
**Four-Year Undergraduate Programme**

## Bachelor of Technology

## Mechanical Engineering

# Faculty of Engineering & Technology

## Parul University

## Vadodara, Gujarat, India

**Faculty of Engineering & Technology**
**Bachelor of Technology in Mechanical Engineering**

## 1. Vision of the Department

To be a nationally and globally recognized center of excellence in technical education, fostering innovation, industry-relevant skills, and academic distinction to develop competent mechanical engineers for a sustainable future.

## 2. Mission of the Department

**M1** To deliver high-quality technical education that equips mechanical undergraduate, postgraduate and research students with strong engineering fundamentals and practical skills aligned with industry needs.

**M2** To promote innovation and research through active collaboration with industry and continuous engagement with emerging technologies for real-world problem solving.

**M3** To cultivate ethical awareness and social responsibility among mechanical graduates, empowering them to contribute meaningfully to sustainable development and societal welfare at both national and global scales.

## 3. Program Educational Objectives

The statements below indicate the career and professional achievements that the B.Tech. Mechanical Engineering curriculum enables graduates to attain.

| | |
|---|---|
| **PEO 1** | To pursue successful career in mechanical engineering involving professional knowledge and skills for analysis, design and solution of real time engineering problems. |
| **PEO 2** | To excel in professional career in the field of mechanical engineering with sound fundamental knowledge and pursue life- long learning including higher education and research. |
| **PEO 3** | To demonstrate interpersonal skills, leadership ability and team building capacity to achieve organization goals and serve society with professional ethics and integrity. |

## 4. Program Outcomes

Program Learning outcomes are statements conveying the intent of a program of study.

| | | |
|---|---|---|
| **PO 1** | **Engineering knowledge** | Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| **PO 2** | **Problem analysis** | Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences. |

| | | |
|---|---|---|
| **PO 3** | **Design/ development of solutions** | Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations. |
| **PO 4** | **Conduct investigations of complex problems** | Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| **PO 5** | **Modern tool usage** | Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations. |
| **PO 6** | **The engineer and the world** | Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. |
| **PO 7** | **Ethics** | Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| **PO 8** | **Individual and team work** | Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| **PO 9** | **Communication** | Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| **PO 10** | **Project management and finance** | Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| **PO 11** | **Life-long learning** | Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

## 5. Program Specific Learning Outcomes

| | | |
|---|---|---|
| **PSO 1** | **Application of Engineering Knowledge and Tools** | Graduates will be able to apply principles of applied mathematics, mechanical engineering, and advanced software tools for the design, development, analysis, testing, and operation of mechanical systems, components, and processes. |
| **PSO 2** | **Professional and Ethical Engineering Practice** | Graduates will demonstrate professionalism, ethical responsibility, and entrepreneurial skills in industrial or business environments by effectively applying design, manufacturing, quality control, and management practices in mechanical engineering. |

## 6. Credit Framework

| **Semester wise Credit distribution of the programme** | |
|---|---|
| Semester-1 | 22 |
| Semester-2 | 20 |
| Semester-3 | 23 |
| Semester-4 | 21 |
| Semester-5 | 22 |
| Semester-6 | 20 |
| Semester-7 | 25 |
| Semester-8 | 14 |
| **Total Credits:** | **167** |

| **Category wise Credit distribution of the programme** | |
|---|---|
| **Category** | **Credit** |
| Major Core | 111 |
| Minor Stream | 0 |
| Multidisciplinary | 23 |
| Ability Enhancement Course | 9 |
| Skill Enhancement Courses | 3 |
| Value added Courses | 0 |
| Summer Internship | 2 |
| Research Project/Dissertation | 19 |
| **Total Credits:** | **167** |

## 7. Program Curriculum

| Semester 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 1 | 303104105 | Environmental Science | AUDIT | 1 | 0 | 0 |
| 2 | 303105102 | Programming for Problem Solving | 4 | 3 | 2 | 0 |
| 3 | 303106101 | Basic Electrical Engineering | 4 | 3 | 2 | 0 |
| 4 | 303109102 | Elements of Mechanical Engineering | 4 | 3 | 2 | 0 |
| 5 | 303191101 | Mathematics-I | 4 | 4 | - | - |
| 6 | 303192101 | Engineering Physics-I | 4 | 3 | 2 | - |
| 7 | 303193103 | Communication Skills | 2 | - | - | 2 |
| | | **Total** | **22** | **17** | **8** | **2** |
| **Semester 2** | | | | | | |
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 8 | 303100101 | Workshop | 2 | 0 | 4 | 0 |
| 9 | 303104155 | Mechanics of Solids | 4 | 3 | 2 | 0 |
| 10 | 303107151 | Basic Electronics | 4 | 3 | 2 | 0 |
| 11 | 303109101 | Engineering Graphics | 4 | 2 | 4 | 0 |
| 12 | 303191151 | Mathematics-II | 4 | 4 | - | - |
| 13 | 303193152 | Advanced Communication & Technical Writing | 2 | - | - | 2 |
| | | **Total** | **20** | **12** | **12** | **2** |
| **Semester 3** | | | | | | |
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 14 | 303109201 | Thermodynamics | 4 | 3 | 0 | 1 |
| 15 | 303109203 | Material Engineering | 3 | 3 | 0 | 0 |
| 16 | 303109204 | Material Engineering Lab | 1 | 0 | 2 | 0 |
| 17 | 303109205 | Manufacturing Processes | 3 | 3 | 0 | 0 |
| 18 | 303109206 | Manufacturing Processes Lab | 1 | 0 | 2 | 0 |
| 19 | 303109207 | Kinematics and Theory of Machines | 3 | 3 | 0 | 0 |
| 20 | 303109208 | Kinematics and Theory of Machines Lab | 1 | 0 | 2 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 21 | 303109210 | Product Realization | 1 | 0 | 2 | 0 |
| 22 | 303191204 | PDE, Probability and Statistics | 4 | 4 | - | - |
| 23 | 303193203 | Professional Communication Skills | 2 | - | - | 2 |
| | | **Total** | **23** | **16** | **8** | **3** |
| **Semester 4** | | | | | | |
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 24 | 303109251 | Metrology and Instrumentation | 3 | 3 | 0 | 0 |
| 25 | 303109252 | Metrology and Instrumentation | 1 | 0 | 2 | 0 |
| 26 | 303109253 | Fluid Mechanics and Machines | 3 | 3 | 0 | 0 |
| 27 | 303109254 | Fluid Mechanics and Machines Lab | 1 | 0 | 2 | 0 |
| 28 | 303109255 | Manufacturing Technology | 3 | 3 | 0 | 0 |
| 29 | 303109256 | Manufacturing Technology Lab | 1 | 0 | 2 | 0 |
| 30 | 303109257 | Strength of Materials | 4 | 3 | 0 | 1 |
| 31 | 303109259 | Dynamics of Machines | 3 | 3 | 0 | 0 |
| 32 | 303109260 | Dynamics of Machines Lab | 1 | 0 | 2 | 0 |
| 33 | 303193252 | Professional Grooming and Personality Development | 1 | - | - | 1 |
| | | **Total** | **21** | **15** | **8** | **2** |
| **Semester 5** | | | | | | |
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 34 | 303109301 | Heat Transfer | 3 | 3 | 0 | 0 |
| 35 | 303109302 | Heat Transfer Lab | 1 | 0 | 2 | 0 |
| 36 | 303109303 | Automation and Control | 3 | 3 | 0 | 0 |
| 37 | 303109304 | Automation and Control Lab | 1 | 0 | 2 | 0 |
| 38 | 303109305 | Applied Thermodynamics | 3 | 3 | 0 | 0 |
| 39 | 303109306 | Applied Thermodynamics Lab | 1 | 0 | 2 | 0 |
| 40 | 303109307 | Industrial Engineering & Project Management | 3 | 2 | 0 | 1 |
| 41 | 303109309 | Machine Design - I | 4 | 3 | 0 | 1 |
| 42 | 303193304 | Professionalism & Corporate Ethics | 1 | - | - | 1 |
| 43 | | Open Elective -I | 2 | 2 | - | - |
| | | **Total** | **24** | **16** | **10** | **3** |
| **Open Elective 01** | | | | | | |

| Sr. No. | Subject Code | Subject Name | Credit | Lect | Lab | Tut |
|---|---|---|---|---|---|---|
| 1 | 303101346 | Basic Aircraft Science | 2 | 2 | 0 | 0 |
| 2 | 303104311 | Disaster Preparedness and Planning | 2 | 2 | 0 | 0 |
| 3 | 303105304 | Cyber Security | 2 | 2 | 0 | 0 |
| 4 | 303107346 | Fundamentals of Communication Engineering | 2 | 2 | 0 | 0 |
| 5 | 303105305 | Internet of Things | 2 | 2 | 0 | 0 |
| **Semester 6** | | | | | | |
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 44 | 303109351 | Computer Aided Design | 3 | 3 | 0 | 0 |
| 45 | 303109352 | Computer Aided Design Lab | 1 | 0 | 2 | 0 |
| 46 | 303109353 | Machine Design - II | 4 | 3 | 0 | 1 |
| 47 | 303109354 | Minor Project | 1 | 0 | 2 | 0 |
| 48 | 303193353 | Employability Skills | 1 | - | - | 1 |
| 49 | | PEC 01 (Compulsory Subjects :1) | 3 | 3 | 0 | 0 |
| 50 | | PEC 02 (Compulsory Subjects :1) | 3 | 3 | 0 | 1 |
| 51 | | PEC 01-LAB (Compulsory Subjects :1) | 1 | 0 | 2 | - |
| 52 | | PEC 01-LAB (Compulsory Subjects :1) | 1 | 0 | 2 | 0 |
| 53 | | Open Elective -II (University Elective) | 2 | 2 | 0 | 0 |
| | | **Total** | **20** | **14** | **8** | **3** |
| **PEC 01** | | | | | | |
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 1 | 303109381 | IC Engine | 3 | 3 | 0 | 0 |
| 2 | 303109383 | Advanced Manufacturing Technology | 3 | 3 | 0 | 0 |
| 3 | 303109385 | Oil Hydraulics and Pneumatics | 3 | 3 | 0 | 0 |
| **PEC 01-LAB** | | | | | | |
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 1 | 303109382 | IC Engine Lab | 1 | 0 | 2 | 0 |
| 2 | 303109384 | Advanced Manufacturing Technology Lab | 1 | 0 | 2 | 0 |
| 3 | 303109386 | Oil Hydraulics and Pneumatics Lab | 1 | 0 | 2 | - |
| **PEC 02** | | | | | | |

| Sr. No. | Subject Code | Subject Name | Credit | Lect | Lab | Tut |
|---|---|---|---|---|---|---|
| 1 | 303109387 | Power Plant Engineering | 4 | 3 | 0 | 1 |
| 2 | 303109388 | Product Development and Value Engineering | 4 | 3 | 0 | 1 |
| 3 | 303109389 | Quality Management Techniques | 4 | 3 | 0 | 1 |
| **Open Elective -II (University Elective)** | | | | | | |
| 1 | 303100351 | Innovation and Entrepreneurship | 2 | 2 | 0 | 0 |
| 2 | 303100352 | Life Sciences | 2 | 2 | 0 | 0 |
| 3 | 303100353 | Fundamentals of Management | 2 | 2 | 0 | 0 |
| 4 | 303100354 | Constitution of India | 2 | 2 | 0 | 0 |
| 5 | 303100355 | Engineering Ergonomics | 2 | 2 | 0 | 0 |
| **Semester 7** | | | | | | |
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 54 | 303109401 | Computer Aided Manufacturing | 3 | 3 | 0 | 0 |
| 55 | 303109402 | Computer Aided Manufacturing Lab | 1 | 0 | 2 | 0 |
| 56 | 303109403 | Finite Element Methods | 3 | 3 | 0 | 0 |
| 57 | 303109404 | Finite Element Methods Lab | 1 | 0 | 2 | 0 |
| 58 | 303109406 | Project-I | 4 | 0 | 8 | 0 |
| 59 | 303109408 | Summer Internship | 2 | 0 | 4 | 0 |
| 60 | | Open Elective III (Compulsory Subjects :1) | 3 | 2 | 0 | 1 |
| 61 | | PEC 03 (Compulsory Subjects :1) | 3 | 3 | 0 | 0 |
| 62 | | PEC 03-LAB (Compulsory Subjects :1) | 1 | 0 | 2 | 0 |
| 63 | | PEC 04 (Compulsory Subjects :1) | 3 | 3 | 0 | 0 |
| 64 | | PEC 04-LAB (Compulsory Subjects :1) | 1 | 0 | 2 | 0 |
| | | **Total** | **25** | **14** | **20** | **1** |
| **Open Elective III** | | | | | | |
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 1 | 303109444 | Waste to Energy | 3 | 2 | 0 | 1 |
| 2 | 303109448 | Nano Material and Surface Engineering | 3 | 2 | 0 | 1 |
| 3 | 303109445 | Industry 4.0 | 3 | 2 | 0 | 1 |
| 4 | 303109443 | Energy Conservation and Management | 3 | 2 | 0 | 1 |
| 5 | 303109446 | Operation Research | 3 | 2 | 0 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 6 | 303109449 | Industrial Safety and Maintenance Engineering | 3 | 2 | 0 | 1 |
| 7 | 303109447 | Electric Vehicles | 3 | 2 | 0 | 1 |
| **PEC 03** | | | | | | |
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 1 | 303109431 | Refrigeration and Air Conditioning | 3 | 3 | 0 | 0 |
| 2 | 303109433 | Tool Design | 3 | 3 | 0 | 0 |
| 3 | 303109435 | Automobile Engineering | 3 | 3 | 0 | 0 |
| **PEC 03-LAB** | | | | | | |
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 1 | 303109432 | Refrigeration and Air Conditioning Lab | 1 | 0 | 2 | 0 |
| 2 | 303109434 | Tool Design Lab | 1 | 0 | 2 | 0 |
| 3 | 303109436 | Automobile Engineering Lab | 1 | 0 | 2 | 0 |
| **PEC 04** | | | | | | |
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 1 | 303109437 | Renewable Energy Engineering | 3 | 3 | 0 | 0 |
| 2 | 303109439 | Industrial Robotics | 3 | 3 | 0 | 0 |
| 3 | 303109441 | Tribology | 3 | 3 | 0 | 0 |
| **PEC 04-LAB** | | | | | | |
| **Sr. No.** | **Subject Code** | **Subject Name** | **Credit** | **Lect** | **Lab** | **Tut** |
| 1 | 303109438 | Renewable Energy Engineering Lab | 1 | 0 | 2 | 0 |
| 2 | 303109440 | Industrial Robotics Lab | 1 | 0 | 2 | 0 |
| 3 | 303109442 | Tribology Lab | 1 | 0 | 2 | 0 |
| **Semester 8** | | | | | | |
| 65 | 303109452 | Industrial Internship | **14** | **0** | **28** | **0** |
| **Total** | | | **167** | | | |

## 8. Detailed Syllabus

**Semester 1**

**(1)**

a. **Course Name:** Environmental Science
b. **Course Code:** 303104105
c. **Prerequisite:** Knowledge of Physics, Chemistry and Mathematics up to 12th science level and Biology up to 10th science level
d. **Rationale:** Basic knowledge of the environment is essential for all human beings for a good life and sustainable existence

e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Apply systems thinking to analyse the city as a system, demonstrating application |
| **CLOBJ 2** | Evaluate the role of smart citizens and approaches for citizen engagement |
| **CLOBJ 3** | Identify sources and stressors of water resources, demonstrating understanding |
| **CLOBJ 4** | Analyse the causes, effects, and control measures of population explosion |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Explain the relationship between environmental health, ecology, and quality of life with reference to sustainable development. |
| **CLO 2** | Evaluate methods for pollution prevention and control considering various sources of pollution. |
| **CLO 3** | Assess the impacts of population growth on natural resources and environmental sustainability. |
| **CLO 4** | Examine recent technological and policy developments addressing various global environmental challenges. |
| **CLO 5** | Discuss the concept of smart cities and use of sustainable engineering solutions for urban development. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **1** | **0** | **0** | **0** | **-** | **50** | **-** | **-** | **-** | **50** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **ENVIRONMENTAL HEALTH, ECOLOGY AND QUALITY OF LIFE**<br>Environmental education: Objective and scope, Impact of technology on the environment, Environmental disasters: Case studies, Global environmental awareness to mitigate stress on the environment, Structure and function of an ecosystem, Ecological pyramids, Pyramid of number, Pyramid of energy and pyramid of biomass. | **25%** | **7** |
| 2 | **POLLUTION PREVENTION**<br>Air & Noise pollution - Sources & their Effects, Case studies of Major Catastrophes, Structure and composition of the atmosphere, Water, Soil, Marine, Thermal & Marine Pollution: The story of fluoride contamination, Eutrophication of lakes, control measures, Measuring water quality: Water quality index, Waste water treatment (general) primary, secondary and tertiary stages, Municipal Solid waste management: Sources and effects of municipal waste, Biomedical waste, Hazardous waste | **20%** | **6** |
| 3 | **POPULATION GROWTH, GLOBAL ENVIRONMENTAL CHALLENGES & LATEST DEVELOPMENTS**<br>Population Explosion - Causes, Effects and Control, an International initiative in population-related issues, Urbanization, Growth of the world's large cities, Water resources: Sources of water, Stress on water resources, Climate Change, Global Warming and Green House Effect, Acid Rain, Depletion of Ozone layer, Variation in concentrations of GHG gases in ambient air during last millennium, Role of Environmental Information System (ENVIS) in India and similar programs run by EPA(USA), Role of soft tools like Quantum GIS, Autodesk Building Information Modelling (BIM) and City Finance Approach to Climate-Stabilizing Targets (C- FACT), Life Cycle Assessment, Bioinformatics and Optimization tools for sustainable development. | **27%** | **7** |
| 4 | **SMART CITIES**<br>**Introduction to smart cities -** about smart cities, what is a smart city, world urbanization, case studies of Songdo, Rio De Janeiro, what makes cities smart.<br>**City as a system of systems –** Introduction, systems | **30%** | **10** |

| | | | |
|---|---|---|---|
| | thinking, Milton Keynes Future Challenges, Rich picture as city challenges, Wicked problems, Development of **smart city approach –** core elements, open data, sustainability, privacy and ethics, development processes.<br>**Smart Citizens –** their role, engaging citizens, IES Cities, Energy systems, Approaches for Citizen Engagement, co-creating smart cities, cities unlocked, living labs, city problems, crowdsourcing ideas, redesigning cities for citizens, all age-friendly cities, mobility on demand, motion maps.<br>**Infrastructure, Technology and Data –** urban infrastructure and its technology, future of lighting, IoT, connected objects, sensing the city, NOx eating paints and air quality sensors, safest, smart citizen kit, sensing your city, Sensored City, Cyber security for data power, open, shared and closed data, satellite data, open data revolution, Smart City Project Data<br>**Innovation –** smart innovations, smart city ecosystem, data-driven innovations for smart cities<br>**Standards and Capacity Building –** the role of Standard, BSI smart city Standards, HyperCat, ITU Smart Sustainable cities, Smart City Readiness, Lessons Learnt from Amsterdam<br>**Smart Measurements -** metrics and indicators, city indicators, WCCD data portal, value proposition, integrated reporting, smart city learning and education, urban data school. | | |

