**2**	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW:

Today many companies are working on international projects where English is increasingly used by engineers across the world to communicate with all groups involved. This course is designed for entry-level Engineering and Technology curriculum enabling the students to learn, acquire, and apply for their learning and career. The course is aimed at providing effective skills for promoting communication skills through English. Hence in the present scenario Engineering English course is to be fully tailored to the specific needs of engineers. The outcome of this course contains a refined level of English proficiency by acquiring all four skills, listening, speaking, reading, and writing to prepare them for global readiness.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Develop the communicative competence of learners
2. Utilize language effectively in academic contexts
3. Change various listening strategies to comprehend various types of audio materials like lectures, discussions, videos, etc.
4. Build on students' interest in English language skills by engaging them in listening, speaking, and grammar learning activities that are relevant to authentic contexts.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Analyse Listening, Comprehend and Correspond with others in various contexts	**10**	
CO2	Apply proper communication modules to Speak legibly and fluently under various lifetime situations	**10**	
CO3	Analyse the meaning and language while reading a variety of writings and technical texts	**10**	
CO4	Demonstrate products and processes and explain their uses and purposes clearly and accurately	**10**	
CO5	Make use of various communicative skills in precise and efficient ways in technological contexts	**10**	
CO6	Create situational conversations and technical writing styles for interpersonal and effective communication.	**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					
CO2										2					
CO3										2					
CO4										2					
CO5										2					
CO6										3					
Avg.										**2.2**					

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

COURSE CONTENT:

Fundamentals of Communication

Listening: Listening for general information-specific details- conversation: Introduction to classmates - Audio /video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form. Listening to TV News and guest Lecturers.

Speaking: Pronunciation Common Vocabulary, Technical Vocabulary, Answering Peer Questions, Conversation with Teacher, making telephone calls Introduction; Introducing a friend

Reading: News magazines, Reading for unfamiliar words, Variety of News Items

Writing: Word formation – Auxiliary verbs – Modal Verbs – Sentence Types – Affirmative, Negative, Interrogative, Concord – Dialogue Writing, Paragraph writing

Narration and Summation

Listening: Listening to Peer Conversations – Brief Speeches – Listening for Specific Information – Recap of Speeches, Listening to podcasts, anecdotes/stories / event narration; documentaries and interviews with celebrities.

Speaking: Telephonic enquiries official/formal enquiries, narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations - describing experiences and feelings- engaging in small talk- describing requirements and abilities.

Reading: Technical Essays – Identifying Sentence Types – Classifying the verb patterns

Writing: Tenses – Simple Present, Present Progressive, Present Perfect, Present Perfect Continuous – Voice – Active & Passive, email writing

Description of A Process / Product

Listening: Listen to product and process descriptions; a classroom lecture; and advertisements about products. Digital Videos for World Information

Speaking: Picture description- describing locations in workplaces- Giving instruction to use the product- explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities(large & small)-talking about precautions.

Reading: Coherence, Development of Thoughts

Writing: Tenses – Simple Past, Past Progressive, Past Perfect, Past perfect continuous – Impersonal Passive-Narrating the past events, Permission Letter for Industrial Visit/Functions held

Classification and Recommendations

Listening: Listening to TED Talks; Listening to Dialects of English – British & American Regional Listening to achievers, eminent personalities

Speaking: Role Plays, Extempore, Responding to specific questions

Reading: Texts on self-confidence, motivation, success path, Comprehensive passages, Reading for specific points

Writing: Tenses – Simple Future, Future progressive, Future Perfect, Future Perfect continuous – Definition – Phrases of Reason – Cause & Effect, Report writing

Self Learning Component: Online Activities on LSRW Skills

Teaching Pedagogy: MAIL, CALL, Online, Blended Teaching, Flipped Classroom

TEXT BOOKS:

1. Board of Editors, "Using English A Course book for Undergraduate Engineers and Technologists", Orient Black Swan Limited, 2015
2. Richards, C. Jack, "Interchange Students' Book-2 New Delhi: CUP, 2015.

REFERENCE BOOKS:

1. Murphy and Raymond, "English Grammar in Use with Answers: Reference and Practice for Intermediate Students", Cambridge: CUP, 2004
2. Thomson, A.J. and Martinet, A.V., "A Practical English Grammar", OUP, New Delhi: 1986
3. Anne Laws, "Writing Skills", Orient Black Swan, Hyderabad, 2011
4. Green and David, "Contemporary English Grammar Structures and Composition", MacMillan, 2010.
5. Thorpe, Edgar and Showick Thorpe, "Basic Vocabulary". Pearson Education India, 2012.
6. Leech, Geoffrey and Jan Svartvik, "A Communicative Grammar of English", Longman, 2003.
7. Rizvi, M. Ashraf, "Effective Technical Communication", Tata McGraw-Hill, 2005.
8. Riordan, Daniel, "Technical Communication", New Delhi: Cengage Publications, 2011.
9. Sen, "Communication and Language Skills", Cambridge University Press, 2015.

Assessment Pattern:

Internal Assessment **Nil**

SEE Practical- Documentation (Reading and Writing) 25 Marks

Listening - 15 Marks

Speaking – 10 Marks

Total 50 Marks

Course Title	**3D Printing Technologies**				**Course Type**		**ETC**	
Course Code	B24ERET02	**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	CIE	SEE
	Total	**1**	**1**	**1**	**14**	**0**	**50 %**	**50 %**

COURSE OVERVIEW

3D printing (Additive manufacturing) technologies are becoming more sophisticated and widespread, allowing for the production of complex geometries, customized parts, and rapid prototyping. Materials range from plastics to metals and even biomaterials, expanding the possibilities for manufacturing across various industries. This course typically provides students with a comprehensive overview of the principles, techniques, applications, and technologies involved in additive manufacturing.

COURSE OBJECTIVES

The objectives of this course are to:

1. To provide a comprehensive understanding of different types of 3D printing technologies, their principles of operation, advantages, limitations, and typical applications.

2. To provide the concept of design parts and products specifically optimized for 3D printing, considering factors such as geometry, material properties, support structures, and manufacturing constraints.
3. To provide the basic knowledge of various materials used in 3D printing, their properties, compatibility with different printing technologies, and post-processing techniques.
4. To provide diverse applications of 3D printing across industries such as aerospace, automotive, healthcare, consumer products, and education, and be able to identify opportunities for using additive manufacturing in specific contexts.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Understand of different types of 3D printing technologies, including their principles, advantages, limitations, and applications.	1	1
CO2	Design parts and products optimized for 3D printing, considering factors such as geometry, material properties, support structures, and manufacturing constraints.	1, 2, 3	1,2
CO3	Understand progress in emerging trends, developments, and innovations in the field of 3D printing, including advancements in materials, technologies, and applications.	1,4,5	1,2
CO4	Aware of ethical, legal, and societal implications of 3D printing, including considerations related to intellectual property rights, environmental sustainability, and equity in access to technology.	1,6,7,8	1,2,3
CO5	Prepare for various career paths and opportunities in industries related to additive manufacturing, including roles in design, engineering, manufacturing, research, entrepreneurship, and education.	1, 11, 12	1,2,3
CO6	Gain experience collaborating with peers, fostering interdisciplinary approaches to solving complex problems using additive manufacturing technology.	1,2,9,10	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

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

COURSE ARTICULATIONMATRIX

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

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

COURSE CONTENT

Introduction to 3D Printing: History and evolution of 3D printing, basic principles and terminology of additive manufacturing, comparison with traditional manufacturing methods.

Types of 3D Printing Technologies: Overview of various 3D printing processes, such as Fused Deposition Modeling (FDM), Stereolithography (SLA), Selective Laser Sintering (SLS), and others, comparison of differences in materials, resolution, speed, and cost between different 3D printing technologies.

Design for Additive Manufacturing (DfAM): Principles of designing parts optimized for 3D printing, considerations for geometry, support structures, material properties, and post-processing.

Materials for 3D Printing: Types of materials used in additive manufacturing, including thermoplastics, metals, ceramics, and composites, properties, advantages, and limitations of different materials, emerging materials and their applications.

3D Printing Software and Tools: Introduction to CAD (Computer-Aided Design) software for creating 3D models, software tools for preparing, slicing, and optimizing 3D models for printing, demonstration of popular 3D printing software packages.

Applications of 3D Printing: Case studies and examples of 3D printing across various industries, including aerospace, automotive, healthcare, consumer products, and education, opportunities and challenges in using additive manufacturing for prototyping, customization, production, and research.

Hands-on Projects:

1. Practical exercises and projects involving designing, prototyping, and printing 3D models.
2. Collaborative projects to solve real-world problems using additive manufacturing technology.

TEXT BOOKS

1. Dr.Sridhar S and Natesh C P, "A Text Book of Introduction to Additive Manufacturing", IPH, 1st Edition, 2020.
2. Andreas Gebhardt, Julia Kessler and Laura Thurn, "3D Printing- Understanding Additive Manufacturing", Hanser, 2nd Edition, 2019

REFERENCE BOOKS

1. Olaf Diegel, Axel Nordin and Damien Motte, "A Practical Guide to Design for Additive Manufacturing", Springer Verlag, Singapore, 1st Edition, 2019.
2. Ian Gibson, David Rosen, Brent Stucker and Mahyar Khorasani, "Additive Manufacturing Technologies", Springer Nature Switzerland AG, 3rd Edition, 2021.

JOURNALS/MAGAZINES

1. 3D Printing and Additive Manufacturing
2. International Journal of 3D Printing and Additive Manufacturing
3. Rapid Prototyping Journal

SWAYAM/NPTEL/MOOCs

1. https://onlinecourses.nptel.ac.in/noc21_me115/preview
2. https://www.udemy.com/course/3d-printing-from-start-to-finish/?couponCode=IND21PM
3. https://www.coursera.org/specializations/3d-printing-additive-manufacturing

3rd Semester

Course Title	Laplace Transforms and Fourier Series				Course Type		FC	
Course Code	B24AS0302	Credits	3		Class		III Semester	
Course Structure	TLP	Credits	Contact Hours	Work Load	Total Number ofClasses 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

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

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.
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.
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.
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	**Introduction to Design Thinking**				**Course Type**		**FC**	
Course Code	**B24CI0309**	**Credits**	**2**		**Class**		**III Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	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:

The objectives of this course are:

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	Develop problem solving skills.	1,2,9,10,12	1,2
CO2	Students will develop human-centric mindset while designing, innovating, developing, and testing solutions for new products, services, and processes	1,2,9,10,12	1,2
CO3	Enhance communication and understanding between the team members.	1,2,9,10,12	1,2
CO4	Enhance creative thinking and apply for solving real world problems.	1,2,9,10,12	1,2
CO5	Understand the role of innovation in the digital era and drive disruptive innovation.	1,2,3,5,9,10	1,2
CO6	Develop the ability to create and test prototypes that are customer-centric and innovative	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							2	2		2	3	2	
CO2	1	3							2	3		2	1	2	
CO3	1	2							3	2		3	1	2	
CO4	1	2							3	2		2	1	2	
CO5	2	2	3		2				3	3		2	2	3	
CO6	2	2	2	2	2				3	2		2	2	3	
Average	**1.7**	**2.2**	**2.5**	**2.0**	**2.0**				**2.7**	**2.3**		**2.2**	**1.7**	**2.3**	

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

THEORY COURSE CONTENT

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.

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 cantered 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 ma perception king problem statements from user
6	Presentation by student teams	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

Course Title	Thermodynamics				Course Type		Hard Core	
Course Code	B24ER0301	Credit	3		Class		III Semester	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	2	2	2				
	Tutorial	1	2	2	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	**3**	**4**	**4**	**56**	**0**	**50%**	**50%**

COURSE OVERVIEW:

Thermodynamics course typically covers fundamental principles and concepts related to the behaviour of energy and matter in physical systems. The course is intended to provide the students with knowledge about fundamentals of thermodynamics which includes thermodynamic systems, processes, thermodynamic laws with applications (heat engines, heat pump) and idealized thermodynamic cycle. Further the course exposé the students to understand the properties of the gases and phase diagrams of pure substances to analyse the processes. Overall, the course provides a basic foundation for understanding how energy flows and interacts within physical systems, laying the groundwork for more advanced studies in engineering and science.

COURSE OBJECTIVES:

The objectives of this course are:

1. To comprehend the fundamental principles of thermodynamics including energy, work, heat and their Inter-relations.
2. To incorporate the knowledge about first and second law of thermodynamics to analyse the practical applications.
3. To understand the principles behind various thermodynamic cycles and their applications.
4. To gain the concepts about ideal gases, real gases and pure substances to solve practical problems.
5. To encourage students to apply thermodynamic principles to analyse and interpret real-world situations.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Apply the knowledge of fundamental concepts of thermodynamics to identify different systems, properties, processes, temperature scales and solve numerical on temperature measurements.	1, 2	1,2
CO2	Develop a comprehensive understanding of different thermodynamic process to analyze and calculate properties of these processes; including heat and work transfer.	1, 2	1,2
CO3	Familiarize with different energy forms and apply the first law of thermodynamics to solve problems involving energy transfer, heat and work transfer in closed and open systems using computing techniques.	1,2,5	1,2
CO4	Gain a comprehensive understanding of second law of thermodynamics, different processes of thermodynamic cycles such as Carnot cycle and calculate their performance parameters in heat engines, heat pump and refrigeration cycles.	1, 2	1.2
CO5	Understand the concept of entropy, behavior of ideal gases, terminologies of ideal gas mixture and evaluate the change in entropy for various thermodynamic process.	1, 2	1,2
CO6	Develop a comprehensive understanding of different phase diagrams of pure substances and calculate the thermodynamic properties of pure substances using property tables and equations.	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	1	
CO2	3	2											3	2	
CO3	3	3			1								3	2	
CO4	3	3											3	2	
CO5	3	2											3	2	
CO6	3	2											3	1	
Average	**3**	**2.3**			**1**								**3**	**1.6**	

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

COURSE CONTENT:

Introduction: Definition, Thermodynamic systems, Thermodynamic state, properties, process and cycle; Thermodynamic equilibrium, Quasi-static process, Zeroth law of thermodynamics, Temperature scales. Simple numerical on temperature scales.

Work and heat: Thermodynamic definition, Units and sign convention, Displacement work(pdV work), displacement work for various thermodynamic processes, shaft work, flow work; path function and point function, Work as a path function, Comparison between Work and heat, Simple numerical.

First Law of Thermodynamics: Joule experiment, First law for a closed system undergoing non-cyclic process, types of energy, enthalpy, specific heats (C_p and C_v),PMM-I, Simple numerical; First law applied for open system-SFEE, applications of SFEE for steady flow engineering devices, Solving simple numerical on SFEE using computing techniques.

Second Law of Thermodynamics: Thermal reservoirs, Cyclic Heat engine, Cyclic Heat pump and Cyclic Refrigerator; Statements of II law of thermodynamics and equivalence of both the statements, PMM-II, Carnot cycle, Carnot's first theorem, Simple numerical.

Entropy: Definition, Clausius Theorem, Prove entropy as property of system, Clausius Inequality, representation of Carnot cycle on T-S diagram, Principle of increase of entropy, Tds equations, Equations for change in entropy during thermodynamic processes; Simple numerical.

Ideal gases: Definition, Derivation of equation of state, Comparison of ideal and real gases, Simple numerical on evaluation of heat ,work and changes in enthalpy, internal energy and entropy for ideal gas process.

Ideal gas mixtures: mass fraction, mole fraction, Gibb's Dalton law, Amagat's law, Internal energy, enthalpy and entropy of gaseous mixtures (Definition only).

Pure substances: Definition, Property diagrams: T-V, P-T diagram of pure substances, triple points and critical points, dryness fraction, enthalpy of dry, wet and superheated steam; determination of dryness fraction of steam-Throttling calorimeter and Combined Separating- throttling calorimeter, Simple numerical.

Self-Learning Component: Temperature measuring devices, other types of work, real gases.

CASE STUDIES:

1. Prepare a report on applications related to temperature measurements, first and second law of thermodynamics.
2. Develop a python programme for analysing (drawing PV diagram) of the Carnot cycle.
3. Prepare a report on applications related to Carnot cycle, Entropy and ideal gases.

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.

<table>
<tr><td>Course Title</td><td colspan="4">Material Science and Characterization Techniques</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B24ER0302</td><td>Credit</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">III Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Lecture</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</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>42</td><td>0</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

Material science and characterization technique is an interdisciplinary course expended from side to side of physics and chemistry of matter, engineering applications, design and industrial manufacturing processes. The study of material science and characterization is to understand the relationship between structure, testing and properties of a material. The course provides the basics of crystal structure, defects in crystal structures and focusing on diffusion mechanisms involved in the materials, phase diagrams, solidification, cooling curves, types of fracture, creep and fatigue behavior of metals and alloys. Students are learning about iron carbon diagram, heat treatment, engineering materials and different characterization techniques.

COURSE OBJECTIVES:

The objectives of this course are:

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

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Recognize and categorize different types of crystal structures, defects and diffusion mechanisms.	1	1,2
CO2	Analyse the phase diagram to predict the different phases, solidification of metals, fracture, creep and fatigue behaviour of the materials	1,2	1,2
CO3	Identify critical points, invariants reactions, effect of cooling and heating on mechanical properties of materials	1,2	1,2
CO4	Understand diversity of materials used in various industries and their specific applications based on their unique properties.	1	1,2
CO5	Understand material characterization techniques and tools necessary to analyse the properties of materials for various applications.	1,5	1,2
CO6	Apply NDT techniques for testing and analysing internal defects of materials.	1,2,5	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 ARTICULATION MATRIX:

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

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

COURSE CONTENT:

Introduction to Crystal Structure, lattice points, unit cell, FCC, BCC, HCP; number of atoms, coordination number, atomic packing factor, defects in crystal structure; point, line, surface and volume defects, Diffusion and diffusion mechanisms, Fick's first law of diffusion.

Phase Diagrams: Isomorphous and eutectic binary phase diagrams, Gibbs phase rule concept of tie line and lever rule, Simple numerical on phase diagrams and lever rule, Solidification of metals and alloys, cooling curves pure metals and alloys, Hume rothery rules, ductile fracture, brittle fracture, creep cure, S-N diagram

Fe-Fe3C Diagram, invariant reactions, different phases, continuous cooling transformation (CCT) diagram, TTT diagram, Hardenability, Jominy-end quench test. Heat treatment; annealing, normalizing, tempering, martempering, austempering, age hardening

Engineering Materials; classification of polymers, ceramics, metals, alloys, advanced materials, nanomaterials, biomaterials and composite materials

Microscopy; working principles of optical microscope and electron microscopes (SEM and TEM) and X-Ray diffraction.

Non-destructive Testing; ultrasonic testing, radiographic testing, magnetic particle testing, die penetrant, acoustic emission testing, Advanced non-destructive testing, computed tomography (CT), digital radiography (DR), infrared thermography (IRT)

TEXT BOOKS:

1. William D. Callister, "Materials Science and Engineering", (Adopted by R. Balasubramaniam), Wiley-Eastern, 2008.
2. Raghavan V, "Materials Science and Engineering - A First Course", Prentice Hall, India, 2007.
3. Non-Destructive Examination and Quality Control, ASM International, Vol.17, 9th Edition, 1989.
4. Ed. Peter.J. Shull, "Non-destructive Evaluation: Theory, Techniques, and Applications", Marcel Dekker, 2002.

REFERENCE BOOKS:

1. James F. Shackelford, "Introduction to Materials Science for Engineers", Prentice Hall, India, 1996.
2. Askeland D.R. and P. P. Fullay, "The Science and Engineering of Materials", 4th Cengage Learning Publishers, 2007.
3. T.V. Rajan, C.P. Sharma and Ashok Sharma, "Heat Treatment – Principles & Techniques", Prentice Hall of India, New Delhi.
4. B.D. Cullit, "Elements of X-ray Diffraction", Addison – Wesley Publishing Company Inc., USA.
5. C. Hellier, Handbook of Non-Destructive Evaluation, McGraw-Hill Professional, 1st Edition, 2001.
6. J. Thomas Schmidt, K. Skeie and P. MacIntire, ASNT Non Destructive Testing Handbook: Magnetic Particle Testing, American Society for Nondestructive Testing, American Society for Metals, 2nd Edition (1989).

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/topics/chemistry/phase-diagrams
2. https://www.sciencedirect.com/topics/chemistry/heat-treatment

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc22_mm05/preview

Course Title	**Manufacturing Technology**				**Course Type**		**Hard Core**	
Course Code	**B24ER0303**	**Credit**	**3**		**Class**		**III Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

Manufacturing technology course covers a broad range of topics related to the processes, techniques, and technologies involved in manufacturing components. The course is designed to understand the concept of various casting and welding processes. Students will be familiarized with various casting and welding defects. Students are introduced to various metal cutting machines like lathe, drilling, shaping and milling machines. The students are exposed to various metal cutting operations. The course focusses on overall view of manufacturing streams in mechanical engineering. The course would encompass a comprehensive study of metal cutting and machine tools. Students will understand the importance of manufacturing in various industries and the role of manufacturing in the economy.

COURSE OBJECTIVES:

The objectives of this course are:

1. To develop the knowledge on casting terminology, patterns selection, molding sand preparation, core making, operation of cupola and defects in casting
2. To incorporate the concepts of various special molding processes used to produce complex mechanical parts.
3. To give exposure on welding processes, equipment and incorporate the knowledge of welding defects and remedies
4. To familiarize the nomenclature of single point cutting tool, chip formation, tool wear, tool materials, and cutting fluids.
5. To give exposure on various machines like lathe, drilling, shaping, and milling machines used in manufacturing of engineering components.
6. To provide knowledge of various operations that can be performed on different machine tools.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Apply the knowledge of casting process to analyze real-world manufacturing challenges and propose potential solutions.	1, 2	1, 2
CO2	Develop a comprehensive understanding of the special molding techniques to develop complex mechanical parts.	1, 2	1, 2
CO3	Gain a solid understanding of the principles of various welding process to provide solutions to issues faced in different metal joining applications.	1	1
CO4	Develop a comprehensive understanding of cutting tool geometry, chip formation, tool wear, tool materials, and cutting fluids.	1	1
CO5	Gain a comprehensive understanding of the principles and working of various machine tools like, lathe, drilling, shaping, and milling machines.	1, 2	1
CO6	Understand the various operations performed on different machine tools and able to select suitable operations for a particular component.	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	2											2	1	
CO2	3	2											2	1	
CO3	3												2		
CO4	3												2		
CO5	2	2											2		

CO6	2	2											2		
Average	**2.7**	**2**											**2**	**1**	

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

COURSE CONTENT:

Introduction: Classification of manufacturing processes.

Metal casting processes: Casting terminology, Pattern – materials, types of patterns, pattern allowances, Moulding tools, Moulding sand – types, additives, properties, Sand moulding methods, Core – core making, types of cores, Cupola furnace – zones, operation, Crucible furnace, Inspection and defects in casting, AI in casting for process optimization.

Special moulding processes: CO_2 moulding, Shell moulding, Investment moulding, Plaster moulding, Ceramic moulding, Die casting – hot chamber and cold chamber, Centrifugal casting – true centrifugal, semi-centrifugal and centrifuged.

Welding processes: Classification, Arc welding – process, equipments, electrodes, TIG & MIG welding processes, Gas welding – process, equipments, flames, Resistance welding – types, Thermit Welding, Friction welding, Laser beam welding, Soldering, Brazing, Welding inspection using machine vision, Welding defects - causes and remedies.

Metal cutting: Introduction, Cutting tool – types, materials, Geometry of a single point cutting tool, Chip formation mechanism, Types of chips, Orthogonal and oblique cutting, Factors affecting cutting tool life, Tool wear – types, Heat generation in metal cutting, Factors affecting heat generation, Cutting fluids – functions, types, ML to predict tool wear.

Lathe: Principle, Specifications, Classification, Engine lathe – components, Capstan and turret lathe – construction and working, Lathe operations.

Drilling machine: Principle, Classification, Radial drilling machine – construction and working, drill bit nomenclature, drilling operations.

Shaping machine: Principle, Classification, horizontal shaper – construction and working, Shaper operations.

Milling machine: Principle, Classification, Horizontal and vertical milling machines – construction and working, Milling operations, Indexing – simple and compound indexing, numerical on simple indexing.

Self-Learning Component: Continuous casting, Electron beam welding, Sensitive drilling machine, Vertical shaper.

CASE STUDIES

1. Prepare a report on significance of casting process in aerospace applications.
2. Prepare a report on recent developments in welding technology and its applications.
3. Develop a python program to estimate the tool life of an end mill cutter.
4. Develop of literature report on various materials and its characteristics used to produce cutting tools.

TEXT BOOKS:

1. S K Hajra Choudhury, A K Hajra Choudhury and Nirjhar Roy, “Elements of Workshop Technology Vol. I & II”, Media promoters and publishers private limited, 15th Edition, 2020.
2. P N Rao, “Manufacturing Technology Vol. I & II”, Tata McGraw Hill, 4th Edition, 2020.

REFERENCE BOOKS:

1. R K Jain, “Production Technology”, Khanna Publishers, 17th Edition, 2005.
2. S Kalpakjian and S R Schmid, “Manufacturing Engineering & Technology”, Pearson Education, 7th Edition, 2018.
3. A Ghosh and A K Mallik, “Manufacturing Science”, East West Press, 2nd Edition, 2010.
4. G C Sen and A Bhattacharyya, Principle of Machine Tools, New Central Book Agency, 2nd Edition, 2009.
5. HMT, “Production Technology”, McGraw-Hill Education, 21st Edition, 2001.

JOURNALS/MAGAZINES

1. Indian Foundry Journal

2. Journal of Manufacturing Process

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc24_me84/preview
2. https://onlinecourses.nptel.ac.in/noc24_me151/preview

Course Title	Strength of Materials				Course Type		Hard Core	
Course Code	B24ER0304	Credit	3		Class		III Semester	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

The Strength of Materials course provides a comprehensive introduction to the fundamental principles and concepts used to analyze and design engineering structures and components subjected to various types of loads. The course covers the behavior of materials under stress and strain, the analysis of stress and deformation, and the application of these principles to real-world engineering problems. This course is essential for students pursuing careers in civil, mechanical, aerospace, and structural engineering.

COURSE OBJECTIVES:

The objectives of this course are:

1. To understand the basic concepts of stress, strain, and material properties.
2. To analyze and design components subjected to axial, torsional, bending, and combined loads.
3. To learn methods for calculating deformations and deflections in structural elements.
4. To apply principles of material strength to ensure the safety and integrity of engineering structures.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Apply Hooke's Law for linear elastic materials, understand its limitations and analyze, Interpret the various regions and points on a stress-strain curve, members subjected to multiple axial loads.	1, 2, 5	1,2
CO2	Construct and analyze shear force and bending moment diagrams for beams under various loading conditions to determine critical points and maximum values of shear force and bending moment.	1, 2, 5	1,2
CO3	Analyze and calculate combined stresses in members subjected to combined axial, torsional, and bending loads.	1, 2, 8	1,2
CO4	Understand and apply the torsion formula to calculate shear stress and angle of twist in circular shafts and design the shaft for specific applications considering factors of safety and allowable stress.	1, 2, 8	1,2
CO5	Apply Euler's critical load formula for columns, understand the concept of buckling and design the columns for specific applications considering slenderness ratio and end conditions as per engineering standard.	1, 2, 8	1,2
CO6	Differentiate between thin-walled and thick-walled cylinders based on the ratio of the wall thickness to the internal radius and calculate the hoop stress and longitudinal stress in thin-walled cylinders.	1,2,8	11,2

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

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

COURSE CONTENT:

Simple Stresses & Strains : Definition of stress and strain, types of stresses & strains, elasticity and elastic limit, Hooke's law , Modulus of Elasticity, Modulus of Rigidity or Shear Modulus, extension/ shorting of bars factor of safety, stress - strain diagram for ductile and brittle materials, constitutive relationship between stress and strain- one dimensional, two dimensional and three dimensional body, Working stress, Factor of safety, Lateral strain, Poisson's ratio & volumetric strain, - Elastic module & the relationship between them (no derivation), Bars of varying sections, analysis of tapered bar of circular cross section- numerical, introduction to composite bars (No numerical) - Temperature stresses.-Simple problems related to temperature stresses. Matlab code for solving the problem and plotting the stress strain curve for brittle and ductile materials.

Compound stresses: Stresses in a three dimensional system, stresses in a two-dimensional system, stress transformation-elements subjected to uni axial direct stress, elements subjected to bi axial direct stresses, elements subjected to general two-dimensional stress system, principal planes and principal stresses, -numerical, Mohr's circles of stress- uni axial direct stress and bi axial direct stresses.

Shear Force and Bending Moment Diagrams: Definition of beams, types of beams, concept of shear force and bending moment, S.F and B.M diagrams for cantilever and simply supported beams subjected to point loads, uniformly distributed load, uniformly varying loads, moment and combination of these loads, matlab code for drawing SFD and BMD.

Bending of Beams: Pure and non-uniform bending, Derivation of bending equation, section modulus for various beam cross sections, numerical on bending of beams with only a symmetrical cross section.

Torsion of Circular Shafts: Theory of pure torsion, Derivation of torsion equations: $T/J=q/r=G\theta/L$, Assumptions made in theory of pure torsion-Torsional moment of resistance – Polar section modulus – Power transmitted by solid and hollow shafts.

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.

Thin and thick Cylinders: Differences between thin and thick cylinders, Thin seamless cylindrical shells – Derivation of longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains, numerical on thin cylinders.

Self-Learning Components: Engineering Materials structure different types of loads, types of beams.

CASE STUDIES:

1. Failure Analysis of Structural Components.

2. Load analysis of the chassis of an automobile.
3. Design and Analysis of Aerospace Structures

TEXT BOOKS:

1. R.K. Bansal, "Strength of Materials", Laxmi Publications, 6th Edition, 2018.
2. Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, David F. Mazurek and Sanjeev Sanghi, "Mechanics of Materials", McGraw Hill, 8th Edition, 2020.
3. S Timoshenko "Strength of Materials", CBS publisher and distributors Pvt Ltd, 3rd Edition, 2021.