**i. Text Book and Reference Book:**


1. "Environmental Studies For Undergraduate Courses",(TextBook),By Dr Erach Bharucha | Orient BlackSwan | Second Edition, Pub. Year 2013.
2. "Basics of Environmental Studies", By U K Khare, Tata McGraw Hill
3. "Environmental Studies" By Anindita Basak, Drling Kindersley (India)Pvt. Ltd Pearson
4. "Environmental Sciences", By Daniel B Botkin & Edward A Keller, John Wiley & Sons
5. "Air Pollution", By M N Rao, H. V N Rao, McGraw Hill Publishing Company Limited, New Delhi
6. "Environmental Engineering" By Howard S. Peavy, Donald R. Rowe, George Tchobanoglous | McGraw-Hill

**(2)**

a. **Course Name:** Programming for Problem Solving
b. **Course Code:** 303105102
c. **Prerequisite:** Requires Basic Knowledge of Computer
d. **Rationale:** This course is design to provide basic ideas of computer programming. This course also makes help to understand programming language. It will help to develop their logical abilities.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Recognize and recall fundamental principles and organizations of computers, demonstrating a foundational understanding of computer architecture and design. |
| **CLOBJ 2** | Comprehend the concepts of computer programming languages, illustrating a grasp of syntax, semantics, and the essential components of programming languages. |
| **CLOBJ 3** | Develop algorithms for solving basic engineering problems, demonstrating the ability to apply theoretical knowledge to practical problem-solving scenarios. |
| **CLOBJ 4** | Demonstrate proficiency in the practical application of C programming by writing, compiling, and debugging programs, showcasing the ability to implement and troubleshoot code effectively. |
| **CLOBJ 5** | Evaluate and analyse complex computational programs written in C, demonstrating the capacity to assess and understand intricate solutions to computational challenges. |
| **CLOBJ 6** | Develop simple projects using the C programming language, showcasing creativity and application of learned principles to produce functional and practical software solutions. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Demonstrate basic knowledge of computer hardware and software. |
| **CLO 2** | Describe problem-solving and logical skills in programming with C and other languages. |
| **CLO 3** | Describe decision-making and looping constructs to solve real-time problems. |
| **CLO 4** | Discuss the concept of functions for adaptive programming. |
| **CLO 5** | Use the comparisons and limitations of the various programming constructs and choose the right one for the task. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **-** | **2** | **4** | **20** | **20** | **20** | **60** | **30** | **150** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Topics | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Number System:** Introduction and type of Number system, Conversion between number system, Arithmetic operations on number system, Signed and unsigned number system Software, Computer Languages and Computer Program | 2% | 3 |
| 2 | **Introduction to 'C' Programming:** Features of C language, structure of C Program, Flow Charts and Algorithms Types of errors, debugging, tracing/stepwise execution of program, watching variables values in memory. | 3% | 3 |
| 3 | **Constants, Variables and data Types:** Character Set, C tokens, Keywords and Identifiers, Constants, Variables, Data types, Declaration of Variables, assigning values to variables, typedef, and defining symbolic constants. | 5% | 2 |
| 4 | **Operators and Expression:** Introduction to Operators and its types, Evaluation of expressions, Precedence of arithmetic operators, Type conversions in expressions, Operator precedence and associatively. | 10% | 3 |
| 5 | **Management Input and Output Operators:** Introduction, reading a character, writing a character, formatted input, formatted output. | 5% | 2 |
| 6 | **Control structure in C:** Decision Making & branching: Decision making with If &I .. Else statements, If.. Else statements (Nested …. Ladder), The Switch & goto statements, The turnery (?:) Operator Looping: The while statement, The break statement & The Do.. While loop, The FOR loop, Jump within loops – Programs | 15% | 4 |
| 7 | **Array:** Introduction, One-dimensional arrays, Two-dimensional arrays, arrays, Concept of Multidimensional arrays. | 10% | 4 |
| 8 | **String:** string, string storage, Built-in-string functions | 10% | 3 |
| 9 | **User-Defined Functions:** Concepts of user defined functions, prototypes, definition of function, parameters, parameter passing, calling a function, recursive function, Macros, Pre-processing. | 10% | 5 |
| 10 | **Structure and Unions:** Introduction, Structure definition, declaring and initializing Structure variables, Accessing Structure members, Copying & Comparison of structures, Arrays of structures, Arrays within structures, Structures within Structures, Structures and functions, Unions | 10% | 5 |
| 11 | **Pointers:** Basics of pointers, pointer to pointer, pointer and array, Pointer to array, array of pointers, functions returning a pointer | 10% | 5 |

| | | | |
|---|---|---|---|
| **12** | **Dynamic memory allocation:** Introduction to Dynamic memory allocation, malloc (), calloc (), free (), realloc () | **5%** | **2** |
| **13** | **File Management in C:** Introduction to file management and its functions | **5%** | **1** |

### i. Text Book and Reference Book:

1. "Programming in ANSI C", (Textbook), By E. Balaguruswamy, Tata McGraw-Hill
2. "C Programming: Test Your Skills", By Ashok Kamthane
3. "Computer Fundamentals", By P.K. Sinha and Priti Sinha, BPB Publications, 4th Edition
4. "Star C Programming", STAR Certification, C Certification Exam
5. "Programming with C", By Byron Gottfried, Tata McGraw Hill Education.
6. "C The Complete Reference", By Herbert Schildt
7. "Let Us C", By Yeshavant Kanetkar | BPB Publications

### j. Experiment List

| Sr. NO. | Experiment List |
|---|---|
| 1 | Write a program to print HELLO FRIENDS! |
| 2 | Write a program that reads two nos. from key board and gives their addition, subtraction, multiplication, division and modulo. |
| 3 | Write a program to calculate area of circle, use Ω as symbolic constants. |
| 4 | Write a program to convert days into months and days. |
| 5 | Write a program which calculates the summation of three digits from the given 3-digit number. |
| 6 | Write a program to demonstrate enumerates data type. |
| 7 | Write a program to compute Fahrenheit from centigrade. |
| 8 | Write a program to calculate simple interest.<br>Read the price of item in decimal form e.g. 12.50 and separate Rs and Paise from the given value e.g. 12 rupees and 50 paise. |
| 9 | Write a program to find the largest of the three nos. using Nested-If-Else statement. |
| 10 | Write a C program to enter a character and to check whether it is a small letter or it is a capital letter or it is a digit or it is a special symbol. |
| 11 | Write a C program to enter a character and to check whether it is a small letter or it is a capital letter or it is a digit or it is a special symbol. |
| 12 | Write a C program to enter a character and to check whether it is a small letter or it is a capital letter or it is a digit or it is a special symbol. |
| 13 | Write a program to read marks from keyboard and your program should display equivalent grade according to following table.<br>Marks Grade<br>100-80 Dist<br>60-79 First Class<br>35-59 Second Class |
| 14 | Write a program to read marks of a student from keyboard whether the student id pass (if). |
| 15 | Write a program to find the sum of first N odd numbers. |
| 16 | Write a program using while loop construct which finds the factorial of a given integer number. |
| 17 | Write a C program using do«while and for loop constructs to reverse the digits of the |

| | |
|---|---|
| | number. |
| 18 | Write a program to demonstrate use of Switch- Break Statement. |
| 19 | Write a program to find out all the numbers divisible by 5 and 7 between 1 to 100. |
| 20 | Check for Armstrong number. A number is Armstrong if sum of cube of every digit is same as the original number. E.g. 153=13+53+33=153 |
| 21 | Write a program to print the output of bellow series. 1!+2!+3!+4!+..... n! |
| 22 | Write a program to print the following outputs using for Loop.<br>1 *<br>12 **<br>123 *** |
| 23 | Write a program to print the following outputs using for Loop.<br>(a) 1 (b) 321<br>21 21<br>321 1 |
| 24 | Write a program which sorts 10 numbers into ascending order. |
| 25 | Write a program to find maximum element from 1-D array. |
| 26 | Write a program to find number of odd and even elements from the 1-D array. |
| 27 | Write a program add two 2x2 matrices. |
| 28 | Write a program to count number of positive, negative and zero elements from 3x3 matrix. |
| 29 | Write a function for the following operations on string:<br>Copy one string to another<br>Comparing two strings<br>Adding a string to the end of another. |
| 30 | Write a program to count vowels from a entered String. |
| 31 | Write a program which finds whether a string is a palindrome or not. |
| 32 | Write a program to find factorial of a number using recursion. |
| 33 | Write a program that used user defined function Swap ( ) and interchange the value of two variable. |
| 34 | Write a function to return 1 if the number is prime otherwise return 0. |
| 35 | Define a structure type, personal that would contain person name, date of joining and salary. |
| 36 | Define a structure called cricket that will describe the following information: Player name Team name Batting average |
| 37 | Write a program to add two numbers using pointers. |
| 38 | Write a program to swap two numbers using pointer |
| 39 | Write a program to illustrate reading files contents. |
| 40 | Write a program to illustrate the use of fgets( ) |

**(3)**

a. **Course Name:** Basic Electrical Engineering
b. **Course Code:** 303106101
c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12th science level
d. **Rationale:** Basic Electrical Engineering knowledge is fundamental as it provides a strong foundation for various engineering disciplines, promotes problem-solving skills, supports innovation, and opens doors to diverse career opportunities.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Gain familiarity with electrical current, potential difference, power and energy, sources of electrical energy and elements of electrical circuit. |
| **CLOBJ 2** | Solve problems related to Alternating current, alternating voltage, etc, Demonstrate a clear understanding of Pure R, L C circuit and combination of RLC, Series and Parallel combination of R, L and C, etc |
| **CLOBJ 3** | Acquire knowledge of the resistor, capacitor, and inductor and their performance characteristics for series and parallel connections. |
| **CLOBJ 4** | Understand different single phase and three phase circuits. |
| **CLOBJ 5** | Demonstrate a clear understanding of the basic concepts, working principles and applications of transformer, DC machines and AC machines. |
| **CLOBJ 6** | Study the use of LT Switch Gear, Fuse, MCB, ELCB etc. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Solve basic electrical circuit problems using Ohm's law, Kirchhoff's laws, and network theorems in DC and AC circuits. |
| **CLO 2** | Discuss the role and performance characteristics of resistor, capacitor, and inductor in pure R, pure L, and pure C circuits. |
| **CLO 3** | Calculate active, reactive, and apparent power using analytical and phasor methods in series RL, RC, and RLC AC circuits. |
| **CLO 4** | Analyze the construction and working principle of a transformer under no-load and load conditions |
| **CLO 5** | Assess the construction and operation of DC and AC machines under different loading conditions. |
| **CLO 6** | Explain the function and application of various electrical components and protective devices in domestic and industrial electrical systems. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **-** | **2** | **4** | **20** | **20** | **20** | **60** | **30** | **150** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **DC Circuits**<br>Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff current and voltage laws, Mesh and Node analysis, Simplifications of networks using series and parallel combinations and star-delta conversions. Superposition, Thevenin and Norton Theorems. | **22%** | **10** |
| 2 | **AC Circuits**<br>Sinusoidal voltages and currents, their mathematical and graphical representation, Concept of instantaneous, peak (maximum), average and R.M.S. values, frequency, cycle, period, peak factor and form factor, phase difference, lagging, leading and in phase quantities and phasor representation. Rectangular and polar representation of phasors, examples based on theory.<br>Study of A.C. circuits consisting of pure resistance, pure inductance, pure capacitance and corresponding voltage-current phasor diagrams and waveforms. Development of the concept of reactance, the study of series R-L, R-C, R-L-C circuit and resonance, study of parallel R-L, R-C and R-L-C circuit, concept of impedance, admittance, conductance and susceptance in case of above combinations and relevant voltage-current phasor diagrams, the concept of active, reactive and apparent power and power factor, examples based on theory.<br>Concept of three-phase supply and phase sequence. Voltages, currents and power relations three-phase have balanced star-connected loads and delta-connected loads along with phasor diagrams, Power and power factor measurement in balanced three-phase circuits (one, two and three wattmeter methods), examples based on theory. | **33%** | **15** |
| 3 | **Transformers**<br>Magnetic effect of an electric current, right-hand thumb rule, Concept of m.m.f., flux, flux density, reluctance, permeability and field strength, their units and relationships, comparison between electrical and magnetic parameters. Fleming's left-hand rule. self and mutual inductance, Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. | **20%** | **9** |
| 4 | **Electrical Machines** | **15%** | **7** |

| | | | |
|---|---|---|---|
| | Construction, working and application of DC Motor and Generator. Generation of 3 phase rotating magnetic fields, Construction and working of a three-phase and Single-phase induction motor and its types. Construction and working of Synchronous generator. | | |
| **5** | **Electrical Installations**<br>Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. | **10%** | **4** |

**i. Text Book and Reference Book:**

1. Electrical Engineering Fundamentals, By V. D. Toro, Prentice Hall India, Pub. Year 1989
2. Basic Electrical Engineering, By D. C. Kulshreshtha, McGraw Hill
3. Fundamentals of Electrical Engineering, By Leonard S. Bobrow, Oxford University Press, Pub. Year 1996
4. Electrical and Electronics Technology, By E. Hughes Pearson, Pub. Year 2010
5. Basic Electrical Engineering, By D. P. Kothari and I. J. Nagrath, Tata McGraw Hill, Pub. Year, 2010
6. A textbook of Electrical Technology Volume 1&2, By B. L. Theraja, S. Chand Publication

**j. Experiment List:**

| Sr. NO. | Experiment List |
|---|---|
| 1 | To Study about Various Electrical and Electronics Symbols and demonstrate various measuring instruments used in Basic electrical Engineering laboratory. |
| 2 | To Perform and Solve Electrical Networks with Series and Parallel Combinations of Resistors Using Kirchhoff ’s Laws. |
| 3 | To Obtain Capacitance, Power and Power Factor of the Series RL Circuit with AC Supply Using Phasor Diagram. |
| 4 | To Obtain Capacitance, Power and Power Factor of the Series RC Circuit with AC Supply Using Phasor Diagram. |
| 5 | To Obtain Capacitance, Power and Power Factor of the Series RLC Circuit with AC Supply Using Phasor Diagram. |
| 6 | Verification of superposition theorem with dc source |
| 7 | Verification of Thevenin's theorem with dc source |
| 8 | Verification of Norton's theorems in dc circuits |
| 9 | Verification of Current and Voltage Relations in Three Phase Balanced Star and Delta Connected Loads. |
| 10 | Find out the Efficiency and Voltage Regulation of Single-Phase Transformer by Direct Load Test. |

**(4)**

a. **Course Name:** Elements of Mechanical Engineering
b. **Course Code:** 303109102
c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12th science level
d. **Rationale:** Elements of Mechanical Engineering Course Provide students with a comprehensive foundation in the fundamental principles and concepts that form the backbone of mechanical engineering for various Engineering disciplines.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Identify and basic mechanical components such as gears, bearings, Pumps, Compressor, boiler, I.C Engines. |
| **CLOBJ 2** | Understand various laws and behaviour of fluid at different conditions. |
| **CLOBJ 3** | Illustrate the operational mechanisms through diagrams, models, or practical demonstrations. |
| **CLOBJ 4** | Demonstrate construction and working principles of diverse mechanical devices, such as engines, pumps, and compressors. |
| **CLOBJ 5** | Evaluate basic problems related to I.C engine, pumps, compressors and fluids. |
| **CLOBJ 6** | Analyse and discuss the interactions and relationships between various mechanical elements within a system |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Explain the basic terminology of Mechanical systems and various sources of energy. |
| **CLO 2** | Determine Properties of Gas and Steam using Thermodynamics Fundamentals. |
| **CLO 3** | Calculate the performance parameters of Heat engine and its cycles. |
| **CLO 4** | Explain the working principle of Steam Generator, Refrigeration, and Air Conditioning system. |
| **CLO 5** | Describe basics of pumps, compressors and Power Transmission Device. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **-** | **2** | **4** | **20** | **20** | **20** | **60** | **30** | **150** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Basics of Thermodynamics**<br>Prime Movers - Meaning and Classification; Concept of Force, Pressure, Energy, Work, Power, System, Heat, Temperature, Specific heat capacity, Internal Energy, Enthalpy, Specific Volume; Thermodynamics – Definition: Change of State, Path, Process, Cycle, Thermodynamic systems, Statement of Zeroth Law, First Law and Second Law of Thermodynamics and its Applications. | **10%** | **5** |
| 2 | **Properties of Gases**<br>Gas Laws, Boyle's law, Charles law, Combined gas law; Gas Constant, Relation between Cp and Cv Constant Volume Process; Constant Pressure Process; Isothermal Process; Adiabatic Process; Poly-tropic Process. Examples based on above topics. | **15%** | **6** |
| 3 | **Properties of Steam**<br>Types of Steam and Steam formation; Specific Enthalpy; Specific Volume; Dryness Fraction of Steam; Measurement of Dryness Fraction; Steam Table. Examples based on above topics. | **15%** | **6** |
| 4 | **Heat Engines**<br>Definition of Heat Engine; Classification of Heat Engine; Carnot Cycle, Rankine Cycle, Otto Cycle and Diesel Cycle.<br>**Internal Combustion Engines:**<br>Two Stroke Petrol and Diesel Engine; Four Stroke Petrol and Diesel Engine; Measurement of Indicated Power and Brake Power: Numerical on calculation of Mechanical, Thermal and Volumetric Efficiency. Examples based on above topics. | **20%** | **10** |
| 5 | **Energy Conversion Devices**<br>**Steam Generators:**<br>Definition and Classification; Cochran, Lancashire, Locomotive, Babcock and Wilcox Boiler: Construction and Working; Boiler Mounting and Accessories.<br>**Refrigeration and Air Conditioning:**<br>Meaning of Refrigeration; Vapor Compression Refrigeration Cycle; Vapor Absorption Refrigeration Cycle; Air conditioning; Window Air Conditioning and Split Air Conditioning. | **20%** | **5** |
| 6 | **Pumps And Air Compressors**<br>**Pumps**<br>Definition, Classification and Application of Pumps; Types and Operation of Rotary pump, Reciprocating Pump, Centrifugal Pump.<br>**Air Compressors** | **10%** | **5** |

| | | | |
|---|---|---|---|
| | Definition, Classification and Application of Compressors; Types and Operation of Rotary and Reciprocating Air Compressor. | | |
| **7** | **Motion And Power Transmission Devices**<br>Shaft and Axle; Belt Drive; Chain Drive; Friction Drive; Gear Drive; Clutch, Coupling and Brake. | **5%** | **3** |
| **8** | **Conventional And Non-Conventional Energy Sources**<br>Introduction and Classification of Energy Sources; Conventional Energy Sources E.g. Solid, Liquid, Gaseous and Nuclear fuels; Calorific Value of Fuels; Non-Conventional Energy Sources E.g. Solar Energy, Wind Energy, Hydro Power, Biomass and Biomass Energy; Comparison of Conventional & Non-Conventional Energy Sources. | **5%** | **3** |

**i. Text Book and Reference Book:**

1. "Elements of Mechanical Engineering", By S.B. Mathur, S. Domkundwar, Dhanpat Rai & Sons Publications.
2. "Thermal Engineering, By R.K Rajput", Laxmi Publications.
3. "Thermal Science and Engineering", By Dr. D. S. Kumar, S. K. Kataria and sons Publishers.
4. "Basic Mechanical Engineering", By T. S. Rajan, Wiley Eastern Ltd
5. "Fundamental of Mechanical Engineering", By G. S. Sawhney, PHI Publication New Delhi.

**j. Experiment List:**

| Sr. NO. | Experiment List |
|---|---|
| 1 | Demonstration and study of construction and working of Petrol Engine Model. |
| 2 | Demonstration and study of construction and working of Diesel Engine Model. |
| 3 | Determination of brake thermal efficiency of an I. C. Engine. |
| 4 | Demonstration and study of construction and working of various types of boiler Models. |
| 5 | Study of construction and working of different boiler mountings and accessories. |
| 6 | Demonstration on construction and working of different types of pumps. |
| 7 | Demonstration on construction and working of different types of air compressors. |
| 8 | Demonstration on vapour compression refrigeration cycle and vapour absorption refrigeration cycle. |
| 9 | Demonstration on construction, working and applications of different types of coupling, clutch and brake. |
| 10 | Demonstration on construction, working and applications of motion and power transmission devices. |

**(5)**

a. **Course Name:** Mathematics-I
b. **Course Code:** 303191101
c. **Prerequisite:** Knowledge of Mathematics up to 12th science level
d. **Rationale:** The Mathematics I syllabus integrates fundamental calculus concepts, advanced mathematical techniques, and matrix algebra, preparing students for engineering challenges with optimized problem-solving skills.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Develop a deep understanding of first-order linear and nonlinear PDEs, including the application of Charpit's Method. Proficiently solve second and higher-order linear PDEs using complementary function and particular integral methods. Apply separation of variables method to solve problems in Cartesian coordinates. |
| **CLOBJ 2** | Apply PDEs to model and analyse physical phenomena such as heat conduction, wave propagation, and electrostatics. Gain proficiency in formulating initial and boundary conditions and solve problems related to the Heat, Wave, and Laplace equations. Utilize visualization tools to interpret and communicate results. |
| **CLOBJ 3** | Comprehend and apply fundamental probability concepts, including probability spaces, conditional probability, and independence. Analyse and solve problems involving discrete random variables, the multinomial distribution, Poisson approximation, and infinite sequences of Bernoulli trials. |
| **CLOBJ 4** | Develop statistical analysis skills covering basic statistics, measures of central tendency, and probability distributions (Binomial, Poisson, and Normal). Evaluate statistical parameters for these distributions. Perform correlation and regression analyses, including rank correlation. Apply the method of least squares for curve fitting, specifically for straight lines, second-degree parabolas, and more general curves. |
| **CLOBJ 5** | Apply probability and statistics concepts to real-world scenarios. Analyse and interpret statistical data to draw meaningful conclusions. Use probability theory to make informed predictions and decisions in various fields. |
| **CLOBJ 6** | Enhance problem-solving and critical thinking skills through the application of mathematical and statistical methods. Demonstrate the ability to approach complex problems systematically, analyse them, and arrive at logical solutions. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Analyze solution of system of linear equations, various properties using Eigenvalues and Eigenvectors |
| **CLO 2** | Discuss the convergence of infinite sequence and series using various tests. |
| **CLO 3** | Apply concept of multivariate functions in engineering problems such as maxima-minima, Tangent plane, Normal Lines etc. |
| **CLO 4** | Formulate mathematical model based on first order differential equations. |

| | |
|---|---|
| **CLO 5** | Evaluate area and volume using definite integrals and improper integrals |
| **CLO 6** | Construct the Fourier series and half range Fourier series for periodic functions |

### g. Teaching & Examination Scheme:

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 4 | - | - | 4 | 20 | 20 | - | 60 | - | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

### h. Course Content:

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Improper Integral & Application of Definite Integral:** Evaluation of definite and improper integrals, Beta and Gamma functions and their properties Area bounded by curves in Cartesian and Polar form, Area of a region bounded by function, Area of a region bounded by curves in Parametric form, Volume by slicing, Volume of solid by revolution. | 8% | 5 |
| 2 | **First order Ordinary Differential equation:** Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type, Applications | 15% | 9 |
| 3 | **Matrices:** Matrices & Determinants with Properties, Linear Independence, Rank of Matrix, System of Linear Equations, Consistency of System, Solution of system of Linear Equations by Gauss Jordan and Gauss-Elimination Method, Eigen values, Eigenvectors, Symmetric, Skew-symmetric, and orthogonal Matrices, Eigen bases, Diagonalization, Cayley Hamilton Theorem and its Applications, Diagonalization, Orthogonal Transformation, Quadratic form. | 25% | 15 |
| 4 | **Sequences and Series:** Basic of Sequences, Bounded and Monotonic Sequences, Series, Convergence of sequence and series, Geometric series, P- series, Cauchy's Integral Test, Comparison Test, Alternating Series, Absolute and Conditional convergence, Ratio test, Cauchy's Root Test, Power series, Taylor's and Maclaurin's series. | 17% | 10 |
| 5 | **Fourier Series:** Fourier Series of 2 periodic functions, Dirichlet's conditions for representation by a Fourier | 10% | 6 |

| | | | |
|---|---|---|---|
| | series, Fourier Series of a function of period 2, Fourier Series of even and odd functions, Half range series. | | |
| **6** | **Multivariable Calculus (Differentiation):** Functions of Several Variables, Limit, Continuity, Partial Derivatives, Homogeneous function, Euler's Theorem for homogeneous function, Modified Euler's Theorem, Chain Rule, Implicit function, Jacobian, Tangent plane and Normal line, Maximum and Minimum Values, Lagrange's Multiplier, Taylor's and Maclaurin's Series for functions of two variables. | **25%** | **15** |

i. **Text Book and Reference Book:**
   1. "Calculus and Analytic Geometry", (Textbook), By G.B. Thomas and R.L. Finney, Addison Wesley
   2. "Calculus with early transcendental functions", By James Stewart, Cengage Learning
   3. "Higher Engineering Mathematics" By B. S. Grewal, Khanna Publication.

**(6)**

a. **Course Name:** Engineering Physics-I
b. **Course Code:** 303192101
c. **Prerequisite:** Knowledge of Physics and some basic concepts in Mathematics like differentiation, integration, limit, differential equation, vector calculus up to $12^{th}$ science level.
d. **Rationale:** Knowledge of physics is essential for all Engineering branch because physics is the foundation subject of all the branches of engineering and it develops scientific temperament and analytical capability of engineering students. Comprehension of basic physics concepts enables the students to solve engineering problem logically and develop scientific approach.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Understand and explain the elastic properties of materials. Analyse the tensile stress-strain curve and its implications for material behaviour. Evaluate shear strength in both perfect and real crystals. |
| **CLOBJ 2** | Investigate thermo-electric effects and their applications. Examine the Wiedemann-Franz law and its significance. Explore phonons and their role in heat transfer. Analyse different modes of heat transfer and specific heat of solids. Compare and contrast the Einstein and Debye models for solids. |
| **CLOBJ 3** | Gain a qualitative understanding of statistical mechanics. Differentiate between Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics. |
| **CLOBJ 4** | Analyse transverse waves on a string and harmonic waves. Investigate reflection, transmission, standing waves, and eigenfrequencies. |
| **CLOBJ 5** | Explore Einstein's theory of matter-radiation interaction. Understand absorption, spontaneous, and stimulated emission of radiation. Identify characteristics and components of lasers. |

| | |
|---|---|
| **CLOBJ 6** | Examine applications of lasers in various fields. |

### f. Course Learning Outcomes:

| | |
|---|---|
| **CLO 1** | Acquire a deep understanding of fundamental principles and concepts in classical mechanics, electromagnetism, thermodynamics, and modern physics. |
| **CLO 2** | Develop proficiency in applying mathematical techniques to solve physics problems. |
| **CLO 3** | Gain familiarity with experimental methods, laboratory equipment, and techniques for conducting physics experiments. |
| **CLO 4** | Apply theoretical knowledge to solve a variety of physics problems. |
| **CLO 5** | Integrate knowledge from different branches of physics to understand interdisciplinary phenomena and real-world applications. |
| **CLO 6** | Evaluate the appropriateness of theoretical models in explaining physical phenomena and predict outcomes. |

### g. Teaching & Examination Scheme:

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 3 | - | 2 | 4 | 20 | 20 | 30 | 60 | 20 | 150 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

### h. Course Content:

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Properties of Material Mechanical Properties**: Elastic properties, Model of elastic behaviour, tensile stress strain curve, shear strength of perfect and real crystals. **Thermal Properties:** Thermo-electric effects, Wiedemann-Franz law, Phonons, Modes of heat transfer, Specific heat of solids, Einstein and Debye Model, Qualitative idea about Maxwell-Boltzmann, Bose Einstein, Fermi-Dirac statistics | 20% | 9 |
| 2 | **Motion in a Plane**: Transformation of coordinates, Newtons laws and its completeness in describing particle motion, Problems including constraints and friction, Motion of a rigid body in the plane; Rotation in the plane; Angular momentum about a point of a rigid body in planar motion | 20% | 9 |
| 3 | **Classical Mechanics:** Degrees of freedom, Constraints and constraint forces, Lagrange's equations of motion, | 20% | 9 |

| | | | |
|---|---|---|---|
| | Conservation law, Euler's laws of motion, non-inertial frames of reference; Centripetal and Coriolis accelerations; **Fluid Mechanics: -** Flow of fluids, Viscosity, Continuity equation, Euler and Bernoulli's equations | | |
| **4** | **Waves &Vibration:** Transverse wave on a string, Wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, Standing waves and their Eigen frequencies, longitudinal waves and the wave equation, Acoustics waves and speed of sound, Phase velocity and group velocity | **20%** | **9** |
| **5** | **Lasers:** Einstein's theory of matter-radiation interaction, Absorption, Spontaneous and Stimulated Emission of Radiation, Characteristics of Laser, Components of Laser, Types of Laser: Nd:YAG Laser, CO2 Laser, Semiconductor, Diode Laser, Applications of Lasers. | **20%** | **9** |

**i. Text Book and Reference Book:**

1. "Engineering Mechanics", by MK Harbola
2. "Engineering Mechanics – Dynamics", by JL Meriam
3. "Mechanical Vibrations" by JP Den Hartog
4. "University Physics", by Sears and Zemansky, Pearson

**j. Experiment List:**

| Sr. NO. | Experiment List |
|---|---|
| 1 | Determination of Velocity of ultrasonic waves in water. |
| 2 | Determination of Dielectric constants of Dielectric samples. |
| 3 | Measurement of Band gap of semiconductor material. |
| 4 | Measurement of Planck's constant using LED. |
| 5 | Measurement of wavelength of laser light using diffraction grating. |
| 6 | Measurement of Numerical aperture of an optical Fiber. |
| 7 | Determine Moment of Inertia of a flywheel. |
| 8 | Measurement of power loss in an optical fibre. |
| 9 | Measurement of a size of a Lycopodium powder. |

**(7)**

a. **Course Name:** Communication Skill
b. **Course Code:** 303193103
c. **Prerequisite:** Knowledge of English Language studied till 12th standard
d. **Rationale:** Basic Communication Skills are essential for all Engineers.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Students will demonstrate the ability to communicate ideas clearly and effectively |
| **CLOBJ 2** | Students will develop strategies for building positive interpersonal relationships, fostering effective collaboration and teamwork. |
| **CLOBJ 3** | Students will develop active listening skills, including the ability to comprehend, interpret, and respond appropriately to spoken messages. |
| **CLOBJ 4** | Students will exhibit proficiency in written communication, crafting clear, concise, and well-organized messages across various formats (emails, reports, memos, etc.). |
| **CLOBJ 5** | Students will develop and deliver professional presentations, incorporating effective visual aids, engaging content, and confident delivery. |
| **CLOBJ 6** | Students will understand and utilize various digital communication tools and platforms, demonstrating proficiency in virtual communication. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Apply creative and critical thinking in academic and professional communication tasks. |
| **CLO 2** | Apply vocabulary with accurate pronunciation in academic and professional communication. |
| **CLO 3** | Use fundamental English grammar accurately in academic communication |
| **CLO 4** | Produce effective reading and writing responses for academic, professional, and social contexts. |
| **CLO 5** | Speak content clearly and appropriately in academic and professional settings, demonstrating growing confidence in their communication skills. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **0** | **2** | **0** | **2** | - | - | - | - | - | **100** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous

Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Crazy Scientist**:<br>• The students will be taught the importance of invention and innovation using some examples that changed the world theway it worked. | 5% | 2 |
| 2 | **Phonetics**:<br>• IPA Introduction (listening tracks)<br>• Phonic Sounds<br>• Pronunciation Practice including transcription | 10% | 4 |
| 3 | **Vocabulary Building & Word Formation Process**:<br>• Compounding, clipping, blending, derivation, creative respelling, coining and borrowing<br>• Prefixes & suffixes, synonyms & antonyms, standard abbreviations (related activities will be provided) | 10% | 2 |
| 4 | **Speaking Activity: Role plays on Critical Thinking (Life boat)**<br>• This activity topic gears towards making students do role play based on various scenarios.<br>• It involves giving them a scenario and asking them to further develop the idea in a very interesting manner, then going on to enact it.<br>• It aims to improve students' convincing skills. | 10% | 4 |
| 5 | **Picture Description & Picture Connector**<br>• Enable students to use vocabulary and useful expression to describe the picture.<br>• In this class the students will be trained to form logical connections between a set of pictures which will be shared with them.<br>• This geared towards building creativity and presentation skills. | 15% | 2 |
| 6 | **Mine Activity: Usage of Preposition**:<br>• Students will learn to use proper propositions by active participation in the activity. | 8% | 2 |
| 7 | **Worksheets on Identifying Common Errors in Writing:**<br>• Sentence structure<br>• Punctuations<br>• Subject-Verb Agreement<br>• Noun-Pronoun Agreement | 12% | 2 |
| 8 | **Reading Skills**:<br>• The art of effective reading and its various strategies to be taught to the learners and practice exercises be given on reading comprehension. | 10% | 2 |

| | | | |
|---|---|---|---|
| **9** | **Speech and spoken Exchanges; Extempore**:<br>• Students will learn the correct usage of spoken language as different from the written form. It will help the students in extempore speech.<br>• This will be done by making the students give variety of impromptu speeches in front of the class: 1 minute talk on simple topics.<br>• To change the average speakers in the class to some of the best Orator. | **10%** | **4** |
| **10** | **Book Review**:<br>• The learners will identify the central idea of the book, author's style and approach towards the book.<br>• This will enable the learners to express their point of view and hone their creativity and writing skills. | **10%** | **4** |
| **11** | **Activity Session**<br>• This will enhance the creative thinking among students.<br>• To develop their interpersonal communication skills. | **0%** | **2** |