REFERENCE BOOKS:

1. S Bhavikatti,"Strength of Materials", Vikas Publications, 4th Edition, 2013.
2. Richard J. Schmidt and Arthur P. Boresi, "Advanced Mechanics of Materials", Wiley Publications, 6th Edition, 2018.

JOURNALS/MAGAZINES

1. Strength of materials, Springer.
2. Mechanics of Materials, Science Direct.

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112107146
2. https://archive.nptel.ac.in/courses/112/106/112106141/

Course Title	**Computer Aided Machine Drawing**				**Course Type**		**Hard Core**	
Course Code	**B24ER0305**	**Credit**	**2**		**Class**		**III Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	2	4	4				
	Total	**2**	**4**	**4**	**0**	**56**	**50%**	**50%**

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:

The objectives of this course are:

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.
5. 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.

6. 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):

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

CO	Course Outcomes	POs	PSOs
CO1	Visualize and formulate detail drawing of a given object.	1,2,5,10, 12	1,2,1
CO2	Design and sketch the orthographic view of square headed and hexagonalheaded bolt and nut assembly as per BIS.	1,2,3,8,10	1,2,1
CO3	Design and sketch single and double riveted lap, butt joints for stated conditions as per engineering standard.	1,2,3,8,10	1,2,1
CO4	Design and sketch details and assembly of cotter joint and knuckle joint for stated conditions as per engineering standard.	1,2,3, 8, 10	1,2,1
CO5	Design and sketch details and assembly of universal coupling for stated conditions as per engineering standard.	1,2,3,8,10	1,2,1
CO6	Create 2D, 3D models and assemble the parts of mechanical systems by using standard CAD software with manufacturing considerations	1,2,3,5,10, 12	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	2			2					2		1	3	1	1
CO2	3	2	2					1		2			3	1	1
CO3	3	2	2					1		2			3	1	1
CO4	3	1	2					1		2			2	1	1
CO5	3	2	2					1		3			3	1	1
CO6	3	2	3		3					3		1	3	1	1
Average	**3.0**	**1.8**	**2.2**		**2.2**			**1.0**		**2.3**		**1**	**2.8**	**1.0**	**1.0**

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

COURSE CONTENT:

Introduction to Geometrical Dimensioning and Tolerance: 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).

Fasteners: Orthographic projection of Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly).
Joints: Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets), Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.
Assembly Drawings: Bushed bearing, Universal coupling, Screw Jack, Machine Vice, Butterfly valve, Preparation of Bill of materials and tolerance data sheet.

Self-Learning Component: Computer Aided Engineering Drawing

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

Course Title	**Manufacturing Technology Lab**				**Course Type**		**Hard Core**	
Course Code	**B24ER0306**	**Credits**	**1**		**Class**		**III Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0				
	Practical	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW:

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. The students are also provided with hands−on experience with the basic machining techniques and using various types of equipment in manufacturing environments. 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:

The objective of this course are:

1. To introduce the experimental procedure in determining the GFN, Permeability, Strength of mould, moisture & clay content in sand sample, core hardness and mould hardness.
2. To give students hands on practice in preparing the sand moulds (Cope & Drag box) using single piece, split pattern and without using pattern.
3. To develop machining skills with appropriate selection of tools.
4. To give students hands on practice in preparing model using lathe, milling machine and shaping machine and 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	Describe the general properties of moulding sand, the influence of grain fineness of silica sand in the preparation of the mould.	1,2, 3,8,9	1,2
CO2	Determine the compression, permeability and shear of a moulding sand for different proportion of clay. the percentage of clay & moisture content for a given	1,2, 3,8,9	1,2
CO3	Develop a sand mould using with or without patterns	1,2, 3,8,9	1,2
CO4	Perform turning, facing, knurling, thread cutting, tapering, eccentric, turning and allied operations using lathe.	1,9	1
CO5	Select cutting parameters like cutting speed, feed, depth of cut and tooling for various machining operations.	1,9	1
CO6	Perform gear cutting operation by using suitable indexing method using milling machine.	1,9	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	1					2	3	3			3	1	3
CO2	3	2	1					2	3	3			3	2	3
CO3	2	1	1					2	3	3			2	2	2
CO4	3								2				2		
CO5	3								2				2		
CO6	3								2	1			2	1	
Average	**2.83**	**1**	**1**					**2**	**2.5**	**1.6**			**2.3**	**1**	**1.3**

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

Part-A

1. Preparation of sand specimens and conduction of the following tests:
   a) Compression, Shear test on Universal Sand Testing Machine.
   b) Permeability test
   c) Sieve Analysis to find Grain Fineness number of Base Sand
   d) Moisture and Clay content determination in Base Sand
2. Preparation of moulds using single piece and Split pattern.
3. Demonstration of basic forging operations

Part-B

1. Preparation of Facing and Turning model
2. Establishing Taper turning and Step turning models
3. Preparing Model involving thread cutting and knurling operations
4. Involute Gear cutting using milling machine and universal dividing head (Demonstration)
5. Cutting V−Groove/Rectangular shapes by using Shaping Machine (Demonstration)
6. Turing operation on CNC Machine (Demonstration)

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.
3. Kalpakjian, Serope, "Manufacturing Engineering and Technology", Addison –Wesley publishing co., New York

REFERENCE BOOKS:

1. Roy A Lindberg, "Process and Materials of Manufacturing", Pearson Education, 4th Edition, 2006.
2 Hajra Choudhury, "Workshop Technology Vol−II", Media Promoters & Publishers Pvt. Ltd. 2004
3. Amitabh Ghosh and Mallik, "Manufacturing Science", affiliated East West Press, 2003
4. G.C Sen & Bhattacharya, "Principle of Machine Tools", Tata McGraw hill, New Delhi.

JOURNALS/MAGAZINES:

1. https://www.sciencedirect.com/science/article/abs/pii/B9780128197264000946
2. International Journal of Machine Tools and Manufacture

SWAYAM/NPTEL/MOOCs

1 https://onlinecourses.nptel.ac.in/noc23_me48/preview
2. https://www.edx.org/course/fundamentals−of−manufacturing−processes
3. https://onlinecourses.nptel.ac.in/noc21_me04/preview

Course Title	**Material Testing Lab**				**Course Type**		**Hard Core**	
Course Code	**B24ER0307**	**Credits**	**1**		**Class**		**III Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0				
	Practical	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**28**	**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:

The objectives of this course are:

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	Understand and study microstructural features such as grain size and phase distribution play crucial roles in determining the strength and hardness of materials and document the result of study.	1,2, 9, 10	1,2
CO2	Determine the impact strength of a material and understand impact strength studies contribute to the development of standardized testing methods (Charpy and Izod impact tests) that ensure consistent and comparable results across different materials and industries and document the result of test.	1,2, 9, 10	1,2
CO3	Identify defects using non-destructive testing methods. Determine of internal and surface defects such as cracks, voids, inclusions, and other discontinuities in material, component, or system without causing damage using NDT method, analyze and document the results.	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	Analyze the surface characteristics of materials through wear tests and assess their hardness using various hardness testing methods.	1,2, 9, 10	1,2,3
CO6	Determine the mechanical properties of materials through experimentation and report the results in a 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. Determination of impact strength of a material using Charpy and Izod tests.
3. Estimating the hardness of various engineering materials by conducting Brinell, Rockwell, and Vickers hardness tests.
4. Non-destructive testing methods, including dye penetration testing, magnetic crack detection, and ultrasonic flaw detection, are used to examine the flaws in cast and welded specimens.

Part-B

1. Estimate the density of composite materials by using the volume method.
2. Conduction of Tensile, shear, and compression tests on metallic and non-metallic specimens with the use of the Universal Testing Machine.
3. Study on how ferrous, non-ferrous, and composite materials wear under various parameters.
4. Conduction of Torsion test of a metal specimen.
5. Conduction of bending test of 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

Course Title	**Course Based Project-1**				**Course Type**		**Hard Core**	
Course Code	**B24ER0308**	**Credits**	**1**		**Class**		**III Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0				
	Practical	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	2	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW

Course based project learning (CBPL) is an instructional methodology that encourages students to learn and apply knowledge and skills through an engaging project. It is a student-centered pedagogy that involves applying theoretical knowledge gained in the classroom to practical, real-world problems. This course allows the students to integrate various aspects of engineering education, including technical skills, problem-solving abilities, teamwork, and communication skills.

COURSE OBJECTIVES:

The objectives of this course are:

1. To create a rich, immersive learning experience that prepares students for the complexities of the real world while making education more engaging and meaningful.
2. To inculcate the process of self-learning and research.
3. To ensure that students not only learn theoretical concepts but also gain valuable hands-on experience, preparing them for the practical demands of their future careers in engineering.

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 and apply ethical principles related to the project, such as sustainability, safety, and social responsibility.	1,6,7	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	1,2,3
CO4	Draw the proper inferences from available results through theoretical / experimental/simulations and adhere to professional standards and practices within the field.	1,2,4,5,8	1,2,3
CO5	Demonstrate project management principles during project work.	9.10,11	1,2,3
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	1,2,3

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	PSO2	PSO3
CO1	3					2	2							
CO2	3	3	2			2							2	
CO3	1								3	3			2	1
CO4	1		2	1	3			2					2	1
CO5									3	2	3		2	1
CO6	1								3	3	2	2	2	1
Average	**1.8**	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**3**	**2.6**	**2.5**	**2**	**2**	**1**

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

COURSE CONTENT:

The team is expected to apply theoretical knowledge gained from the courses studying the current semester to design and create the physical model/mini project to understand the engineering concept/solve specific

engineering problem, develop idea to solve real-world problems. The project integrates various aspects of engineering, science including research, design, implementation, and evaluation.
The students have to make a project team consisting of two, three or four members. Every student in a group shall take up a course based project in the beginning of semester in consultation with the course teachers/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

Course Title	**Soft Skill-1**				**Course Type**		**AEC**	
Course Code	**B24ER0309**	**Credits**	**1**		**Class**		**III Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0				
	Practical	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	2	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW:

This course enables the overall personality skill development encompasses a broad range of attributes that contribute to an individual's ability to interact effectively and harmoniously with others, adapt to various situations, and achieve personal and professional success. Also develop a well-rounded personality that enhances their technical skills and prepares them for successful careers.

COURSE OBJECTIVES:

The objectives of this course are:

1. To develop the ability to articulate ideas and technical concepts clearly and confidently.
2. To develop skills which enhance both oral and written communication capabilities.

3. To impart ability to solve problems, think logically, and understand complex concepts.
4. To develop programming and coding skills that are essential for success in their academic pursuits and future careers in engineering and technology.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Communicate clearly and articulate verbal communication in both formal presentations and informal discussions and express ideas, opinions, and solutions to team members/audience with confidence.	9, 10, 12	3
CO2	Acquire a range of communication skills, from basic language comprehension to advanced verbal reasoning and expression and participate in and contribute to meetings and discussions.	9, 10, 12	3
CO3	Perform better aptitude tests used in recruitment processes, leading to increased job opportunities.	1, 2	3
CO4	Acquire proficiency in C programming language, including understanding syntax, data structures, algorithms, and memory management.	1,2,5,12	1,2,3
CO5	Excel in academic projects and research that require programming knowledge and prepare for advanced studies in computer science and related fields	1,2,5,12	1,2,3
CO6	Work on a wide range of projects, from system-level programming to application development and adapt quickly in the ever-evolving field of technology.	1,2,5,12	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									2	2		2			1
CO2									2	2		2			1
CO3	2	1													1
CO4	2	1			1							1	1	1	1
CO5	2	1			1							1	1	1	1
CO6	2	1			1							1	1	1	1
Average	**2**	**1**			**1**				**2**	**2**			1	1	1

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

COURSE CONTENT

Soft Skill: Removing inferiority complex, building self-confidence, positive thinking, goal setting, SWOT analysis and communication skills.

Verbal Ability Skill: Parts of speech, tenses, sentence formation, correction and improvement.

Aptitude Skill: Speed Math, Percentage, Profit and Loss, Ratio and Proportion, Coding and Decoding, Direction Sense.

Technical Skill: C Programming control flow functions, recursive functions, pointers and arrays, character arrays and strings, string handling functions (strlen, strcpy, strcat, strcmp) pointer manipulation with strings dynamic memory allocation,malloc, calloc, realloc, free handling memory allocation errors pointers and dynamic memory structures and file i/o arrays of structures pointers to structures nested structures unions and enumerations file I/O file handling functions (fopen, fclose, fread, fwrite, fprintf, fscanf) reading from and writing to files binary file operations, reading from and writing to files binary file operations advanced file I/O file pointers and random access error handling in file operations command-line arguments

TEXT BOOKS

1. S P Dhanavel, “English and Soft Skills” Orient BlackSwan, 1st Edition, 2010.
2. Dr. Soma Mahesh Kumar, “Soft Skills: Enhancing Personal and Professional Success”, McGraw Hill, 1st Edition, 2023.
3. R.S Agarwal, “Quantitative Aptitude, Verbal & Non-Verbal Reasoning for Competitive Examination”, S chand, 2nd Edition, 2021.
4. B.W. Kernighan and D.M. Ritchie, "C Programming Language", Prentice Hall Software Series, 2nd Edition, 2005.

REFERENCE BOOKS

1. Shikha Kapoor, “Personality Development and Soft Skill: Preparing for Tomorrow”, Dreamtech Press, 1st Edition, 2020.
2. Arun Sharma and Meenakshi Upadhyay, “Verbal Ability and Reading Comprehension for CAT”, McGraw Hill, Standard Edition, 2022.
3. Herbert Schildt, “C: The Complete Reference”, Tata McGraw Hill, 4th Edition, 2000.

4th Semester

Course Title	Probability and Sampling Theory				Course Type		FC	
Course Code	B24AS0403	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**	**42**	**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

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.

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

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

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.

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, 1st Edition.

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	**B24CS0301**	**Credits**	**1**		**Class**		**IV Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	1	1	1				
	Tutorial	0	0	0				
	Practical	0	0	0	Theory	Practical	IA	SEE
	Total	**1**	**1**	**1**	**14**	**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 OBJECTIVES:

The objectives of this course are:

1. To understand the professional Rules of conduct for Engineers.
2. To appreciate codes of conduct, professional Rules of conduct.
3. To recognize the conflict of interest and Develop strategies
4. To understand the importance of communication with all stakeholders.
5. To 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	3
CO2	Awareness of professional rights and responsibilities of an Engineer, safety and risk benefit analysis of an Engineer	8,9,10	3
CO3	Acquiring knowledge of various roles of Engineer In applying ethical principles at various professional levels	8,9,10	3
CO4	Professional Ethical values and contemporary issues	8,9,10	3
CO5	Apply practical strategies for handling ethical dilemmas	8,9,10	3
CO6	Appreciate codes of conduct, professional Rules of conduct	8,9,10	3

BLOOM'S LEVEL OF THE COURSE OUTCOMES

	Bloom's Level					
CO	**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					1
CO2								3	2	2					1
CO3								3	2	2					1
CO4								3	2	2					1
CO5								3	2	2					1
CO6								3	2	2					1
Average								**3**	**2**	**2**					1

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

COURSE CONTENT:

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.

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.

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.

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.

Course Title	**Universal Human Values**				**Course Type**		**FC**	
Course Code	**B24EE0301**	**Credits**	**1**		**Class**		**IV Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	1	1	1				
	Tutorial	0	0	0				
	Practical	0	0	0	Theory	Practical	IA	SEE
	Total	**1**	**1**	**1**	**14**	**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:

The objectives of this course are:

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

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.

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

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.

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 first 50 percent 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 remaining 50 percent 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. This exam will be conducted during semester end examination slot.

Course Title	**Kinematics and Dynamics of Machines**				**Course Type**		**HC**	
Course Code	**B24ER0401**	**Credit**	**3**		**Class**		**IV Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	2	2	2				
	Tutorial	1	2	2	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	**3**	**4**	**4**	**56**	**0**	**50%**	**50%**

COURSE OVERVIEW:

Kinematics and Dynamics of Machines is a course 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, vehicles. It also aims at the study of controlling forces on governors.

COURSE OBJECTIVES:

The objectives of this course are:

1. To gain the knowledge on mobility of mechanisms, velocity, and acceleration of mechanisms.
2. To analyse velocity and acceleration of mechanism, different tooth forms, mesh, and their arrangements.
3. To understand the gyroscopic effect in aero plane, ship, two−wheeler, and four−wheeler vehicle.
4. To understand the working principle, mechanism, and application of governors.
5. To develop the analytical approach and graphical methods in balancing the unbalanced forces and couples in engine.
6. To understand the load carrying capacity, frictional losses and analyse the performance of journal bearing

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Analyze the motion of four-bar linkage mechanism and its inversions and perform the velocity andacceleration analysis of parts of mechanism.	1,2	1,2
CO2	Identify different types of gears and their applications, calculate gear ratios of gear trains and analyze the speed of gear systems.	1,2	1,2
CO3	Design cam profiles for desired follower motion and understand different types of followers and their applications.	1, 2,3	1,2
CO4	Draw the pressure distribution and hence evaluate the frictional losses, load carrying capacity of journal bearing.	1,2	1,2
CO5	Perform static and dynamic balancing of rotating masses to minimize vibrations	1,2	1,2
CO6	Evaluate the performance of governor and apply knowledge of gyroscopic effects to analyze the behavior of ships, airplanes, and vehicles.	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											1	2	
CO2	3	2											1	3	
CO3	3	2	1										3	1	
CO4	3	2											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:

Introduction: Define and classify the kinematic links, Kinematic pairs, Kinematic Chains, Types of motion ,Computing the degrees of freedom for different types of linkages, condition for the existence of mechanism and identifying whether it is rocker mechanism or crank rocker mechanism etc., inversions of 4 bar chain mechanisms , shaping and slotting mechanisms. Computer techniques on identifying the kind of mechanism.

Velocity and Acceleration of Mechanism: Computation of velocities and acceleration for 4 bar and single slider crank chain mechanism by relative velocity method, computation of velocity for 4 bar and single slider crank chain by instantaneous centre. Computer techniques to evaluate the velocity of mechanism.

Gears and Cams: Classification of gear and gear trains, Law of gearing, Terminology of gears , gear tooth form and comparisons ,Interference and methods to reduce interference, Study of type of follower and motions and numerical on SHM, uniform velocity, Uniform acceleration and retardation motion with knife edge and roller follower.

Journal Bearing: Hydrostatic and Hydrodynamic lubrication, Basic terminologies in design of journal bearing, Load carrying capacity, friction losses in journal bearing, Petroff's equation of pressure loading(derivation included) ,Mechanism of pressure development in journal bearing, Numerical on journal bearing

Balancing of Rotating and Reciprocating Masses: Static and dynamic balancing. Balancing of several rotating masses in same planeand in different planes.

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

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

CASE STUDIES

1. Develop a Python Programming for classifying the mechanisms based on the lengths of mechanism.
2. Develop a Python Program to evaluate the velocity of different mechanisms.

TEXT BOOKS:

1. R K Bansal, "Theory of Machines", Lakshmi Publications, 6th Edition, 2016.
2. V P Singh, "Theory of Machine", Dhanpat Rai & Co, 5th Edition, 2017.

REFERENCE BOOKS:

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

JOURNALS/MAGAZINES

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	B24ER0402	Credit	3		Class		IV Semester	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

Thermal Engineering Systems typically covers the fundamental principles and applications of thermodynamics in engineering. The course play an important role in design of many mechanical, electrical and electronics system. The course is designed to understand the fundamentals of combustion thermodynamics, jet propulsion systems and expose the students to various engineering applications, such as power cycles (Gas, Rankine, and Brayton cycles), refrigeration cycles. Further the course introduce the students to properties of moist air and their applications in air

conditioning systems. Overall, this course equips students with the theoretical foundation and problem-solving skills necessary to analyse thermodynamic systems in engineering and scientific applications.

COURSE OBJECTIVES:

The objectives of this course are:

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 and performance characteristics of gas and vapour power cycles.
4. To develop the knowledge about basic definitions and concepts of refrigeration, psychometry and air-conditioning systems.
5. To provide basic understanding of gas turbine and Jet Propulsion systems.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Analyze the combustion processes using stoichiometric principles to combustion reactions, balancing combustion equation and estimate the percentage of excess air used including the air-fuel ratio.	1, 2	1,2
CO2	Evaluate the performance characteristics of IC engines, including torque, power output, efficiencies and construct heat balance sheet to account for energy flows within these systems.	1, 2	1,2
CO3	Develop a comprehensive understanding of operations of power cycles and apply thermodynamic principles in analyzing the changes in thermodynamic properties, heat transfer and work.	1,2	1,2
CO4	Evaluate the properties of moist air using computing techniques and performance parameters of air-conditioning systems by applying the concept of refrigeration and psychometry with familiarize of various terminologies and process.	1, 2,5	1.2
CO5	Gain a comprehensive knowledge of techniques for optimizing the performance, efficiency of gas turbine and analyze the performance of gas turbine engines including work output and thermal efficiency.	1, 2	1,2
CO6	Gain a comprehensive understanding of operating principles of jet propulsion systems and their applications.	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											2	1	

CO2	3	3											3	2	
CO3	3	3											3	2	
CO4	3	2			1								3	2	
CO5	3	2											2	2	
CO6	2												1	1	
Average	**2.8**	**2.4**			**1**								**2.3**	**1.6**	

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

COURSE CONTENT:

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.

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

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. Simple numerical only on Rankine cycle.

Refrigeration: Vapour compression refrigeration system-description, terms used in refrigeration: refrigeration, refrigerating effect, ton of refrigeration, COP, Properties of refrigerants and types of refrigerant, Vapour 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, Solving simple numerical using computing techniques.

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

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.

Self-Learning Component: Different dynamometers for measuring torque, Carnot vapor cycle, Ram jet engines.

CASE STUDIES:

1. Develop a python programme for analysing (drawing PV diagram) of the Otto 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/

Course Title	**Measurements and Instrumentation**				**Course Type**		**Hard Core**	
Course Code	**B24ER0403**	**Credit**	**3**		**Class**		**IV Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	2	2	2				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	1	2	2				
	Total	**3**	**4**	**4**	**28**	**28**	**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 surface roughness, speed, temperature, pressure. Furthur thus course emphasis on Digital instrumentation which involves the use of electronic devices to measure and display physical quantities, such as temperature, pressure, flow rate, and electrical signals. Students are introduced to the Advances in Metrology and machine vision systems.

COURSE OBJECTIVES:

The objectives of this course are to:

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 temperature measurement.
4. To explore the various aspects regarding the use of electronic devices to measure and display physical quantities and advances in metrology.

COURSE OUTCOMES (COs):

On successful completion of this course, the student shall 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	Illustrate the need of limit system and working of different types of comparators.	**1**	**1**

CO3	Enumerate the pressure, speed, surface, roughness measurement and temperature Measurements.	**1**	**1**
CO4	Elaborate the concept of Digital instrumentation employing electronic devices and machine vision systems in inspection	**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**	**1**	

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

COURSE CONTENT:

Introduction to Metrology: Definition, objectives of metrology, Material Standards, Wavelength Standards, Classification of standards, Line and End standards, Calibration of End bars. Numerical examples. Slip gauges- Indian standards on slip gauges, Wringing of slip gauges, Problems on building of slip gauges (M87, M112).

System of Limits, Fits, Tolerance and Gauging: 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, tolerance grade, design of GO and NO GO gauges using Taylor's principle. Numerical on Limits, Fits and Tolerances.

Comparators: Characteristics and Classification, Mechanical- Johnson Mikrokator, Sigma comparators, Dial indicator, Pneumatic comparators- Principle of back pressure, Solex comparators, Optical comparators- Zeiss ultra optimeter.

Measurement of screw thread and gear: Terminology of screw threads, Measurement of major diameter, Minor diameter, Pitch, Angle and Effective diameter of screw threads by 2- wire and 3-wire methods, Measurement of gear tooth thickness and depth by using gear tooth vernier caliper.

Digital Instrumentation: Digitalization, Implementation Strategy, Data Acquisition, Fundamentals for Measurement and Data Acquisition, Length Measurement in Open Loop, Thermal Measurement and Data-Acquisition Considerations, Data Transfer to Cloud, Internet of Things (IoT) Metrology, Closed-Loop Data Analysis-(In-Process Inspection), Digital Twin Metrology Inspection.

Surface Roughness: Introduction, Factors affecting surface roughness and reasons for controlling, Modes of defining surface texture, Terminologies used: Roughness and waviness, surface texture symbols and specifications, Tomlinson surface meter.

Advances in Metrology: profile projector, tool maker's microscope, co-ordinate measuring machine, Machine Vision in Metrology, Stages of Machine Vision, Applications of Machine Vision in Inspection, laser interferometer.

Temperature Measurement: Resistance thermometer, thermocouple, law of thermocouple, materials used for construction, optical pyrometer and radiation pyrometer

Pressure and speed Measurements: principle, Bridgeman gauge, McLeod gauge, contact and non-contact type measurement

PRACTICE:

Sl. No	Title of the Experiment	Tools and Techniques	Expected Skill /Ability
1.	Calibration of Micrometer by using slip gauges	Sine bar and slip gauges	Material Identification
2	Measurement of angle by using Sine bar	Sine center and slip gauges	Hands on Experience
3.	Measurement of angle by using Sine center	Gear tooth vernier caliper	Hands on Experience
4.	Measurement of taper angle using Roller set method	Micrometer and external thread	Hands on Experience
5.	Measurement of effective diameter using 3 wire method	Surface tester	Hands on Experience
6.	Autocollimator	Lathe tool Dynamometer	Hands on Experience
7.	Measurement of gear tooth thickness using gear tooth vernier caliper	Micrometer, slip gauges	Hands on Experience
8.	Measurement of cutting forces using Lathe Tool Dynamometer.	Specimen, slip gauges and rollers	Hands on Experience
9	Drill Tool Dynamometer.	Comparator	Hands on Experience
10	LVDT	Autocollimator	Hands on Experience

TEXT BOOKS:

1. Engineering Metrology and Measurements, NV Raghavendra, L Krishna murthy, 2013, Oxford publishers. ISBN: 978-0198085492.

2. Mechanical Measurements, Beckwith Marangoni and Leinhard, Pearson Education, 6th Ed., 2006

REFERENCE BOOKS:

1. Engineering Metrology, I C Gupta, Dhanpat Rai Publications, Delhi.

2. Mechanical Measurements and Instrumentation, Er. R K Rajput, S K Kataria & Sons Publications, 2012

JOURNALS/MAGAZINES

1. International Journal of Instrumentation and Measurement.
2. Journal of Instrumentation

SWAYAM/NPTEL/MOOCs:

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

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

Course Title	Industrial Engineering and Industry 4.0				Course Type		Hard Core	
Course Code	B24ER0404	Credit	3		Class		IV Semester	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

In the present scenario the technology advancement including Industry 4.0 plays a vital role in the manufacturing aspects which offers various advantages, which should be backed by management techniques in order to enhance the efficiency. The industrial engineering techniques such as work study, Method study, Work measurement, work sampling along with Industry 4.0 technologies will have a great impact on the production process

COURSE OBJECTIVES:

The objectives of this course are:

1. To provide knowledge of basic Industrial Engineering concepts
2. To incorporate the concept of Work study, method study, time study and work sampling.
3. To give exposure in the field of Productivity, Ergonomics and value analysis.
4. To provide a basic understanding on the role of Industry 4.0 technologies in Industry
5. To incorporate the concepts of Industry 4.0 like Artificial Intelligence, Machine Learning etc.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Develop a comprehensive understanding of the fundamentals of Industrial Engineering and its evolution	1	1,2
CO2	Gain a solid understanding of the fundamental principles of Work study including method study, time study and Work sampling	1, 2	1,2
CO3	Apply the knowledge of Industrial Engineering to analyze real-world challenges and propose potential solutions to improve the productivity of any Process. Also Determine standard time for different process.	1,2,3	1,2,3
CO4	Develop a comprehensive understanding of Productivity, Ergonomics, Value analysis and Value Engineering	1,2	1,2,3
CO5	Gain a comprehensive understanding of the principles of Industry 4.0	1	1,2
CO6	Understand the applications of Industry 4.0 Technologies in various fields, such as manufacturing and service sectors.	1,5	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES:

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

CO4		√	√	√		
CO5		√				
CO6		√	√			

COURSE ARTICULATION MATRIX:

CO / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1											2		
CO2	2	2											2	2	
CO3	2	2	2										2	2	
CO4	1	2	2			1						1	2	2	
CO5	1				2								1	1	2
CO6	1				3								1	1	2
Average	**1.5**	**1.75**	**2**		**2.5**	**1**						**1**	**1.6**	**1.3**	**2**

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

COURSE CONTENT:

Introduction: Definition, Industrial Revolution and historic development of the factory, Primary activities of Industrial engineering, Techniques of Industrial engineering, Applications of Industrial Engineering.

Plant location and layout: Factors influencing plant location, location economics, Selection of specific site. Objectives of plant layout, principles of plant layout, types of plant layout, their merits and demerits, Evaluation of Layouts. .

Work study: Definition of work study & Method study, Basic procedure of work study & Method study,
Use of recording techniques such as outline process, flow process chart, two handed process chart, multiple activity chart, flow diagram, string diagram, Travel chart.

Time study: Definition, Common steps in Time study, Time study method, breaking the task into work elements, types of elements, rating and different methods of rating. Allowances and its types. Calculation of basic time and standard time with numerical.

Work sampling: Principles, Procedure, confidence limits, number of observations required, advantages and disadvantages, applications.

Productivity: Introduction, Indices of Productivity, Factors Affecting Productivity, Productivity Improvement, Difficulties in measuring Productivity, Numerical on Productivity.