**i. Text Book and Reference Book:**


1. "Understanding and Using English Grammar", Betty Azar & Stacy Hagen; Pearson Education
2. "Business Correspondence and Report Writing ", SHARMA, R. AND MOHAN, K.
3. "Communication Skills", Kumar S and Lata P; New Delhi Oxford University Press
4. "Technical Communication: Principles and Practice" Sangeetha Sharma, Meenakshi Raman; Oxford University Press
5. "Practical English Usage MICHAEL SWAN
6. "A Remedial English Grammar for Foreign Student", F.T. WOOD
7. "On Writing Well", William Zinsser; Harper Paperbacks,2006; 30th anniversary edition
8. "Oxford Practice Grammar", John Eastwood; Oxford University Press

## Semester 2

**(1)**

a. **Course Name:** Workshop
b. **Course Code:** 303100101
c. **Prerequisite:** Zeal to learn the subject.
d. **Rationale:** The workshop practice is the backbone of the real industrial trades which helps to develop and enhance relevant technical hands-on experience of using various tools and instruments related to various trades. The use of workshop practices in day to day industrial as well domestic life helps to solve the problems. Further, it also deals with basic introduction of system components of electrical and electronic systems, and provides hands on practice in assembling, interconnecting, testing, and repairing such system by making use of various tools used in electrical and electronic workshop. Electronic systems are built on printed circuit board (PCB) and breadboard. One need to use source instruments (power sources and signal sources), and appropriate measuring instruments to study behaviour of a system.

e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Provide an overview of the principles, scope, and importance of mechanical engineering, including its various sub-disciplines and applications. |
| **CLOBJ 2** | Emphasize and enforce safety protocols, practices, and procedures to ensure a safe working environment within a mechanical workshop. |
| **CLOBJ 3** | Measurement Techniques and Instruments: Familiarize students with various measurement techniques and instruments used in mechanical engineering, emphasizing precision and accuracy in measurements. |
| **CLOBJ 4** | Introduce students to basic manufacturing processes such as machining, casting, forming, and welding, providing insights into how different materials are shaped and manipulated. |
| **CLOBJ 5** | Hands-on Experience with Tools and Equipment: Familiarize students with basic tools, machines, and equipment commonly used in mechanical engineering through hands-on activities and demonstrations in a workshop setting. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Comprehend the safety measures required to be taken while working in workshop. |
| **CLO 2** | Catogorized the appropriate tools and manufacturing techniques for specific operation on given raw materials. |
| **CLO 3** | To prepare Fitting, Carpentry, Plumbing, Welding and Tin smithy Job. |
| **CLO 4** | Identify measure and test different passive & active electronics components. |
| **CLO 5** | Understand working principle of various electrical & electronics measurement equipments. |
| **CLO 6** | Comprehend the safety measures to be taken while working in the laboratory and safety standards. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 0 | - | 4 | 2 | - | - | 40 | - | 60 | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**


1. Electronic Principles by Albert Paul Malvino | TMH
2. Electronic Devices by Thomas L. Floyd | Pearson, Prentice Hall "Linear Systems and Signals" by B.P. Lathi.
3. Electronic Devices and Circuits by David A. Bell | Oxford Publication
4. Electronic Devices and Circuits by Jacob Millman and Halkias | Tata McGraw Hill Publication New Delhi.
5. Shop Theory by Anderson James & Earl E. Tatro | Macmillan/McGraw-Hill School.
6. Workshop Technology by Bava H. S. | Tata McGraw Hill Publishing Co. Ltd.
7. Elements of Workshop Technology Vol. I By Hajra Chaudhary S.K. | Asia Publishing House.
8. Workshop Technology by Chapman, W.A.J. ELBS Low Price Text | Edward Donald Pub. Ltd.
9. Basic Machine Shop Practice Vol. I & II By Tejwani, V.K. | Tata McGraw Hill Pub. Co.
10. Workshop Technology Vol. I & II By Arora, B.D. | Satya Prakashan, New Delhi" Signals and Systems" by Simon Haykin and Barry Van Veen.


**i. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| 1 | Study of Digital Multi meter and Measurement of voltage, current, frequency, phase difference, power, power factor for single phase supply using Digital Millimeter. |
| 2 | To study about safety, Electric shock, First aid for electric shock and other Hazards of electrical Laboratories and Safety rules. |
| 3 | Identification and symbolic representation of basic passive components |
| 4 | Understanding of working and specifications of CRO and Function generator |
| 5 | Identification, symbolic representation and testing of various electronics components (including SMD). |
| 6 | To understand working and specifications of DC regulated Power supply. |
| 7 | Understanding soldering techniques and practicing proper soldering and de-soldering. |
| 8 | Overview of PCB layout designing and fabrication. |

| Exp. No. | Name of the Experiment |
|---|---|
| **9** | Study of different types of cables, wires, probes, connectors |
| **10** | To understand series & parallel type of connections and to perform Bulb wiring, Fan wiring, Tube-light wiring |
| **11** | To perform staircase wiring, double stair case wiring, and Go-down wiring. |
| **12** | Demonstration of Fuse, MCB along its operation and study of ELCB. |
| **13** | Prepare installation diagram for a newly built room, Simple room wiring with one fan, one tube-light and one bulb with switch board |
| **14** | Introduction to Workshop Layout and Its Importance |
| **15** | Introduction to Industrial Safety |
| **16** | Introduction to Measuring Instruments |
| **17** | Fitting and Drilling Practice |
| **18** | Carpentry Practice |
| **19** | Sheet Metal Practice |
| **20** | Smithy Practice |
| **21** | Metal Joining Processes: Welding and Soldering Practice |
| **22** | Plumbing Practice |
| **23** | Metal Cutting on Lathe machine. |

**(2)**

a. **Course Name:** Mechanics of Solids
b. **Course Code:** 303104155
c. **Prerequisite:** System of units, Laws of motion, Basic idea of force, Concept of centroid Fundamentals of stress, strain and their relationships
d. **Rationale:** Mechanics of Solids is conceptual applications of principles of mechanics in Engineering.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Comprehend the concepts of stress, strain, and deformation in solid materials under various loading conditions, and apply this understanding to analyse structural behaviour. |
| **CLOBJ 2** | Gain insight into the mechanical properties of materials such as elasticity, plasticity, and failure mechanisms, and their implications in designing resilient and safe structures. |
| **CLOBJ 3** | Analyse structural components, including beams, columns, and trusses, under different loading scenarios using principles of mechanics of solids, determining stresses, and deformations. |
| **CLOBJ 4** | Develop proficiency in constructing shear force and bending moment diagrams to understand internal forces and moments in structural elements, crucial for design and analysis. |
| **CLOBJ 5** | Calculate deflections and assess stability criteria for structural elements, recognizing critical conditions that impact structural integrity and safety. |

| | |
|---|---|
| **CLOBJ 6** | Apply principles of mechanics of solids to design structural elements, ensuring they meet safety standards, considering factors such as material selection, loading conditions, and design codes. |

### f. Course Learning Outcomes:

| | |
|---|---|
| **CLO 1** | Explain the fundamental concepts of mechanics including force systems, equilibrium, and free-body diagrams |
| **CLO 2** | Apply the principles of centroid and moment of inertia for various geometrical sections in structural analysis. |
| **CLO 3** | Analyze shear force and bending moment in beams subjected to various loading conditions. |
| **CLO 4** | Apply the principles of friction to solve engineering problems involving ladders, wedges, and belts. |
| **CLO 5** | Calculate stresses and strains in axially loaded members using the concepts of elasticity and deformation. |

### g. Teaching & Examination Scheme:

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **-** | **2** | **4** | **20** | **20** | **20** | **60** | **30** | **150** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

### h. Course Content:

| **Sr. No.** | **Content** | **Weightage** | **Teaching Hours** |
|---|---|---|---|
| **1** | **INTRODUCTION:**<br>Forces/Equilibrium of Rigid body, Scalar and vectors, system of forces,resultant force, Statics of particles. Free-body diagrams. Equilibrium ofparticle in two dimensions, Resultants of three or more concurrent forces, Resolution of a force into components. Rectangular components of a force. Resultants by rectangular components, Concurrent force system in space: Resolution of a force into rectangular components in space, Coplanar Non-Concurrent Force Systems, Moments about Points and Axes, Equilibrium, Non-coplanar Non-concurrent Forces. | **15%** | **5** |
| **2** | **CENTROID MOMENT OF INERTIA:**<br>Distributed forces: Centroid and centre of gravity. Determination of centroid of lines and areas using integral technique, Determination of centroid of composite wires and areas, Centroid of volumes. Theorems of Pappus- | **15%** | **5** |

| | | | |
|---|---|---|---|
| | Guldinus and its applications, Second moment of areas, Definition of moment of inertia. Determination of moment of areas by integration, Parallel axis theorem for Moment of Inertia. MI of composite areas, Concept of Mass moment of inertia of bodies. | | |
| **3** | **BEAMS:**<br>Definitions, types of beams, types of loading, types of supports. Determination of reactions for simply, Supported and overhanging beams. Relation between distributed load, Shear force and BendingMoment, Shear force and Bending moment in beams with diagrams | **20%** | **6** |
| **4** | **FRICTION:**<br>The Laws of Dry Friction. Coefficients of Friction, Angles of Friction, Analysis of systems involving dry frictions such as ladders spheres etc.,Belt Friction, Analysis of flat and v-belt. | **25%** | **8** |
| **5** | **SIMPLE STRESSES & STRAINS:**<br>Basics of stress and strain: 3-D state of stress (Concept only), Normal/axial stresses: Tensile & compressive Stresses: Shear andcomplementary shear Strains, Linear, shear, lateral, thermal and volumetric. Hooke's law, Elastic Constants: Modulus of elasticity, Poisson's ratio. | **25%** | **8** |

**i. Text Book and Reference Book:**


1. "Statics and Dynamics" Beer, F.P. and Johnston, E.R. Vector mechanics for engineers; Tata McGraw-Hill
2. "Engineering Mechanics: Statics and Dynamics" J.A Desai and B.B Mistry; Popular Prakashan
3. "Engineering Mechanics: Statics and Dynamics", R.C Hibbeler; Prentice Hall of India
4. "Engineering Mechanics: Statics and Dynamics "S Rajsekaran; Vikas Publication
5. "Engineering Mechanics" S.S. Bhavikatti and K. G. Rajashekarappa; Wiley 'Eastern Ltd
6. "Engineering Mechanics", J.L. Meriam, and L.G.Kraige; John Wiley and sons, New York Signals and Systems" by Simon Haykin and Barry Van Veen.


**j. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| **1** | Equilibrium of Coplanar-Concurrent force system (Law of Parallelogram of forces) by analytical method |
| **2** | Equilibrium of Coplanar-Concurrent force system (Law of Parallelogram of forces) by graphical method |
| **3** | Equilibrium of Coplanar-Concurrent force system (Law of Polygon of forces) by analytical method |

| Exp. No. | Name of the Experiment |
|---|---|
| **4** | Equilibrium of Coplanar-Concurrent force system (Law of Polygon of forces) by graphical method |
| **5** | Equilibrium of Coplanar non-concurrent forces (theory) |
| **6** | Equilibrium of Coplanar non-concurrent forces (performance) |
| **7** | Theorem Equilibrium of parallel force system - Simply Supported Beam |
| **8** | Verification of principle of the moment: Bell crank lever |
| **9** | Determination Coefficient of static friction (theory) |
| **10** | Determination Coefficient of static friction (performance) |
| **11** | Brinell Hardness test |
| **12** | Izod impact test |
| **13** | Compression test on timber |
| **14** | Transverse test on Timber |
| **15** | Tensile test on mild steel |

**(3)**

a. **Course Name:** Basic Electronics
b. **Course Code:** 303107151
c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12$^{th}$ science level
d. **Rationale:** The course provides introductory treatment of the field of Basic of Electronics to the students of various branches of engineering.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | To study basics of semiconductor & devices and their applications in different areas. |
| **CLOBJ 2** | Compare design issues, advantages, disadvantages and limitations of basic electronics components. |
| **CLOBJ 3** | To study and analyze different biasing techniques to operate transistor. |
| **CLOBJ 4** | Study the DC regulated power supply with different voltage regulator ICs. |
| **CLOBJ 5** | Study the use of sensors and transducers. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Analyze the behaviour of PN junction diodes under various operating conditions. |
| **CLO 2** | Describe the behaviour of special purpose diodes under specified operating conditions. |
| **CLO 3** | Analyze BJT circuits under various biasing and operating conditions. |
| **CLO 4** | Design voltage regulator circuits for various application requirements. |
| **CLO 5** | Explain the fundamentals of sensors and transducers. |

### g. Teaching & Examination Scheme:

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 3 | 0 | 2 | 4 | 60 | 20 | 30 | 20 | 20 | 150 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

### h. Course Content:

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | Diode Theory and Its Applications Introduction to Ideal Diode, Effect of temperature Ideal diodes, unbiased diode and forward and reverse bias of Diode. PIV, surge current, Diode as Uncontrolled switch. Rectifiers: Half wave, Full wave and bridge wave. IDC, VDC and $I_{rms}$ Measurements. Ripple factor, PIV rating. Choke and Capacitor input filter rectifiers, Clipper and Clamper circuits, Voltage multiplier: Half wave voltage doubler and full wave voltage doubler | 15% | 10 |
| 2 | Special Purpose Diodes Construction of Zener diode, Characteristics of Zener diode, Application of Zener Diode as Voltage Regulator, load line, Optoelectronic devices (LED and Photo Diode), Seven Segment Display, Schottky diode and its Application, Varactor Diode and its Application, Understanding Datasheets. | 15% | 6 |
| 3 | Transistor Fundamentals and its Biasing techniques Construction of BJT, working principle of BJT, Characteristics & specifications of BJT (PNP & NPN transistors), Biased and unbiased BJT, Configuration of transistor, concept of gain & BW, Operation of BJT in cut-off, saturation & active regions (DC analysis), BJT as switch, Transistor as an amplifier, Voltage divider bias and analysis, VDB load line and Q point. | 30% | 15 |
| 4 | DC Regulated Power Supply Voltage Regulator-Basic series and shunt regulator, Types of voltage regulator IC: Fixed and adjustable positive and negative linear voltage regulator, IC linear fixed voltage regulator (78XX, 79XX, LM340 Series), Linear Adjustable Regulator (IC LM317, LM337, and IC 723 IC regulator), DC Regulated Power supply, Switched mode power supply (SMPS). | 20% | 6 |
| 5 | Introduction to Sensors and Transducers Introduction to sensors and Transducers, Comparison between sensors and Transducers, Applications of Sensors and Transducers, Types of Electronic sensors, Types of Transducers. | 20% | 6 |

**i. Text Book and Reference Book:**

1. "Electronic Principles", By A. P. Malvino, Tata McGraw Hill Publication New Delhi
2. "Electronic Devices and Circuits", By Jacob Millman and Halkias | Tata McGraw Hill Publication New Delhi.
3. "Electronic Devices and Circuits" By Robert L. Boylestad and Louis Nashelesky, Pearson, Prentice Hall.
4. "Electronic Devices" By Thomas L. Floyd | Pearson, Prentice Hall.
5. "Linear Electronic Circuits and Devices" By James Cox, | Delmar Publication.
6. "Electronic Devices and Circuits" By David A. Bell | Oxford Publication.

**j. Experiment List:**

| Sr. NO. | Experiment List |
|---|---|
| 1 | To Plot V-I characteristics Diodes. (a) PN junction diode Characteristic, (b) Zener Diode characteristics. |
| 2 | To Observe Rectifier Circuit (a) Half wave Rectifier without filter, (b) Full wave rectifier without filter, (c) Half wave Rectifier with (L, C) filter, and (d) Full wave Rectifier with (L,C) filter and measure DC voltage regulation and ripple factor for various load currents in case of filtered output. |
| 3 | Designing of power supply using IC regulator circuit. (a) Designing of +5 Volt DC Power Supply using 7805, (b) Designing of -5 Volt DC Power Supply using 7905, (c) Designing of +12 Volt DC Power Supply using 7812, and (d) Designing of -12 Volt DC Power Supply using 7912. |
| 4 | To Observe Response of Clipping and Clamping circuits using diodes (a) Diode Positive Clipper without and with Biased clipper, (b) Diode Negative Clipper without and with Biased clipper, (c) Biased Positive Negative Clipper (Combinational Clipper), and (d) Positive Clamper, and Negative Clamper. |
| 5 | (a) To Plot and Study input-output characteristics of common Base ( CB ) configuration of Transistor, and (b) To Plot and Study input-output characteristics of common Emitter (CE) configuration of Transistor. |
| 6 | To study Voltage divider bias circuit: (a) To observe the effect of change in base current on Q-operating point, and (b) To set Q point for operation of transistor amplifier in linear region. |
| 7 | Optoelectronic devices: (a) To plot characteristics of LED, (b) To plot Characteristic of Photo Diode, and (c) To observe isolated control of optocoupler. |
| 8 | To plot characteristics of Schottky and Varactor diode. |
| 9 | Designing of Linear Adjustable Regulator using IC LM317. |

**(4)**

**a. Course Name:** Engineering Graphics

**b. Course Code:** 303109101

**c. Prerequisite:** Knowledge of Physics and Mathematics up to $12^{th}$ science level

**d. Rationale: "**Engineering Graphics" course Provide students with a comprehensive foundation in the fundamental principles and concepts that form the backbone of mechanical engineering for various Engineering disciplines.