Value: Definition, Types of Value, Reasons for Poor Value, Value Analysis, Value Engineering

Ergonomics: Objectives, Man Machine system, Important Aspects of Man Machine system, Anthropometry, Ergonomics and Fatigue, Principe's of motion economy.

Introduction to Industry 4.0: Definition, Importance , Principles, Advantages, Applications and Challenges

Industry 4.0 Technologies: Artificial Intelligence, Machine Learning,3D Printing, Drones, Future Robots, Internet of Things(IOT),Big data ,Augmented reality/Virtual reality, Block chain, Cyber security.

Self-Learning Component: Production Systems, Material Handling, Motion study.

CASE STUDIES

1. Ford Motors –Industrial Engineering Activities and Jobs
2. Industry 4.0 applications at siemens

TEXT BOOKS:

1. V. RAVI, Industrial Engineering and Management, PHI Publisher, 1st Edition.
2. International Labor organization (2001), *Introduction to Work study*, IBH Publishing Co.Pvt.Ltd, 5th Edition.

REFERENCE BOOKS:

1 .M. Mahajan, Industrial Engineering & Production Management, Dhanapat Rai & Co, 5th Edition.

2 Hand book of Industrial Engineering, Maynard.

JOURNALS/MAGAZINES

1. International Journal of Industrial Organization
2. Journal of Industrial and Production Engineering

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc22_me04/preview
2. https://www.coursera.org/learn/industry-4-plm-value-chain-and-smart-factory

<table>
<tr><td>Course Title</td><td colspan="4">Geometric Dimensioning and Tolerance</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B24ERS411</td><td>Credit</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>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Lecture</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>Tutorial</td><td>1</td><td>2</td><td>2</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>4</td><td>4</td><td>56</td><td>0</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

The course is designed in a way to build from the basic concepts of engineering drawing towards more complex concepts. It starts with explaining the importance of an engineering drawing and going on to explain why GD&T the need has arisen and then a deep dive into the concepts of GD&T. This course provides an in-depth understanding of Geometric Dimensioning and Tolerancing (GD&T), a symbolic language used on engineering drawings and models to define the permissible limits of variation in size, form, orientation, and location of features on parts. GD&T ensures that parts fit and function as intended in assemblies and that they are interchangeable. This course skill for engineering students, particularly those involved in mechanical design, manufacturing, and quality assurance. Developing a comprehensive GD&T curriculum can help students understand and apply these standards effectively.

COURSE OBJECTIVES:

The objectives of this course are:

1. To understand the basic concepts and terminology of GD&T and benefits of GD&T in engineering and manufacturing.
2. To Identify and interpret various GD&T symbols used in technical drawings.
3. To comprehend the concept of datum features and datum reference frames.
4. To apply tolerance zones for form, orientation, location, and profile controls.
5. To understand form tolerances (flatness, straightness, circularity, cylindricity) and their applications.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Apply the principles and rules of GD&T based on the ASME Y14.5 standard for creating engineering drawing.	1	1,2
CO2	Represent geometric dimensioning and tolerance symbols in creating production drawings.	1	1,2
CO3	Apply GD&T principles to create accurate engineering drawings that meet industry standards.	1,2,3	1,2

CO4	Analyze and evaluate engineering drawings for accuracy and adherence to GD&T standards.	1,2	1
CO5	Use modern engineering tools and software to apply and analyze GD&T in engineering tasks.	5	1,2,3
CO6	Develop solutions to engineering problems by applying GD&T principles, ensuring product quality and manufacturability.	1,2,3,5	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES:

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

COURSE ARTICULATION MATRIX:

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

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

COURSE CONTENT:

Scope, Definitions, and General Dimensioning: General, References, Definitions, Fundamentals rules, Unit of measurement, Types of dimensioning, Dimensioning features, Location of features.

General Tolerancing and Related Principles: Direct tolerancing methods, Tolerance expression, Interpretation of limits, Single limits, Tolerance accumulation, Limits of size, Applicability of RFS, MMC and LMC, Screw threads, Gear and splines, Virtual condition, Angular surface, Conical tapers, Flat tapers, Radius, Statistical tolerancing.

Symbology: Use of notes to supplement symbols, Symbol construction, Geometric tolerance symbols, Feature control frame placement.

Datum Referencing: Immobilization of parts, Datum features, Specifying datum features in an order of precedence, Establishing datum's, Datum targets.

Tolerances of Location: Positional tolerancing, Fundamental explanational tolerancing, Feature pattern location, Projected tolerance zone, Nonparallel holes, Counterbored holes, Closer control at one end of a feature, Bidirectional positional tolerancing of features, Noncircular features, Coaxially controls, Positional tolerancing for symmetrical relationships, Spherical features.

Tolerances of Form, Profile, Orientation and Runout: Form and orientation control, Specifying form and orientation tolerances, Form tolerances, Profile control, Orentational tolerances, Runout, Free state variation.

Self-Learning Component: Computer Aided Machine Drawing

CASE STUDIES

1. Interpretation of complex engineering drawings, with real-world case studies.
2. Application of GD&T in design and manufacturing, including lab work on CAD software.
3. Detailed study of GD&T symbols and terms with hands-on drawing exercises.

TEXT BOOKS:

1. P S Gill, “Geometric Dimensioning and Tolerancing”, S K Kataria and Sons, 2013 Edition.
2. “ASME Y14.5 -Dimensioning and Tolerancing - Engineering Product Definition and Related Documentation Practices”, ASME, 2018.

REFERENCE BOOKS:

1. Geometric Dimensioning and Tolerancing" by David A. Madsen, David P. Madsen, and Connie M. Dotson
2. James D. Meadows, "Geometric Dimensioning and Tolerancing Textbook and Workbook", Media Promoters & Publishers Pvt. Ltd, 2000. James D. Meadows & Associates, Inc.; First Edition (4 May 2020).
3. David A. Madsen and David P. Madsen, “Geometrical Dimensioning and Tolerancing”, 9th Edition, The Goodheart-Willcox Company, Inc., 2013.
4. Gene R. Cogorno, “Geometrical Dimensioning and Tolerancing for Mechanical Design”, McGraw-Hill, 2006.

JOURNALS/MAGAZINES

1. Journal of Manufacturing Science and Engineering (ASME).
2. Manufacturing Engineering Magazine.
3. Journal of Engineering Design.

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	**Operations and Supply chain Management**				**Course Type**		**Soft Core**	
Course Code	**B24ERS412**	**Credit**	**3**		**Class**		**IV Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

This course provides insight into various fundamental aspects of production planning and forecasting techniques. It also presents various decision making techniques, aggregate and master production planning methods. Various inventory monitoring and control are discussed. Handling dependent demand items and techniques for MRP and continuous improvement methods are also discussed. The course contains routing, dispatching methods and also supply chain managements. Quantitative techniques are used in operations and improving their efficiency and effectiveness. Overall objective of this course is to manage production system in better way.

COURSE OBJECTIVES:

The objectives of this course are:

1. To study the fundamentals of production and Inventory management
2. To provide knowledge about decision making, MRP and ERP systems
3. To introduce the concepts of purchasing and supply chain management
4. To acquire knowledge of production planning operations and its functions

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Comprehensive understanding of the concept in operations management and apply the decision models to solve the real word problems.	1,2,3,5	1,2,3
CO2	Recognize the role of operations management in business functions and organizations strategic planning and forecast the demand	1,2,3,11	1,2,3
CO3	Formulate and analyse aggregate planning and master production schedule concepts	1,2,11	1,2,3
CO4	Analyze inventory models for a range of operations.	1,2,11	1,2,3
CO5	Evaluate a selection of frameworks used in the design and delivery of operations using MRP and ERP	1,2,3,11	1,2,3
CO6	Summarize the concepts of routing, purchasing and SCM.	1, 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	2	1		1								3	1	1
CO2	3	3	1								1		3	1	1
CO3	3	2									1		3	1	1
CO4	3	3									1		3	1	1
CO5	3	2	1								1		3	1	1
CO6	3										1		3	1	1
Average	**3**	**2.**	**1**		**1**						**1**		**3**	**1**	**1**

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

COURSE CONTENT:

Introduction to Process Planning, Control and Forecasting: Definitions, Objectives of production Planning and Control, Functions of production planning and control, Types of production, Organization of production planning and control.

Forecasting: Importance of forecasting, Types, principles, qualitative and quantitative methods, time series methods, Exponential smoothing, Regression methods. Python programing for regression analysis

Operations Decision: Introduction, Characteristics of decisions, framework for Decision Making, Decision methodology, Decision supports systems, Economic models-Break−even analysis in operations, numerical.

Aggregate Planning and Master Scheduling: Planning and Scheduling, Objectives of Aggregate Planning, Aggregate Planning Methods, Master Scheduling Objectives, Master Scheduling Methods, solving numerical using excel

Inventory Management: Definition and need, components of Inventory, inventory control. Functions of inventories, inventory costs, EOQ model, Inventory control systems, P–Systems and Q–Systems, ABC analysis, VED analysis, numerical using Excel

MRP & ERP: Introduction to MRP & ERP, JIT inventory, MRP Logic, Capacity Management, CRP activities. Concept of continuous improvement of process, numerical.

Routing - Dispatching: Definition, Routing & Dispatching procedure, Route sheets, Bill of material, Factors affecting routing procedure. Dispatching –definition and procedure

Supply Chain Management: Introduction to supply chain management– Approaches to purchase and supply chain management, Bull whip effect, make or buy decision, e–Procurement, Vender development, vendor rating methods, Simple numerical using Excel

Self-Learning Component: Routing & Dispatching procedure, Route sheets

CASE STUDIES:

1. SAP successful story of developing ERP software in manufacturing Industry
2. Forecasting of CSP (critical spare parts of an automotive industry)
3. Inventory management (A case study at various manufacturing industries)
4. Implementation of supply chain management of a global enterprise-Honda/TVs/Motorola

.

TEXT BOOKS:

1. Samuel Eilon, "Elements of Production planning and control", Universal publishing Corp., 1st edition, 1999
2. Joseph Monks, "Operations Management –Theory and Problems", McGraw-Hill, 3rd Edition, 1987

REFERENCE BOOKS:

1. Baffa & Rakesh Sarin, "Modern Production / Operations Management", John Wiley & Sons, 8th Edition, 2002.
2. S.N. Chary, "Operations Management", TMH, 1st Edition, 1996
3. Pannerselvam R, "Production and Operation Management", PHI publications, 2nd Edition.
4. Everett E. Adams, Ronald J. Ebert "Production and Operations Management", Prentice Hall of India Publications, Fourth Edition
5. P Rama Murthy, "Production and operations management" 1st edition, New age, 2022

JOURNALS/MAGAZINES:

1. https://www.tandfonline.com/toc/tprs20/current– International journal of Production research
2. https://www.emerald.com/insight/publication/issn/0144–3577–– International journal of operation and production management

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/110107141
2. https://nptel.ac.in/courses/112107238

Course Title	Automotive Engineering				Course Type	Soft Core
Course Code	B24ERS413	Credits	3		Class	IV
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage
	Lecture	3	3	3		

	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

This course introduces mechanical engineering students to the fundamentals and advanced concepts of automotive engineering. The focus is on the development, manufacturing, and maintenance of automotive vehicles. Topics include vehicle dynamics, engine technology, materials, manufacturing processes, and emerging trends in the automotive industry.

COURSE OBJECTIVES:

The objective of course are:

1. To understand the basic principles of automotive engineering.
2. To impart knowledge on vehicle structure
3. To analyze the design and performance of various automotive systems.
4. To develop knowledge of modern automotive technologies and materials.
5. To apply engineering principles to solve problems related to automotive design and manufacturing.
6. To explore current and future trends in the automotive industry.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Describe the construction and working of different components of vehicle	1	1
CO2	Illustrate the working of transmission systems like clutch, gear, axle	1	1
CO3	Understand the concept of steering and suspension system.	1	1
CO4	Understand the various aesthetics and vehicle standards to be maintained while manufacturing	1	1
CO5	Classify the braking system of vehicle based on the speed and performance of the vehicle	1,2	1
CO6	Analyze the vehicle loading and the various standards employed in testing by considering various parameters	1,2,6,7,8	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												1		
CO2	3												1		
CO3	3												1		
CO4	3												1		
CO5	3	1											1		
CO6	3	2				2	2	2					1		
Average	**3**					**2**	**2**	**2**					**1**		

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

COURSE CONTENT:

Vehicle Structure: Introduction to Automotive components, subsystems and their positions - chassis, frame and body - front, rear and four-wheel drives - operation and performance- forces on vehicles, traction force and tractive resistance power required for the automobile - rolling air and gradient resistance.

Transmission System: Clutch: Types- diaphragm type clutch, single and multi-plate clutches – Gearbox: Types- constant mesh, sliding mesh and synchromesh gearbox, layout of gearbox, gear selector and shifting mechanism, overdrive, hydraulic coupling, automatic transmission, propeller shaft, universal joint, slip joint, differential and rear axle arrangement.

Steering System: Types - front and rear suspension, conventional and independent type suspension, leaf springs, coil springs, dampers, torsion bars, stabilizer bars, arms, air suspension systems, active suspension systems, wheels and tires, Nomenclature of tire.

Braking System: Load transfer, brake force distribution, stopping distance, types of brakes - disc & drum brakes, actuation - mechanical, hydraulic, air, engine brakes, anti-lock braking system (ABS), electronic brake force distribution (EBD), traction control system (TCS), electronic stability program (ESP).

Ergonomics and Comfort: Ergonomics: Regulations and requirements, passenger and driver's cabin, dashboard equipment arrangement, positioning of operational controls, human factors, pedal positioning.

Vehicle Testing and Standards: Vehicle performance & emission testing: Energy consumption and emission tests under part load and full load condition of vehicles, grade ability test, road and track testing methods – testing on chassis dynamometers, driving cycles.

CASE STUDIES:

1. Next-generation low carbon vehicles
2. Accelerating Progress in the Automotive Industry with AI
3. High Horsepower Engines Test Cell Design, Construction, and Integration
4. Driving Transformation: A Global Auto Success Story

TEXT BOOKS:

1. Jack Erjavec, Martin Restoule, Stephen Leroux, Rob D. Thompson, Automotive Technology - A Systems Approach, Nelson Education Limited, Canada, 2019
2. James D. Halderman, Automotive Chassis Systems, 7th Edition, Pearson Publishers, US, 2016
3. K.V. Fadadu, B.H.Kadiya, Vehicle Testing And Homologation, First Edition, Books India Publications, 2016.

REFERENCE BOOKS:

1. Bosch Automotive Handbook, 11th Edition, Wiley Publications, 2022.
2. Dr. Kirpal Singh, Automobile Engineering, 13th Edition, Vol 1 & 2, Standard Publishers, New Delhi, 2021

JOURNALS/MAGAZINES:

1. International Journal of Automotive Engineering (https://ijae.jp/)
2. Journal of Automotive Technology
3. SAE (Society of Automotive Engineering) (https://saeindia.org)
4. Automotive Power Train Technology International
5. Industrial Vehicle Technology International
6. Automotive Testing Technology International
7. Race Tech Magazine
8. Auto technician Magazine
9. Motor Trend Magazine

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses
2. https://nptel.ac.in/courses/107103084
3. https://nptel.ac.in/courses/107106088

Course Title	**Fundamentals of Aerospace Engineering**				**Course Type**	**Soft Core**
Course Code	**B24ERS414**	**Credit**	**3**		**Class**	**IV Semester**
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage
	Lecture	3	3	3		

	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

This course serves as an introduction to aerospace engineering, giving students a thorough overview of the subject and its fundamental ideas. The course usually lasts for one semester and combines both theoretical ideas and real-world applications. Physics and mathematics fundamentals are expected of all students. Students exposed to introduction to the aerodynamics, propulsion, and flight mechanics of flight. Study of the effects of weight, lift, drag, and thrust on flight performance. A thorough investigation of air behavior and how it interacts with aircraft. An introduction to the structural, propulsion, electrical, and communication systems of spacecraft. Analyzing the principles and factors involved in structural design for aerospace applications.

COURSE OBJECTIVES:

The Objectives of this course are:

1. To introduce the basics of aircraft and components of an aircraft.
2. To explore the concepts involved in jet propulsion.
3. To familiarize the nozzle used in jet engines
4. To provide the concepts with respect to turbine jet in aircraft engines.
5. To give exposure on the rocket engines.
6. To understand the concept involved in aircraft structures.

COURSE OUTCOMES (Cos)

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

CO	Course Outcomes	POs	PSOs
CO1	Understand the different types of aircraft and their primary components.	1	1,2
CO2	Apply the basic principles of space flight, including the physics of motion in space and the challenges of operating in the space environment.	1	1,2
CO3	Comprehend how lift is generated through Bernoulli's principle and Newton's third law, and how these principles apply to different types of aircraft.	1,2	1,2
CO4	Gain knowledge of the different types of propulsion systems used in aircraft, including piston engines, turboprops, turbojets, turbofans, ramjets, and scramjets.	1	1,2
CO5	Understand the basic principles and physics of rocket propulsion, including Newton's third law of motion and the conservation of momentum.	1	1,2
CO6	Understand the basic principles of aircraft structural design, types of structure, material selection, properties and also understand the basic principles and functions of aircraft instruments used in navigation, communication, and flight control.	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	1	
CO2	3												2	1	
CO3	3	1											2	1	
CO4	2												2	1	
CO5	2												2	1	
CO6	3	1											2	1	
Average	**2.67**	**1**											**2**	**1**	

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

COURSE CONTENTS

Introduction to Aircrafts: History of aviation, International Standard atmosphere, Atmosphere and its properties, Temperature, pressure and altitude relationships, Classification of aircrafts, V/STOL machines, and Modern developments in Aviation like UAV.

Introduction to Space Flight: History of Space Flight & spacecraft technologies Difference between space and atmosphere, upper atmosphere, Introduction to basic orbital mechanics, types of Orbits (LEO, MEO, Geosynchronous and Geostationary, Polar orbits), Kepler's Laws of planetary motion

Basic principles of flight: Significance of speed of sound, Propagation of sound, Mach number, subsonic, transonic, supersonic, hypersonic flows, Bernoulli's theorem, Aerodynamic forces and moments on an Airfoil, Lift and drag components, lift curve, drag curve, types of drag, factors affecting lift and drag; Centre of pressure and its significance, Aerodynamic centre, Aspect ratio, Airfoil nomenclature, Basic characteristics of airfoils, NACA nomenclature, Simple problems on lift and drag.

Aircraft Propulsion: Introduction, Classification, Piston Engine & its application, Brayton cycle, Principle of operation of Turboprop, turbojet and turbofan engines, Introduction to ramjets and scramjets; performance characteristics

Rocket Propulsion: Principles of operation of rocket, Classification of Rockets, Types of rockets and typical applications, Introduction to Space Exploration.

Aircraft Structures: Introduction, General types of construction, Monocoque, Semi-Monocoque and Geodesic structures, typical wing and fuselage structure; Metallic and non-metallic materials for aircraft application. Use of aluminum alloy, titanium, stainless steel and composite materials.

Aircraft Instruments: Instrument Displays, Introduction to Navigation Instruments, Basic Air data systems & Probes, Mach meter, Air speed indicator, Vertical speed indicator, Altimeter, Gyro based instruments.

TEXT BOOKS:

1. John D. Anderson, "Introduction to Flight", McGraw-Hill Education, 8th Edition, 2015.
2. Lalit Gupta and O P Sharma, Fundamentals of Flight Vol-I to Vol-IV, Himalayan Books. 2006.

REFERENCE BOOKS:

1. Ian Moir, Allan Seabridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 3rd edition, 2011, ISBN: 9781119965206
2. Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 9th Edition, 2016.
3. A.C. Kermode, "Flight without formulae", Pearson Education India, 5th Edition, 1989.
4. Nelson R.C., "Flight stability and automatic control", McGraw-Hill, 2nd Edition, 1998.

Course Title	**Kinematics and Dynamics lab**				**Course Type**	**Hard Core**
Course Code	**B24ER0405**	**Credits**	**1**		**Class**	**IV Semester**
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage
	Lecture	0	0	0		

Tutorial	0	0	0				
Practical	1	2	2	Theory	Practical	IA	SEE
Total	**1**	**2**	**2**	**0**	**28**	**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:

The objectives of this course are:

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, comapre the analytical and computuoinal results, prepare the document of results.	1,2, 5, 9, 10	1, 2
CO2	Use CAE tool in order to model and validate the velocity and acceleration of mechanisms and document the results.	1,2,5, 9, 10	1, 2
CO3	Evaluate the performance characteristics of a porter governor and document the work.	1, 2, 9, 10	1, 2
CO4	Determine the stability, direction of motion for a gyroscopic couple and prepare the result of the experiments.	1, 2, 9, 10	1, 2
CO5	Examine the balancing of engine and document the results.	1, 2, 9,10	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	2			3	3	1
CO2	3	2			2				2	2			3	3	1
CO3	3	2							2	2			2	3	1
CO4	2	2							2	2			3	3	
CO5	3	2							2	2			3	2	

CO6	3	2							2	2			3	3	
Average	**2.7**	**1.8**			**2**				**2**	**2**			**2.8**	**2.8**	**1**

COURSE CONTENT:

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. Determination of the magnitude, position of unknown rotating masses using balancing machine experimentally.
2. Determination of the power, effort, controlling force and sensitiveness of the porter governor experimentally.
3. Determination of gyroscopic couple, angle of precision for a rotating disc experimentally.
4. Study of pressure distribution of oil in journal bearing 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	**B24ER0406**	**Credits**	**1**		**Class**		**IV Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0				
	Practical	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW

Heat engine lab deals with the conduction of experiments to find the various properties of fuel such as Flash point, Fire point, Calorific value, Viscosity and these properties are essential to find the alternative fuel for IC engine. This course also deals with study of different parts of multicylinder engine. This course enables the students to have hands on experience to conduct performance test on IC engines. The students must conduct the experiments to find the performance test on Centrifugal blower and reciprocating compressor. The practical work enables the students to gain expertise and become familiar in automobile sector. This course also focuses on study of speed control on electric motor.

COURSE OBJECTIVES:

The objective of this course are to:

1. The course will provide a basic understanding of fuel properties and its measurements using various types of measuring devices.
2. Study the working and parts of multicylinder engine and speed control of Electric Motor.
3. Give students hands on practice to evaluate the performance of petrol and diesel engines.
4. Understand the performance characteristics of compressor and blower.
5. Analyzing Coefficient of Performance for refrigeration and air conditioning systems.
6. Gain the knowledge on 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	Identify and explain the different parts of multicylinder engine and study speed control of Electric motor.	1,2,9,10	1
CO2	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.	1,9	1,2
CO3	Conduct experiments, interpret, and analyze the performance of 4 stroke petrol engine and 4-stroke diesel engine and document the results in the form of technical report.	1,2,9,10	1,2
CO4	Evaluate the frictional power in a multi cylinder engine by conducting Morse test and prepare the report	1,2,9,10	1,2
CO5	Conduct experiments, interpret, and analyze the performance of Refrigeration and Airconditioning system 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 performance of 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	3	2							1	2			2		
CO2	2		1						1	2			3	1	1
CO3	3	2	1						3	2			3	1	1
CO4	3		1						3	2			3	1	1
CO5	3	3	1						3	2			3	1	1
CO6	3	3	1						3	2			3	1	1
Average	**2.8**	**2.5**	**1**						**2.3**	**2**			**2.8**	1	**1**

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

COURSE CONTENT:

Part-A

1. Determination of Flash point and Fire point of lubricating oil using Cleveland's (Open Cup) Apparatus.
2. Determination of Viscosity of a lubricating oil using Redwoods Viscometer.

3. Determination of Calorific value of gaseous fuels.
4. Conduct a speed control test on Universal Electric Motor.
5. Study on various parts of an Automobile vehicle Engines in REVA-Toyota Center of Excellence

Part-B

1. Performance Tests on following 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 I.C. Engine.
2. Performance test on two stage Reciprocating air compressor.
3. Performance test on Centrifugal air blower.
4. Performance test on vapour compression refrigerator and air conditioner.

TEXT BOOKS:

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. 2010
4) Complete Book of Electric Vehicles Domus Books, Revised Edition, 1981.

JOURNALS/MAGAZINES:

1. The International Journal of Engine Research, SAGE Journal, https://journals.sagepub.com/metrics/jer
2. Combustion and flame, https://www.sciencedirect.com/journal/combustion-and-flame

SWAYAM/NPTEL/MOOCs:

1. https://www.coursera.org/learn/thermodynamics-intro
2. https://archive.nptel.ac.in/courses/112/103/112103262

<table>
<tr><td>Course Title</td><td colspan="4">Course Based Project-2</td><td colspan="2">Course Type</td><td colspan="2">Hard Core</td></tr>
<tr><td>Course Code</td><td>B24ER0407</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>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>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>Practical</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 OVERVIEW:

Course based project learning (CBPL) is an instructional methodology that encourages students to learn and apply knowledge and skills through an engaging project. It is a student-centered pedagogy that involves applying theoretical knowledge gained in the classroom to practical, real-world problems. This course allows the students to integrate various aspects of engineering education, including technical skills, problem-solving abilities, teamwork, and communication skills.

COURSE OBJECTIVES:

The Objectives of this course are:

1. To create a rich, immersive learning experience that prepares students for the complexities of the real world while making education more engaging and meaningful.
2. To inculcate the process of self-learning and research.
3. To ensure that students not only learn theoretical concepts but also gain valuable hands-on experience, preparing them for the practical demands of their future careers in engineering.

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 and apply ethical principles related to the project, such as sustainability, safety, and social responsibility.	1,6,7	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	1,2,3
CO4	Draw the proper inferences from available results through theoretical / experimental/simulations and adhere to professional standards and practices within the field.	1,2,4,5,8	1,2,3
CO5	Demonstrate project management principles during project work.	9.10,11	1,2,3
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	1,2,3

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	2						3		
CO2	3	3	2			2							3	2	
CO3	1								3	3			3	2	1
CO4	1		2	1	3			2					3	2	1
CO5									3	2	3		3	2	1
CO6	1								3	3	2	2	3	2	1
Average	**1.8**	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**3**	**2.6**	**2.5**	**2**	**3**	**2**	**1**

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

COURSE CONTENT:

The project team is expected to apply theoretical knowledge gained from the courses studying the current semester to design and create the physical model/mini project to understand the engineering concept/solve specific engineering problem, develop idea to solve real-world problems. The project integrates various aspects of engineering, science including research, design, implementation, and evaluation.

The students have to make a project team consisting of two, three or four members. Every student in a group shall take up a course based project in the beginning of semester in consultation with the course teachers/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

Course Title	**Soft Skill-2**				**Course Type**		**AEC**	
Course Code	**B24ER0408**	**Credits**	**1**		**Class**		**IV Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	0	0	0				
	Tutorial	0	0	0				
	Practical	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	2	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW:

This course enables the overall personality skill development encompasses a broad range of attributes that contribute to an individual's ability to interact effectively and harmoniously with others, adapt to various situations, and achieve personal and professional success. Also develop a well-rounded personality that enhances their technical skills and prepares them for successful careers.

COURSE OBJECTIVES:

The Objectives of this course are:

1. To develop the ability to articulate ideas and technical concepts clearly and confidently.
2. To develop skills which enhance both oral and written communication capabilities.
3. To impart ability to solve problems, think logically, and understand complex concepts.
4. To develop programming and coding skills that are essential for success in their academic pursuits and future careers in engineering and technology.

COURSE OUTCOMES (COs):

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

CO	**Course Outcomes**	**POs**	**PSOs**

CO1	Communicate effectively, efficiently and articulate verbal communication in both formal presentations and informal discussions and express ideas, opinions, and solutions to team members/audience with confidence.	9, 10, 12	3
CO2	Acquire a range of communication skills, from basic language comprehension to advanced verbal reasoning and expression and participate in and contribute to meetings and discussions.	9, 10, 12	3
CO3	Perform better aptitude tests used in recruitment processes, leading to increased job opportunities.	1, 2	3
CO4	Acquire proficiency in C++ programming language, including understanding syntax, conditional statements, Functions, arrays and pointers, algorithms, and memory management.	1,2,5,12	1,2,3
CO5	Excel in academic projects and research that require C++ programming knowledge and prepare for advanced studies in computer science and related fields	1,2,5,12	1,2,3
CO6	Work on a wide range of projects, from system-level programming to application development and adapt quickly in the ever-evolving field of technology.	1,2,5,12	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									2	2		2			1
CO2									2	2		2			1
CO3	2	1													1
CO4	2	1			1							1	1	1	1
CO5	2	1			1							1	1	1	1
CO6	2	1			1							1	1	1	1
Average	**2**	**1**			**1**				**2**	**2**			1	1	1

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

COURSE CONTENT

Soft Skill: Layers of communication, types of communication, 7C's of communication, LWRS, grooming etiquette, handling stress, creative thinking.

Verbal Ability Skill: Reading comprehension, error spotting, synonyms and antonyms.

Aptitude Skill: Number system, HCF and LCM, time, speed and distance, time and work, alpha numerical series and coded blood relation.

Technical Skill: C++ Overview of C++ Installing a C++ compiler and IDE Writing and running a C++ program, Basic syntax: variables, data types, and operators Input and output in C++ With example programs Conditional statements: if, else, switch Loops: while, do-while, for, Functions: defining

functions, parameters, return values Function overloading and scope Recursion in C++ With company specific examples, Arrays: declaration, initialization, and manipulation, Pointers: basics, pointer arithmetic Dynamic memory allocation and deallocation With company specific examples, Strings Introduction to Object-Oriented Programming (OOP) Classes and Objects Constructors and Destructors With company specific examples Inheritance and its types Polymorphism and types Method overloading and overriding Operator overloading With company specific examples Encapsulation, Abstraction and Access modifiers Friend function and virtual function With company specific examples Reading and writing to files in C++ Exception handling: try, catch, throw Standard exceptions Custom exception classes With company specific examples.

TEXT BOOKS:

1. S P Dhanavel, "English and Soft Skills" Orient BlackSwan, 1st Edition, 2010.
2. Dr. Soma Mahesh Kumar, "Soft Skills: Enhancing Personal and Professional Success", McGraw Hill, 1st Edition, 2023.
3. R.S Agarwal, "Quantitative Aptitude, Verbal & Non-Verbal Reasoning for Competitive Examination", S chand, 2nd Edition, 2021.
4. Scott Meyers, "Effective C++: 55 Specific Ways to Improve Your Programs and Designs", Addison-Wesley Professional, 3rd Edition, 2005.

REFERENCE BOOKS:

1. Shikha Kapoor, "Personality Development and Soft Skill: Preparing for Tomorrow", Dreamtech Press, 1st Edition, 2020.
2. Arun Sharma and Meenakshi Upadhyay, "Verbal Ability and Reading Comprehension for CAT", McGraw Hill, Standard Edition, 2022.
3. E. Balagurusamy, "Object Oriented Programming with C++", McGraw Hill, 8th Edition, 2020

5th Semester

Course Title	Smart Materials and Intelligent Mechanical Systems				Course Type		Open Elective	
Course Code	B24MEO501	Credit	3		Class		V Semester	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment In Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**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 Intelligent based devices 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):

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

CO	Course Outcomes	POs	PSOs
CO1	Demonstrate the fundamental knowledge of smart materials, smart structures, piezoelectric, MR, ER fluids to solve problems in the field of medicine and engineering.	1,2	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	2
CO4	Recognize the need of analysis to good problem definition of smart structures.	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	1
CO6	Illustrate the relevant methods and techniques of advances in Sensing applications of smart sensors of structural health monitoring.	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	1	2											1		
CO2	1	2											1		
CO3	1	2												2	
CO4	1	2												2	
CO5	1	2												2	
CO6	1	2												2	
Average	**1**	**2**											**1**	**2**	

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

COURSE CONTENT:

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 and Fluids (SMAs) - Shape memory effect - Shape memory polymers, Introduction to Electro-active Materials, Electro-active Polymers, Ionic Polymer - Electro-rheological Fluids - Magneto Rhelological Fluids.

Smart Actuators: Modelling Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magnetovolume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control.

Smart Composites: Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on the Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, governing Equation of Motion.

Advances in Smart Structures; Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials.

Intelligent Based Devices, Piezoelectric Inchworm devices, Inchworm devices for Actuation, Sizes and Specifications, Inchworm devices for Locomotion, Unimorph Thunder, Rainbow Actuator**,** Active Elasto-dynamic Motion.

Applications: Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, MEMS - MEMS Product development - Deployment devices - Molecular machines.

Sensing Applications; Piezeoelctric Strain Sensors, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM).

TEXT BOOKS:

1. Mohsini Shahenpoor (Ed.), “Fundamentals of Smart Materials”, RSC, Cambridge, UK, 2020
2. Chander Prakash, Sunpreet Singh, J. Paulo Davim (Ed.), Functional and Smart Materials, CRC Press, 1st Edition, 2021.
3. Chang Liu, “Foundation of MEMS”, Pearson Education (ISBN: 9788131764756).
4. M .V. Gandhi and B. S. Thompson, “Smart Materials and Structures”, Chapmen & Hall, London, 1992
5. Mel M. Schwartz, “Smart Materials”, CRC Press, 2009.
6. Donald J. Leo, “Engineering analysis of smart material systems”, John Wiley & Sons, 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	**Machine Design-1**				**Course Type**		**Hard Core**	
Course Code	**B24ER0501**	**Credit**	**3**		**Class**		**V Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	2	2	2				
	Tutorial	1	2	2	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	3	4	4	**56**	**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, welded and bolted joints, power screws and impact strength

COURSE OBJECTIVES:

The objectives of this course are:

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 shafts.
5. To introduce the concept of safe design of riveted, welded and bolted joints in industry applications.

COURSE OUTCOMES (COs):

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

CO	**Course Outcomes**	**POs**	**PSOs**
CO1	Apply concepts of the stresses in a machine element with the use of computing tools and predict failure of components by applying theories of failure.	1, 2, 5	1,2
CO2	Evaluate the effect of impact load and Apply the Soderberg’s and Goodman’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	1,2,3
CO6	Design the Fasteners and Power screws for different applications as per ISO standards.	1,2,3,6,8	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	2			1								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	1
CO6	3	2	2			1		2					3	3	1
Average	**3**	**2.4**	**2.3**		**1**	**1**		**2**					**3**	**3**	**1**

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

COURSE CONTENT:

Introduction: Definition of Normal, shear, biaxial and triaxial stresses, Stress tensor, Principal stresses, Failure of brittle materials and ductile materials, Factor of Safety, Design considerations: Codes and Standards.

Design for Static Strength: Static loads subjected to Axial, Bending and torsion loads, and solution to simple problems using computing tools.

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

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

Design for Fatigue Strength: Introduction to S-N Diagram, Low cycle and High cycle fatigue, Endurance limit, Endurance limit modifying factors, size, surface and load factor, Stress concentration effects, Goodman's and Soderberg's relationship, Simple numerical (no combined loading).

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 Joints: knuckle joint and cotter joint, threaded Fasteners: Stresses in threaded fasteners, Effect of initial tension, Design of threaded fasteners under static loading, Riveted Joints, Welded Joints (without Eccentric loading).

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

Self-Learning Component: Introduction to S-N Diagram, Low cycle and High cycle fatigue.

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

DATA HAND BOOKS

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

REFERENCE BOOKS:

1 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.
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. Robert L. Norton, "Machine Design", Pearson Education Asia, 2001.

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:

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in
2. https://nptel.ac.in/courses

Course Title	**Fluid Mechanics and Machines**				**Course Type**		**Hard Core**	
Course Code	**B24ER0502**	**Credit**	**3**		**Class**		**V Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

Fluid Machines and Machines have a wide scope and are of prime importance in almost all fields of engineering. The course emphasizes the basic underlying fluid mechanical principles governing energy transfer in a fluid machine and also description of the different kinds of hydraulic and air machines along with their performances. There is a well-balanced coverage of physical concepts, mathematical operations along with examples and exercise problems of practical importance. After completion of the course, the students will have a strong foundation on Fluid Machines and will be able to apply the basic principles, the laws, and the pertinent equations to engineering design of the machines for required applications.

COURSE OBJECTIVES:

The objectives of this course are:

1. To introduce fluid properties, measurement of fluid pressure and behaviour of fluids at rest.
2. To identify the flow characteristics and dynamics of flow field for Engineering Applications.
3. To know the importance of major and minor losses of fluid flows through pipes.
4. To understand the main properties of viscous flow and flow over the immersed bodies.

5. To analyze the velocity components and energy transfer in fluid machines.

COURSE OUTCOMES:

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

CO	Course Outcomes	POs	PSOs
CO1	Solve practical problems involving fluid properties and hydrostatic pressure, and predict the stability of floating bodies.	1,2	1,2
CO2	Apply the principles of fluid kinematics, fluid dynamics and dimensional analysis for to solve fluid problems and utilize it for model testing of fluid machineries	1,2,5	1,2
CO3	Estimate the pumping power by considering major and minor losses in flow through pipes.	1,2	1,2
CO4	Apply the fundamentals of fluid flow for analyzing flow of viscous fluid through pipes and around immersed bodies.	1,2	1,2
CO5	Apply the fundamental concepts of energy conversion principles for analyzing 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)**	**Analyse (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	1									3	2	
CO2	3	3	1	1	3								3	2	
CO3	3	3	1	1									3	2	
CO4	3	3	1	1									3	2	
CO5	3	3	1	1									3	2	
CO6	3	3	1	1									3	2	
Average	**3**	**3**	**1**	**1**	**2**								**3**	**2**	

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

COURSE CONTENT:

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

Fluid Statics: Pascal's law, Hydrostatic law, absolute, gauge, atmosphere, and vacuum pressure, Manometers simple and differential manometers. Discussion on Total pressure, Centre of pressure, Buoyancy, Centre of buoyancy, Metacenter and Meta centric height, Numerical.

Fluid kinematics: Types of fluid flow, flow lines, three dimensional continuity equation in (Cartesian co-ordinate system), velocity and acceleration, Discussion on velocity potential function and stream function.

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

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

Flow through Pipes: Frictional loss in pipe flow, Darcy-Weisbach equation and Chezy's equation for loss of head due to friction in pipes, Discussion on minor loses in pipes, hydraulic gradient line and total energy line, Numerical.

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.

Energy Exchange in Fluid machines: Fluid flow through a generalized turbomachine, Euler's turbine equation.

Centrifugal Pumps: Parts of centrifugal pump, different heads and efficiencies of centrifugal pump, minimum speed for starting the pump, Work done by the Centrifugal pump, Pumps in series and parallel. Numerical.

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 python programming for plot and visualization of stream line of fluid flow.
2. Conduct the experiment to determine the coefficient of friction for fluid flowing through pipes of different diameter and compute the same using MAT lab.
3. Prepare a report on any pumps used in Agricultural field/ Industry by mentioning following details: Make and specifications, operating conditions, construction, working principle, and applications.
4. Prepare a report on any Mini or Macro hydroelectric 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. Dr. Bansal, "A text book of Fluid Mechanics and Hydraulic Machines", R.K.Lakshmi Publications Pvt. Ltd, 9th Edition, 2018.
2. D S Kumar, "Fluid Mechanics, S.K. Kataria & Sons, 2nd Edition, 2022

REFERENCE BOOKS

1. Yunus A. Cengel and John M.Cimbala, "Fluid Mechanics", 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	**Automation Technologies for Manufacturing**				**Course Type**		**Hard Core**	
Course Code	**B24ER0503**	**Credit**	**3**		**Class**		**V Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

This course provides a comprehensive understanding of automation technologies used in modern manufacturing environments and fluid power systems. Students will learn about various automation systems, including robotics, programmable logic controllers (PLCs), industrial sensors, principles, components and applications of hydraulic and

pneumatic systems in various engineering fields. The course will cover topics such as system design, integration hydraulic and pneumatic components, circuit design, system maintenance and troubleshooting. Through lectures and hands-on lab sessions, students will gain both theoretical & practical skills in designing, implementing, and optimizing automated manufacturing systems to improve efficiency, quality, and productivity.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the principles and components of automation systems used in manufacturing.
2. Explore different types of industrial robots, their applications, and programming methods.
3. Learn about programmable logic controllers (PLCs) and their role in automated control systems.
4. Explore the use of industrial sensors for monitoring and control in manufacturing environments.
5. Understand the principles of system integration and automation network protocols.
6. Explore the components and functions of hydraulic and pneumatic systems, including pumps, valves, actuators, and control devices.
7. Gain proficiency in hydraulic and pneumatic circuit design and analysis.
8. Develop skills in designing, troubleshooting, and optimizing automated manufacturing systems.
9. Apply knowledge and skills acquired to real-world automation projects and case studies.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Develop a comprehensive understanding of the fundamental principles and concepts of automation technologies to enhance productivity, quality, and efficiency in manufacturing processes	1,2	1,2
CO2	Gain a solid understanding of the fundamental principles of automation systems i.e., Robotics, PLC's (Programmable Logic Controllers) and characteristics of automation components i.e., sensors, actuators and industrial networks.	1,2,5	1,2
CO3	Gain proficiency in operating automation systems & develop skills in writing code, configuring parameters and troubleshooting common issues in automation systems.	1,2,3	1,2
CO4	Understanding of the fundamental principles of fluid power transmission & comprehend the differences between hydraulic and pneumatic systems and their respective applications in engineering.	1,2	1
CO5	Gain proficiency in designing and analyzing the hydraulic and pneumatic circuits for various applications using mathematical model.	1,2,3,5	1,2
CO6	Understand the application of fundamental principles of electro-pneumatic systems, including the interaction between electrical and pneumatic components including solenoid valves, Limit switches, Push Button, pneumatic cylinders, relays and sensors.	1,2,6,9	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	1											2	1	
CO2	3	2			1								2	1	
CO3	3	1	3										2	1	
CO4	3												2		
CO5	3	2			1								2	1	
CO6	3	2	3			3			3				2	1	3
Average	**3**	**1.6**	**3**		**1**				**3**				**2**	**1**	**3**

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

COURSE CONTENT:

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.

Manufacturing Support System: Process Planning, Computer Aided Process Planning, and Concurrent Engineering& Design for Manufacturing, Advanced Manufacturing Planning, Just−in Time Production System, Basic concepts of lean manufacturing tools and techniques and Agile manufacturing.

Group Technology and Flexible Manufacturing Systems: Part Families, Parts Classification and coding, Production Flow Analysis, Cellular Manufacturing. FMS Components, Layout, Application and benefits.

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.

Hydraulic Systems: Hydraulic fluids-types, properties, and selection criteria, Hydraulic pumps, actuators and valves

Pneumatic Systems: Pneumatic fluids-properties, compressibility, and contamination control, Pneumatic Compressors, actuators and valves.

Elements of electro-pneumatic: Advantages over hydraulics & pneumatic control, solenoid valves, relays, factory automation sensors, electrical sensors, process automation sensors and their interfaces.

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**.**
4. Performance evaluation of double acting hydraulic cylinder circuit using FLUIDSIM Software
5. Study on hydraulic system contamination control.

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. Anthony Esposito, “Fluid Power with Applications”, Pearson Education, 7th Edition, 2013.
4. Majumdar S.R, “Oil Hydraulics”, Tata McGraw−Hill, New Delh, 2017.
5. John R. Hackworth & Frderick D. Hackworth Jr, “Programmable Logic Controllers – Pogramming 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 Private Limited, Revised2nd Edition, 2011.
4. Nakra, B. C., “Theory and Applications of Automatic Controls”, New Age International Publishers, 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.
7. Majumdar S.R, “Pneumatic systems – Principles and Maintenance”, Tata McGraw Hill, New Delhi, 2017.
8. James R. Daines, Martha J. Daines, “Fluid Power: Hydraulics and Pneumatics”, Goodheart−Willcox; 3rd Edition, 2021.

JOURNALS/MAGAZINES:

1. https://www.sciencedirect.com/search?qs=automation
2. https://asmedigitalcollection.asme.org/manufacturingscience
3. https://www.industrialautomationindia.in/
4. https://www.sciencedirect.com/journal/procedia engineering.
5. https://link.springer.com/article/10.1631/jzus.A1500042

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/112103293
2. https://www.digimat.in/nptel/courses/video/112104288/L01.html
3. https://nptel.ac.in/courses/ 112106300/
4. https://nptel.ac.in/courses/ 112105046/

Course Title	Engineering Economics and Financial Markets				Course Type		Hard Core	
Course Code	B24ER0504	Credits	3		Class		V Semester	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

This subject explores the importance of economics in the industries. Engineering economics is an interdisciplinary subject in which financial aspect of the industrial product and investment interest rates are discussed. The course emphasis on evaluation of different interest rates, comparison of different alternatives using PW, AW, FW and Internal rate of return. This subject also deals with evaluation of selling price and depreciation, financial markets such as NSE, BSE, Equity.

COURSE OBJECTIVE:

The objectives of this course are:

1. To Study principles and techniques of economic evaluation in different field of Engineering
2. To know the assessment procedure for the evaluation of alternatives.
3. To calculate interest under various conditions.
4. To learn Budgeting process and its preparation.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Illustrate the economic strength of organization in the decision making process related to Engineering application	1,2,11	1
CO2	Apply the concept of different Interest and Interest factors to evaluate interest rate.	1,2,11	1
CO3	Estimate the Present, annual and future worth comparisons for each of the cash flows	1,2,11,12	1
CO4	Demonstrate the knowledge to estimate the rate of return, depreciation charges and income taxes.	1,2,11,12	1
CO5	Understand and apply the concepts of various financial ratios.	1,2,11	1
CO6	Enumerate different cost entities in estimation and costing, budgeting.	1,2,3,11,12	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	3	
CO2	3	3									3		3	3	
CO3	3	3									3	1	3	3	
CO4	3	3									3	1	3	3	
CO5	3	3									3		3	3	
CO6	3	3	2								3	1	3	3	
Average	**3**	**3**	**2**								**2**	**1**	**3**	**3**	

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

COURSE CONTENT:

Introduction to Engineering Economy: Introduction to Indian Economy, Basic terminologies used in economy, Engineering Decision-Makers, Engineering and Economics, Problem solving and Decision making. 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, Simple Exercises.

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.

Estimation, Costing and Final Accounts: Estimation for simple components (with calculations of all types of costs involved in it). Introduction, Scope of Finance, and Finance Functions, Statements of Financial Information: Source of financial information, financial statements, Balance sheet, Profit and Loss Account, Simple Numerical

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. Privatization Initiatives: A Source for Engineering Economy
2. Decision Making Using Engineering Economic Tools: A Real Case Study

TEXT BOOKS:

1. Riggs J.L., "Engineering Economy", McGraw Hill, 2004.
2. Blank, L., & Tarquin, A. "Engineering Economy", 9th Edition. McGraw-Hill, 2019
3. Frederic S Mishkin & Stanley Eakins, "Financial Markets and Institutions", Pearson, 2017

REFERENCE BOOKS:

1. Pathak Bharti, "Indian Financial System", Pearson, 2018.
2. O P Khanna, "Industrial Engineering and Management", Dhanpat Rai & Sons. 2000.

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/110105053
2. https://nptel.ac.in/courses/110105035
3. https://nptel.ac.in/courses/112107209

Course Title	Energy Technology				Course Type		Hard Core	
Course Code	B24ER0505	Credits	3		Class		V Semester	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**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. As the world shifts towards sustainable energy solutions, knowledge in different energy resources is crucial for developing and managing environmentally friendly power plants. 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:

The objectives of this course are:

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 energy resources available in the nature and conversion of steam energy in to electrical energy using steam and nuclear power plant, nuclear waste disposal methods.	1,6,7	1
CO2	Analyze the water resources for the generation of electricity using hydel plants and plot the hydrograph, flow duration curve using computing technique.	1,2, 5, 6,7	1,2
CO3	Demonstrate the concept of energy conversion from solar, hydrogen energy resources and its applications.	1,6,7	1
CO4	Discuss the principles of energy conversion of wind, ocean energy resources	1,6,7	1
CO5	Elaborate the main characteristics of biomass energy source and construction factors of biogas digesters.	1,6,7	1
CO6	Illustrate 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					1	1						3		
CO2	3	2			2	1	1						3	1	
CO3	3					1	1						3		
CO4	3					1	1						3		
CO5	3					1	1						3		
CO6	3					1							3		
Average	**3**	**2**			**2**	**1**	**1**						**3**	**1**	

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

COURSE CONTENT:

Introduction to energy system: types of energy resources, Review of energy scenario in India.

Steam Power plant: 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- Natural and forced cooling towers.

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

Hydro-Electric power plant: General layout of hydel power plants, classification of hydel plants, Hydrographs, flow duration curve, numerical on hydrograph and flow duration curve, Case studies. Plotting the hydrograph and flow duration curve using computing technique.

Solar Energy and Applications: Solar radiation - Availability- Measurement, Advantages, disadvantages and Applications of solar energy source- Solar water heater, solar pump, Solar furnace.

Hydrogen Energy: Introduction to hydrogen energy, methods of hydrogen production (electrolysis method), applications.

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

Tidal Power: Introduction, working of single basin tidal power plant, advantages and disadvantages tidal power plants.

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

Biomass Energy Sources: Photosynthesis process, Energy plantation, Biomass resources, Energy through fermentation -Ethanol Production from sugarcane. 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 of Proton Exchange Membrane Fuel Cells, applications of fuel cells and Introduction, types of Batteries, working of Lithium-Ion (Li-Ion) Battery and applications of batteries.

Self-Learning Component: Different Types of Fuels used for steam power plant, 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. Mehrdad Ehsani, "Modern Electric, Hybrid electric and Fuel Cell Vehicles", CRC Press, 3rd Edition, 2019.
3. Mark Pilgrim, "Dive into Python 3", A Press Special Edition, 2015.

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.
5. John V. Guttag, "Introduction to Computation and Programming using Python", MIT Press, 2016.

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. http.s://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	**Design for Manufacturing and Assembly**				**Course Type**		**Soft Core**	
Course Code	**B24ERS511**	**Credit**	**3**		**Class**		**V Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

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:

The objectives of this course are to:

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 understand the concepts of design for economy, compatibility, accessibility.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Demonstrate the concept of DFMA and its impact on industry.	1	1,2
CO2	Apply DFMA techniques in design of manual assembly.	1,2,3	1,2
CO3	Apply DFMA techniques in design of high speed automatic assembly, robot Assembly and sand casting.	1,2,3	1,2
CO4	Implement product design rules for automation.	1,2	1,2
CO5	Relate 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 LEVEL OF THE COURSE OUTCOMES:

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

COURSE ARTICULATION MATRIX:

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

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.

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.

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.

Design for Sand Casting, Introduction, Sand Casting Alloys, Basic Characteristics and Mold Preparation, Sand Cores, Melting and Pouring of Metal, Cleaning of Castings , Cost Estimating , Design Rules for Sand Castings, Example Calculations.

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.Applications" CRC Press publisher, 2021.

JOURNALS/MAGAZINES:

1. Materials & Design

2. Journal of Manufacturing Systems

SWAYAM/NPTEL/MOOCs:

1. https://archive.nptel.ac.in/courses/107/103/107103012/
2. https://www.my-mooc.com/en/categorie/mechanical-engineering.

Course Title	**Digital Quality Control**				**Course Type**		**Soft Core**	
Course Code	**B24ERS512**	**Credit**	**3**		**Class**		**V Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

The course emphasis on the statistical quality control concepts and hands–on training in the methods, digital methods 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 .The 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:

The objectives of this course are:

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 various systems and improve the reliance of a system

6. To understand the basic concepts of digital tools used in quality control

COURSE OUTCOMES (COs):

On successful completion of this course, the student shall 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	1,2,5,9	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 digital tools in quality control and six sigma methodology	1,2,3,5,9	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	
CO2	3	2			2				2				2	3	
CO3	3	3							2				2	3	
CO4	3	3											2	3	
CO5	3	3							2				2	3	
CO6	3	3	1		2				2				2	3	
Average	**3**	**2.67**	**1**		**2**				**2**				**2**	**2.8**	

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

COURSE CONTENT:

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 & Obstacles of TQM

Statistical Process Control: Introduction to SPC, Data types, Measure of central tendency and dispersion– numerical, 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.

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

Acceptance Sampling: Lot by lot sampling – types – probability of acceptance in single, double 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

Reliability and Life Testing: Definition of reliability, Failure models of components, Failure rate analysis, Bath Tub Curve, MTBF, MTTR, and Availability. Reliability evaluation in simple cases of exponential failures in series, parallel and series−parallel device configurations. Reliability improvements – techniques

Digital Tools in Quality Management System: Digital quality Inspection, Cloud based data base management system, Use of data analytics in QMS, Application of modern AI in Quality improvement,

Robust Quality system design: Principles of experimentation, completely randomized designs (CRD), Randomized block designs (RBD)

Quality Assurance and Six Sigma: Quality assurance, ISO 9000, 14000 standards, introduction to Six sigma, 7 quality tools .Overview of DMAIC methodology, DFSS, DMADV Methods.

Self-Learning Component: Quality assurance, ISO 9000, 14000 standards

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 & Sons, 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 quality management and reliability
5. 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	Green Fuels				Course Type		Soft Core	
Course Code	B24ERS513	Credit	3		Class		V Semester	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

The course provides a comprehensive overview of alternative green fuels, addressing their importance in mitigating environmental issues like the greenhouse effect and exploring various types such as hydrogen, LPG, CNG, biofuels, biogas, and reformulated conventional fuels. It covers topics ranging from production methods to properties, usage in internal combustion engines, and their impact on performance and emissions. Additionally, the course touches upon future green fuel prospects, offering insights into emerging technologies like liquid nitrogen and ammonia. Overall, it equips students with the knowledge needed to understand, evaluate, and contribute to the advancement of sustainable fuel solutions in the automotive industry.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the significance of green fuels and their role in addressing environmental challenges.
2. Explore factors influencing the greenhouse effect and learn about emission norms and fuel quality standards.
3. Analyze technological advancements and business factors driving the adoption of alternative fuels.
4. Identify and address implementation barriers to widespread green fuel usage.
5. Develop a strategic roadmap for integrating alternative fuels into existing energy systems.
6. Gain comprehensive knowledge about various green fuels, including hydrogen, biofuels, biogas, and reformulated conventional fuels, and their applications in internal combustion engines.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Gain a solid understanding of the fundamental concepts and importance of green fuels, including their role in mitigating environmental impacts and addressing the greenhouse effect.	1, 2,6,7	1
CO2	Evaluate the global carbon budget and carbon footprint, and assess emission norms and fuel quality standards, particularly in the context of Bharat Standards.	1, 2,6,7,8	1
CO3	Identify technological advancements required for the adoption of alternative fuels and analyze key business driving factors influencing their implementation.	1, 2,6,7	1
CO4	Develop strategies to overcome implementation barriers hindering the widespread adoption of green fuels, and create a roadmap for integrating alternative fuels into existing energy systems.	1, 2,6,7	1
CO5	Demonstrate comprehensive knowledge of various green fuel types, including hydrogen, LPG, CNG, biofuels, bio-diesels, biogas, reformulated conventional fuels, and future green fuels, along with their properties, production methods, and applications in internal combustion engines.	1, 2,6,7	1
CO6	Apply optimization techniques, such as MiniTab/DOE, to blend bio-diesels effectively and optimize engine performance parameters, contributing to the development and utilization of sustainable fuel solutions.	1, 2, 5, 6,7	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	PSO3
CO1	3	2				2	2						2		
CO2	3	2				2	2	1					2		
CO3	3					2	2						2		
CO4	3					2	2						2		
CO5	3					2	2						2		
CO6	3				2	2	2						2		
Average	**3**	**2**			**2**	**2**	**2**	**1**					**2**		

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

COURSE CONTENT:

Introduction: Introduction to Green Fuels, Need of Green Fuels, Greenhouse effect, Factors affecting greenhouse effect, Study of Global Carbon Budget and Carbon foot print, Emission norms as per Bharat Standards, Fuel quality aspects related to emissions. Technological up gradation required business driving factors for alternative fuels. Implementation barriers for green fuels. Road map for alternative fuels.

Hydrogen Fuel: Hydrogen as a green fuel, Properties, Sources and methods of Production of Hydrogen, Storage and Transportation of hydrogen. Also, the economics of Application and Advantages of hydrogen as fuel for IC engine/ hydrogen car. Layout of a hydrogen car.

LPG & CNG: Properties of LPG & CNG as engine fuels, fuel metering systems, combustion characteristics, effect on performance, emission, cost and safety.

Biofuels: Alcohol: Sources of Methanol and Ethanol, methods of its production. Properties of methanol & ethanol as engine fuels, Use of alcohols in S.I. and C.I. engines, performance of blending methanol with gasoline. Emulsification of alcohol and diesel. Improvement/Change in emission characteristics with respect to % blending of alcohol

Bio-Diesels: Different Sources used for production of Bio Diesel and extraction, Process of separation of Bio Diesel, Properties of Diesel blended with vegetable oil, challenges associated with Bio-Diesel fuels. Optimization engine performance parameters of bio diesel blending using MiniTab/DOE.

Biogas: Introduction to Biogas system, biogas formation and extraction, Factors affecting biogas formation. Usage of Biogas in SI engine & CI engine.

Reformulated Conventional Fuels: Introduction, Production of coal water slurry - properties as an engine fuel, emissions of Constructed wetlands (CWs), RFG, Emulsified fuels. Hydrogen enriched gasoline.

Future Green Fuels: Overview of Ammonia, Liquid-Nitrogen, Boron, Compressed Air, Water as fuel for Internal combustion Engine

Self-Learning Component: Sustainable Aviation Fuel, Thermal methods of Hydrogen Production, Methods to enhance trans-esterification process, Dual- fuel engines.

CASE STUDIES:

1. Analysis and optimization of engine process parameters for different percentage of blending of bio diesel and alcohol by using DOE/Minitab.
2. Prepare comparison report on suitability reformulated green fuels, emulsified fuels, Cryogenic green fuels.

TEXT BOOKS:

1. Carlos Ricardo Soccol, Satinder Kaur Brar and Craig Faulds, "Green Fuel Technology", Springer Publishers, 4th Edition, 2022.

2. S.S. Thipse, "Alternative Fuels", JAICO Publishing House, 1st Edition, 2010.

REFERENCE BOOKS:

1. Venkateswarlu. K., Murthy, BSR. "Alternative Fuels and Advanced Vehicle Technologies", PHI Publication Ltd, 2018.
2. Christain Lorrache, "Bio-Fuels", Science Direct, 2011.
3. Sunggyu Lee, James G. Speight and Sudarshan K. Loyalka, "Handbook of Alternative Fuel Technologies (Green Chemistry and Chemical Engineering)", CRC press, 2nd Edition, 2014.
4. James Halderman "Hybrid and Alternative Fuel Vehicles" Pearson Publisher, 4th Edition 2016.
5. S.M. Ashrufar Rahman "Alternative Fuels and their Applications to Combustion Engines", MDPI AG Press Publisher, 2021.

JOURNALS/MAGAZINES:

1. Renewable and Sustainable Energy Reviews – Science Direct
2. Journal of Petroleum Technology and Alternative Fuels- Academic Journal l=Ltd.
3. Alternative Fuels and Green combustion – MDPI Journal
4. Progress in Alternative Fuels and energies – WILEY

SWAYAM/NPTEL/MOOCs:

1. https://www.udemy.com/course/biofuels-in-automobile-mechanical-alternativefuels-ezenith-engineering/?couponCode=24T3MT53024
2. https://www.nfpa.org/product/nfpas-alternative-fuel-vehicles-training-program-ol/evt004

<table>
<tr><td>Course Title</td><td colspan="3">Basics of Aerodynamics</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B24ERS514</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>LTP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Lecture</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Tutorial</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>Practical</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>42</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW:

The primary purpose of the course Basic aerodynamics 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 exposes the students to working of the devices like compressors and refrigeration systems.