### e. Course Learning Objective:

| | |
|---|---|
| **CLOBJ 1** | Identify and name common drafting tools and their uses. |
| **CLOBJ 2** | Interpret engineering drawings and symbols. |
| **CLOBJ 3** | Demonstrate the ability to create accurate engineering drawings using industry-standard software. |
| **CLOBJ 4** | Solve engineering design problems by applying geometric and spatial concepts. |
| **CLOBJ 5** | Generate accurate and professional engineering drawings independently. |
| **CLOBJ 6** | Design and create 3D models of engineering components using computer-aided design (CAD) tools. |

### f. Course Learning Outcomes:

| | |
|---|---|
| **CLO 1** | Identify the uses of drawing instruments, accessories, scales and BIS drawing standards in engineering graphics. |
| **CLO 2** | Construct engineering curves using fundamental drafting techniques. |
| **CLO 3** | Illustrate the projections of points and lines using orthographic projection techniques. |
| **CLO 4** | Draw projections of planes, section of solids and development of surfaces using reference planes. |
| **CLO 5** | Draw orthographic and isometric projections of objects. |
| **CLO 6** | Draft 2D engineering drawings with aid of basic AutoCAD tools |

### g. Teaching & Examination Scheme:

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 2 | - | 2 | 4 | 20 | 20 | 20 | 60 | 30 | 150 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

### h. Course Content:

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **INTRODUCTION TO ENGINEERING GRAPHICS**<br>Scope of Engineering Drawing in all Branches of Engineering, Uses of Drawing Instruments and Accessories, Introduction to Drawing Standards BIS-SP-46, Representative Fraction, Types of Scales (Plain and Diagonal Scale), Dimensioning Terms and Notations, | 5% | 0 |

| | | | |
|---|---|---|---|
| | Types of Arrowheads, Lines, Lettering, Numbering and Dimensioning | | |
| **2** | **ENGINEERING CURVES:**<br>Classification of Engineering Curves, Application of Engineering Curves, Constructions of Engineering Curves - Conics, Spirals, Involutes and Cycloids with Tangents and Normal | **10%** | **5** |
| **3** | **PRINCIPLES OF PROJECTIONS:**<br>Types of Projections - Oblique, Perspective, Orthographic and Isometric Projections; Introduction to Principal Planes of Projections, Projections of Points located in all four Quadrants; Projections of lines inclined to one of the Reference Plane and inclined to two Reference Planes. | **10%** | **4** |
| **4** | **PROJECTIONS OF PLANES:**<br>Projections of various planes – Polygonal, Circular and Elliptical shape inclined to one of the Reference Plane and inclined to two Reference Planes; Concept of Auxiliary Plane of Projections. | **10%** | **4** |
| **5** | **PROJECTIONS OF SOLIDS AND SECTIONS OF SOLIDS:**<br>Classifications of basic Solids, Projections of Solids - Right Regular Prism, Pyramid, Cone, Cylinder, Tetrahedron and Cube inclined to one of the Reference Plane and inclined to two Reference Planes; Frustum of Prism, Pyramid and Cone inclined to one of the Reference Plane; Types of Cutting Planes - Auxiliary Inclined Plane, Auxiliary Vertical Plane, Horizontal Cutting Plane, Profile Cutting Plane; Sections of Solids resting on H.P/V.P and Inclined to only one of the Reference Planes; Sectional Views, True Shape of the Sections | **20%** | **10** |
| **6** | **DEVELOPMENT OF SURFACES:**<br>Methods of Development of Lateral Surfaces of Right Regular Solids, Parallel Line Development and Radial Line Development, Applications of Development of Surfaces. | **10%** | **5** |
| **7** | **ORTHOGRAPHIC PROJECTIONS:**<br>Projections on Principal Planes from Front, Top and Sides of the Pictorial view of an Object, First Angle Projection and Third Angle Projection method; Full Sectional Orthographic Views – Side and Front, Offset Cutting views | **15%** | **0** |
| **8** | **ISOMETRIC VIEW/DRAWING AND ISOMETRIC PROJECTIONS:**<br>Conversion of Orthographic Views into Isometric Projection, View or Drawing; Isometric Scale. | **15%** | **0** |
| **9** | **OVERVIEW OF COMPUTER AIDED DRAFTING TOOL:**<br>Introduction to Computer Aided Drafting Software; Preparation of Orthographic Projections and Isometric Views Using Drafting Software | **5%** | **0** |

**i. Text Book and Reference Book:**


1. Engineering Drawing N.D. Bhatt & V.M. Panchal; Charotar Publishing House
2. ENGINEERING GRAPHICS P. J. Shah; S. Chand & Co., New Delhi Publications.
3. Graphic Science and Design French, T.E. Vierck, C.J & Foster; Tata McGraw Hill Publications.
4. Fundamentals of Engineering Drawing Luzadder; W. J & Duff Prentice Hall Publications.
5. Engineering Drawing and Graphics Venugopal k; New Age International Private Limited Publishers.


**j. Experiment List:**

| Sr. NO. | Experiment List |
|---|---|
| 1 | Introduction to Engineering Graphics: Types of lines, Letterings, Drawing Symbols, Numberings, Dimensioning Terms and Notations, Title Block, Geometric Constructions etc. |
| 2 | Drawing Sheet on Engineering Curves. |
| 3 | Drawing Sheet on Projections of Points and Lines. |
| 4 | Drawing Sheet on Projections of Planes. |
| 5 | Drawing Sheet on Projections of Solids and Sections of Solids. |
| 6 | Drawing Sheet on Development of Surfaces. |
| 7 | Drawing Sheet on Orthographic Projections. |
| 8 | Drawing Sheet on Isometric Projection/View or Drawing. |
| 9 | Prepare 2D Drawings using AutoCAD. |
| 10 | Prepare Isometric Views using AutoCAD. |

**(5)**

a. **Course Name:** Mathematics-II
b. **Course Code:** 303191151
c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12$^{th}$ science level
d. **Rationale:** The mathematics II syllabus integrates fundamental calculus concepts, advanced mathematical techniques, and vector calculus, preparing students for engineering challenges with optimized problem-solving skills.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Define and identify ordinary differential equations of higher order. Classify ODEs based on homogeneity and linearity. Solve homogeneous linear ODEs of higher order with constant coefficients, and variable coefficients. |
| **CLOBJ 2** | Solve homogeneous linear ODEs of higher order with constant coefficients, variable coefficients |
| **CLOBJ 3** | Apply the Method of Undetermined Coefficients to solve nonhomogeneous ODEs. Utilize the Solution by Variation of Parameters for solving nonhomogeneous ODEs. Explore applications of ODEs in real-world scenarios. |
| **CLOBJ 4** | Understand power series solutions for ordinary points and regular singular points. Explore properties and applications of Legendre polynomials and Bessel functions. |
| **CLOBJ 5** | Define Laplace transform and its inverse. Understand the linearity property of Laplace transforms. Solve ordinary differential equations using Laplace transforms. |
| **CLOBJ 6** | Define Fourier Integral and its applications. Explore Fourier Cosine and Sine Integrals. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Solve higher-order ordinary differential equations with constant coefficients and Euler's ODE with variable coefficient |
| **CLO 2** | Apply series solution methods and special functions like Bessel's' functions to solve the differential equations and analyze complex physical phenomena |
| **CLO 3** | Use the Laplace transform as a tool to solve differential equations and Fourier integral representation |
| **CLO 4** | Apply Fourier integral to analyse the representation of functions in terms of frequency component. |
| **CLO 5** | Apply mathematical tools needed in evaluating vector calculus and their usage like Work, Circulation and Flux. |
| **CLO 6** | Apply Multiple Integration to solve physical problems such as Area, Volume etc. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 4 | - | - | 4 | 20 | 20 | - | 60 | - | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Higher order ordinary differential equations:** Ordinary differential equations of higher orders, Homogeneous Linear ODEs of Higher Order, Homogeneous Linear ODEs with Constant Coefficients, Euler–Cauchy equations, Nonhomogeneous ODEs, Method of Undetermined Coefficients, Solution by Variation of Parameters, Applications | 8% | 5 |
| 2 | **Power Series:** Power series solutions at ordinary point and regular singular point; Legendre polynomials, Bessel functions of the first kind and their property | 15% | 9 |
| 3 | **Laplace Transform:** Laplace Transform and inverse Laplace transform, Linearity, First Shifting Theorem (s-Shifting), Transforms of Derivatives and Integrals, ODEs, UNIT Step Function (Heaviside Function), Second Shifting Theorem (t-Shifting), Laplace transform of periodic functions, Short Impulses, Dirac's Delta Function, Convolution, Integral Equations, Differentiation and Integration of Transforms, Solution of ordinary differential equation by Laplace transform | 25% | 15 |
| 4 | **Fourier Integral:** Fourier Integral, Fourier Cosine Integral and Fourier Sine Integral | 17% | 10 |
| 5 | **Vector Calculus:** Gradient of scalar field, Directional Derivative, Divergence and curl of Vector field, Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes. | 10% | 6 |
| 6 | **Multivariable Calculus (Integration):** Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Triple integrals (Cartesian) | 25% | 15 |

**i. Text Book and Reference Book:**

1. "Calculus and Analytic Geometry (Textbook)", By G.B. Thomas and R.L. Finney, Addison Wesley
2. "Calculus with early transcendental functions", By James Stewart, Cengage Learning
3. "Higher Engineering Mathematics", By B. S. Grewal | Khanna Publications
4. "Elementary Linear Algebra (Textbook)", By Howard Anton, Chris Rorres | Willy India Edition | 9th Edition
5. "Advanced Engineering Mathematics (Textbook)", By Erwin Kreyszig | Willey India Education

**(6)**

**a. Course Name:** Advanced Communication & Technical Writing
**b. Course Code:** 303193152
**c. Prerequisite:** Knowledge of English Language studied till 12th standard
**d. Rationale:** Communication confidence laced with knowledge of English grammar is essential for all engineers.
**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Demonstrate the ability to adapt writing style to different audiences and purposes. |
| **CLOBJ 2** | Create comprehensive technical documents such as reports, manuals, and proposals. |
| **CLOBJ 3** | Refine editing and proofreading skills for complex technical documents. |
| **CLOBJ 4** | Explore and apply technical communication through various mediums (video, web content, multimedia) |
| **CLOBJ 5** | Incorporate advanced document design principles for clarity and readability. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Employ the four basic language skills—listening, speaking, reading, and writing—in structured academic and real-world communication contexts |
| **CLO 2** | Construct grammatically correct and error-free sentences for effective written and spoken communication. |
| **CLO 3** | Develop and deliver professional presentations effectively while building confidence to engage audiences. |
| **CLO 4** | Apply critical thinking skills to analyze and solve problems |
| **CLO 5** | Compose various types of written communication—such as emails, reports, proposals, and technical documents—for academic and professional purposes. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 0 | 2 | 0 | 2 | - | - | - | - | - | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Developing Effective Listening Skills**:<br>• To help students understand the meaning and importance of good listening skills, learning the traits of being a good listener through activity and listening audio tracks. | 10% | 2 |
| 2 | **Error analysis**:<br>• To provide insights into the complicated processes of language development as well as a systematic way for identifying, describing and explaining errors. (Tenses, Voices, Reported speech) | 10% | 4 |
| 3 | **Delivering different types of speeches:**<br>Students will understand and use the different patterns for structuring speeches: Welcome / Introductory speech, Vote of Thanks speeches, Farwell speeches | 10% | 2 |
| 4 | **Professional**<br>Presentations: Students will learn Combating stage fright, preparing power point presentation, Delivering PPT | 10% | 4 |
| 5 | **Essay writing**:<br>Students will overcome the common pitfalls in the task of essay writing by understanding<br>• Basics of Paragraph development and paragraph jumble<br>• Types of essays<br>• Characteristic features of essays<br>• Guiding Principles | 10% | 2 |
| 6 | **Reading Comprehension**:<br>• Employing Different Reading Skills<br>• Activity<br>• Practice | 10% | 2 |

| | | | |
|---|---|---|---|
| **7** | **Project Proposal**:<br>• To equip students with the various elements required to prepare a winning proposal. | **5%** | **2** |
| **8** | **Misplaced Modifiers**:<br>• Students will understand how to place the improperly separated word, phrase or clause from the word it describes. | **5%** | **2** |
| **9** | **Movie Review**:<br>• A movie show followed by writing a review.<br>• To provide an exposure to students how to express their opinions about some film or documentary with unbiased and objective approach. | **10%** | **4** |
| **10** | **Narrative Writing**:<br>• Narrative writing helps them explore different characters and settings.<br>• To help students clarify their thinking, and teach them to express that in writing in an organized way. | **5%** | **4** |
| **11** | **Writing Reports**:<br>• Process of writing<br>• Order of writing<br>• Final draft & checklist for reports<br>• Sample reports:<br>• Memorandum<br>• Letter report | **10%** | **2** |
| **12** | **Critical Thinking**:<br>• Need, relevance and Significance of Critical Thinking<br>• Logic in problem solving and decision making(activities) Moral Reasoning (Case Studies) | **5%** | **1** |
| **13** | **Activity Session (Presentation)**<br>An activity where the scene of a press conference is created in the class. Students are encouraged to ask sharp questions and in turn are invited to assume roles of famous personalities, thus answering the questions posed. | **0%** | **1** |

**i. Text Book and Reference Book:**


1. "Understanding and Using English Grammar", Betty Azar & Stacy Hagen; Pearson Education
2. "Business Correspondence and Report Writing ", SHARMA, R. AND MOHAN, K.
3. "Communication Skills", Kumar S and Lata P; New Delhi Oxford University Press
4. "Technical Communication: Principles and Practice" Sangeetha Sharma, Meenakshi Raman; Oxford University Press.

## Semester 3

**(1)**

a. **Course Name:** Thermodynamics
b. **Course Code:** 303109201
c. **Prerequisite:** Basic knowledge of Mechanical workshop
d. **Rationale:** To impart basic knowledge to enable the student to assimilate the concurrent manufacturing operations and process in the discipline of metal casting and machining.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Grasp the distinctions between work and heat interactions, comprehending their roles in the transfer of energy between a system and its surroundings. |
| **CLOBJ 2** | Utilize the first law of thermodynamics to analyse energy conservation in diverse devices, elucidating the balance of energy between a system and its surroundings. |
| **CLOBJ 3** | Apply the second law of thermodynamics, considering entropy and enthalpy, to assess and compute system performance, emphasizing energy transformation efficiency. |
| **CLOBJ 4** | Assess changes in substance properties during processes like compression and heating, gaining insights into the principles governing energy transfer and transformation. |
| **CLOBJ 5** | Distinguish between high- and low-grade energies, recognizing their utility and efficiency, and understand their impact on the performance of energy conversion systems. |
| **CLOBJ 5** | Apply the first law to analyse energy conversion devices such as engines and turbines, elucidating the transformation of energy forms and their implications on system behaviour. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| CLO 1 | Explain the concept of heat and work transfer applicable to various engineering applications using thermodynamics law. |
| CLO 2 | Apply 2nd law of thermodynamics for different flow and non-flow processes. |
| CLO 3 | Analyze the concepts of entropy and exergy by applying 2nd law of thermodynamics. |
| CLO 4 | Describe the relations between various thermodynamics properties for pure substance. |
| CLO 5 | Analyze the working principles of basic thermodynamic cycles. |
| CLO 6 | Apply thermodynamic laws and relations for ideal and real gases. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 3 | 1 | 0 | 4 | 20 | 20 | 50 | 60 | - | 150 |

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **BASICS OF THERMODYNAMICS**<br>(a) Introduction to Engineering Thermodynamics - Macroscopic vs microscopic view point, Thermodynamic systems, properties, process, cycle, thermodynamic equilibrium, Reversible, Irreversible & Quasistatic Process, Zeroth Law of thermodynamics, concept of continuum. Exact & Inexact differentials. Work-electrical, magnetic, gravitational, spring and shaft work, Displacement work (P-dv), flow work, stirring work, free expansion, Equation of state of a gas, properties of Ideal gas, specific heat, work done in various quasi-static processes, work as a path function. Heat transfer-sensible heat, latent heat, heat as a path function.<br>(b) First Law of thermodynamics - Joulės experiment, internal energy as property of system, first law applied to various quasi static processes, PMMI, Limitations of the First Law, control volume, Steady flow energy equation, Applications of SFEE. | **25%** | **12** |
| 2 | **SECOND LAW OF THERMODYNAMICS AND ENTROPY**<br>(a) Second law of thermodynamics: Thermal Reservoir, Heat Engine, cyclic Heat engine, Kelvin-Planck statement and Clausius Statements and their Equivalence, Refrigerator and Heat pump, COP, PMM II, reversibility and irreversibility, causes of irreversibility, Carnot cycle, reversed heat engine, Carnot theorem, corollaries of Carnot theorem, Absolute thermodynamic temperature scale.<br>(b) Entropy: Clausius theorem, the property of entropy, the inequality of Clausius, Entropy principle and its | **25%** | **12** |

| | | | |
|---|---|---|---|
| | Applications, Entropy change during different thermodynamic processes, entropy generation in closed systems and open systems. | | |
| **3** | **EXERGY**<br>Available energy, availability and availability function of a closed system, availability and availability function of an open system, dead state, Helmholtz function, Gibbs functions, Irreversibility and Gouy-Stodola Theorem, Second law efficiency. | **15%** | **7** |
| **4** | **PROPERTIES OF PURE SUBSTANCE**<br>Thermodynamic properties of pure substances in solid, liquid and vapour phases, Phase Transformations, dryness fraction, Gibbs phase rule, Triple point, critical state, p-v, p-T, T-s, h-s, p-h diagrams, Properties and processes in ideal vapour, use of steam tables and Mollier̛s diagram in determination of steam properties, energy interaction and entropy calculations for various thermodynamic processes. | **20%** | **8** |
| **5** | **Thermodynamic Cycles & Relations**<br>(a) Thermodynamic cycles - Basic Rankine cycle, Basic Brayton cycle, Basic vapor compression cycle and comparison with Carnot cycle.<br>(b) Thermodynamic relation- Maxwell relation, first and second law combined (T-ds relation). Joule-Kelvin effect (real gas), basics of Fuel cell. | **15%** | **6** |