COURSE OBJECTIVES:

The objective of this course are:

1. To understand the basic principles of fluid dynamics as they apply to airflows, including the behavior of gases and the properties of air.
2. To gain knowledge of airfoil terminology and characteristics, including camber, chord, thickness, and angle of attack.
3. To understand the characteristics of incompressible flow and how it applies to subsonic flight regimes. Discuss the
4. To understand the fundamental aerodynamic principles that govern how air flows around cylindrical objects.
5. To learn about different types of aerodynamic testing facilities, including wind tunnels, water tunnels, and flight testing facilities.

COURSEOUTCOMES (Cos):

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

CO	Course Outcomes	POs	PSOs
CO1	Understand the concepts of streamlines, path lines, and streak lines, which represent	1,2	1,2

	the trajectories of fluid particles in steady, unsteady, and time-dependent flows, respectively.		
CO2	Analyze the drag characteristics of airfoils, including profile drag, induced drag, and their relationship with Reynolds number.	1,2	1,2
CO3	Demonstrate knowledge on typical airfoil characteristics and two-dimensional flows over airfoil and study the incompressible over finite wings	1,2	1,2
C04	Understand the principles of potential flow theory, which assumes irrotational and incompressible flow, and its applications in aerodynamics and fluid dynamics.	1,2	1,2
CO5	Demonstrate the procedure used for analyzing Flow Over Cylinders	1, 2	1,2
C06	Familiarize with different types of aerodynamic testing facilities, such as wind tunnels, water tunnels, and flight test facilities, and their applications.	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			✓			
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	2	
CO2	3	2											1	2	
CO3	3	2											1	2	
C04	3	2											1	2	
CO5	3	2											3	2	
C06	3	2											3	2	
Average	3	2											**1.7**	**2**	

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

COURSE CONTENT:

Review of Basic Fluid Mechanics: Continuity, momentum and energy equation, units and dimensions, Types of flow, compressibility, and Mach number regimes.

Fluid Motion: Euler and Lagrangian descriptions, Control volume approach to continuity and momentum equations, Path lines, Streamlines and Streak lines, Angular velocity, Vorticity, Circulation, Stream function, Velocity potential and Relationship between them.

Airfoil Characteristics: Airfoil section geometry and wing plan form geometry, Fundamental aerodynamic variables, Aerodynamic forces and moments and pressure coefficient. Centre of pressure, calculation of airfoil lift and drag from measured surface pressure distributions, typical airfoil aerodynamic characteristics at low speeds.

Two-Dimensional Inviscid Incompressible Flows: Bernoulli's equation, Pitot-tube measurement of airspeed, condition on velocity for incompressible flow. Governing equations for Irrotational, incompressible flow: Laplace equation and boundary conditions. Two-dimensional source, sink and doublet flows and vortex flow and combinations of elementary flows.

Flow Over Circular Cylinders: Non-lifting flow over a two-dimensional circular cylinder, Lifting flow over a two-

dimensional circular cylinder, Kutta-Joukowski theorem and generation of lift, D'Alembert's paradox. **Incompressible Flow over Airfoils:** Kelvin's circulation theorem and the starting vortex, vortex sheet, Kutta condition, Classical thin airfoil theory for symmetric and cambered airfoils.

Introduction to Aerodynamic Testing: Principles of wind tunnel flow simulation, open and closed-circuit wind tunnels, and Major features of low speed, transonic and supersonic wind tunnels, smoke and tuft flow visualization techniques, Pressure and Aerodynamic load measurements on a model, total drag determination of two-dimensional bodies using wake survey at low speeds

TEXT BOOKS:

1. John D. Anderson Jr,"Fundamentals of Aerodynamics", Tata McGraw Hill Publishing Co. Ltd, 6th, 2017.
2. Houghton E.L and Carpenter P.W., "Aerodynamics for Engineering Students", CBS Publications and Distributors, 5th Edition.

REFERENCE BOOKS

1. John David Anderson, "Introduction to Flight", Tata McGraw-Hill Publishing Co. Ltd., Special Indian Edition, 2007.
2. Hermann Schlichting (Deceased) and Klaus Gersten, "Boundary Layer Theory", Springer Berlin, Heidelberg.
3. Pope A. and Harper, "Low Speed Wind Tunnel testing", John Wiley & Sons Inc, 3rd Edition, 1966.
4. Pope A. and Goin, KL, "High Speed Wind Tunnel Testing", John Wiley & Sons Inc, 99th Edition, 1965

JOURNALS/MAGAZINES

1. International Journal of Aerodynamics
2. Journal of Wind Engineering & Industrial Aerodynamics
3. Journal of Aerodynamics

SWAYAM/NPTEL/MOOCs:

1. https://archive.nptel.ac.in/courses/101/105/101105059/

Course Title	**Fluid Mechanics and Machines Lab**				**Course Type**		**Hard Core**	
Course Code	**B24ER0506**	**Credits**	**1**		**Class**		**V Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0				
	Practical	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW

Fluid Machines and Machines Lab is focused on the hands on experimentation of theoretical concepts learned from the Fluid mechanics and machines course. The course exposes the students to practical knowledge on different measurement techniques of flow rates, pressure differentials and other relevant parameters for performance testing of Hydraulic turbines, Centrifugal Pumps, blowers and Reciprocating pumps. The practical work enables the students to gain deeper understanding of fluid behaviour and its applications in various engineering fields.

COURSE OBJECTIVES

The objective of this course are:

1. To impart practical knowledge in understanding principles of fluid flow.
2. To predict the flow behaviour and energy losses using experimental test results and engineering formulae.
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.
5. Students will have exposure to 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	Describe various properties of fluid for analysing fluid flow applications.	1	1
CO2	Understand the principle of energy conservation and various mechanisms which contribute to energy losses and determine the energy losses for fluid flowing through pipe and pipe fittings.	1,2,9,10	1,2
CO3	Understand the importance of coefficient of discharge in fluid flow measurements and determine the coefficient of discharge for fluid flow through pipes and open channel using various flow measurement devices and compare with theoretical predictions.	1,2,9,10	1,2
CO4	Compute the coefficient of impact for a jet striking the vanes by measuring the force exerted by the jet and be familiar with theoretical principles underlying the impact of jets.	1,2,9,10	1,2
CO5	Conduct experiments, interpret the data, analyse the performance of 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, analyse the performance of 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 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			2		
CO2	3	2							3	2			3	2	
CO3	3	2							3	2			3	2	
CO4	3	2							3	2			3	2	
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

COURSE CONTENT:

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 Venturi meter, 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, 2018.
2. Jagadish Lal, "Fluid Mechanics and Hydraulic", 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	Automation and HP Lab				Course Type		Hard Core	
Course Code	B24ER0507	Credits	1		Class		V Semester	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0				
	Practical	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW:

This lab-based course provides hands-on experience in designing, building, and testing automation systems incorporating both electrical and fluid power components. Students will learn to integrate programmable logic controllers (PLCs), electrical sensors, actuators, and hydraulic/pneumatic components to create automated control systems. Through a series of laboratory exercises and projects, students will develop practical skills in circuit design, PLC programming, sensor interfacing, and troubleshooting. The course emphasizes safety procedures, ethical considerations, and teamwork in the context of real-world automation applications.

COURSE OBJECTIVES:

The objective this course are to:

1. Gain practical experience in designing and building automation systems using PLCs and fluid power components.
2. Develop skills in programming PLCs for controlling electrical and fluid power actuators.
3. Learn to interface electrical sensors with PLCs to monitor system parameters and trigger actions.
4. Understand the principles and operation of hydraulic and pneumatic systems in automation applications.
5. Acquire hands-on experience in assembling, testing, and troubleshooting automation circuits and systems.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Understand the concept of logic gates and the application of PLC circuit for conveyer feed movement with emitter & receiver	1, 2	1, 2
CO2	Design the concepts of building a ladder diagram for different virtual models and Analyses the construction of ladder diagram for control devices with respect time	1,2,3,9,10	1,2

CO3	Identify and select the hydraulic and pneumatic control valves for the different applications.	1,2,3,9,10	1,2
CO4	Design and build the different hydraulic and pneumatic circuits for the given applications,	1,2,3,9,10	1,2
CO5	Build and demonstrate on pneumatic circuit by using different control valves.	1,2,3,9,10	1,2
CO6	Analyze of hydraulic circuit and document the results.	1,2,3,9,10	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	3	1											3	1	3
CO2	3	3	2						2	1			3	3	3
CO3	3	2	2						2	1			3	3	3
CO4	3	3	2						2	1			3	3	3
CO5	3	3	2						2	1			3	3	3
CO6	3	3	2						2	1			3	3	3
Average	**3**	**2.5**	**2**						**2**	**1**			**3**	**2.6**	**3**

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

COURSE CONTENT:

Part-A

1. Using PLC ladder diagram realize the following logic gates: AND, OR, NOT, NAND, NOR, EX-OR.
2. Water level controller using programmable logic controller
3. Batch process reactor using programmable logic controller
4. Speed control of ac servo motor using programmable logic controller
5. Lift control system using programmable logic controller
6. Star delta starter using programmable logic controller
7. Design a PLC ladder diagram to construct an alarm system.
8. Build a pneumatic circuit for Stamping operation by using single acting cylinder being controlled by 3way 2 position directional control valves
9. Build a pneumatic circuit for forward and reverse speed control of a double acting cylinder (meter in meter out)

Part-B

The following pneumatic circuits experiments are designed and analyzed by using pneumatic cylinder and control valves

1. Direct Actuation of Cylinder Circuit using Double Acting Cylinder, 5/3 Solenoid Valve.
2. Use 5/3 as memory valve Circuit using Double Acting Cylinder, 5/3 Solenoid Valve, 3/2 Solenoid valve.

3. Two handed Safety Circuit using Single Acting Cylinder, AND Gate, 3/2 Solenoid valve.
4. Two Cylinder Pneumatic Circuit using Double Acting Cylinder, 5/3 Solenoid Valve.
5. Two Cylinder circuit for Coordination motion control using Double Acting Cylinder, 5/3 Solenoid Valve, Reed Switch.
6. Sequential Motion Control using Double Acting Cylinder, 5/3 Solenoid Valve, Reed Switch.
7. AND Gate Circuit using Single Acting Cylinder, 5/3 Solenoid Valve, AND Gate.
8. OR Gate circuit using Single Acting Cylinder, 5/3 Solenoid Valve, OR Gate.
9. Pressure Circuit for lifting/pushing using Double Acting Cylinder, 5/3 DCV, Reed Switch.

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	**Soft Skill-3**				**Course Type**		**AEC**	
Course Code	**B24ER0508**	**Credits**	**1**		**Class**		**V Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0				
	Practical	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	2	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW:

This course enables the overall personality skill development encompasses a broad range of attributes that contribute to an individual's ability to interact effectively and harmoniously with others, adapt to various situations, and achieve personal and professional success. Also develop a well-rounded personality that enhances their technical skills and prepares them for successful careers.

COURSE OBJECTIVES:

The objective this course are to:

1. To impart rules and behaviors that are considered appropriate and professional in a business environment.
2. To develop skills which enhance both oral and written communication capabilities.
3. To impart ability to solve problems, think logically, and understand complex concepts.
4. To develop programming and coding skills that are essential for success in students academic pursuits and future careers in engineering and technology.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Exhibit a well-rounded approach to professional conduct, self-awareness, effective communication, and continuous personal and professional growth.	9, 10, 12	3
CO2	Acquire a range of communication skills, from basic language comprehension to advanced verbal reasoning and expression and participate in and contribute to meetings and discussions.	9, 10, 12	3
CO3	Perform better aptitude tests used in recruitment processes, leading to increased job opportunities.	1, 2	3
CO4	Gain a strong understanding of Python syntax, including variables, data types, control structures, functions, and object-oriented programming.	1,2,5,12	1,2,3
CO5	Enhance job prospects in fields like software development, data science, machine learning, web development, and automation.	1,2,5,12	1,2,3
CO6	Build a strong foundation for learning other programming languages and technologies.	1,2,5,12	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									2	2		2			1
CO2									2	2		2			1
CO3	2	1													1
CO4	2	1			1							1	1	1	1
CO5	2	1			1							1	1	1	1
CO6	2	1			1							1	1	1	1
Average	**2**	**1**			**1**				**2**	**2**			1	1	1

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

COURSE CONTENT:

Soft Skill: Corporate etiquette, self-awareness, email etiquette, decision making, interpersonal skills, introspection technique

Verbal Ability Skill: Idioms, phrases, direct and indirect speech, metaphor

Aptitude Skill: Permutation and combination, probability, problems on trains, simple interest and compound interest, pipes and cistern, seating arrangement, syllogism

Technical Skill: Python Collections / Data Structures in Python Lists Tuples Dictionaries Sets Advanced Python Concepts File Handling Reading and writing files Error and Exception Handling Try-except blocks Catching specific exceptions Raising exceptions Modules and Packages Importing modules Creating custom modules Installing and using third-party packages with pip Object-Oriented Programming Inheritance and polymorphism Special methods (init, str, repr, etc.) Iterators and Generators Iterator

protocol Creating iterators with classes Generators and the yield keyword Regular Expressions Syntax and patterns Using the re module NumPy Pandas Matplotlib and Seaborn APIs and Web Scraping Making HTTP requests with requests Parsing HTML with BeautifulSoup Accessing APIs and handling JSON data.

TEXT BOOKS:

1. S P Dhanavel, "English and Soft Skills" Orient BlackSwan, 1st Edition, 2010.
2. Dr. Soma Mahesh Kumar, "Soft Skills: Enhancing Personal and Professional Success", McGraw Hill, 1st Edition, 2023.
3. R.S Agarwal, "Quantitative Aptitude, Verbal & Non-Verbal Reasoning for Competitive Examination", S chand, 2nd Edition, 2021.
4. Eric Matthes, "Python Crash Course: A Hands-On, Project-Based Introduction to Programming", No Starch Press, 3rd Edition, 2023.

REFERENCE BOOKS:

1. Shikha Kapoor, "Personality Development and Soft Skill: Preparing for Tomorrow", Dreamtech Press, 1st Edition, 2020.
2. Arun Sharma and Meenakshi Upadhyay, "Verbal Ability and Reading Comprehension for CAT", McGraw Hill, Standard Edition, 2022.
3. Quan Nguyen,"Advanced Python Programming: Accelerate your Python programs using proven techniques and design patterns", Packt Publishing, 2nd Edition, 2022.

6th Semester

Course Title	Energy Technology				Course Type		Open Elective	
Course Code	B24MEO601	Credits	3		Class		VI Semester	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**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. As the world shifts towards sustainable energy solutions, knowledge in different energy resources is crucial for developing and managing environmentally friendly power plants. 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:

The objectives of this course are:

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 energy resources available in the nature and conversion of steam energy in to electrical energy using steam and nuclear power plant, nuclear waste disposal methods.	1,6,7	1
CO2	Analyze the water resources for the generation of electricity using hydel plants and plot the hydrograph, flow duration curve using computing technique.	1,2, 5, 6,7	1,2
CO3	Demonstrate the concept of energy conversion from solar, hydrogen energy resources and its applications.	1,6,7	1
CO4	Discuss the principles of energy conversion of wind, ocean energy resources	1,6,7	1
CO5	Elaborate the main characteristics of biomass energy source and construction factors of biogas digesters.	1,6,7	1
CO6	Illustrate 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					1	1						3		
CO2	3	2			2	1	1						3	1	
CO3	3					1	1						3		
CO4	3					1	1						3		
CO5	3					1	1						3		
CO6	3					1							3		
Average	**3**	**2**			**2**	**1**	**1**						**3**	**1**	

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

COURSE CONTENT:

Introduction to energy system: types of energy resources, Review of energy scenario in India.

Steam Power plant: 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- Natural and forced cooling towers.

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

Hydro-Electric power plant: General layout of hydel power plants, classification of hydel plants, Hydrographs, flow duration curve, numerical on hydrograph and flow duration curve, Case studies. Plotting the hydrograph and flow duration curve using computing technique.

Solar Energy and Applications: Solar radiation - Availability- Measurement, Advantages, disadvantages and Applications of solar energy source- Solar water heater, solar pump, Solar furnace.

Hydrogen Energy: Introduction to hydrogen energy, methods of hydrogen production (electrolysis method), applications.

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

Tidal Power: Introduction, working of single basin tidal power plant, advantages and disadvantages tidal power plants.

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

Biomass Energy Sources: Photosynthesis process, Energy plantation, Biomass resources, Energy through fermentation -Ethanol Production from sugarcane. 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 of Proton Exchange Membrane Fuel Cells, applications of fuel cells and Introduction, types of Batteries, working of Lithium-Ion (Li-Ion) Battery and applications of batteries.

Self-Learning Component: Different Types of Fuels used for steam power plant, 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. Mehrdad Ehsani, “Modern Electric, Hybrid electric and Fuel Cell Vehicles”, CRC Press, 3rd Edition, 2019.
3. Mark Pilgrim, “Dive into Python 3”, A Press Special Edition, 2015.

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.
5. John V. Guttag, “Introduction to Computation and Programming using Python”, MIT Press, 2016.

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. http.s://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	**B24ER0601**	**Credit**	**3**		**Class**		**VI Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	2	4	4				
	Tutorial	1	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	**3**	**4**	**4**	**56**	**0**	**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:

The objectives of course are:

1. To introduce the basic modes of heat transfer and their governing equations.
2. To identify the combined heat transfer processes for steady and unsteady state.
3. To analyse conduction, convention and radiation problems.
4. To design heat exchangers and analyse boiling and condensation process.

COURSE OUTCOMES (COs):

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

CO	**Course Outcomes**	**POs**	**PSOs**
CO1	Demonstrate the various modes of heat transfer and implement the basic heat conduction equations for steady one dimensional thermal system.	1, 2	1, 2
CO2	Analyse the combined mode of heat transfer through composite walls and fins.	1,2	1,2
CO3	Apply Lumped system and Heisler chart analysis to interpret transient heat conduction phenomenon.	1,2,3,5	1,2
CO4	Identify and apply the appropriate method to solve heat transfer problems.	1,2	1,2
CO5	Design heat exchangers using LMTD and Effectiveness-NTU method based on practical consideration.	1,2,3,5	1,2

CO6	Analyse the phase change convective process during boiling and condensation process.	1,2	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES

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

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	**2**											3	**2**	
CO2	3	2											3	2	
CO3	3	3	2		1								3	1	
CO4	3	2											3	1	
CO5	3	2	2		3								3	1	
CO6	3	3											3		
Average	**2.83**	**2.33**	**2**		**2**								**3**	**1.25**	

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

COURSE CONTENT:

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 in Series and in Parallel, Numerical.

Conductive Heat transfer: Critical thickness of insulation on spheres and cylinders, 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

Natural Convection: Hydrodynamic and thermal boundary layer over a flat plate and Flow through duct, critical Reynolds number, Application of dimensional analysis for free convection, Numerical.

Forced Convection: Applications of dimensional analysis for forced convection, physical significance of Reynolds, Prandtl, Stanton, Nusselt numbers, Numerical on applications involved with laminar and turbulent flow.

Thermal Radiation: 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.

Heat Exchangers: Classification, Overall heat transfer coefficient, fouling and fouling factors, LMTD, Discussion on effectiveness-NTU method of analysis of heat exchangers, Numerical.

Phase Change Convective Process: Condensation and its types, Boiling-types of boiling, Regimes of pool boiling.

CASE STUDIES:

1. Develop the python programming to understand the one dimensional heat equation and draw the temperature variation.
2. Develop the python programming for analyzing the 2D temperature distribution.
3. Development of a MATLAB Program for Transient Heat Transfer Coefficient Studies.

4. How refractory layers are organized in furnace construction and explain the conceptual design.
5. Discuss the heat transfer theory behind the design of Microwave oven and Egg boiler.

TEXT BOOKS:

1. Tirumaleshwar, "Heat & Mass Transfer", Pearson Education, 2nd Edition, 2012.
2. Ozisik, "Heat transfer-A basic approach", Tata McGraw Hill, 1st Edition, 1985.

REFERENCE BOOKS:

1. Yunus A-Cengel, "Heat and Mass Transfer", Tata McGraw hill, 6th Edition, 2020.
2. Mahesh M Rathore, "Heat and Mass Transfer", Laxmi publications, 3rd Edition, 2016.
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, "Principles of Heat and Mass transfer", John Wiley and sons, 6th Edition, 2018.
5. R K Rajput, "A Textbook of Heat and Mass Transfer", S Chand Publications, 7th Edition, 2019.

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	**B24ER0602**	**Credit**	**2**		**Class**		**VI Semester**	
Course Structure	LTP	Credit	Contact Hours	Workload	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	1	1	1				
	Tutorial	1	2	2	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	2	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

A Finite Element Method (FEM) course provides a comprehensive understanding of this numerical technique widely used in engineering and physics. It begins with foundational concepts, including mathematical principles like linear algebra and differential equations. This course deals with discretization techniques, creating finite element meshes and employing shape functions for interpolation. This course includes lecture and practical exercises, they explore structural analysis, heat transfer, and fluid dynamics problems and also hands-on experience with FEM software tools for modeling and simulation.

COURSE OBJECTIVES:

The course objectives of this course are to:

1. Gain a solid understanding of the mathematical and theoretical foundations of the Finite Element Method, including discretization strategies.
2. Enhance problem-solving abilities by learning to formulate and solve engineering problems using FEM techniques. This includes understanding boundary conditions, constraints, and applying appropriate solution methods.
3. Learn how to apply FEM to solve a wide range of engineering problems, including structural analysis, heat transfer, fluid dynamics, and electromagnetics. Develop the ability to choose appropriate FEM approaches for different types of problems.
4. Acquire proficiency in using complex engineering systems. This involves hands-on experience with mesh generation, model setup, solution, and result interpretation.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Discuss the basics of Finite Element Method and its applications.	1,2,3	1,2
CO2	Analyse the types of elements, its behaviours, and the stiffness matrix of different elements in different coordinate systems.	1,2,3	1,2
CO3	Analyse higher order elements, Lagrange's interpolation for shape functions.	1,2,3	1,2
CO4	Compute the displacement, stresses and reaction forces for engineering structural members using penalty and elimination approach.	1,2,3,6	1,2
CO5	Analyse the hermite shape functions for beam.	1,2,3,6	1,2
CO6	Evaluate the application of FEM in thermal analysis.	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											3	2	
CO2	3	1											3	3	
CO3	3	3	2		3							1	3	2	1
CO4	3	3	2										3	3	1
CO5	3	3	2										3	2	1
CO6	3	3	3		3							1	3	3	1
Average	**3**	**2.6**	**2.2**		**3**							**1**	**3**	**2.5**	**1**

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

COURSE CONTENT:

Introduction: Steps involved in FEM, Phases of FEM, Engineering applications, Advantages and Disadvantages, List of commercial FEM Packages. Discretization: Types of elements used in FEM, Shape and behaviour, Choice of element types, size and number of elements, Location of nodes, Node numbering, coordinate systems, and Convergence criteria. Stiffness matrix and its properties.

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, simple numerical.

Solution of 1-D Bars: Derivation of element stiffness matrix, Numerical on bars on the uniform, stepped, and tapered cross-sections to analyse displacements, reactions and stresses by using penalty and elimination approaches.

Trusses: 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 element.
Beams: Hermite shape functions for beam element, Derivation of stiffness matrix using Hermite shape functions, Numerical on beams carrying concentrated & Uniformly Distributed Load.
Thermal Analysis: Steady-state heat transfer, 1D heat conduction governing equation, Boundary condition, Numerical on heat conduction and convection in composite walls, and 1-D pin fins.

CASE STUDIES:

1. Parametric Finite Element Analysis of Bicycle Frame Geometries.
2. Truss bridge structure frame section analysis by using Finite element analysis.
3. Stress Analysis of the truck chassis using Finite Element Analysis (FEA).
4. Structural dynamic analysis of storage frames**.**

TEXT BOOKs:

1. S. S. Bhavikatti, "Finite Element Analysis", New Age International Publishers, 2021.
2. Tirupathi. R. Chandrapatla and Ashok. D. Belegundu, "Finite Elements in Engineering", Pearson Education India, 4th Edition, 2015.

REFERENCE BOOKS:

1. J. N. Reddy, "Introduction to Finite Element Method", McGraw Hill, 4th Edition, 2020.
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

Course Title	**Machine Design-2**				**Course Type**		**Hard Core**	
Course Code	**B24ER0603**	**Credit**	**3**		**Class**		**VI Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	2	2	2				
	Tutorial	1	2	2	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	3	4	4	**56**	**0**	**50%**	**50%**

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. Tribology deals with the concept of tribology problems and wear.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the concept of design applies to springs, brakes, curved beams, flexible power transmission elements such as belts and ropes.
2. Give exposure for the design of gears.
3. Understanding the selection of ball and roller bearings from the standard design catalogue for various applications.

COURSE OUTCOMES (COs):

On successful completion of this course, the student shall 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 bevel gear subjected to static, dynamic and wear load conditions as per AGMA standards.	1,2,3,6,8	1,2
CO5	Understand the concept of tribology and analyse the tribological problems.	1,2	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 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	3	1			2		2					3	3	
CO2	2	2	3			2		2					3	3	
CO3	3	3	3			2		2					3	3	
CO4	2	3	3			2		2					3	2	
CO5	2	2											2	3	
CO6	2	3	1			2		2					3	3	
Average	**2.16**	**2.66**	**1.83**			**2**		**2**					**2.83**	**2.83**	

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

COURSE CONTENT:

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.

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.

Design of Gears: Definitions, stresses in gear tooth: Lewis's equation and form factor, Design of the Spur and Bevel gears based on Strength, Dynamic and Wear load.

Introduction to Tribology: Concept of tribology, tribological problems, nature of engineering surfaces, surface interactions and surface topography.

Wear: Types of wear, importance of wear and different types of wear, adhesive wear, Abrasive wear, erosive wear, corrosive wear, fatigue wear, fretting fatigue wear.

Bearings: Bearing Life, equivalent bearing load, selection of bearings, Bearings for cyclic loads and speeds for ball bearing.

Self-Learning Component: Definitions, stresses in gear tooth.

CASE STUDIES:

1. Design a spring to withstand the weight of an elevator which varies 1500N to 2000N force and operating 16 Hrs /day.
2. Design a crane hook to lift gold mining in hatti gold mine.
3. Design a clutch for a 350 cc bike by considering all the various factors into account.
4. Design a gear of sugarcane crusher by considering all the factors into account.
5. Design a bearing for front and rear wheel of a car.
6. A disk brake is used in AUDI car to slow down the vehicle speed from 200 kph to 60 kph, what is the heat generated in the brake.

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.
3. Rabinowicz E., "Friction and Wear of Materials", John Wiley & Sons, Inc., 2nd Edition, 2013.

DATA HAND BOOKS

1. K. Lingaigh, "Machine Design Databook", Volume-1 and Volume-2, McGraw Hill Education, 2nd Edition 2017.

REFERENCE BOOKS:

1 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.

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. Robert L. Norton, "Machine Design", Pearson Education Asia, 2001.
4. Majumdar B. C., "Tribology of Bearings", S Chand, 2010.

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. https://onlinecourses.nptel.ac.in 2. https://nptel.ac.in/courses
2. Gear and Gear Unit Design: Theory and Practice - Course (nptel.ac.in)

Course Title	**Mechatronics and Control Systems**				**Course Type**		**Hard Core**	
Course Code	**B24ER0604**	**Credits**	**3**		**Class**		**VI Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0				
	Practical	0	0	0	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**42**	**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:

The objectives of this course are:

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 and compare with computational result.	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:

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.

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.

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.

Stability Analysis: Routh's-Hurwitz Criterion, stability analysis using root locus plots, Matlab code and Python Code for stability of system, 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	**Advanced Engineering Materials**				**Course Type**		**Soft Core**	
Course Code	**B24ERS611**	**Credits**	**3**		**Class**		**VI Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

Advanced engineering materials are deals with the materials such as composites adopted for different applications. The study is focused on smart materials and nano materials to study their behavior at different conditions. Bio ceramics, bulk metallic glasses, amorphous materials, low temperature materials, properties and applications will

be studied. The advanced materials course includes the high strength and high temperature materials used as the industrial applications.

COURSE OBJECTIVES:

The objectives of this course are:

1. To explain the composite, smart materials to be used for different industrial applications
2. To illustrate the different shape memory alloys, nanomaterials, bio ceramics for medical and other applications.
3. To discuss the properties and applications of low and high temperature materials, Metallic and Nonmetallic Materials.
4. To demonstrate the self-healing materials, functionally graded materials, Energy Harvesting Materials.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Understand use/role of fibers and other reinforcements used in composite materials. Properties and applications of MMC, PMC and CMC.	1	1,2
CO2	Analyze types of smart materials such as shape memory alloys and the Nano materials.	1,2	1,2
CO3	Understand different types of ceramics and glasses.	1	1,2
CO4	Analyze the properties of materials for low and high temperature applications.	1,2,3	
CO5	Demonstrate the types of high strength and high temperature alloys	1	1,2
CO6	Analyze the non-metallic materials molecular structure, production techniques.	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	2												3	3	
CO2	3	1											3	3	
CO3	3		2										3	3	
CO4	3	1											3	3	
CO5	3												3	3	
CO6	3	1											3	2	
Average	**2.8**	**1**	**2**										**3**	**2.8**	

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

COURSE CONTENT:

Composite Materials: Introduction to composites, fiber reinforced, laminated and dispersed materials, polyesters and epoxy resins, Reinforcement and Matrix materials, Metal Matrix Composites, Polymer Matrix Composites and Ceramic Matrix Composites, Properties, advantages, disadvantages and applications of Composite Materials

Smart Materials: Introduction to Smart Materials, Types of smart materials, Piezoelectric, Electrostrictive, Magnetostrictive Materials, Advantages, Disadvantages and Applications of smart materials, Shape memory alloys, and its bio-medical applications.

Nanomaterials: Definition, types of nanomaterials including carbon nanotubes, Boron nanotubes, graphene and nanocomposites, physical and mechanical properties, applications of nanomaterials.

Bio-ceramics: Nearly inert ceramics, bio-reactive glasses and glass ceramics, porous ceramics; Calcium phosphate ceramics: grafts, bulk metallic glasses, glassy and amorphous materials,

Low & High Temperature Materials: Properties required for low temperature applications, Materials available for low temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.

Modern Metallic Materials: Superalloys: types, properties and applications.

Non-metallic Materials: Polymeric material, Fibers, Foams, Adhesives and Coatings. Materials for space and Air crafts, 3D Printing.

Self-Healing Polymer: Types, factors affecting self-healing process, applications.

Functionally graded materials (FGM) and its potential applications

Energy Harvesting Materials: Types and basics of energy harvesting techniques and materials, thermoelectric, piezoelectric, photovoltaic, pyroelectric, electromagnetic, wind and vibration energy harvesting**.**

TEXT BOOKS:

1. M.F. Ashby, “Materials Selection in Mechanical Design”, Pergamon Press, 1992
2. WD. Callister Jr., “Materials Science and Engineering” Wiley India Pvt. Ltd, 2010
3. Niit, ‘Introduction to Engineering Materials & Manufacturing Processes”, Prentice Hall of India, 2004.

REFERENCE BOOKS:

1. Gladius Lewis, “Selection of Engineering Materials”, Prentice-Hall, 1990
2. James A. Jacobs and Thomas F. Kilduff, “Engineering Material Technology”, Prentice Hall Pearson, 4th Edition, 2000.
3. Kenneth G. Budinski and Michael K. Budinski “Engineering Materials Properties and Selection”, Prentice Hall, 7th Edition, 2002.
4. G.E. Dieter, “Engineering Design: A Materials and Processing Approach”, McGraw Hill, 1991

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/113105081
2. https://www.classcentral.com/course/swayam-advanced-materials-and-processes-13888

JOURNALS/MAGAZINES:

1. https://onlinelibrary.wiley.com/toc/15214095/2023/35/20
2. https://iopscience.iop.org/journal/1468-6996
3. https://www.scientific.net/AMR.1175
4. https://www.sciencedirect.com/journal/materials-science-and-engineering-a
5. https://www.oatext.com/Advanced-Material-Science-AMS.php
6. https://www.sciencedirect.com/science/article/abs/pii/S2214785321058740
7. https://www.researchgate.net/publication/329626611_Emerging_Materials_for_Energy_Harvesting

Course Title	**Additive and Digital Manufacturing**				**Course Type**	**Soft Core**
Course Code	**B24ERS612**	**Credit**	**3**		**Class**	**VI Semester**
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage

Lecture	3	3	3				
Tutorial	0	0	0	Theory	Practical	CIE	SEE
Practical	0	0	0				
Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

This course provides an in-depth exploration of Additive Manufacturing (AM) and Digital Manufacturing (DM) technologies, their applications, and their integration into modern manufacturing processes. Students will learn about the principles, techniques, and advantages of AM methods such as 3D printing (SLA/SLS/FDM/LOM/SGC), as well as the digital tools and strategies used in DM to optimize production workflows. Through lectures, hands-on exercises, and case studies, students will gain practical skills in designing for additive manufacturing, implementing digital manufacturing solutions, and harnessing the potential of emerging technologies for innovative product development and production.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the principles and classifications of Additive Manufacturing (AM) processes.
2. Explore various AM techniques, materials, and applications across different industries.
3. Learn the fundamentals of Digital Manufacturing (DM) and its integration with AM technologies.
4. Gain proficiency in CAD software for designing parts optimized for additive manufacturing.
5. Develop skills in preparing and optimizing digital models for 3D printing and other AM processes.
6. Examine case studies and real-world examples of AM and DM implementations in industry.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Demonstrate the fundamental concept of 3D printing.	1	1,2,3
CO2	Gain proficiency in designing parts and assemblies optimized for Additive Manufacturing (AM) using CAD software by apply design principles such as topology optimization, lattice structures, and support optimization to enhance manufacturability and performance.	1,2,3	1,2,3
CO3	Develop a comprehensive understanding the concepts and components of DM and its integration with AM technologies by exploring digital tools and strategies used in DM, including computer-aided process planning, digital twinning & cyber-physical systems.	1,2	1,2,3
CO4	Understand the application AM and DM technologies to solve real-world engineering and manufacturing problems by demonstrating the ability to prepare digital models for 3D printing and other AM processes.	1,2,3	1,2,3
CO5	Cognizant of emerging trends and advancements in AM and DM technologies with potential future directions, challenges, and opportunities in the field, including advancements in materials, processes, and applications.	1,2	1,2,3
CO6	Demonstrate professionalism, ethical conduct, and lifelong learning habits in their study and practice of Additive and Digital Manufacturing for careers in advanced manufacturing industries, research institutions, and academia, equipped with the knowledge and skills to contribute to innovation and sustainability.	1,2,3,5	1,2,3

BLOOM'S LEVEL OF THE COURSE OUTCOMES:

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

CO6			√			

COURSE ARTICULATION MATRIX:

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

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

COURSE CONTENT:

Introduction to AM: Definition of AM, Prototypes, Types of prototypes, roles of prototypes, Need for the compression in product development, Impact of RP in product development, history of RP systems, Survey of applications, classification of RP systems, Basic methodology of RP, Benefits & limitations.

Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.

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.

Concept Modelers: Introduction, types, 3D printing to 5D printing − principle of operation.

Software for RP: STL files, Overview of Solid view, magic's, Mimics, magic communicator, Internet based manufacturing.

Process Optimization: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.

Introduction to DM: Overview of digitalization of manufacturing process, Concepts and common tools for digitalmanufacturing, Digital design and modeling, Common modeling and analysis tools

Digital Design and Fabrication: Digital twins and applications , Digital process twins in manufacturing , Agile (Additive) Manufacturing Systems − 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

Intelligent Manufacturing Systems: Components of IMS, Tool and techniques of IMS, Benefits and Application of IMS.

Self-Learning Component: Smart Machine tools, Robotics and Automation, Sensor network and devices.

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
3. Kumar K, "Smart Manufacturing and Industry 4.0", Taylor & Francis, 2021.
4. Mikell P. Grover, "Automation, Production Systems and Computer Integrated Manufacturing", 4th Edition, Pearson Education, 2016.

REFERENCE BOOKS:

1. Terry Wohlers, "Rapid Prototyping", Wohler's Report 2000", Wohler's Association, 2000.
2. Gurumurthi, "Rapid Prototyping Materials", IISc, Bangalore
3. Chua, C.K., Leong, K.F., "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley and Sons

Inc., 2000, Indian reprint 2019.
4. William MacDougall, “Industry 4.0: Smart Manufacturing for the Future”, Germany Trade & Invest, 2014.
5. E. Turban, L. Volonino, “Information Technology for Management: Transforming Organizations in the Digital Economy”, Wiley India Private Limited, 7th Edition, 2010.
6. Jayakrisna Kandasamy, Kamalakantha Muduli, V P Komula, Putrushottam L Meena, “Smart Manufacturing Technologies for Industry 4.0 Inteigration, Benefits and Operational Activities”, Routledge, Taylor and Francis, 1st Edition, 2023.

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
4. https://www.journals.elsevier.com/journal−of−manufacturing−processes
5. https://ojs.wiserpub.com/index.php/DMT/about
6. https://www.frontiersin.org/journals/mechanical−engineering/sections/digital−manufacturing
7. https://www.springer.com/journal/10845

SWAYAM/NPTEL/MOOCs:

1. https://archive.nptel.ac.in/courses/112/103/112103306/
2. https://www.coursera.org/specializations/additive−manufacturing
3. https://www.coursera.org/specializations/3d−printing−additive−manufacturing
4. https://nptel.ac.in/courses/110106146
5. https://nptel.ac.in/courses/108103009
6. https://www.udemy.com/course/digital−manufacturing−and−industry−40−training−
7. https://www.coursera.org/specializations/digital−manufacturing−design−technology.

Course Title	**Basics of HVAC and Cryogenics**				**Course Type**		**Soft Core**	
Course Code	**B24ERS613**	**Credit**	**3**		**Class**		**VI Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

This course provides a comprehensive introduction to the principles and practices of Heating Ventilation Air Conditioning (HVAC) and Cryogenics. It covers the fundamental concepts of thermodynamics, heat transfer, psychrometric, and the study and operation of heating, cooling, and ventilation systems. The course aims to equip students with the essential knowledge and skills needed to understand, design, manage HVAC and Cryogenic systems in various applications.

COURSE OBJECTIVES:

The objectives of this course are:

1. To understand the fundamental principles of HVAC systems, learn the basics of thermodynamics and heat transfer
2. To analyze and interpret the different psychrometric process, familiar with psychrometric charts an air distribution system.
3. To give exposure in the field of cryogenics, principle, importance of cryogenics for various fields.
4. To gain knowledge on behaviour and properties of materials at cryogenic temperatures.
5. To provide knowledge on systems for the storage and transportation of cryogenic fluids and applications of cryogenic fluid.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Demonstrate the fundamental principles of HVAC systems and heat transfer applicable to HVAC.	1, 2	1,2
CO2	Apply the concept of Psychrometry to evaluate various Psychrometry processes. Explore different types of heating, cooling, and ventilation systems.	1, 2	1,2
CO3	Illustrate the components and operation of air distribution systems.	1	1,2
CO4	Outline the fundamental principles of cryogenics, importance of cryogenic fluid in various industries.	1, 5	1
CO5	Interpret the behavior and properties of materials at cryogenic temperatures, including superconductivity, super fluidity, and the impact on mechanical properties.	1, 5	1,2,3
CO6	Summarize the systems for the storage and transportation of cryogenic fluids and applications of cryogenic fluid.	1	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	1											2	1	
CO2	3	2											3	1	
CO3	3												2	1	
CO4	3				1								2		
CO5	3				1								2	1	1
CO6	3												2	1	1
Average	**3**	**1.5**			**1**								**2.2**	**1**	**1**

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

COURSE CONTENT:

Introduction to HVAC: Applications of HVAC Systems, Heat Transfer Methods: Conduction, Convection, and Radiation

Psychrometry: Properties of air and water mixture, Psychrometric processes: Heating, Cooling, Humidification, and Dehumidification. Psychrometric chart.

Heating and Cooling systems: Types of Heating Systems, Heat Pumps, and Radiant Heating Components of Heating Systems, Types of Cooling Systems: Air Conditioners, Chillers, and Heat Pumps, Components of Cooling Systems,

Ventilation Systems: Importance of Ventilation, Types of Ventilation: Natural and Mechanical, Components of Ventilation Systems, Indoor Air Quality (IAQ) and Standards.

Air Distribution Systems: Ductwork Design and Sizing, Air Handling Units (AHUs) and Terminal Units, Fans and Blowers, Airflow Measurement and Balancing.

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.

Gas Liquefaction and Cryogenic Systems: Liquefaction of gases – Linde Hampson system – Claude system – Heylandt system – Critical components of liquefiers, – Cryo coolers – Stirling Cry cooler – Gifford – McMahon cryo cooler – Pulse tube cryo cooler, Storage and Transfer Systems, Applications of cryogenic systems.

Self-Learning Component: Practical exposure to HVAC systems of commercial buildings and Hospitals, visiting to cryogenic development centre in Indian Institute of Science for further knowledge. The student can lean REVIT or equivalent software for 3D modelling for HVAC design.

CASE STUDIES:

1. Prepare a report on HVAC systems installation for a commercial buildings or Hospitals.
2. Prepare a report on Cryogenic techniques used and their applications in Industry.

TEXT BOOKS:

1. Ronald H. Howell, Harry J. Sauer Jr., and William J. Coad, “Principles of Heating, Ventilation, and Air Conditioning", ASHRAE, 7th Edition 2013.
2. Randall F. Barron, "Cryogenic Systems", Oxford University Press, 2nd Edition, 1985.

REFERENCE BOOKS:

1. Andrew D. Althouse, Carl H. Turnquist, and Alfred F. Bracciano, “Modern Refrigeration and Air Conditioning“, Goodheart-Willcox Publisher, 22nd Edition, 2023.

JOURNALS/MAGAZINES

1. International journal of Air conditioning and refrigeration. https://link.springer.com/journal/44189.
2. ASHRAE Journals. https://www.ashrae.org/technical-resources/ashrae-journal

Course Title	**Aircraft Structures**				**Course Type**		**Soft Core**	
Course Code	**B24ERS614**	**Credits**	**3**		**Class**		**VI Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number ofClasses Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

The course discusses about the structures designed to provide strength, stability, and functionality while withstanding the harsh conditions of flight, including aerodynamic forces, vibrations, temperature extremes, and high-pressure environments. The course discusses how structures are designed and why particular materials are chosen, understand various loads and stresses aerospace structures have to withstand. The course also discusses safety philosophies that are used in aerospace structural design and how they affect design choices.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the concept of normal, shear and torsional stress, codes and standards in the engineering in relevance to Aerospace engineering
2. Know the concept of static & impact strength in machine elements and theories of failure.
3. Understand the fatigue failure.
4. Discuss different aerospace materials and explain the various loads on structures

5. Explain the concepts of theory of elasticity.

COURSEOUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Apply the concept of static & impact strength in machine elements and theories of failure.	1,2	1,2
CO2	Evaluate the effect of impact and fatigue load on machine elements and factors affecting it.	1,2	1,2
CO3	Analyze the effect of stress concentration for various aerospace elements.	1,2	1,2
C04	Compute the various loads on aircraft structure.	1,2	1,2
CO5	Analyze solutions for trusses, and beam for stated structural boundary conditions.	1,2	1,2
C06	Evaluate strain energy using various methods.	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				✓		
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	2	
CO2	3	3											1	3	
CO3	3	3											1	2	
C04	3	2											1	3	
CO5	3	3											1	3	
C06	3	2											1	2	
Average	**3**	**2.5**											**1**	**2.5**	

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

COURSE CONTENT:

Design for Static Strength: Introduction: Normal, shear, biaxial and tri-axial stresses, Stress tensor, Principal Stresses, Stress Analysis, Design considerations, Codes and Standards. Static Strength: Static loads and factor of safety, Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Maximum strain theory, Strain energy theory, and Distortion energy theory, failure of brittle and ductile materials, Stress concentration, and Determination of Stress concentration factor.

Design for Impact and Fatigue Strength: Impact Strength: Introduction, Impact stresses due to axial, bending and torsional loads, effect of inertia. Fatigue Strength: Introduction, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, modifying factors: size effect, surface effect, Stress concentration effects, Fluctuating stresses,

Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage.
Loads on Aircraft: Structural nomenclature, Types of loads, load factor, Aerodynamics loads, Symmetric manoeuvre loads, Velocity diagram, Function of structural components.
Aircraft Materials: Metallic and non-metallic materials, use of aluminium alloy, titanium, stainless steel and composite materials. Desirable properties for aircraft application. Fracture and Fatigue, Stress Intensity Factor, Crack Growth Rate Derivation.
Theory of Elasticity: Theory of Elasticity: Concept of stress and strain, derivation of Equilibrium equations, strain displacement relation, compatibility conditions and boundary conditions. Plane stress and Plane strain problems in 2D elasticity. Principle Stresses and Orientation of Principle Directions.
Structures: Statically Determinate and Indeterminate structures, Analysis of plane truss, Method of joints, 3D Truss, Plane frames, Composite beam, Clapeyron's Three Moment Equation.
Energy Methods: Strain Energy due to axial, bending and Torsional loads. Castigliano's theorem, Maxwell's Reciprocal theorem.
Columns: Columns with various end conditions, Euler's Column curve, Rankine's formula, Column with initial curvature, Eccentric loading, south-well plot, Beam-column.

TEXT BOOKS:

1. Megson, T.H.G, "Aircraft Structures for Engineering Students", Butterworth-Heinemann, 6th Edition, 2016.
2. Donaldson, B.K., "Analysis of Aircraft Structures – An Introduction", Cambridge University Press, 2nd Edition, 2012.

REFERENCE BOOKS:

1. Robert L. Norton, "Machine Design", Pearson Education Asia, 2nd Edition, 2002.
2. V.B. Bhandari, 'Design of Machine Elements', Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition, 2007.
3. Peery, D.J., and Azar, J.J., "Aircraft Structures", McGraw, Hill, N.Y, 2nd Edition, 1993.

JOURNALS/MAGAZINES:

1. Fatigue of Aircraft Structures- The Journal of Institute of Aviation
2. Aircraft Materials and Structures.

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/101105084

<table>
<tr><td>Course Title</td><td colspan="4">Electric and Hybrid Vehicles</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B24ERS621</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>LTP</td><td>Credits</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Lecture</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Tutorial</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>Practical</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>42</td><td>0</td><td>50 %</td><td>50 %</td></tr>
</table>

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:

The objectives of this course are:

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, including the various systems and features adopted for EHVs and their social and environmental importance	1,2,6,7	1
CO2	Recognize different configurations of Hybrid vehicles power trains and analyze the various hybrid load tracking architectures	1,2,6,7	1
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	1,2,5,6,7	1
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	1
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	1
CO6	Demonstrate the various hybrid vehicular network architectures and analyze the advanced power management systems used on EHVs for optimum operations.	1,2,5,6,7	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 ARTICULATIONMATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2				1	1						2	1	
CO2	3	2				1	1						3	1	
CO3	3	2			1	1	1						2	1	
CO4	3	2	1										3	1	
CO5	3	2											2	2	
CO6	3	2	1		1	1	1						3	2	
Average	**3**	**2**	**1**		**1**	**1**	**1**						**2.5**	**1.3**	

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

COURSE CONTENT:

Introduction: Sustainable Transportation, A Brief History of EHVs, EHVs –Global scenario, Need of EHV technology, Architectures of EHVs, social and environmental importance of hybrid and electric vehicles, Challenges and Key Technology of EHVs. 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

Hybrid Electric Drive-trains: Impact of modern drive-trains on energy supplies, Basic Architecture of Hybrid Drive Trains, electronic differential system in electric vehicles, Hybrid drive train configurations- series configuration, Parallel configurations, Series-Parallel configurations and complex configurations, power flow control in hybrid drive-train topologies

Basic Architecture of Electric Drive Trains: Electric Vehicles drive train configurations, Introduction to various electric drive-train topologies, Electric Vehicle (EV) drivetrain Alternatives Based on Drivetrain Configuration, Electric Vehicle (EV) Drivetrain Alternatives Based on Power Source Configuration.

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, Battery based energy storage and its analysis –SOC,SOH, Problems associated with battery systems in EHVs, Temperature controlling methods, modern battery technologies, simple analysis of BMS for EHVs by using analysis tools.

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 - Super and Ultra Capacitors -Flywheels.

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, Design and Sizing of Traction Motors.

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 comparison of different energy management strategies

CASE STUDIES:

1. Design and modelling battery packs for EHV BMS.
2. Design and analysis of EHV drive train configurations.
3. Advances in battery health monitoring and prognostics technologies for electric vehicle (EV) safety and mobility.
4. Energy storage systems for electric vehicle applications: issues and challenges.
5. Design of a hybrid electric vehicle powertrain for optimum performance parameters.
6. A comprehensive review on estimation strategies used in hybrid and battery electric vehicle.
7. Data-driven reinforcement learning–based real-time energy management system for plug-in hybrid electric vehicles.
8. Impacts assessment of plug-in hybrid vehicles on electric utilities and regional Indian power grids.
9. Analysis of Fuel cell technology and methods to improve the efficiency of fuel cells.
10. Simulation study and crash analysis of Hydrogen vehicles.

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, 2010.
3. James Larminie and John Lowry, “Electric Vehicle Technology”, Wiley publications, 3rd Edition, 2003.
4. Ameer, Saber, Avesta, “Electric and Hybrid Vehicles”, John Wiley & Sons Ltd, 4th Edition, 2014

REFERENCE BOOKS:

1. James Larminie, John Lowry, “Electric Vehicle Technology Explained”, 3rd Edition, Wiley, 2003
2. Seth Leitman, “Build Your Own Electric Vehicle” McGraw-Hill, 2nd Edition, 2013.
3. Chris Mi, M A Masrur, D W Gao, “Hybrid Electric Vehicles – Principles and applications with practical perspectives”, 4th Edition, Wiley, 2011
4. C.C Chan, K.T Chau, “Modern Electric Vehicle Technology”, Oxford University Press Inc., New York 2001
5. Amgod Elgowainy, “Electric, Hybrid and Fuel Cell Vehicles”, Springer publication, 2nd Edition, 2021

JOURNALS/MAGAZINES

1. https://www.sciencedirect.com/book/9780444535658/electric-and-hybrid-vehicles
2. https://www.scimagojr.com/journalsearch.php?q=11600153305&tip=sid
3. https://onlinelibrary.wiley.com/
4. https://www.gore.com/resources/fuel-cell-industry-publications
5. https://www.pv-magazine-india.com/category/energy-storage/hydrogen-fuel-cells/

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc21_ee112/preview
2. https://www.edx.org/course/electric-cars-technology
3. https://www.classcentral.com/course/edx-hybrid-vehicles-10285
4. https://www.udemy.com/course/electric-and-hybrid-vehicle-engineering
5. https://archive.nptel.ac.in/courses/108/103/108103009/

<table>
<tr><td>Course Title</td><td colspan="4">Operation Research with AI</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B24ERS622</td><td>Credit</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>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Lecture</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</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>42</td><td>0</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

This course provides a comprehensive understanding of the principles, techniques, and applications of Operations Research (OR) in conjunction with Artificial Intelligence (AI) methodologies. Students will learn how to apply advanced optimization techniques, simulation methods, and predictive analytics to solve complex decision-making problems in various domains. The course will cover topics such as linear and nonlinear programming, network optimization, and evolutionary algorithms. Through lectures & case studies students will gain practical skills in modelling, analyzing, and optimizing systems using OR and AI approaches, contributing to improved decision-making and efficiency in real-world applications.

COURSE OBJECTIVES:

The objectives of this course are to:

1. To understand the fundamentals of Operations Research (OR) and its applications in solving optimization and decision-making problems.
2. To analyze the waiting line model for real world applications.
3. To determine the project completion time by using PERT and CPM.
4. To know the scheduling of machines in the shop floor by using Johnson's algorithm.
5. To discuss the conflict between the two players in a game and determine the best strategy for the play.
6. To explore the principles and algorithms of Artificial Intelligence (AI), including machine learning, Python -Pulp for decision making
7. Learn how to integrate OR techniques with AI methodologies to address complex and dynamic decision-making scenarios.
8. To gain proficiency in mathematical modeling and algorithm design for optimization problems using OR and AI approaches.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Understanding of Operations Research (OR) Principles, methodologies, and techniques for solving optimization and decision-making problems by grasping the principles of linear programming, network optimization and other OR techniques.	1,2,3	1,2

CO2	Develop a proficiency in mathematical modelling for optimization problems using OR and AI approaches and able to formulate optimization models, define decision variables, constraints, and objectives, and apply appropriate solution methods.	1,2,3	1,2
CO3	Formulate and obtain optimal solution for the transportation and assignment models with real world application	1,2,4,5	1,2
CO4	Identify the importance of sequencing of jobs & Analyze networks using PERT & CPM techniques to improve decision making withobjective analysis of decision problems.	1,3,5,9	1,2
CO5	Apply the knowledge of OR and AI techniques to real-world problems & ability to analyze data, build predictive models, optimize processes and make informed decisions using OR and AI approaches.	1,5	1,2
CO6	Gain a comprehensive understanding of practical skills in implementing OR and AI algorithms using programming languages and software tools and frameworks such as Python, MATLAB, or R for algorithm development, data analysis, and visualization.	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 ARTICULATION MATRIX:

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

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

COURSE CONTENT:

Introduction to Operations Research and Artificial Intelligence: Overview of Operations Research (OR) and its application, Artificial Intelligence (AI) and its subfields, Integration of OR and AI methodologies for optimization and decision-making. OR Models, Characteristics and phases of OR. Advantages and limitation of OR.

Linear programming Problem: Assumptions and formulation of Mathematical model, Graphical Solution to LPP, Convex and Non Convex sets, Slack, Surplus and Artificial Variable, Iterative method -Simplex and Big-M technique, Special cases in iterative method.

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.

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.

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 Xn 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.

Implementation of OR and AI algorithms using Python and relevant libraries (e.g., NumPy, pulp, SciPy, TensorFlow, PyTorch)

CASE STUDIES:

1. Implementation of OR Models to realistic problems − practical cases, by using TORA, WinQSB., Phyton Pulp
2. Product / Production Mix Problem
3. Transportation Model
4. Assignment Model / Travelling Salesman Model
5. 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/previ

<table>
<tr><td>Course Title</td><td colspan="4">Refrigeration and Air Conditioning</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B24ERS623</td><td>Credit</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>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Lecture</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</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>42</td><td>0</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

Refrigeration and air conditioning course is the extension of application of thermodynamics. The course is designed to understand the basic concept and various thermodynamic cycles used for producing cooling effect. It gives exposure on working fluids used in refrigeration systems and their limitations and various components used in refrigeration and air conditioning system. It also provides knowledge on estimation of the cooling load or heating load to design 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:

The objectives of this course are:

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 the principles of psychrometry 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 to get an employment opportunities R&AC industries

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Apply the knowledge of refrigeration cycle to analyze the vapour compression, vapour absorption and air cycle refrigeration system	1, 2	1,2
CO2	Demonstrate the knowledge on refrigerants and their properties and functions of various components used in refrigeration system	1, 6, 7	1
CO3	Apply the concept of psychrometry to demonstrate the various process involved in air conditioning process	1,2	1,2
CO4	Analyze the various heat sources and design the process by calculating the cooling load/heating load for the given condition	1, 2, 3, 6	1,2
CO5	Illustrate the knowledge on working principle of various types of air condition systems and functions of various components used in Air conditioning systems	1	1
CO6	Demonstrate the knowledge on construction, working and maintenance of various domestic devices such as refrigerator, water coolers and air conditioners.	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	2											3		
CO2	3	1				2	1						3		

CO3	3	2											3		
CO4	3	3	2										3	1	
CO5	2	1											3		
CO6	2	1											3		
Average	**2.6**	**2.3**	**2**			**2**	**1**						**3**	**1**	

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

COURSE CONTENT:

Introduction: Review of basics of refrigeration, Vapour compression refrigeration, Simple and actual vapour absorption refrigeration, Aircraft refrigeration.

Refrigerants: Refrigerant classification–primary and secondary refrigerants. Designation—Detail discussion about selection of refrigerants, CFC'S, HCFC's and HFC's, Ozone layer depletion, global warming, Alternate refrigerants, Refrigerant absorbent combinations for vapor absorption system

Refrigeration Equipment's: Refrigerant compressors-Reciprocating, Rotary and centrifugal type, Condensers, Evaporators, Expansion devices, Low side-high side float, low pressure and high pressure cut outs, solenoid valves

Psychrometry and Load Estimation: Review of Moist air properties-various psychometric process, Load estimation-comfort chart-SHF-GRSHF-ERSHF, cooling load estimate, heating load estimate, solar heat gain, infiltration, internal heat gain, Numerical on load estimation.

Air-conditioning Equipment's: Air conditioning cycle, classification, unitary system, central system and zoned system. Air handling system- ducts and its arrangements, filters, fans, air distribution system- principles, room air distribution- supply air outlets

Application of R and AC: Food storage- Domestic refrigerator-construction, working and maintenance, cold storage plants. Water coolers-storage type and pressure type, Dessert cooler, Window air conditioners, split air conditioners, centralized air conditioner

Self-Learning Component: Automotive Air conditioner, Air coolers

CASE STUDIES:

1. Estimate the cooling load in library centers, auditorium, hospital, cinema hall etc.
2. Prepare comparison report on currently available AC's and Refrigerators in Indian Market. The comparison on the basis of Capacity, type of refrigerant used, any new technology used and cost.

TEXT BOOKS:

1. R K Rajput, "Text Book of Refrigeration and Air conditioning", S.K. Kataria & Sons, 3rd Edition, 2015.
2. R S Khurmi and J K Gupta, "Text Book of Refrigeration and Air conditioning", S Chand, revised 5th Edition, 2019.

REFERENCE BOOKS:

1. C P Arora, "Refrigeration and Air Conditioning", McGraw Hill Education, 4th Edition, 2021.
2. P N Ananthnarayanan, "Basic Refrigeration and Air Conditioning", McGraw Hill Education, 4th Edition, 2013.
3. Shankar Kumar Chatterjee, "A Practical Approach to Air Conditioning and Refrigeration", Notion Press; 1st Edition 2021.
4. W.F.Stocker and J.W.Jones "Refrigeration & Air Conditioning", McGraw Hill Book Company, 2nd Edition, 2014

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	Propulsion Systems				Course Type		Soft Core	
Course Code	B24ERS624	Credits	3		Class		VI Semester	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

This course explores the concept of thermal energy conversion, also introduces the, Different Types of Fuels used for steam generation and Equipment for burning coal in lump form. This course introduces to bio mass energy and its characteristics. It also emphasizes on conversion of various biomass energy into solid, liquid and Gaseous forms. Further the course deals with conversion of biomass into methanol, ethanol, biogas, bio diesel etc. It focuses on green energy.