**i. Text Book and Reference Book:**


1. "Thermodynamics-An Engineering Approach" By Cengel, Y.A & Boles, M.A., TMH, 2011
2. "Engineering Thermodynamics", By P K Nag | Tata McGraw-Hill
3. "Fundamental of Engineering Thermodynamics" By R. Yadav, CPH Publications
4. "Thermodynamics", By C.P. Arora | Tata McGraw Hill

**(2)**

a. **Course Name:** Materials Engineering
b. **Course Code:** 303109203
c. **Prerequisite:** Knowledge of Engineering Physics and Engineering Chemistry
d. **Rationale:** Basic principles of science are used to study the structure-properties relationship of various materials for their proper applications in this subject. Especially study of different types of ferrous and non-ferrous metals and alloys, in terms of their composition, structure, properties and applications; non-destructive testing are included in this course to understand the basic concept of selection and processing of metals and materials for their applications.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Develop a comprehensive understanding of the fundamental properties of engineering materials, including mechanical, thermal, and electrical characteristics. |
| **CLOBJ 2** | Apply principles of materials science to design and optimize materials for specific engineering applications. |
| **CLOBJ 3** | Understand the influence of processing parameters on the microstructure and mechanical properties of materials, and apply this knowledge to optimize manufacturing processes. |
| **CLOBJ 4** | Investigate the role of material defects, fatigue, corrosion, and other factors in determining the life expectancy and reliability of engineering components. |
| **CLOBJ 5** | Investigate the impact of nanotechnology on materials engineering, including the development of new materials and innovative manufacturing techniques. |
| **CLOBJ 6** | Understand the concept of chemical analysis for materials and explore innovative technologies for material synthesis. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Understand the Crystal structures and imperfections for engineering applications. |
| **CLO 2** | Metamorphose the Phase diagrams , phase rules constraints impacting the solid solution. |
| **CLO 3** | Investigate the Influence of Alloying elements on the properties of steels |
| **CLO 4** | Explain various heat treatment and powder metallurgy processes including TTT diagrams. |
| **CLO5** | Categorize the types of Copper and Aluminium alloys, plastics, ceramics, composites & smart materials. |
| **CLO6** | Illustrate non-destructive testing techniques and metallography. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 3 | 0 | 0 | 3 | 20 | 20 | 0 | 60 | 0 | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Engineering Materials and Crystal Structures** Classification of Engineering Materials, Engineering requirements of materials, Criterion for selection of materials for engineering applications through, Structure-Properties Performance correlation ship. Unit Cell, Crystal structure, Bravais lattice, atomic packing factor, coordination number, crystal directions and planes, Miller indices, Imperfections in crystals and their effect on properties, Strain hardening, Recovery, Recrystallization and Grain Growth. | 15% | 7 |
| 2 | **Phase Diagrams and Theory of Alloys** Unary and Binary equilibrium phase diagrams, Lever rule, Gibb's phase rule, solid solutions and compounds, Solid Solution Strengthening Mechanisms, Hume-Rothery rules; cooling curves, Different reactions like eutectic, eutectoid etc. Allotropy of Iron, Iron-Iron-Carbide equilibrium diagram. Plain carbon steels, its classification and properties, Alloy Steel, its classification and properties, Stainless steel, Tool Steel, designation of Steels, Effect of alloying elements like Cr, Mo, Ni, W, V, Nb, B, Al, etc on the Properties of Steel, Cast Iron, its classification and properties, White Cast iron, Grey Cast iron, Nodular Cast iron, Malleable Cast iron, Chilled Cast Iron etc. | 25% | 13 |
| 3 | **Heat Treatment of Steels and Alloys** Heat Treatment Cycle, Time-Temperature Transformation (TTT) Diagram, CCR, Different types of heat Treatments like Annealing, Normalizing, Hardening, Tempering, Austempering, Martempering, Ausforming, Surface hardening and Case hardening treatments, Jominy Hardenability Test. | 15% | 9 |

| | | | |
|---|---|---|---|
| **4** | **Non-Ferrous Alloys, Non-Metallic Materials and Nanomaterials**<br>Copper alloys, Aluminium alloys: Classification, Composition, Properties and applications. Plastics, Composites, Ceramics: Classification, Composition, Properties and applications. Introduction to Nanomaterials and its applications | **20%** | **12** |
| **5** | **Powder Metallurgy**<br>Production of Powder, blending, Compacting, Sintering; Application, advantages and limitations. | **10%** | **4** |
| **6** | **Non-Destructive Testing**<br>Principle, Advantages, limitations and Applications of Dye Penetration Testing, Magnetic Particle Testing, Eddy current testing Radiography Testing, UT. | **10%** | **2** |
| **7** | **Metallography**<br>Structure of Metals, Macro-examination: Macro-etching; Microscopic examinations: Specimen Preparation, etching, grain size measurement; Concept of chemical analysis of steel and Iron for Carbon, Sulphur & Phosphorous. | **5%** | **2** |

**i. Text Book and Reference Book:**


1. Introduction to Physical Metallurgy by Sydney H. Avner | Tata McGraw-Hill
2. Callister's Material Science and Engineering, 2 By R. Balasubramaniam | Wiley India.
3. Practical Non-Destructive Testing, By Baldev Raj, T. Jayakumar and M. Thavasimuthu | Narosa Pub. House
4. Mechanical Metallurgy by George E. Dieter | McGraw-Hill book company
5. Materials Science and Engineering: By V. Raghavan | A First Course, 5th Edition Prentice Hall India, 2004.

**(3)**

a. **Course Name:** Material Engineering Lab
b. **Course Code:** 303109204
c. **Prerequisite:** Knowledge of Engineering Physics and Engineering Chemistry
d. **Rationale:** Basic principles of science are used to study the structure-properties relationship of various materials for their proper applications in this subject. Especially study of different types of ferrous and non-ferrous metals and alloys, in terms of their composition, structure, properties and applications; non-destructive testing are included in this course to understand the basic concept of selection and processing of metals and materials for their applications.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Enable a comprehensive understanding of their inherent properties and diverse applications of materials in various fields. |
| **CLOBJ 2** | Proficiently prepare specimens for microstructure examination and skilfully observe the microstructures of standard specimens. |
| **CLOBJ 3** | Proficiently demonstrate the heat treatment of steel and perform the Jominy end quenching test. |
| **CLOBJ 4** | Explore and investigate the principles and applications of powder metallurgy for material synthesis. |
| **CLOBJ 5** | Demonstrate the ability to perform various non-destructive tests for effective evaluation of material integrity and flaw detection. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Assess engineering requirements for material selection in engineering applications |
| **CLO 2** | Prepare metallographic samples for micro structural observation. |
| **CLO 3** | Assess the Effects of Heat Treatment on Steel microstructure and properties |
| **CLO 4** | Demonstrate the use of Optical Metallurgical microscopes with image analyser software to measure grain size. |
| **CLO5** | Demonstrate key concepts of NDT methods to find out the defects in materials |
| **CLO6** | Compare Powder Metallurgy with traditional manufacturing methods |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| 0 | 0 | 2 | 1 | 0 | 0 | 20 | 0 | 30 | 50 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**

1. Introduction to Physical Metallurgy by Sydney H. Avner, Tata McGraw-Hill
2. Callister's Material Science and Engineering, 2 By R. Balasubramaniam, Wiley India.
3. Practical Non-Destructive Testing, By Baldev Raj, T. Jayakumar and M. Thavasimuthu, Narosa Pub. House
4. ASM Handbook Vol. 9: Metallography and Microstructure by Ed. George F. Vander Voort, ASM International
5. Mechanical Metallurgy by George E. Dieter, McGraw Hill
6. Materials Science and Engineering: By V. Raghavan, A First Course, 5th Edition Prentice Hall India, 2004

**i. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| **1** | Study of Engineering Materials and its Classification. |
| **2** | Demonstration of Metallurgical Micro Scope. |
| **3** | Specimen Preparation for Micro Structural Examination |
| **4** | Observation of Micro Structure for Standard Samples. |
| **5** | Demonstration on Heat Treatment of Steels. |
| **6** | Study of Powder Metallurgy |
| **7** | Demonstration of Liquid Penetrant Test/Dye Penetrant Test. |
| **8** | Demonstration of Magnetic Particle Test. |
| **9** | Flaw Detection through Ultrasonic Testing |
| **10** | Demonstration of Jominy Hardenability Test. |

**(4)**

a. **Course Name:** Manufacturing Process
b. **Course Code:** 303109205
c. **Prerequisite:** Basic knowledge of Mechanical workshop
d. **Rationale:** To impart basic knowledge to enable the student to assimilate the concurrent manufacturing operations and process in the discipline of metal casting and machining.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Identify and differentiate various machine tools utilized in manufacturing processes. Demonstrate an understanding of the applications and limitations of different machine tools in diverse industrial contexts. Apply knowledge of machine tools to make informed decisions regarding tool selection for specific machining operations. |
| **CLOBJ 2** | Organize and sequence machining operations systematically to achieve the desired end product. Demonstrate the ability to create a step-by-step plan for machining processes, considering efficiency and precision. |
| **CLOBJ 3** | Define the concept of patterns and their role in shaping materials for manufacturing. Describe the purpose and function of gating systems in the casting process. Demonstrate the ability to articulate the importance of patterns, moulding processes, and gating systems in the broader context of manufacturing. |
| **CLOBJ 4** | Demonstrate practical knowledge by executing casting processes in controlled environments. Apply theoretical knowledge to real-world scenarios, ensuring proficiency in the implementation of casting processes. |
| **CLOBJ 5** | Demonstrate practical knowledge by setting up and operating unconventional machining equipment. Apply critical thinking to assess the suitability of unconventional machining processes for different manufacturing challenges. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Describe the construction and operations of lathe machines. |
| **CLO 2** | Explain the various conventional machine tools and their related operations. |
| **CLO 3** | Understand the different surface finishing processes. |
| **CLO 4** | Describe moulding and casting processes. |
| **CLO 5** | Explain non-conventional machining processes and their applications. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| 3 | - | 0 | 3 | 20 | 20 | - | 60 | - | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Lathe Machines Tool:** Introduction to lathe machine and its classification, Construction, Setting and Operations of lathe machines, construction and principal units of engine lathes, Operations carried on engine lathe, plain turning lathes, facing lathes, multiple tool lathes, special purpose lathes, Capstan and turret lathes, shift invariance, causality, stability, reliability. | **13%** | **6** |
| 2 | **Conventional Machining Processes:** Introduction to Turning, shaping, planning, milling, drilling, broaching processes; types of machines and operations; different mechanisms on the machine; tool and work holding devices; special attachments; machining time calculations. | **36%** | **16** |
| 3 | **Finishing Processes:** Introduction to grinding, types of machines and operations, dressing and trueing, glazing, designating system, selection of grinding wheel, lapping, honing, etc | **11%** | **5** |
| 4 | **Moulding and Casting processes:** Patterns, Requirements of a good pattern, pattern materials, types of patterns, pattern allowances - Mould making, types of moulds, moulding processes, types of sand moulding - Core making, types of cores, core prints, core box - Moulding Sand, Properties of moulding sand, types of moulding sand, Gating system and its design, Introduction to casting, Different types of Casting processes, Casting Defects, Cleaning and Inspection of casting. | **27%** | **12** |
| 3 | **Non-Conventional Machining Processes:** Introduction and Classification and applications of non-Conventional machining processes. EDM, EBM, PAM, IBM, ECM, ECG, CM, AJM, WJM, AWJM, wire cut EDM, USM, LBM process principles, and their applications | **13%** | **6** |

**i. Text Book and Reference Book:**


1. “Manufacturing Technology (Textbook)" by By P.N. Rao, Tata McGraw Hill publication.
2. “Manufacturing Science" By A Ghosh and A K Mallik, Wiley Eastern, 1986.
3. “A Course in Workshop Technology" By Raghuwamsi B S, Dhanpat Rai and Sons, 1682 Nai Darak, New Delhi. Pub. Year 1982.
4. “Elements of Workshop Technology (Vol I & Vol II)" By Hajra Choudhary, Media Promoters and Publishers Pvt ltd.
5. “Introduction to Machining Science”, By G K LAL, New Age International Pvt Ltd., 2007.

**(5)**

a. **Course Name:** Manufacturing Processes Lab
b. **Course Code:** 303109206
c. **Prerequisite:** Basic knowledge of Mechanical workshop.
d. **Rationale:** To impart basic knowledge to enable the student to assimilate the concurrent manufacturing operations and process in the discipline of metal casting and machining.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Identify and differentiate various machine tools utilized in manufacturing processes. Demonstrate an understanding of the applications and limitations of different machine tools in diverse industrial contexts. Apply knowledge of machine tools to make informed decisions regarding tool selection for specific machining operations. |
| **CLOBJ 2** | Organize and sequence machining operations systematically to achieve the desired end product. Demonstrate the ability to create a step-by-step plan for machining processes, considering efficiency and precision. |
| **CLOBJ 3** | Define the concept of patterns and their role in shaping materials for manufacturing. Describe the purpose and function of gating systems in the casting process. Demonstrate the ability to articulate the importance of patterns, moulding processes, and gating systems in the broader context of manufacturing. |
| **CLOBJ 4** | Demonstrate practical knowledge by executing casting processes in controlled environments. Apply theoretical knowledge to real-world scenarios, ensuring proficiency in the implementation of casting processes. |
| **CLOBJ 5** | Demonstrate practical knowledge by setting up and operating unconventional machining equipment. Apply critical thinking to assess the suitability of unconventional machining processes for different manufacturing challenges. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Perform various lathe machine operations. |
| **CLO 2** | Demonstrate working of shaper, milling, and grinding machine. |
| **CLO 3** | Demonstrate the operation of an EDM machine. |
| **CLO 4** | Prepare wooden pattern considering different allowances. |
| **CLO 5** | Demonstrate gating system for sand mould casting process. |

**g. Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **0** | **-** | **2** | **1** | **-** | **-** | **20** | **-** | **30** | **50** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**


1. “Manufacturing Technology (Textbook)" By P.N. Rao, Tata McGraw Hill publication.
2. “A Course in Workshop Technology" By Raghuwamsi B S, Dhanpat Rai and Sons, 1682 Nai Darak, New Delhi. Pub. Year 1982.
3. “P C Sharma, “A Textbook of Production Engineering”. S. Chand publishers.
4. “Manufacturing Science" By A Ghosh and A K Mallik, Wiley Eastern, 1986.
5. “Introduction To Machining Science”, By G K LAL, New Age International Pvt Ltd., 2007
6. “Metal Cutting Principles”, By M C Shaw, MIT Press, 2004.


**i. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| **1** | To perform various lathe operation on a given work-piece. |
| **2** | Machining practices on drilling machine. |
| **3** | Machining practices on milling machine to cut spur gear. |
| **4** | Machining practices on shaping machine |
| **5** | Machining practice on grinding machine. |
| **6** | Demonstration of Capstan lathe. |
| **7** | Demonstration of EDM. |
| **8** | To understand the basic concept of pattern and its allowances and making of pattern. |
| **9** | To demonstrate the procedure of moulding. |
| **10** | To demonstrate the procedure of casting**.** |

**(6)**

a. **Course Name:** Kinematics and Theory of Machines
b. **Course Code:** 303109207
c. **Prerequisite:** Basic knowledge of physics, mechanics and mathematics.
d. **Rationale:** It is important for mechanical engineers to understand about relative motions amongst various elements of mechanisms of machines responsible to perform the targeted task. This course is essential to provide fundamental study about establishment of relative motions for designing various mechanisms to build various machines.

e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Classify different links and joints, understand the motion of mechanisms and determine degrees of freedom, study the concept of inversions |
| **CLOBJ 2** | Understand velocity and acceleration vectors, draw velocity diagrams using Relative velocity method and instantaneous centers, understand radial, transverse and Corioli's components of acceleration, draw acceleration vector diagrams to analyse the motion of the links in the mechanisms |
| **CLOBJ 3** | Understand cams and followers, its terminology and classification, analyse output follower motion, create displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions. |
| **CLOBJ 4** | Classification of gears and gear trains, understand gear terminology, gear teeth profiles, concept of contact ratio, interference and undercutting, evaluate minimum number of teeth on pinion to avoid interference, classify gear train: simple, compound, reverted and epicyclic. |
| **CLOBJ 5** | Understand working principle and application of governors, classify governors, understand gyroscopic effect and gyroscope in various applications. |
| **CLOBJ 6** | Study the concept of friction and apply it to various friction devices like clutches, bearings, brakes and power transmission elements, understand the working principles of various friction devices and its classification. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Demonstrate the inversions of simple kinematic chains with respect to degree of freedom, mechanical advantage, and transmission angle |
| **CLO 2** | Interpret velocity and acceleration diagram of planner kinematic chain for definite configuration. |
| **CLO 3** | Synthesis the cams for generating required follower motions. |
| **CLO 4** | Determine the design parameters of gear and gear train for specified operating conditions. |
| **CLO 5** | Explain the working and applications of centrifugal governors and gyroscope. |
| **CLO 6** | Evaluate design parameters of clutch, bearing, brakes, belt and rope drives for specified operating parameters. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 3 | - | - | 3 | 20 | 20 | - | 60 | - | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Mechanisms And Machines:** Basic kinematic concepts, definition and classification of link, kinematic pair, joint, kinematic chain, mechanism and machine, types of constraint motion, Degrees of freedom (mobility) - Kutzbach and Grubler's criterion for degrees of freedom, Grashof's law, Kinematic inversions of four bar chain, single slider crank chain and double slider- crank chain, Mechanical advantage, Transmission angle, Introduction of exact and approximate straight-line mechanisms. | **16%** | **7** |
| 2 | **Velocity and Acceleration Analysis:** Velocity Analysis: Vectors, Displacement of a rigid body, Definition of velocity, angular velocity, Relative velocity method for four bar mechanism and slider-crank mechanism, Kennedy's theorem. Graphical velocity analysis using instantaneous centers. Acceleration Analysis: Definition of acceleration, Angular acceleration, Radial and transverse components of acceleration, Corioli's component of acceleration, Difference of synthesis and analysis. | **22%** | **10** |
| 3 | **Cam And Followers:** Classification of cams and followers, Terminology and definitions, Description of follower movement, Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions, specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile. | **18%** | **8** |
| 4 | **Gears & Gear Trains**: Classification of gears, Gear terminology, Involute and cycloidal gear profiles, Law of gearing, spur gear | **16%** | **7** |

| | | | |
|---|---|---|---|
| | contact ratio and interference and Undercutting of Involute teeth. Minimum number of teeth on pinion to avoid interference. Gear Train: Simple, compound, reverted and epicyclic gear train. | | |
| **5** | **Governors & Gyroscope:**<br>Types of governors, Working principle and application of governors, characteristics of governor. Gyroscope. | **6%** | **3** |
| **6** | **Friction Devices:**<br>Clutch: Surface contacts - sliding and rolling friction, Function and classification of clutches, Torque transmission capacity using uniform wear and uniform pressure theory applicable to various clutches. Bearings: Friction and classification of bearings, Working principle and Applications, Lubrications. Brakes: Function and classification of brakes, Braking effect, case studies of applications. Power Transmission Elements: Classification of belt and rope drives, Working principle, construction of rope drives, case studies of application. | **22%** | **10** |