COURSE OBJECTIVES:

The objectives of the course are to:

1. Understand the working principles of gas turbine and ramjet propulsion systems, the design principles of inlets, combustion chambers, nozzles used in them.
2. Learn the operation of compressors and turbines in gas turbine propulsion systems.
3. Understand the operation of rocket propulsion.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Understand the fundamental principles of propulsion, including Newton's laws of motion, conservation of momentum, and energy conversion.	1	1,2
CO2	Identify and differentiate between various types of propulsion systems, such as rocket propulsion, jet propulsion and propeller-driven propulsion.	1,2	1,2
CO3	Comprehend the thermodynamic principles underlying propulsion systems, including combustion processes, thermodynamic cycles and efficiency considerations	1,2	1,2
CO4	Familiarize with the components of propulsion systems, including combustion chambers, nozzles, compressors, turbines, propellers, and exhaust systems.	1,2	1,2
CO5	Optimize the performance and efficiency of the compressor and turbine systems.	1,2	1,2
CO6	Classify and compare rockets based on propellants used.	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 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	2	
CO3	3	2											2	2	
CO4	3	2											2	2	
CO5	3	2											2	2	
CO6	3	2											2	2	
Average	**3**	**2**											**2**	**2**	

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

COURSE CONTENT:

Introduction: Classification of power plants, Methods of aircraft propulsion, Propulsive efficiency, Specific fuel consumption, Thrust and power, Factors affecting thrust and power, Illustration of working of Gas turbine engine, Characteristics of turboprop, turbofan and turbojet , Ram jet, Scram jet, Methods of Thrust augmentation.

Propeller Blade Theory: Momentum theory, Blade element theory, combined blade element and momentum theory, propeller power losses, propeller performance parameters, prediction of static thrust and in flight, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts.

Nozzles and Combustion Chamber: Subsonic and supersonic inlets, Relation between minimum area ratio and external deceleration ratio, Starting problem in supersonic inlets, Modes of inlet operation, jet nozzle, Efficiencies, Over expanded, under and optimum expansion in nozzles, Thrust reversal. Classification of Combustion chambers, Combustion chamber performance, Flame tube cooling, Flame stabilization.

Compressor and Turbine: Introduction to centrifugal compressors, Axial flow compressor, geometry, twin spools, three spools, stage analysis, velocity polygons, degree of reaction, radial equilibrium theory, performance maps, axial flow turbines, geometry- velocity polygons, stage analysis, performance maps, thermal limit of blades and vanes.

Introduction to rocket propulsion: Introduction to rocket propulsion, Reaction principle, Thrust equation, Classification of rockets based on propellants used, solid, liquid and hybrid, Comparison of these engines with special reference to rocket performance, electric propulsion, classification, electro thermal, electro static, electromagnetic thrusters, geometries of Ion thrusters, beam/plume characteristics, hall thrusters.

TEXT BOOKS:

1. Hill. P.G. and Peterson C.R, "Mechanics and Thermodynamics of Propulsion", Pearson India, 2nd Edition, 2009.
2. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H, "Gas Turbine Theory", Dorling Kindersley, 5th Edition,2002.

REFERENCE BOOKS:

1. G.C. Oates, "Aerothermodynamics of Aircraft Engine Components", AIAA Education Series, 1985.
2. G.P.Sutton, "Rocket Propulsion Elements", Wiley India Pvt Ltd, 7th Edition, 2010.
3. W.P.Gill, H.J.Smith and J.E. Ziurys, "Fundamentals of Internal Combustion Engines as applied to Reciprocating, Gas turbine & Jet Propulsion Power Plants", Oxford & IBH Publishing Co.,4th Revised Edition,2007.

Course Title	**Heat Transfer Lab**				**Course Type**		**Hard Core**	
Course Code	**B24ER0605**	**Credits**	**1**		**Class**		**VI Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0				
	Practical	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW:

Heat Transfer laboratory provides fundamental and practical knowledge about modes of heat transfer, like conduction, convection and radiation, and their application. It provides knowledge about working of various thermal devices like heat exchangers, refrigerator and air conditioner. It gives knowledge about thermal properties like thermal conductivity, heat transfer coefficients etc, and its evaluation by using standard procedure. This course also provides additional skills on operating the equipment and various measuring devices and also on performance evaluation.

COURSE OBJECTIVES:

The objectives of this course are:

1. To provide knowledge on modes of heat transfer and laws governing the Heat transfer
2. To gain the knowledge and skill on operating and using the equipment's for measurement and evaluation of heat transfer properties.
3. To understand the procedure to be followed and related equations apply to evaluate performance and properties related o heat transfer.
4. To conduct experiments related to various heat transfer processes and devices and analyze the measurement data.
4. To provide exposure to practical applications including writing of a technical report related to each experiment and make them comfortable to work in real time applications

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Conduct the different experiments of heat transfer and identify the mode of heat transfer and justify the type of heat transfer.	1,2	1,2
CO2	Perform conduction experiment to estimate thermal conductivity ,overall heat transfer coefficient of composite slab and document the results in the form of technical report	1,2,4,9,10	1,2,3
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	1,2,4,8,9,10	1,2,3
CO4	Determine the surface emissivity and Stefan- Boltzmann's constant by conducting experiments on radiation heat transfer and prepare the document	1,2,4,8,9,10	1,2,3
CO5	Conduct the performance test on Heat exchanger and Fin to evaluate the efficiency and effectiveness and document the results	1,2,4,8,9,10	1,2,3
CO6	Conduct the performance test on vapour compression refrigeration, Air conditioning system to evaluate COP and document the results	1,2,4,8,9,10	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	2	2							1	1			2	2	
CO2	3	3		1				1	1	1			2	1	1
CO3	3	3		1				1	1	1			2	1	1
CO4	3	3		1				1	1	1			2	1	1
CO5	3	3		1				1	1	1			2	1	1
CO6	3	3		1				1	1	1			2	1	1
Average	**2.8**	**2.8**		**1**				**1**	**1**	**1**			**2**	**1**	**1**

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

COURSE CONTENT:

1. Demonstration of thermal conductivity of a metal rod and heat transfer through composite surfaces
2. Experiment on heat transfer through pin-fin.
3. Demonstration of transient conduction heat transfer.
4. Determination of heat transfer coefficient for natural convection heat transfer.
5. Determination of heat transfer coefficient for forced convection heat transfer.
6. Determination of emissivity of a surface
7. Demonstration of Radiation heat transfer and Stefan Boltzmann coefficient.
8. Determination of LMDT and effectiveness in a parallel flow and counter flow heat exchangers.
9. Demonstration boiling of liquid and condensation of vapour.
10. Performance test on vapour compression refrigeration.
11. Performance test on a vapour compression air – conditioner
12. Mat Lab Programs on transient heat transfer and temperature distribution in composite wall

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://onlinecourses.nptel.ac.in/noc19_ch23/preview

Course Title	Computer Aided Engineering Analysis Lab				Course Type	Hard Core
Course Code	B24ER0606	Credits	1		Class	IV Semester
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester	Assessment in Weightage
	Lecture	0	0	0		

Tutorial	0	0	0				
Practical	1	2	2	Theory	Practical	IA	SEE
Total	**1**	**2**	**2**	**0**	**28**	**50 %**	**50 %**

COURSE OVERVIEW:

Computer Aided Engineering (CAE) Analysis Lab provides specialized environments where computational tools and techniques are utilized to simulate and analyze engineering designs and processes. This lab integral in modern engineering practices, providing the means to optimize designs and predict performance. Finite Element Analysis is used for structural analysis, stress analysis, thermal analysis, and fluid flow analysis. Provide hand on training on ANSYS WORKBENCH software to analyze the engineering problems.

COURSE OBJECTIVES:

The objectives of this course are:

1. To enhance students' understanding of the principles and theory of FEM by applying them to real-world problems.
2. To familiarize students with commercial FEM software (ANSYS WORKBENCH) and develop proficiency in using tool for solving engineering problems.
3. To develop students' ability to model and analyse complex engineering systems, including structures, thermal systems, modal and fluid dynamics problems, using FEM techniques.
4. To provide the knowledge to understand the basics of Ansys-fluent.
5. To provide knowledge for fluid flow over the immersed bodies using Ansys-Fluent.
6. To analyse the aerodynamic properties for various geometries.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Determine the internal forces and moments, as well as the deflections and stresses within the beam, when subjected to various types of loads and support conditions.	1,2,3,5,9,10	1,2,3
CO2	Analyzing the SFD and BMD, engineers can design beams and structural elements that are safe, efficient, and economical, ensuring the integrity and longevity of the structure.	1,2,3,5,9,10	1,2,3
CO3	Investigate the thermal properties of components under thermal loading and tabulate the result in tabulated form.	1,2,3,5,9,10	1,2,3
CO4	Apply the computational fluid dynamic fundamentals by using advanced solvers	1,2,3,5,9,10	1,2,3
CO5	Investigate the behaviour of external flow structured objects and document the results in the form of a technical report	1,2,3,5,9,10	1,2,3
CO6	Estimate the Aerodynamic properties for flow over Symmetrical Aero foil and heat transfer analysis document the results in the form of a 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	3	**1**		2				1	1			2	1	**1**
CO2	3	3	1		2				1	1			2	1	1
CO3	3	3	1		2				1	1			2	1	1
CO4	3	3	1		2				1	1			2	1	1
CO5	3	3	1		2				1	1			2	1	1
CO6	3	3	1		2				1	1			2	1	1
Average	**3**	**3**	**1**		**2**				**1**	**1**			**2**	**1**	**1**

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

COURSE CONTENT:

Part A

1. Analysis of Bar of uniform cross section with one end fixed condition.
2. Analysis of Stepped bar with both end fixed condition and using different material conditions.
3. Analysis simply supported beam with point load, uniformly distributed load, uniformly varying load and moment.
3. Stress analysis of Rectangular plate with hole
4. Thermal Analysis - with 2 D problem with convention boundary conditions.
5. Modal analysis of a given beam to find the first three natural frequency and to obtain corresponding mode shapes.

Part B

Introduction to CFD: Basics of Computational Fluid Dynamics: Fluid properties, Types of Fluid flow, Introduction to CFD, Capabilities of CFD, Discussion on Governing Equations for Fluid Dynamics, Models of the Flow- Basic discretization method, Finite Control Volume, Initial and Boundary conditions, Discussion on Turbulent fluid flow models and Basics of Ansys Fluent- Pre-processor, Processor, and post processor.

List of Experiments:

1. Analysis of Flow over a flat plate
2. Analysis of Flow through circular pipe
3. Analysis of Flow Measuring devices-Venturi meter
4. Analysis of Flow Measuring devices -Nozzle flow for compressible fluid
5. Flow over a symmetrical aero foil
6. Analysis of convective heat transfer analysis of a 2D component.

TEXT BOOKS:

1. Suhas V Patankar, “Numerical Heat Transfer and Fluid Flow”, CRC Press, 1st Edition, 2018.
2. J.N.Reddy, “An introduction to the finite elements methods”, McGraw Hill education, 3rd Edition 2017.

REFERENCE BOOKS:

1. Norman Rhodes, “Computational Fluid Dynamics in Practice”, Wiley, 1st Edition, 2001.
2. Witt Robert D. Cook, Malkus, Plesha,”Concepts and Applications of Finite Elements Analysis”, Wiley Publication, 4th Edition, 2007.
3. Seshu, “Textbook of Finite Element Analysis”, Prentice Hall India Learning Private Limited, 1st 2003.
4. John D Anderson, “Fundamental of Computational fluid dynamics”, McGraw-Hill Publications, 6th Edition, 1995.

JOURNALS/MAGAZINES:

1. Finite Elements in Analysis and Design, Science direct.
2. Finite Element Analysis and Simulation of Materials, MDPI.
3. International Journal of Computational Fluid Dynamics, Taylor and Francis.
4. 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)
3. https://onlinecourses.nptel.ac.in/noc22_me43/preview
4. https://archive.nptel.ac.in/courses/112/104/112104193/

Course Title	**Research Based Mini Project**				**Course Type**		**Hard Core**	
Course Code	**B24ER0607**	**Credits**	**1**		**Class**		**VI Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0				
	Practical	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	2	**0**	**28**	**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:

The objectives of this course are:

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	3		2		3								3	2	
CO5									3	2	3		3	2	
CO6	3								3	3	2	2	3	2	
verage	**2.6**	**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	CAD/CAM/CIM				Course Type		Hard Core	
Course Code	B24ER0701	Credit	3		Class		VII Semester	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	2	2	2				
	Tutorial	1	2	2	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	**3**	**4**	**4**	**56**	**0**	**50%**	**50%**

COURSE OVERVIEW:

CAD involves using computer software to create, modify, analyze, and optimize designs for products and components. It allows engineers and designers to create detailed 2D and 3D models of parts or assemblies. CAD software provides tools for drafting, modelling, rendering, and simulation, enabling precise visualization and evaluation of designs before they are physically produced. **CAM** involves using computer software and machinery to automate manufacturing processes, including planning, tool path generation, and machining operations. CAM software interprets CAD models and generates instructions (G-codes) for CNC (Computer Numerical Control) machines such as mills, lathes, and routers. CAM systems optimize machining strategies, tool selection, and material usage to improve efficiency, accuracy, and quality in manufacturing operations. **CIM** is a broader concept that integrates CAD and CAM systems with other manufacturing processes and functions through computer technology and automation. CIM aims to achieve seamless coordination and control of various manufacturing activities, including design, engineering, production planning, scheduling, inventory management, quality assurance, and supply chain management. CIM facilitates the transition towards Industry 4.0 by enabling smart factories capable of adaptive and autonomous manufacturing processes.

CAD/CAM/CIM technologies play crucial roles in modern engineering and manufacturing by enabling efficient design creation, automated manufacturing operations, and integrated production management. They contribute to improving product quality, reducing time-to-market, and enhancing competitiveness in global markets.

COURSE OBJECTIVES:

The objectives of this course are:

1. To provide students with a solid understanding of the fundamental concepts, principles, and terminology related to CAD, CAM, and CIM technologies.
2. To develop proficiency in using CAD software to create, modify, analyze, and visualize 2D and 3D models of mechanical components, assemblies, and systems.
3. To familiarize students with CAM software and techniques for generating tool paths, simulating machining operations, and programming CNC machines to manufacture parts and components efficiently and accurately.
4. To educate students about the integration of CAD and CAM systems with other manufacturing processes and functions, including product design, process planning, production scheduling, quality assurance, and supply chain management.
5. To provide hands-on experience with CAD and CAM software tools, simulation packages, and CNC machining equipment through laboratory exercises and real-world case studies.

6. To develop the ability in order to analyze engineering and manufacturing problems, identify opportunities for applying CAD/CAM/CIM technologies, and propose innovative solutions to enhance productivity, quality, and competitiveness.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Proficiency in using CAD Software to create 2D and 3D models of mechanical parts and assemblies by applying sketching techniques, constraints and parametric modelling effectively.	1,2,5	1,2
CO2	Mastery of CAM Techniques to generate tool paths for machining operations such as turning, milling and drilling. Also understanding CNC programming & to demonstrate the ability to simulate and verify tool paths for accuracy and efficiency.	1,2,3,5,8	1,2
CO3	Understand CIM Concepts and its significance in modern manufacturing environments with the integration of CAD and CAM systems with other manufacturing processes, including process planning, production scheduling and quality control.	1,2	1
CO4	Gain a comprehensive understanding of the mathematical models used in the production systems.	1,2,3	1
CO5	Gain proficiency in various line balancing techniques by applying mathematical algorithms and software tools to optimize assembly line configurations and minimize cycle time.	1,2,5	1,2
CO6	Demonstrate the ability to design parts and assemblies for manufacturability, considering factors i.e., material selection, tolerance analysis, and cost optimization to solve real-world engineering and manufacturing problems	1,2,3,8, 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			1								2	1	
CO2	3	2	2		2			1					2	3	
CO3	3	1											2	1	
CO4	3	3	1										2		
CO5	3	3			1								2	3	
CO6	3	1	2					1		2		1	2	1	
Average	**3**	**2**	**1.6**		**1.3**			**1**		**2**		**1**	**2**	**1.8**	

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

COURSE CONTENT:

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.

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, Machine Language (G & M) codes, Cutter Radius Offset, Tool Length Offset, Programming based on Fixed Cycles/canned cycles, Turning and milling programs. (Using CAM software demonstrate turning and milling operations).

Computer Integrated Manufacturing System: Introduction to CIM, Model of manufacturing, Information processing cycle in manufacturing, Types of Production systems, Production Concepts & its Mathematical models with numerical.

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.

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 Auto desk 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	

NOTE:

1. After having hand on experience on 3D modelling in Auto desk 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 modelling in Fusion 360 will be given to students.
3. Rest will be 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 10 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.

RFERENCE 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/1121042

Course Title	**Introduction to Vibration and Noise Engineering**				**Course Type**		**Hard Core**	
Course Code	**B24ER0702**	**Credit**	**3**		**Class**		**VII Semester**	
Course Structure	LTP	Credit	Contact Hours	Workload	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	2	2	2				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	1	2	2				
	Total	**3**	**4**	**4**	**28**	**28**	**50%**	**50%**

COURSE OVERVIEW:

The course is designed to explore the basic principles of vibrations and their impact on mechanical systems. It covers topics such as free and forced vibrations in systems with a single degree of freedom, both damped and un-damped conditions. These fundamental vibration systems serve as a foundation for understanding vibrations in general and their application in solving simple mechanical problems. The course also aims to impart theoretical and practical knowledge in the measurement, analysis, mitigation of machinery vibrations and noise, as well as the identification of faults using condition monitoring techniques.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Provide the fundamental principles of vibration, encompassing free and forced vibrations, damping, and resonance.
2. Develop and evaluate mathematical models of vibratory systems by employing differential equations.
3. Offer theoretical insights for addressing practical engineering challenges associated with vibrations in mechanical systems.
4. Empower students to describe the sources, characteristics, and propagation of noise in mechanical systems.
5. Emphasize the significance of condition monitoring in enhancing equipment reliability, performance, and lifespan.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Describe the causes, effects of vibration in mechanical systems and apply basics of engineering fundamentals to vibrating mechanical system and develop mathematical models to obtain their governing equations of motion and their response.	1,2,3	1,2

CO2	Compute the natural frequency of a single-degree-of-freedom system for both undamped and damped vibration system using analytical and experimental methods and document the results.	1,2,3,9,10	1,2
CO3	Analyse forced vibration in single-degree-of-freedom (SDOF) systems subjected to harmonic excitations and predict the behaviour under various conditions.	1,2,3,9,10	1,2
CO4	Classify different vibration measuring instruments, perform vibration analysis concepts and experimental techniques including modal analysis.	1,2,3,6,9,10	1,2
CO5	Develop and implement effective noise control solutions and vibration mitigation strategies in various engineering applications.	1,2,3,6	1,2
CO6	Evaluate the application of Condition Monitoring for Machinery Diagnostics and applying various diagnostic techniques to Identify various modes of machinery failures	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						2	2			3	3	
CO2	3	3	2						2	2			3	3	
CO3	3	3	2						2	2			3	3	
CO4	3	3	2										3	3	
CO5	3	3	1			1							3	3	
CO6	3	2	1			1							3	3	
Average	**3**	**2.8**	**1.6**			**1**							**3**	**3**	

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

COURSE CONTENT:

Introduction: Types of vibrations, Definitions, Causes and effects, Simple Harmonic Motion (S.H.M.), beat phenomenon and Principal of Superposition.

Undamped Free Vibration: 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,

Damped free vibrations: Types of damping, Analysis with viscous damping - Derivations for under damped systems and discuss over, critical damping, Logarithmic decrement and Problems, experimental determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional).

Forced vibration: Introduction, Analysis of forced vibration with constant harmonic excitation- magnification factor, rotating and reciprocating unbalances, force and motion transmissibility and Problems, experimental study of forced damped vibration of spring mass system.

Vibration Measurements: Accelerometer, vibrometer, Frequency measuring Instruments, Theoretical and Experimental study on Whirling of shafts, discussion of speeds above and below critical speeds and Problems, demonstration of vibration measurements by accelerometer.

Introduction to Noise: Basic concepts of sound and noise, Sources and types of noise, Sound pressure level, intensity, and power, Noise Measurement and Analysis and Noise Control Techniques.

Introduction to Condition Monitoring: Importance and benefits of condition monitoring, Overview of maintenance strategies, condition monitoring techniques, Case studies and Experimental Modal Analysis

CASE STUDIES:

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems.
2. Find the amplitude of mechanical system subjected to forced excitation.

TEXTBOOKS:

1. S S Rao, "Mechanical Vibrations", Pearson Education Inc, 6th Edition, 2018.
2. Leo L. Beranek, "Noise and Vibration Control Engineering_ Principles and Applications", Wiley, 2005
3. C Sujatha, "Vibrations and Acoustics – Measurements and signal", Tata McGraw Hill Education Private Limited, 2010

REFERENCE BOOKS:

1. W T Thomson, "Theory of Vibration with Applications", Pearson Education Inc, 5th edition, 2008.
2. V P Singh, "Mechanical Vibrations", Dhanpat Rai & Company, 3rd Edition, 2007.
3. Amberkar A G, "Mechanical Vibrations and Noise Engineering", PHI Learning Pvt. Ltd, 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">Robotics and Applications</td><td colspan="2">Course Type</td><td colspan="2">Soft Core</td></tr>
<tr><td>Course Code</td><td>B24ERS711</td><td>Credit</td><td colspan="2">3</td><td colspan="2">Class</td><td colspan="2">VII Semester</td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Lecture</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</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>42</td><td>0</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

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

COURSE OBJECTIVES:

The objectives of this course are:

1. To learn about the basics of robots, including their components, types, and how they work.
2. To understand the principles of robot design, including mechanical structure, actuators, sensors, and control systems.
3. To study the motion involved in robot movements.
4. To explore the various types of grippers and sensors used in robotics.
5. To explore real-world applications of robotics across industries and also learn robot programming part.
6. To use of robo analyse software to solve transformation matrix and forward kinematic problems.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Understand the fundamentals of robotics, structure and specification of robots, classification and work volume.	1, 2	1
CO2	Gain the knowledge of positions, orientation and also different frames associated with robots along with understanding of Eular Angles.	1, 2	1
CO3	Understand Homogeneous transformation and apply the knowledge to solve combined transformation matrix.	1,2,5	1,2
CO4	Apply the knowledge of forward kinematic to solve 3R,SCARA and Puma 560 robots	1, 2,5	1,2
CO5	Know the applications the different types of grippers and sensors for robots.	1	1
CO6	Develop part programs for various robotic applications and understand the role of robots for the various industrial applications.	1, 2,5	1

BLOOM'S LEVEL OF THE COURSE OUTCOMES:

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

COURSE ARTICULATION MATRIX:

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

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

COURSE CONTENT:

Introduction: Brief history of robotics, Fundamental laws of robotics, classification of robots, robot Specification, resolution, repeatability and accuracy of robots, numerical,

Components of Robots and Structure of Robots: types of joints, representation of joints, degrees of freedom and workspace, Configuration of Robots.

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

Transformations: Translation, Rotation matrix (2D and 3D derivation), numerical, composite rotation matrix and its properties, numerical, homogeneous representation of transformations, Composite homogeneous matrix and its properties, combined transformations, numerical, use of Roboanalyser software to solve transformation.

Forward and Inverse Kinematics : introduction to Forward kinematics, Links and Joint parameters, forward kinematics for 2R link manipulator, implementation of D-H convention and obtaining transformation matrices for 3R manipulator, SCARA manipulator, use of Roboanalyser software to solve forward kinematic problems, Introduction to Inverse kinematics.

Robot End Effectors and Sensors: Types of end effectors, mechanical gripper, types of mechanical grippers, magnetic gripper, vacuum gripper, adhesive gripper, other special grippers.Introduction to sensors, desirable properties of sensors,Tactile sensors, proximity and range sensors, vision sensors.

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

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

Self-Learning Components: Build your own robot using online resources.

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 a comparison report on the suitability of following materials with respect to their properties and application: Mild Steel, Cast Iron and Aluminum.

TEXT BOOKS:

1. Saeed B Niku, “Introduction to Robotics: Analysis, Control, Applications”, Wiley Publications 2nd Edition, 2011.
2. M.P. Groover, "Industrial Robotics - Technology, Programming and Applications", TATA McGraw-Hill, 2nd Edition 2017.

.**REFERENCE BOOKS:**

1. Deb.S.R and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2010.
2. Fu.K.S, Gonzalez.R.C&Lee.C.S.G, “Robotics Control, Sensing, Vision and Intelligence”, Tata- McGraw Hill Pub. Co., 2008
3. Klafter.R.D, Chmielewski.T.A, and Noggin’s., “Robot Engineering: An Integrated Approach”’, Prentice Hall of India Pvt. Ltd., 1994.
4. Yoremkoren, "Robotics for Engineers", TATA McGraw-Hill Education Pvt Ltd, USA, 2nd Edition 1987.

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

Course Title	Internet of Things and Machine Learning for Industry 4.0			Course Type	Soft Core
Course Code	B24ERS712	Credits	3	Class	VII Semester

Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

Industry 4.0 is concerned with transforming industrial processes by integrating 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. This course also introduces machine learning, with various aspects involved in machine learning, supervised learning and various algorithms in supervised learning. There is an emphasis on Industry 4.0 on modern industries specifically in the mechanical engineering sector.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the principles and applications of IoT and ML in Industry 4.0.
2. Learn the architecture and components of IoT systems relevant to mechanical engineering.
3. Explore various machine learning algorithms and their applications in industrial settings.
4. Develop practical skills in designing and implementing IoT and ML solutions for smart manufacturing.
5. Analyze the impact of Industry 4.0 technologies on modern industries, specifically in mechanical engineering contexts

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Understand the principles and applications of Industry 4.0	1	1,2
CO2	Understand and Identify IoT technology for given applications.	1,2	1,2
CO3	Apply the concept of machine learning concepts and technologies.	1,2	1,2
CO4	Explore various machine learning algorithms and their applications in industrial settings	1,2,5	1,2
CO5	Develop practical skills of designing and implementing IoT and Machine learning to solve real world problems.	1,2,5	1,2
CO6	Analyze the impact of Industry 4.0 Technologies on Modern Industries	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												3	3	
CO2	3	2											3	3	
CO3	3	2											3	3	

CO4	3	2			2								3	3	
CO5	3	2			2								3	3	
CO6	3	2			2								3	3	
Average	**3**	**2**			**2**								**3**	**3**	

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

COURSE CONTENT:

Overview of Industry 4.0: Definition and pillars of Industry 4.0, Evolution from Industry 1.0 to Industry 4.0, Key technologies driving Industry 4.0, Digital Transformation in Manufacturing, Smart factories and digital twins, Cyber-physical systems (CPS), Challenges and benefits of digital transformation

Fundamentals of IoT: Introduction, Definition and scope of IoT, IoT architecture and protocols, communication models, IoT Devices and Sensors, Types of IoT devices and sensors, Data acquisition and sensor integration, Wireless communication technologies (Wi-Fi, Bluetooth, Zigbee), Networking fundamentals for IoT, Communication protocols (MQTT, CoAP, HTTP/HTTPS), IoT data management and storage, Overview of IoT platforms (AWS IoT, Google Cloud IoT, Azure IoT),

Fundamentals of Machine Learning: Introduction to Machine Learning, Definition and types of machine learning (supervised, unsupervised, reinforcement) Key concepts and terminology, Applications of machine learning in industry, Data collection and cleaning, Feature selection and extraction, Handling missing data and outliers, Supervised Learning Algorithms, Unsupervised Learning Algorithms

Applications of IoT and ML in Industry 4.0: Predictive Maintenance, IoT-enabled predictive maintenance systems, Machine learning for failure prediction and maintenance scheduling, Quality Control and Optimization, Real-time quality monitoring with IoT, Machine learning for process optimization, Smart Supply Chain Management, IoT for supply chain visibility and tracking, ML for demand forecasting and inventory management, Integration of IoT and ML in supply chain operations, Security and Privacy in Industry 4.0, Security challenges in IoT and ML applications, Data privacy concerns and solutions

CASE STUDIES:

1. Improving the efficiency of machines in the food package industry
2. Manufacturing Analytics
3 Smart metering from Electricity board – Vodafone
4. Connected cars for TATA
5. Global Shipment Tracking – Vodafone
6. Intelligent Supermarket: Real-time inventory management- Bosch

TEXTBOOKS:

1. Andy King, “Programming the Internet of Things: An Introduction to Building Integrated, Device to Cloud IoT Solutions", OREILLY, 2021
2. Dominik T Matt, “Industry 4.0 for SME’s: Challenges, Opportunities and Requirements”, Kindle Edition, 1st edition, 2020
3. Tom Mitchell, “Machine Learning”, McGraw –Hill, 1st Edition, 2017

REFERENCE BOOKS:

1. Dominique D Guinard 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”, McGraw-Hill, 3rd Edition, 2009

JOURNALS/MAGAZINES:

1. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=8548628
2. https://theiotmagazine.com/?gi=7cfc1349c469
3. https://readwrite.com/
4. https://becominghuman.ai/?gi=58b98910fc8a
5. https://www.journals.elsevier.com/knowledge-based-systems
6. https://aijourn.com/

SWAYAM/NPTEL/MOOCs:

1. https://nptel.ac.in/courses/108108123
2. https://nptel.ac.in/courses/106105152
3. https://nptel.ac.in/courses/111105489
4. https://nptel.ac.in/courses/106105195

Course Title	Automotive Air conditioning				Course Type		SC	
Course Code	B24ERS713	Credit	3		Class		VII Semester	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	CIE	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

Automotive Air Conditioning course is designed to provide students with a comprehensive understanding of air conditioning systems used in modern vehicles. The course covers the fundamental principles of refrigeration, the components and operation of automotive air conditioning systems, diagnostic and repair techniques, and safety practices. Further, the course expose the students to inclusive understanding of the various components and mechanisms involved in the distribution and control of air conditioning systems.