**i. Text Book and Reference Book:**

1. "Theory of Machine" by R. S. Khurmi and J. K. Gupta.
2. "Theory of Machine" by S S Ratan.
3. "Theory of Machine" by P.L. Ballaney.
4. "Theory of Machine" by V P Singh.
5. “Theory of Machines”, by Dr. Sadhu Singh

**(7)**

**a. Course Name:** Kinematics and Theory of Machines Lab

**b. Course Code:** 303109208

**c. Prerequisite:** Basic knowledge of physics, mechanics and mathematics.

**d. Rationale:** It is important for mechanical engineers to understand about relative motions amongst various elements of mechanisms of machines responsible to perform the targeted task. This course is essential to provide fundamental study about establishment of relative motions for designing various mechanisms to build various machines.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Define and classify mechanical links and joints, apply Kutzbach and Gruebler’s criteria to determine the degrees of freedom, comprehend Grashof’s law, study inversions and mechanical advantage. |
| **CLOBJ 2** | Understand the concept of velocity and acceleration vectors, apply graphical methods to do velocity and acceleration analysis, Understand the Coriolis component of acceleration. |

| | |
|---|---|
| **CLOBJ 3** | Demonstrate a comprehensive understanding of centrifugal governor principles, including assembly, adjustment, and graphical representation of governing characteristics. |
| **CLOBJ 4** | Understanding angular momentum, precession, and be able to analyse and communicate the observed gyroscopic behaviours and effects. |
| **CLOBJ 5** | Classification of cams and followers, analyse displacement diagrams, and apply graphical and analytical methods to synthesize disc cam profiles. |
| **CLOBJ 6** | Demonstrate a comprehensive understanding of gear classification, profile analysis, and gear train kinematics, as well as the function, classification, and application of frictional devices. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Analyze the inversion of planer kinematic chain. |
| **CLO 2** | Interpret velocity and acceleration diagram of planner kinematic chain |
| **CLO 3** | Construct cam profile for follower with uniform velocity, parabolic, simple harmonic and cycloidal motions. |
| **CLO 4** | Demonstrate the operating characteristics of Governors and Gyroscope. |
| **CLO 5** | Calculate the design parameters of gear and gear train for specified operating conditions. |
| **CLO 6** | Describe role of friction in function of clutch, bearing, brakes, belt and rope drives. |

**g. Text Book and Reference Book:**


1. "Theory of Machine" by R. S. Khurmi and J. K. Gupta.
2. "Theory of Machine" by S S Ratan.
3. "Theory of Machine" by P.L. Ballaney.
4. "Theory of Machine" by V P Singh.
5. “Theory of Machines”, by Dr. Sadhu Singh


**h. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| **1** | Exercise based on basic concepts of kinematics. |
| **2** | Performance to determine the gyroscopic effect. |
| **3** | Study of working principle and construction of the different types of the centrifugal governor. |
| **4** | Performance to determine operating characteristics of Porter governor. |
| **5** | Exercise on velocity analysis of four-bar and slider crank mechanisms by ICR method. |
| **6** | Exercise on velocity and acceleration analysis of four bar and slider-crank mechanisms by relative velocity and relative acceleration method. |

| Exp. No. | Name of the Experiment |
|---|---|
| **7** | Study of synthesis of cam and follower mechanism. |
| **8** | Exercise on the kinematics of gear and gear train. |
| **9** | Exercise to learn about friction devices. |
| **10** | Exercise using Mech Analyzer software. |

**(8)**

a. **Course Name:** PDE, Probability, and Statistics
b. **Course Code:** 303191204
c. **Prerequisite:** Basic knowledge of physics, mechanics and mathematics.
d. **Rationale:** The course provides solution techniques of Partial Differential Equations, Probability Methods and Statistical Methods for Mechanical and Automobile Engineering.

e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Solve first-order linear and nonlinear PDEs, use Charpit's Method, and apply methods for second and higher-order linear equations. Model and solve problems related to Heat, Wave, and Laplace equations. |
| **CLOBJ 2** | Understand probability spaces, conditional probability, and independence. Analyse discrete and continuous random variables, distributions (including normal and exponential), and properties of random sequences. |
| **CLOBJ 3** | Develop skills in basic statistics, measures of central tendency, probability distributions, correlation, regression, and curve fitting using the method of least squares. |
| **CLOBJ 4** | Apply probability and statistics to real-world scenarios. Use mathematical and statistical tools to make informed predictions and decisions in practical situations. |
| **CLOBJ 5** | Enhance problem-solving and critical thinking skills through the application of mathematical and statistical methods. Approach complex problems systematically and arrive at logical solutions. |
| **CLOBJ 6** | Communicate mathematical and statistical results effectively in written and oral forms. Present solutions, interpretations, and implications to technical and non-technical audiences. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Formulate and solve problems in engineering involving PDEs. |
| **CLO 2** | Demonstrate an ability to apply the concepts of probability, Probability distribution and Mathematical expectation. |
| **CLO 3** | Analyse numerical data using various statistical parameters. |
| **CLO 4** | Test various assumptions on the basis of evidential support at chosen level of significance |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 4 | - | - | 4 | 20 | 20 | - | 60 | - | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Partial Differential Equations:** First-order partial differential equations, solutions of first-order linear and nonlinear PDEs, Charpit's Method, The solution to homogeneous and nonhomogeneous linear partial differential equations second and higher order by complementary function and particular integral method. Separation of variables method to simple problems in Cartesian coordinates, second-order linear equations and their classification, Initial and boundary conditions, Modeling and solution of the Heat, Wave and Laplace equations. | **40%** | **24** |
| 2 | **Probability:** Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality. Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule. | **33%** | **20** |
| 3 | **Statistics:** Basic Statistics, Measures of Central tendency: Moments, skewness and Kurtosis – Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation. Curve fitting by the method of least | **27%** | **16** |

| | | | |
|---|---|---|---|
| | squares- fitting of straight lines, second-degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, Tests for single mean, difference of means, and difference of standard deviations. Test for ratio of variances – Chi-square test for goodness of fit and independence of attributes. | | |

**i. Text Book and Reference Book:**


1. "Advanced Engineering Mathematics", E. Kreyszig, 9th Edition, John Wiley & Sons, 2006.
2. "Applied Statistics and Probability for Engineers", D. C. Montgomery and G. C. Runger, Wiley
3. "Introduction to Probability Theory", Universal Book Stall P. G. Hoel, S. C. Port and C. J. Stone, 2003 (Reprint).
4. "A First Course in Probability", S. Ross, 6th Ed., Pearson Education India, 2002.
5. "A text book of Engineering Mathematics", N.P. Bali and Manish Goyal, Laxmi Publications, Reprint, 2010.
6. "Elementary Applied Partial Differential equations with Fourier Series and Boundary Value Problem", R. Haberman, 4th Ed., Prentice Hall, 1998


**(9)**

**a. Course Name:** Professional Communication Skills

**b. Course Code:** 303193203

**c. Prerequisite:** Knowledge of English language in practical life

**d. Rationale:** Knowledge and application of English, Aptitude and Management Skills are crucial for better employability as well as professionalism.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Demonstrate the ability to communicate clearly and persuasively in oral presentations. |
| **CLOBJ 2** | Practice active listening techniques to enhance understanding in professional interactions. |
| **CLOBJ 3** | Write professional emails, memos, and reports with clarity and conciseness. |
| **CLOBJ 4** | Understand and practice professional etiquette in various business settings. |
| **CLOBJ 5** | Demonstrate skills in resolving conflicts and negotiating effectively. |
| **CLOBJ 6** | Use digital communication tools and platforms effectively. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Exhibit effective oral and written communication for diverse purposes. |
| **CLO 2** | Produce formal written texts such as reports, emails, and proposals, using appropriate tone, structure, and language conventions. |
| **CLO 3** | Apply interpersonal communication skills to collaborate effectively and enhance productivity in workplace settings. |
| **CLO 4** | Evaluate the effectiveness of time management strategies in achieving personal and academic goals under real-world conditions. |
| **CLO 5** | Use a wide range of vocabulary to communicate ideas clearly and appropriately in diverse situations. |

**g. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| **1** | **Technical Writing: Email etiquette & Email writing Letter Writing (Types of Letters & Layouts)**:<br>• Trains students on detailed email and letter writingetiquette.<br>• Students will be able to write formal letters following certain stipulated formats.<br>• They will learn different types of letters for different official purposes. | **10%** | **4** |
| **2** | **Interpersonal Communication at Workplace: Dynamics of communication**:<br>• To develop the confidence to handle a wide range of demanding situation more effectively at the workplace<br>• To enable the students to analyze their own interpersonal communication style. | **10%** | **2** |
| **3** | **Debate: The three-minute debate planner**:<br>• To enable the students to generate effective critical thinking into primary issues in the given topic.<br>• Students will be able to resolve controversies and recognize strengths and weaknesses of arguments. | **10%** | **4** |
| **4** | **Goal setting & Tracking**:<br>To enable the students to define strategies or implementation steps to attain the identified goals and make progress every day. | **10%** | **2** |
| **5** | **Time Management & Task Planning (Case –study)**:<br>• To enable the students to identify their own time wasters and adopt strategies to reduce them. | **5%** | **2** |

| | | | |
|---|---|---|---|
| | • To enable students to clarify and priorities their objective and goals by creating more planning time | | |
| **6** | **Reading Comprehension: Intermediate level**:<br>• To enable the students, develop the knowledge, skills, and strategies they must possess to become proficient and independent readers | **5%** | **2** |
| **7** | **Information design and writing for print and online media: Blog Writing**:<br>• To enable students to design information that is targeted to specific audiences in specific situation to meet defined objectives.<br>• To create blogs and share their own knowledge and experience to the world. | **5%** | **2** |
| **8** | **Advanced vocabulary Building:**<br>• The students will expand their vocabulary so as to enhance their proficiency in reading and listening to academic texts, writing, and speaking.<br>• The students will attain vocabulary to comprehend academic and social reading and listening texts.<br>• The students will develop adequate speaking skills to communicate effectively. | **10%** | **4** |
| **9** | **Picture Perception**:<br>• To prepare the students for a test for basic intelligence and IQ, generally done on the first day of SSB (Sashastra Seema Bal is one of India's Central Armed Police Forces) | **5%** | **1** |
| **10** | **Appreciation, Apology and Acknowledgement letters**:<br>• To enable the students to maintain productive business relationship through different types of letters.<br>• To enable the students to express their feelings without speaking out loud. | **10%** | **2** |
| **11** | **The Art of Negotiation**:<br>• To enable the students to reach an agreement for mutual benefits through negotiation.<br>• To enable the students to learn a process by which compromise or agreement is reached while avoiding argument and dispute. | **5%** | **2** |

**i. Text Book and Reference Book:**


1. "Understanding and Using English Grammar", Betty Azar & Stacy Hagen; Pearson Education
2. "Business Correspondence and Report Writing ", SHARMA, R. AND MOHAN, K.
3. "Communication Skills", Kumar S and Lata P; New Delhi Oxford University Press
4. "Technical Communication: Principles and Practice" Sangeetha Sharma,

**Semester 4**

**(1)**

a. **Course Name:** Metrology and Instrumentation
b. **Course Code:** 303109251
c. **Prerequisite:** Basic knowledge of Elements of Mechanical Engineering
d. **Rationale:** Metrology and Instrumentation are critical disciplines that underpin precision and quality in various industries. Mastery of these subjects ensures the accurate measurement of parameters, compliance with standards, and the development and maintenance of advanced instruments. As technology advances, the knowledge of metrology and instrumentation becomes increasingly indispensable for innovation, efficiency, and safety across diverse fields.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Explain the fundamental principles and purpose of metrology in measurement science and precision engineering. |
| **CLOBJ 2** | Apply knowledge to select appropriate linear measuring instruments for accurate measurements of diverse component dimensions. |
| **CLOBJ 3** | Demonstrate the ability to choose suitable instruments for measuring angular and taper features in a variety of components. |
| **CLOBJ 4** | Develop the skill to differentiate between various screws based on precise measurements of their dimensional characteristics. |
| **CLOBJ 5** | Apply measurement techniques to distinguish between different gears by assessing various dimensions critical to their function. |
| **CLOBJ 6** | Assess machining process effectiveness by quantifying and analysing the surface finish of produced components for improved quality control and performance optimization. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Explain fundamental measurement principles and standards to effectively design limits, fits, and gauging for quality control in manufacturing processes. |
| **CLO 2** | Describe accurate linear and angular measurements with sources of error. |
| **CLO 3** | Analyze surface finish, thread parameters and gear characteristics to ensure quality and precision in engineering applications. |
| **CLO 4** | Identify appropriate instruments and methods to measure force, torque, and pressure in various engineering applications. |
| **CLO5** | Implement appropriate measurement techniques for strain, speed, and temperature for diverse applications. |
| **CLO 6** | Describe advanced instrumentation systems for data acquisition, analysis and automated inspection. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 3 | 0 | 0 | 3 | 20 | 20 | 0 | 60 | 0 | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Fundamental of Measurement System**<br>Principal, Metrology and its types, Methods of Measurement, Measurement Terminology, Measurement Standards, Uncertainty in Measurement, Characteristics of an Instruments, Classification of an Instruments, Calibration Process, Need of Inspection and Quality Control, Quality attributes. | **12%** | **5** |
| 2 | **Linear and Angular Measurement**<br>Line standards, end standards, sources of error in measurement. Various Linear measuring instruments like Callipers, surface plates, vernier height gauge, vernier depth gauges, micrometres, slip gauges. Comparators: classification and Characteristics of comparators, uses, working principal, advantages and disadvantages of various types of comparators.<br>Angular measurements: Bevel protector, sine principle and sine bars, angle gauges, clinometers, optical instrument for angle measurements. | **20%** | **8** |
| 3 | **Limits, fits and gauges**<br>Tolerances, limits, fits and allowances, basis of system (Shaft and Hole), types of fits and their interpretation, types of gauges and gauge design. | **8%** | **4** |
| 4 | **Measurement of Surface Finish, Screw Threads & Gears Measurement of Surface Finish:**<br>Meaning of surface texture & surface roughness, terminology as per Indian standards, methods of measuring surface finish, surface roughness measurement techniques.<br>Measurement of screw threads and gears: Metrology of screw thread: screw thread terminology, errors in threads, measurements of various elements of thread. | **10%** | **6** |

| | | | |
|---|---|---|---|
| | Gear measurement: Sources of error in manufacturing gears, gear tooth terminologies, rolling tests, measurements of various gear elements. | | |
| **5** | **Measurements of Force, Torque, and Pressure**<br>**Measurement of Force:** platform balance, load cell, proving ring;<br>**Measurement of Torque:** dynamometer; Pressure Measurement Scales, Method of Pressure Measurement, Ring Balance, Inverted Bell Manometer, Dead-weight Pressure Gauge, Measurement of Vacuum, High Pressure Measurement. | **15%** | **7** |
| **6** | **Measurements of Strain, Speed, and Temperature**<br>Techniques of Measurement of Strain, Strain Gauge Material, Backing or Carrier Materials, Adhesives, Protective Coatings, Bonding of Gauges. Different techniques of Measurement of speed such as tachometer, Speedometers and Stroboscope, Different techniques of temperature measurement: Thermistor, Thermocouples, Thermometer. | **15%** | **7** |
| **7** | **Transducers, Sensors and Miscellaneous Instrumentation.**<br>Transducers-concept, classifications, measurable physical quantities Electrical transducers-types, working principles and applications, types of transducers, Sensors-classification and applications, proximity sensor, piezo electric sensor, RTD Sensor, LVDT. Coordinate measuring machines, Precision Instruments based on Laser, Automated Inspection, Machine Vision, Data Acquisition System, Data Analysis Tools, Interfacing, Digital and Analog Converter, Microcontrollers, VFD. | **20%** | **8** |