COURSE OBJECTIVES:

The objectives of this course are:

1. To understand the fundamental principles of refrigeration and air conditioning.
2. To recognize and understand the function of key components in an automotive air conditioning system.
3. To study the air distribution systems, control devices and their functions.
4. To impart knowledge on diagnosing common issues, routine maintenance and repairs of air conditioning systems used in automobiles.
5. To impart knowledge on safety practices and adhere to environmental regulations related to automotive air conditioning.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Demonstrate the fundamental principles of automotive air conditioning systems including thermodynamics and heat transfer.	1,2	1, 2
CO2	Summarize understanding of different layouts and the functions of various components of automotive air conditioning systems.	1,2	1, 2
CO3	Identify and quantify different types of thermal loads in automobiles.	1, 2, 8	1, 2
CO4	Extend the role of various control devices and duct distribution systems for optimal air distribution in automobile.	1,2	1, 2
CO5	Apply skills to diagnose common issues and proper maintenance procedures for efficient working of the automotive air conditioning systems.	1,2	1, 2
CO6	Develop a comprehensive understanding of environmental impact of refrigerants and apply safety practices to prevent injuries while working with air conditioning systems.	1,2,6,7	1, 2

BLOOM'S LEVEL OF THE COURSE OUTCOMES:

	Bloom's Level

CO	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	1	
CO2	3	2											3	1	
CO3	3	1						1					3	2	
CO4	3	1											3	1	
CO5	3	2											3	1	
CO6	3	2				2	1						3	1	
Average	**3**	**1.7**				**2**	**1**	**1**					**3**	**1.2**	

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

COURSE CONTENT:

Introduction: Methods of refrigeration, Applications of refrigeration and air conditioning, Automobile air conditioning- Overview and importance, Air conditioning for passengers, transport vehicles; Thermoelectric cooling and Thermo acoustic refrigeration.

Air Conditioning Systems: Classification and layouts - Central / unitary air conditioning systems; Components like compressors, evaporators, condensers, expansion devices, fan blowers, heating systems

Load Analysis: Outside & inside design consideration, Factors forming the load on refrigeration & air conditioning systems, Cooling & heating load calculations, Load calculations for automobiles, Effect of air conditioning load on engine performance.

Distribution System: Distribution duct system, sizing, supply / return ducts - Types of grills, diffusers, ventilation, air noise level - Layout of duct systems for automobiles and their impact on load calculation.

Control devices: Automatic temperature Control, Control of air handling systems, Air Conditioning Control: Common control such as thermostats, Humidistats, Control dampers - Pressure cut outs and relays.

Diagnostics, Maintenance and Repair techniques: Common air conditioning system problems and symptoms, Refrigerant recovery, recycling and recharging; leak detection and repair techniques.

Environmental impact and Safety considerations: Environmental impact of refrigerants and regulations, proper handling, storage and disposal of refrigerants, safety practices to prevent injury and contamination.

Self-Learning Component: Refrigerants used in automotive air conditioning, future trends in automotive air conditioning.

CASE STUDIES:

1. Study and prepare a report on air conditioning systems used in Indian cars.
2. Study and prepare a report on air conditioning systems used in passenger heavy vehicles (Bus).
3. Study and prepare a report on transportation vehicle (trucks).
4. Prepare a report on implementation of health and safety systems in automobile air conditioning.
5. Prepare a report on thermal comfort improvement through advanced control systems in automobile air conditioning.

TEXT BOOKS:

1. Mark Schnubel, “Automotive Heating and Air conditioning”, Today’s Technician, 5th Edition, 2013.
2. Anil Chhikara, “Automobile Engineering-Volume VI- Automotive Air conditioning”, Satya Prakashan Publications, New Delhi, India, Volume 6, 2024.

REFERENCE BOOKS:

1. Steven Daly, “Automotive Air Conditioning and Climate Control Systems”, Butterworth-Heinemann, 1th Edition, 2006.
2. Norman C. Harris, “Modern Air-Conditioning Practice”, McGraw-Hill Education, 3rd Edition, 1984.
3. Althouse, Turnquist, Bracciano “Modern Refrigeration and Air Conditioning”, Goodheart-Willcox, 6th Edition, 1992.

JOURNALS/MAGAZINES:

1. https://www.sciencedirect.com/topics/engineering/automotive-air-conditioning.

SWAYAM/NPTEL/MOOCs:

1. https://archive.nptel.ac.in/courses/112/107/112107208/

Course Title	**Aircraft Maintenance**				**Course Type**		**Soft Core**	
Course Code	**B24ERS714**	**Credits**	**3**		**Class**		**VII Semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	IA	SEE
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

An aircraft maintenance course provides comprehensive training to individuals interested in pursuing a career in aircraft maintenance and repair. The course covers various aspects of aircraft systems, maintenance procedures, and regulatory requirements to ensure the safe operation of aircraft. This course typically begins with an introduction to the aviation industry, including its history, evolution, and current trends. Students learn about different types of aircraft, their components, and the roles and responsibilities of aircraft maintenance personnel. The course covers the fundamental maintenance procedures followed in the aviation industry. Topics include inspection techniques, documentation requirements, scheduled maintenance tasks, and the use of specialized tools and equipment. Students gain knowledge about preventive maintenance, troubleshooting methods, and rectification of defects.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Explore Fundamentals of Aircraft Maintenance
2. Develop documentation for maintenance
3. Explore the aircraft logbook and maintenance crew skill requirements
4. Study the safety regulations and materials storage and handling practices

COURSE OUTCOMES (COs)

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

CO	**Course Outcomes**	**POs**	**PSOs**
CO1	Understand and interpret the aircraft maintenance manual and logbook	1,2,12	1,2
CO2	Analyse the various certification requirements in aviation.	1,2,12	1,2
CO3	Apply the various technical policies and procedure manuals used in aircrafts.	1,2, 12	1.2
CO4	Interpret material management and inventory control requirements in aircraft	1,2,12	1,2
CO5	Apply the safety regulations and standards used in aircraft	1,2,12	1,2

CO6	Analyze the trouble shooting and malfunctions.	1,2,12	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	3	3	
CO2	3	3										1	3	3	
CO3	3	2										1	3	3	
CO4	3	3										1	3	3	
CO5	3	3										1	3	3	
CO6	3	3										1	3	3	
Average	**3**	**2.6**										**1**	**3**	**3**	

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

COURSE CONTENT:

Fundamentals of Maintenance & Certification: Types of maintenance, Redesign, Failure rate pattern, Other maintenance considerations, Aviation industry certification requirements, Type certificate (FAA form 8110.9), Airworthiness certificate (FAA form 8100-2), Aviation maintenance certifications, General, Airframe, Power plant, Avionics courses.

Documentation for Maintenance: Manufacturers documentation, Airplane maintenance manual, Fault insulation manual, Illustrated parts catalogue, structural repair manual, wiring diagram manual, Master minimum equipment, Federal Aviation regulation (FAR), Advisory circulars, Airworthiness direction ATA document standards, Technical policies and procedure manuals (TPPM)

Aircraft Management Maintenance: Structure, Role of aviation management, Line supervisory management, Management areas of concern in airlines, Aircraft Logbook, Maintenance crew skill requirements.

Hanger Maintenance (on Aircraft) & Material Support: Introduction, organization of hanger maintenance, Non-routine item, parts availability, cannibalization, Types of shops- sheet metal shop, Aircraft interior shop, Engine shop, Avionics shop, ground support equipment, outsourcing of shop maintenance work, operation of overhaul shops, Material support, Material management inventory control, Support functions of material, Parts ordering, Storage, Issue, control and handling, Parts receiving quality control, calibration program, stock level adjustments, shelf life, exchanges, warranty & modifications of parts

Maintenance Safety & Trouble shooting: Safety regulations, occupational safety and health standards maintenance safety program, Airlines safety management, General safety rules, Accident & injury reporting, Hazardous materials storage and handling aircraft furnishing practices trouble shooting, Knowledge of malfunctions.

CASE STUDIES:

1. Data Analytics in the aircraft maintenance, repair and overhaul
2. Analyzing the safety regulations and aviation maintenance facilities

TEXT BOOKS:

1. Harry A Kinnison and Tariq Siddiqui, “Aviation Maintenance Management”, Mc Graw Hill Education (India) Private Ltd, 2013.
2. Kroes, Watkins and Delp, “Aircraft maintenance and repair”, Mc Graw Hill, 2013.

REFERENCE BOOKS:

1. Federal Aviation Administration (FAA), “Aviation Maintenance Technician Handbook”, 2018th Edition.
2. Larry Reithmaier “Aircraft Repair Manual" Palmar Books, Marquette, 1992.
3. Brimm. DJ, Bogges, HE, Aircraft Maintenance, Pitman publishing corp, London, 1952.

Course Title	Industry Training				Course Type		Soft core	
Course Code	B24ERS715	Credits	3		Class		VII semester	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0				
	Practical	3	3	3	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**0**	**42**	**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:

The objectives of this course are:

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 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	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, 6th Edition, 2013.

Course Title	Sustainable Engineering				Course Type	Soft Core
Course Code	B24ERS721	Credit	3		Class	VI Semester
Course Structure	LTP	Credit	Contact Hours	Workload	Total Number of Classes Per Semester	Assessment Weightage
	Lecture	3	3	3		

	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

Sustainable engineering is a way of designing and creating things that meet our needs without harming the environment or depleting natural resources. Sustainable engineers focus on minimizing waste, using renewable energy sources, reducing pollution, and creating long-lasting, efficient systems that can be enjoyed by future generations. The importance of sustainable engineering comes from the industry's aim to create a better world. This is done by considering the well-being of both people and the planet in their engineering practices.

COURSE OBJECTIVES:

The objectives of this course are:

1. To develop basic awareness amongst students of the importance of sustainable practices for a better environment.
2. To understand the role of engineering & technology for better sustainable development.
3. To give exposure on life cycle assessment of a product or a system.
4. To incorporate the sustainable engineering principles to real time engineering problems.
5. To analyze the global challenges and sustainable development goals.

COURSE OUTCOMES (COs):

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

CO	Course Outcomes	POs	PSOs
CO1	Understand the concept of sustainability and its three pillars: environment, society, and economy.	1,7,12	1,2,3
CO2	Apply sustainable engineering principles to real-world engineering problems & analyze the integration methods of sustainability to Engineering Design	1,7,12	1,2,3
CO3	Identify and evaluate different sustainable technologies, environmental agreements and protocols and practices.	1,7,12	1,2,3
CO4	Apply the Principle of sustainability and methodology of Life Cycle Assessment Tool to engineering systems	1,7,12	1,2,3
CO5	Analyze between carbon emissions for regular and sustainable cities and explain different practices to move industries towards sustainability	1,7,12	1,2,3
CO6	Discuss different renewable energy resources and explain methods to implement green technology	1,7,12	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	2						1					1	2	1	1
CO2	1						2					2	1	2	1
CO3	1						2					2	1	2	2
CO4	2						1					1	1	2	2
CO5	1						2					1	1	1	1
CO6	2						2					1	1	1	1
Average	**1.5**						**1.67**					**1.33**	**1.2**	**1.5**	**1.3**

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

COURSE CONTENT:

Introduction to Sustainable Engineering - Sustainable development, concepts of sustainable development: three pillar model, egg of sustainability model, Atkisson's pyramid model, prism model, principles of sustainable development, sustainable engineering, threats for sustainability. Environmental Ethics and Legislations – Environmental ethics and education, multilateral environmental agreements and protocols, enforcement of environmental laws in India – The Water Act, The Air Act, The Environment Act.

Local Environmental Issues - Solid waste, impact of solid waste on natural resources, zero waste concept and three R concept, waste to energy technology: thermo-chemical conversion, biochemical conversion.

Global Environmental Issues - Resource degradation: deterioration of water resources, land degradation, air pollution, climate change and global warming, ozone layer depletion, carbon footprint, carbon trading.

Tools for Sustainability - Environmental management System (EMS), concept of ISO14000, life cycle assessment (LCA): basic components, advantages, disadvantages, case study. Environmental impact assessment (EIA), environmental auditing, bio mimicking, case studies.

Sustainable Habitat - Concept of green building, green building materials, green building certification and rating: green rating for integrated habitat assessment (GRIHA), leadership in energy and environmental design (LEED) rating, energy efficient buildings, sustainable cities case studies in sustainability engineering: Green building, sustainable city, sustainable transport system. Sustainable Industrialization and Urbanization – Sustainable urbanization, industrialization, material selection, pollution prevention, industrial ecology, industrial symbiosis, poverty reduction.

Renewable energy resources- Conventional and non- conventional forms of energy, solar energy, fuel cells, wind energy, small hydro plants, biogas systems, biofuels, energy from ocean, geothermal energy, conservation of energy.

Green technology and Green Business: Sustainable business, green technology, green energy, green construction, green transportation, green chemistry, green computing.

TEXTBOOKS:

1. R. L. Rag and Lekshmi Dinachandran Remesh," Introduction to Sustainable Engineering", PHI Learning Pvt. Ltd., 2nd Edition, 2016.
2. Krishna R. Reddy, Claudio Cameselle and Jeffrey A. Adams, "Sustainable Engineering" Wiley Publication, 1st Edition, 2019.

REFERENCE BOOKS:

1. D. T. Allen and D. R. Shonnard, "Sustainability Engineering: Concepts, Design and Case Studies", Prentice Hall, 1st Edition, 2011.
2. A.S. Bradley, A. O. Adebayo, P.Maria. Engineering applications in sustainable design and development, 1st Edition, Cengage learning, 2016.

JOURNALS/MAGAZINES

1. International Journal of Sustainable Engineering

2. International Sustainable Engineering and Science

3. Engineering Sustainability/ emerald group publishing

SWAYAM/NPTEL/MOOCs:

1. https://ocw.mit.edu/course-lists/environment-engineering-for-sustainability-5/
2. https://graduate.northeastern.edu/program/graduate-certificate-in-sustainability-engineering-19153/
3. https://onlinecourses.nptel.ac.in/noc23_ce90/preview.
4. https://www.mtu.edu/globalcampus/degrees/certificates/engineering-sustainability-resilienc

Course Title	**Advanced Manufacturing Process**				**Course Type**		**Soft Core**	
Course Code	**B24ERS722**	**Credit**	**3**		**Class**		**VII Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

This course introduces the working principle of the various advanced manufacturing techniques. Course also covers the details of advanced machining theory and practices, advanced machining processes, advanced metal forming processes, advanced welding processes and advanced foundry processes follow in modern industries. Furthermore, the course emphasizes on theoretical principles, practical applications, and the integration of these processes within contemporary manufacturing systems.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Discuss in detail the various non-traditional/unconventional or advanced machining processes (AMPs).
2. Impart fundamentals of the theory of machining, advanced machining, finishing processes.
3. Develop an understanding to familiarize the underlying principles of advanced manufacturing techniques.
4. Provide hands-on experience with state-of-the-art manufacturing technologies and to explore the challenges associated with implementing advanced manufacturing processes.

COURSE OUTCOMES (COs):

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

CO	**Course Outcomes**	**POs**	**PSOs**
CO1	Understand and gain in-depth knowledge of non-traditional machining processes	1	1,2
CO2	Understand sustainable forming practices and how to implement them to minimize environmental impact, such as reducing energy consumption and material waste.	1, 7	1,2
CO3	Apply forging process knowledge in interdisciplinary projects, integrating insights from materials science, mechanical engineering, and industrial engineering.	1	1,2,3
CO4	Apply casting process knowledge in interdisciplinary projects, integrating insights from materials science, mechanical engineering, and industrial engineering.	1	1,2,3
CO5	Gain proficiency in integrating PM with additive manufacturing techniques for creating complex geometries and high-performance materials.	1	1
CO6	Gain the knowledge on the latest advancements and trends in PM technologies, ensuring continual professional growth.	1, 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	2												2	1	
CO2	2												2	1	
CO3	2						1						2	1	
CO4	2												2		
CO5	2												2	1	1
CO6	2											1	2	1	1
Average	**2**						**1**					**1**	**2**	**1**	**1**

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

COURSE CONTENT:

Introduction: Evolution, need and classification of advanced machining processes (AMPs).

Advanced Machining Processes: Introduction; Process principle and mechanism of material removal; Process Parametric (parameters) analysis; Applications; Operational characteristics; Limitations of Ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive water jet machining (AWJM) processes, Electrochemical machining (ECM); Electro discharge machining (EDM); Electron beam machining (EBM); Laser beam machining (LBM) processes.

Conventional Forming: Process details of Forging, Casting, and Extrusion.

Advanced Forming : Details of high energy rate forming (HERF) process; Electro-magnetic forming, explosive forming; Electro-hydraulic forming; Stretch forming; Contour roll forming; Advanced welding processes - Details of electron beam welding (EBW); laser beam welding (LBW); ultrasonic welding (USW).

Advanced Casting Processes: Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting.

Advanced Powder Metallurgy: Powder Production Methods - Gas Atomization, Water Atomization, Mechanical Alloying. Consolidation Techniques - Hot Isostatic Pressing (HIP), Spark Plasma Sintering (SPS). Sintering Mechanisms - Surface Diffusion, Grain Boundary Diffusion, Volume Diffusion, Liquid Phase Sintering, Solid-State Sintering. Microstructural Evolution - Grain Growth Kinetics, Phase Transformations, Porosity Evolution, Particle Morphology.

Applications of Powder Metallurgy: Automotive, Aerospace, Biomedical Devices.

Self-Learning Component: Understanding of basic concept of Manufacturing Processes

TEXT BOOKS:

1. Ghosh A., Mallik A. K., "Manufacturing Science", Affiliated East-West Press Ltd, New Delhi
2. Jain V. K.,"Advanced Machining Processes", Allied Publishers, New Delhi.
3. Pandey P. C., Shan H. S. "Modern Machining Processes", Tata McGraw-Hill Publishing Co. Ltd, New Delhi.
4. Mishra P. K., "Nonconventional Machining", Narosa Publishing House, New Delhi.

REFERENCE BOOKS:

1. E.P. DeGarmo, J. T Black, R.A.Kohser, "Materials and Processes in Manufacturing", Prentice Hall of India, 8th Edition.
2. Benedict G. F., "Nontraditional Manufacturing Processes", Marcel Dekker Inc. New York.

4. McGeough J. A., "Advanced Method of Machining", Chapman and Hall, New York.

JOURNALS/MAGAZINES:

1. Journal of Manufacturing Processes
2. International Journal of Advanced Manufacturing Technology
3. Additive Manufacturing
4. Journal of Materials Processing Technology
5. Manufacturing Letters
6. Advanced Manufacturing
7. IEEE Transactions on Automation Science and Engineering

SWAYAM/NPTEL/MOOCs:

1. SWAYAM: "Advanced Manufacturing Processes (NOC18-MM20)"
2. NPTEL: "Advanced Manufacturing Processes"
3. Coursera: "Advanced Manufacturing Process Analysis"
4. edX: "Advanced Manufacturing Process Analysis and Optimization".
5. Udemy: "Practical Guide to Advanced Manufacturing Processes".

Course Title	**Computational Fluid Dynamics**				**Course Type**		**Soft Core**	
Course Code	**B24ERS723**	**Credit**	**3**		**Class**		**VII Semester**	
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	3	3	3				
	Tutorial	0	0	0	Theory	Practical	**CIE**	**SEE**
	Practical	0	0	0				
	Total	**3**	**3**	**3**	**42**	**0**	**50%**	**50%**

COURSE OVERVIEW:

CFD or computational fluid dynamics is a branch of continuum mechanics that deals with numerical simulation of fluid flow and heat transfer problems. The exact analytical solutions of various integral, differential or integro-differential equations, obtained from mathematical modeling of any continuum problem, are limited to only simple geometries. Thus for most situations of practical interest, analytical solutions cannot be obtained and a numerical approach should be applied. In the field of mechanics, the approach of obtaining approximate numerical solutions with the help of digital computers is known as Computational Mechanics whereas the same is termed as Computational Fluid Dynamics for thermo-fluidic problems. CFD, thus, deals with obtaining an approximate numerical solution of the governing equations based on the fundamental conservation laws of mass, momentum and energy.

COURSE OBJECTIVES:

The objectives of this course are:

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):

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

CO	**Course Outcomes**	**POs**	**PSOs**

CO1	Gain the fundamental Knowledge of computational fluid dynamics and describe boundary conditions and numerical errors.	1	1,2
CO2	Develop the governing equations related to CFD applications.	1,2,3	1,2
CO3	Analyze the fluid flow fields using discretization techniques.	1,2	1,2
CO4	Apply turbulence models for fluid flow analysis over immersed bodies.	1,2,3,4,5,6	1,2
CO5	Demonstrate the procedure used for analyzing fluid flow characteristics performance using CFD tool.	1,2,3,4,5,6,9	1,2,3
CO6	Solve real-world applications related fluid flow analysis using CFD tools.	1,2,3,4,5	1,2,3

BLOOM'S LEVELOF THECOURSE OUTCOMES

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

COURSE ARTICULATIONMATRIX

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

COURSE CONTENT:

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.

Fundamentals of Discretization: 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.

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 disadvantages, RNG κ-ε model and κ-ω model, Multiphase flow, Pressure - velocity coupling in steady flows: Staggered grid, SIMPLE algorithm, Assembly of a complete method, SIMPLER, SIMPLEC and PISO algorithms, Worked examples of the above algorithms.

Application 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, Discussion on Practical problems using CFD tools.

CASE STUDIES:

1. Thermal Comfort Analysis of an Office
2. Aircraft Aero CFD Simulation Using the NASA Common Research Model
3. Analysis of Fluid Flow over a Car.
4. A Numerical Investigation of the Incompressible Flow through a Butterfly Valve Using CFD
5. Explain briefly how to simulate a NACA 0012 Airfoil at a 6 degree angle of attack placed in a wind tunnel, using FLUENT.
6. Study of Flow around a Rotating Cylinder

TEXT BOOKS:

1. J. D Anderson, “Fundamental of Computational Fluid Dynamics”, McGraw-Hill Publications, 6th Edition, 2017.
2. Jiyuan Tu “Computational Fluid Dynamics – A Practical Approach“, Butterworth Heinemann, 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	**Aircraft Transportation Systems**				**Course Type**	**Soft Core**
Course Code	**B24ERS724**	**Credits**	**3**		**Class**	**VII Semester**
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes	Assessment in Weightage

Lecture	3	3	3	Per Semester			
Tutorial	0	0	0	Theory	Practical	IA	SEE
Practical	0	0	0				
Total	**3**	**3**	**3**	**42**	**0**	**50 %**	**50 %**

COURSE OVERVIEW:

This course serves as an introduction to aircraft transportation, giving students a thorough overview of the subject and its fundamental ideas. The course usually lasts for one semester and combines both theoretical ideas and real-world applications. Physics and mathematics fundamentals are expected of all students. Students exposed to Airport planning, Airlines, Aircraft characteristics and Manufacturers. Study of the Environment, transport and mobility, Development of airportand Air navigation system, introduction to the ICAO, Regulatory frame work and market aspect aircraft characteristics and manufacturers.

COURSE OBJECTIVES:

The objectives of this course are:

1. To understand the Development of aircraft design driver-speed and range.
2. Acquire the knowledge of Airport, Airlines, ICAO, Regulatory Frame work and Market Aspects.
3. To Understand the Aircraft characteristics and manufacturing
4. To provide the concepts with respect to Flight performance and mission.
5. To give exposure on role Aircraft navigation system.

COURSE OUTCOMES (COs)

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

CO	Course Outcomes	POs	PSOs
CO1	Outline for development of aircraft design drive-speed and range	1	1
CO2	Elaborate the development of Airport, Airlines and ICAO	1	1,2
CO3	Discuss about Aircraft manufactures and supply chain	1	1
CO4	Outline airport operation and services and airport planning - infrastructure	1, 11	1
CO5	Elaborate the principle of operation and role of air navigation services	1,	1
CO6	Discuss the concept of air cargo-market for air freight and principles of airline scheduling, fleet planning.	1	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		
CO2	2												1	1	
CO3	2												1		
CO4	2										1		1		
CO5	2												1		
CO6	2												1		

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

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

COURSE CONTENT:

Air Transport Systems: Introduction, environment, transport and mobility, systematic description and current challenges. Development of aircraft design driver-speed and range, development of airport, Airlines, ICAO, Regulatory Frame work and Market Aspects.

Aircraft Characteristics and Manufacturers: Classification of flight vehicles, cabin design, basics of flight physics-structures, mass and balance. Flight performance and mission. Aircraft manufacturers, development process, production process, supply chain.

Airlines, Airport and Infrastructure: Airline types, Network management. Flight strategy and aircraft selection, flight operations, MRO. Role of Airport, Regulatory Issues, Airport operation and services. Airport planning - infrastructure.

Air Navigation System & Environmental Systems: Principle of operation- Role of Air Navigation services. Air space structures, Airspace and Airport capacity, Aircraft separation. Flight guidance system. Communication system. Integrated air traffic management and working system. Environmental aspects-emission, noise, and sound.

Managerial Aspects of Airlines: Airline passenger marketing, forecasting methods, pricing and demand. Air cargo-market for air freight. Principles of airline scheduling. Fleet planning.

CASE STUDIES:

1. Case study on classification on airport and airlines
2. Case study on Air navigation system

TEXT BOOKS:

1. Dieter Shmitt, and Valker Gollnick, “Air Transport System”, Springer, 2016.
2. Jhon G Wensveen, “Air Transportation-A Management Prospective”, Ashgate Publishing Ltd, 2011

REFERENCE BOOKS:

1. Mike Hirst, “The Air Transportation System”, Woodhead Publishing Ltd, England, 2008.

JOURNALS/MAGAZINES:

1. https://arc.aiaa.org/journal/jat
2. https://www.nata.aero/products-and-services/aviation-business-journal
3. https://libguides.singaporetech.edu.sg/atm/journals
4. https://arc.aiaa.org/loi/jat

SWAYAM/NPTEL/MOOCs:

1 https://www.youtube.com/watch?v=cWDCXFwPLIs&list=PLvAvkZqpoPNNEnHsfkJbjpE8Sc5g5njnO
2. https://www.youtube.com/watch?v=JltYcdVvzXE&list=PLpAeOMof3DUwUjqe6I3M6MTMouqsPezp0
3. https://www.youtube.com/watch?v=cWDCXFwPLIs&list=PLvAvkZqpoPNNEnHsfkJbjpE8Sc5g5njnO
4. https://www.youtube.com/watch?v=JltYcdVvzXE&list=PLpAeOMof3DUwUjqe6I3M6MTMouqsPezp0.

Course Title	**Internship**				**Course Type**		**Soft Core**	
Course Code	**B24ERS725**	**Credits**	**3**		**Class**		**VII semester**	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0				
	Practical	3	3	3	Theory	Practical	IA	SEE
	Total	**3**	**3**	**3**	**0**	**42**	**50 %**	**50 %**

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:

The objectives of this course are:

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

	Bloom's Level					
CO	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	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 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	CIM and Machine Learning Lab				Course Type		Hard Core	
Course Code	B24ER0703	Credits	1		Class		VII Semester	
Course Structure	LTP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0	0				
	Tutorial	0	0	0				
	Practical	1	2	2	Theory	Practical	IA	SEE
	Total	**1**	**2**	**2**	**0**	**28**	**50 %**	**50 %**

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:

The objectives of this course are:

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 concepts of NC programming Languages - Manual Part Programming	1,2,5	1,2
CO2	Analyze the various operations involved in the profile with its syntax format formachining 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/partgeometry 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, Threadcutting operations and document the results in the form of technical report Familiarize with the computer numerical control software and its ability togenerate the cutter tool path as per given profile in the dry run and document theresults in the form of technical report.	1,2,5,9,10	1,2
CO5	Apply Machine Learning Models for tool condition monitoring using Python.	1,2,5,9,10	1,2
CO6	Analyze the various operations involved in the profile with its syntax format formachining and document the results in the form of technical report.	1,2,5,9,10	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	3	2			1								2	1	3
CO2	2	3			3				2	2			2	2	2
CO3	2	3			3				2	2			2	2	2
CO4	2	3			3				2	2			2	2	2
CO5	2	3			3				2	2			2	2	2
CO6	3	2			1				1	1			2	1	3
Average	**2.3**	**2.6**			**2.3**				**1.8**	**1.8**			**2**	**1.6**	**2.3**

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

COURSE CONTENT:

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 canned cycle programs.
3. Simulation of milling operations. Typical simulations to be carried out using simulation packages like: Cadem, CAM Lab−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.

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	Capstone Project Phase-1			Course Type		Hard Core	
Course Code	B24ER0704	Credits	2	Class		VII Semester	
Course Structure	LTP	Credits	Contact Hours	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0				
	Tutorial	0	0				
	Practical	2	4	Theory	Practical	IA	SEE
	Total	**2**	**4**	**0**	**56**	**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:

The objectives of this course are:

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.
3. 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.
4. 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	Capstone Project			Course Type		Hard Core	
Course Code	B24ER0801	Credits	10	Class		VIII Semester	
Course Structure	LTP	Credits	Contact Hours	Total Number of Classes Per Semester		Assessment in Weightage	
	Lecture	0	0				
	Tutorial	0	0				
	Practical	10	20	Theory	Practical	IA	SEE
	Total	**10**	**20**	**0**	**280**	**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:

The objectives of this course are:

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 of modelling, simulation, experimental & analysis, model/prototype design, fabrication of new equipment, analysis of data, software development, Industry needs based basic survey or Testing or Analysis etc. or a combination of these.

The students have to make a project team consisting of two, three or four members. In case of multidisciplinary project the team members should not exceed six. 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.

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

REVA UNIVERSITY

Bengaluru, India

Rukmini Knowledge Park, Kattigenahalli
Yelahanka, Bengaluru - 560 064
Karnataka, India.

Ph: +91- 90211 90211, +91 80 4696 6966
E-mail: admissions@reva.edu.in

www.reva.edu.in

Follow us on

/revauniversity_official /REVAUniversity

/revauniversity_official /@revauniversity_official /REVA University

reva.edu.in +91 90211 90211