**i. Text Book and Reference Book:**


1. A textbook of metrology, By M. Mahajan
2. Engineering Metrology, By G. Thomas and G. Butter | Worth PUB
3. Engineering Metrology and Measurement, By N V Raghavendra and Krishnamurthy | Oxford University Press
4. Metrology and Measurement, By Anand Bewoor & Vinay Kulkarni | McGraw-Hill

**(2)**

a. **Course Name:** Metrology and Instrumentation Lab
b. **Course Code:** 303109252
c. **Prerequisite:** Basic knowledge of Elements of Mechanical Engineering
d. **Rationale:** The "Metrology and Instrumentation Lab" provides students with practical exposure to precision measurement techniques and advanced instruments, bridging the gap between theoretical knowledge and real-world applications. This experiential learning environment is essential for cultivating hands-on skills, ensuring that students are well-prepared to meet the demands of industries that rely on accurate measurements and instrumentation expertise.

e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Explain the fundamental principles and purpose of metrology in measurement science and precision engineering. |
| **CLOBJ 2** | Apply knowledge to select appropriate linear measuring instruments for accurate measurements of diverse component dimensions. |
| **CLOBJ 3** | Demonstrate the ability to choose suitable instruments for measuring angular and taper features in a variety of components. |
| **CLOBJ 4** | Develop the skill to differentiate between various screws based on precise measurements of their dimensional characteristics. |
| **CLOBJ 5** | Apply measurement techniques to distinguish between different gears by assessing various dimensions critical to their function. |
| **CLOBJ 6** | Assess machining process effectiveness by quantifying and analysing the surface finish of produced components for improved quality control and performance optimization. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Elaborate the core concepts of Metrology and Mechanical measurement. |
| **CLO 2** | Carry out linear & angular measurement for mechanical components. |
| **CLO 3** | Measure important dimensions of various thread forms and gears. |
| **CLO 4** | Determine the surface roughness for machined components. |
| **CLO5** | Perform calibration test for pressure & temperature measuring devices. |
| **CLO 6** | Conduct measurements of displacement & velocity for mechanical systems. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 0 | 0 | 2 | 1 | 0 | 0 | 20 | 0 | 30 | 50 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Exp. No. | Name of the Experiment |
|---|---|
| **1** | Basic understanding of measurements and metrology: concepts, application, advantage and future aspects. |
| **3** | Angular measurement |
| **4** | Temperature measurement |
| **5** | Speed measurement |
| **6** | Surface roughness measurement |
| **7** | Thread parameter measurement |
| **8** | Gear tooth measurement |
| **9** | Calibration of Pressure Gauge and Micrometre |
| **10** | Study of Stress, strain and force measurements |
| **11** | Demonstration of Profile Projector |

**(3)**

a. **Course Name:** Fluid Mechanics and Machines
b. **Course Code:** 303109253
c. **Prerequisite:** Basic knowledge of Elements of Mechanical Engineering
d. **Rationale:** The subject builds the ability of the student to analyse Fluid Properties and its flow parameters by applying different theories and principles of Fluid Mechanics and Fluid Machines.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Develop a thorough grasp of the fundamental principles, properties, and their applications in diverse engineering scenarios. |
| **CLOBJ 2** | Apply acquired knowledge to solve problems and address challenges in fluid mechanics and hydraulics within engineering contexts. |
| **CLOBJ 3** | Assess, identify, and utilize key performance parameters crucial in evaluating fluid systems and apply various measuring techniques to quantify and assess the performance of fluid systems. |
| **CLOBJ 4** | Understand & analyse the static and dynamic behaviour of fluids using foundational principles. |
| **CLOBJ 5** | Apply mathematical models to investigate fluid behaviour, solving engineering problems related to fluid mechanics, and evaluating the performance of hydraulic devices. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Identify fluid properties, viscosity, and pressure measurements in fluid statics. |
| **CLO 2** | Apply Bernoulli's equation to flow measurement devices for fluid dynamics. |
| **CLO 3** | Describe viscous fluid behaviour and energy losses in pipes. |
| **CLO 4** | Apply dimensional analysis for solving fluid dynamics problems. |
| **CLO5** | Analyze the Power and Efficiency of Impulse and Reaction turbines |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| 3 | 0 | 0 | 3 | 20 | 20 | 0 | 60 | 0 | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination.

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Fluid Properties and Fluid Statics**<br>Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Pascal's law, hydrostatic law, pressure measurements through Piezometer and U-Tube manometer. | **10%** | **6** |
| 2 | **Fluid Dynamics (Inviscid flow)**<br>Control volume- application of continuity equation and momentum equation, Incompressible flow, Euler's equation, Bernoulli's equation and its application. Flow measurements using Venturimeter, Orifice meter and Pitot tube. | **15%** | **8** |
| 3 | **Fluid Dynamics (Viscous flow)**<br>Flow of viscous fluids in a circular pipe, shear stress and pressure gradient relationship, Velocity distribution, Major and Minor energy losses in pipes, Darcy-Weisbach equation, Moody's diagram, pipes in series and parallel connection. | **15%** | **7** |
| 4 | **Dimensional Analysis**<br>Dimensional homogeneity, Rayleigh's method, Buckingham-pi theorem, Dimensionless Numbers, Geometrical, Kinematics and Dynamic Similarity. | **10%** | **3** |
| 5 | **Impact of Jet**<br>Impact of jet on fixed and moving flat and curved plates. | **10%** | **4** |
| 6 | **Turbo machinery Hydropower Plant**<br>Introduction and essential components. Impulse Turbine: Classification of a turbine, Impulse turbine, Pelton wheel, Construction working, work done, Head & efficiencies and design aspects. Reaction Turbine. Radial flow reaction turbine, Francis turbine: construction & working, work done, efficiency and design aspect, Propeller and Kaplan turbine, Draft tube, Specific speed, Unit quantities, Cavitation, Degree of reaction, Performance Characteristics, Governing of turbines. | **20%** | **9** |
| 7 | **Pumps & Hydraulic Devices**<br>Classification of Pumps, Construction and working of Centrifugal Pump and Reciprocating Pump, work done, Heads, Efficiencies, Characteristic curves, Net positive suction head, minimum starting speed of the pump, Cavitation phenomena. Hydraulic press, Hydraulic | **20%** | **8** |

| | | | |
|---|---|---|---|
| | accumulator, Hydraulic lift, Hydraulic ram, Hydraulic coupling, Hydraulic intensifier. | | |

**i. Text Book and Reference Book:**

1. Fluid Mechanics & Hydraulics Dr. R. K. Bansal; Laxmi Publications
2. Fluid Mechanics By Yunus A. Cengel, John M. Cimbala | Tata McGraw Hill.
3. Introduction to Fluid Mechanics and Fluid Machines By S. K. Som and G. Biswas | Tata McGraw Hill.
4. Fluid Mechanics and Fluid Power Engineering D.S. Kumar; S.K. Kataria & Sons
5. Engineering Fluid Mechanics By K.L. Kumar | Eurasia Publication House

**(4)**

**a. Course Name:** Fluid Mechanics and Machines Lab
**b. Course Code:** 303109254
**c. Prerequisite:** Knowledge of Engineering Physics and Engineering Chemistry
**d. Rationale:** The subject builds the ability of the student to analyse Fluid Properties and its flow parameters by applying different theories and principles of Fluid Mechanics and Fluid Machines.
**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Illustrate how variations in fluid properties influence overall system behaviour and performance. |
| **CLOBJ 2** | Analyse how design, operational variables, and fluid properties affect device efficiency and functionality. |
| **CLOBJ 3** | Apply experimental findings to evaluate the practical performance of hydraulic systems in real-world scenarios. |
| **CLOBJ 4** | Analyse and quantify the efficiencies, coefficients, and forces exerted by fluid flows on different structures and components. |
| **CLOBJ 5** | Evaluate the performance characteristics of hydraulic devices such as pumps, turbines, orifices, and other components. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Validate Bernoulli's Theorem for water flow in a tapering circular duct. |
| **CLO 2** | Compare the Coefficient Values for Orifice meter and Venturi Meter. |
| **CLO 3** | Examine flow types and Notch calibration. |
| **CLO 4** | Analyze the specific speed and efficiency of Pelton wheel and Francis Turbines. |
| **CLO 5** | Measure output power and overall efficiency of a Centrifugal Pump. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 0 | 0 | 2 | 1 | 0 | 0 | 20 | 0 | 30 | 50 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**


1. Fluid Mechanics & Hydraulics Dr.R. K. Bansal; Laxmi Publications
2. Fluid Mechanics, By Yunus A. Cengel, John M. Cimbala | Tata McGraw Hill.
3. Introduction to Fluid Mechanics and Fluid Machines, By S. K. Som and G. Biswas | Tata McGraw Hill.
4. Fluid Mechanics and Fluid Power Engineering D.S. Kumar; S.K. Kataria & Sons
5. Engineering Fluid Mechanics, By K.L. Kumar | Eurasia Publication House


**i. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| **1** | To validate Bernoulli's theorem as applied to the flow of water in a tapering circular duct. |
| **2** | To determine coefficient of discharge for venturimeter. |
| **3** | To study laminar and turbulent flow and its visualization on Reynolds apparatus. |
| **4** | To calibrate the given rectangular, triangular and trapezoidal notches. |
| **5** | To determine hydraulic coefficients of an orifice. |
| **6** | To determine the impact forces of a jet of water on the flat and hemispherical vane. |
| **7** | To determine the output power and overall efficiency of a centrifugal pump. |
| **8** | To determine the specific speed and efficiency of a Pelton wheel turbine. |
| **9** | To determine the specific speed and efficiency of a Francis turbine. |
| **10** | To study about wind tunnel experiment. |

**(5)**

a. **Course Name:** Manufacturing Technology
b. **Course Code:** 303109255
c. **Prerequisite:** Knowledge of Manufacturing Processes
d. **Rationale:** Manufacturing technology focuses on manufacturing process of conventional and non-conventional methods, gear manufacturing process and techniques used for holding and fixing of work piece during manufacturing process. This subject is helpful for getting basic knowledge of metal cutting, force analysis, tool wear, welding, jig and fixture.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Demonstrate a comprehensive understanding of fundamental metal machining processes. Interpret tool signature parameters. |
| **CLOBJ 2** | Explain the forces involved in metal cutting, significance of Merchant circle diagrams. |
| **CLOBJ 3** | Apply knowledge of metal cutting forces to optimize cutting parameters and understand the economic implications of machining processes |
| **CLOBJ 4** | Evaluate the applications and advantages of different metal forming methods |
| **CLOBJ 5** | Analyse and select the most appropriate welding process based on material compatibility, joint configuration, and application requirements. |
| **CLOBJ 6** | Demonstrate the ability to design jigs and fixtures for manufacturing processes, considering accuracy and repeatability. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Explain the mechanics of metal cutting and chip formation. |
| **CLO 2** | Gain knowledge of thread and gear manufacturing and finishing processes. |
| **CLO 3** | Design the punch, die, clearance and blank size for press tool and forming operations. |
| **CLO 4** | Discuss about principles, processes, equipment, and applications of welding, soldering, and brazing process. |
| **CLO 5** | Design jigs and fixture for drilling, boring and milling operations. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| 3 | - | 0 | 3 | 20 | 20 | - | 60 | - | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Mechanics of Metal Cutting**<br>Introduction to basic elements of machining. Classification of cutting tools, tool geometry and nomenclature, selection of tool materials, characteristics of cutting tool materials. Tool life, factors affecting tool life. Mechanics of chip formation, types of chips and conditions conducive for the formation of Built-up edge, chip breakers.<br>Orthogonal v/s Oblique cutting- Merchant circle diagram. Force and velocity relationship, shear plane angle. Energy consideration in Machining, Earnst-Merchant theory. Economics of metal machining. | **20%** | **9** |
| 2 | **Gear and Threads Manufacturing**<br>Different types of threads, manufacturing methods, and tools involved. Different types of gears, it's forming and generating methods with their special features. Gears finishing processes. Gear manufacturing machines. | **10%** | **4** |
| 3 | **Presses and Press** Work Classification of presses and Press operations. Classification of dies, cutting actions in dies, clearance, cutting forces, centre of pressure. | **10%** | **4** |
| 4 | **Introduction and mechanism of metal forming processes**<br>Plastic deformation and yield criteria, Material behaviour in metal forming processes, Role of temperature in forming processes, Classification of metal forming processes. Hot and Cold Working, Rolling, Extrusion, Wire and Tube Drawing, Cold working processes: Shearing, Drawing Squeezing, Blanking, Piercing, Deep Drawing, Bending, Coining and embossing, Metal working defects. Mechanism of bulk deformation processes (rolling, forging, wire drawing, and extrusion) and sheet metal forming processes, Applications of metal forming processes. | **25%** | **12** |
| 5 | **Metal Joining Processes**<br>Importance, classification, advantages and limitations in general, comparison between fusion & non-fusion welding processes. Principle of operation, characteristics and applications of: Diffusion welding (arc welding, resistance welding, oxy-fuel welding), ultrasonic welding, friction welding, electron beam, laser beam, plasma arc welding, explosive welding, soldering, brazing and adhesive bonding. Spot, Projection and Seam welding process. Welding defects and its remedies. Welding joints and | **25%** | **12** |

| | | | |
|---|---|---|---|
| | positions. Overview of underwater welding. | | |
| **6** | **Jigs & Fixtures**<br>Difference between jigs& fixtures. Design principles, Types of jigs & fixtures, design of jigs and fixtures for various machining operations. | **10%** | **4** |

**i. Text Book and Reference Book:**

1. "Metal Cutting Principles", by Trent McGraw Hill Publication.
2. "Tool Design, by Donaldo", Tata McGraw Hill Publication.
3. "Fundamentals of Machining and Machine Tools", by Boothroyd CRC Publications.
4. "Production Technology", by HMT-Tata Mc Graw Hill Publicatio

**(6)**

**a. Course Name:** Manufacturing Technology Lab

**b. Course Code:** 303109256

**c. Prerequisite:** Knowledge of Manufacturing Processes

**d. Rationale:** Manufacturing technology focuses on manufacturing process of conventional and non-conventional methods, gear manufacturing process and techniques used for holding and fixing of work piece during manufacturing process. This subject is helpful for getting basic knowledge of metal cutting, force analysis, tool wear, welding, jig and fixture.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Demonstrate a comprehensive understanding of fundamental metal machining processes. Interpret tool signature parameters. |
| **CLOBJ 2** | Apply the theoretical Knowledge of forces calculation in Machining and compare practical. |
| **CLOBJ 3** | Illustrate the Gear and Thread Manufacturing types with advantages and limitations. |
| **CLOBJ 4** | Apply the Welding concepts to see the coalescing of materials, flames and the characteristics. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Examine the effect of chosen parameters on the type of chip produced. |
| **CLO 2** | Determine the chip thickness ratio and shear angle during turning operation on lathe machine. |
| **CLO 3** | Measure the cutting forces on Lathe machine during turning operation. |
| **CLO 4** | Perform gas welding and arc welding. |
| **CLO 5** | Illustrate mechanism and state applications of metal forming processes. |
| **CLO 6** | Design a Jig and Fixture for given component. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 0 | - | 2 | 1 | - | - | 20 | - | 30 | 50 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**

1. "Metal Cutting Principles", by Trent McGraw Hill Publication.
2. "Tool Design, by Donaldo", Tata McGraw Hill Publication.
3. "Fundamentals of Machining and Machine Tools", by Boothroyd CRC Publications.
4. "Production Technology", by HMT-Tata Mc Graw Hill Publication.

**i. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| 1 | To understand the Effect of chosen parameters on the type of chip produced |
| 2 | Determination of chip-thickness ratio during Machining. |
| 3 | Determination of shear plane angle during machining |
| 4 | Measurement of cutting forces in turning using Lathe Tool Dynamometer and preparation of Merchant's circle |
| 5 | To study and practice of thread manufacturing. |
| 6 | Design a Jig and Fixture for given component |
| 7 | To study different types of press tool dies and exercise on strip layout and centre of pressure. |
| 8 | To measure the force required in extrusion. |
| 9 | To understand the principle and performance of gas welding and gas cutting process |
| 10 | To understand and practice of arc welding process: TIG, MIG, SMAW |

**(7)**

a. **Course Name:** Strength of Materials
b. **Course Code:** 303109257
c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12th science level
d. **Rationale:** Basic Electrical Engineering knowledge is fundamental as it provides a strong foundation for various engineering disciplines, promotes problem-solving skills, supports innovation, and opens doors to diverse career opportunities.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Understand the concept of all stresses and strains and principal stress in 2D state of stress. |
| **CLOBJ 2** | Solve problems of strain energy in different loading conditions |
| **CLOBJ 3** | Solve 2-dimension state of stress and apply theories of failures to find safety of an object. |
| **CLOBJ 4** | Understand the torsion of shaft and design the shaft in standard loading conditions |
| **CLOBJ 5** | Derive the flexure and shear stress equation and apply the same on beams. |
| **CLOBJ 6** | Derive the equations for long and short columns and apply the same to decide the safety of columns and beams deflections |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Analyze Principal stresses and strains in two-dimensional stress systems using Mohr's circle and analytical methods. |
| **CLO 2** | Calculate strain energy in elastic members under different loading conditions |
| **CLO 3** | Evaluate different failure theories for safe design limits for materials under different loading conditions |
| **CLO 4** | Determine deflections in statically determinate beams and critical loads in columns using analytical methods |
| **CLO 5** | Analyze torsional stresses and deformation in solid and hollow circular shafts under applied torque. |
| **CLO 6** | Compute shear and bending stresses in beams under various loading conditions and draw corresponding stress distribution diagrams. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| 3 | 1 | | 4 | 20 | 20 | 50 | 60 | - | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Principal Stresses**<br>Normal stress and strain, shear stress and strain, stresses on inclined sections, stress transformation, state of plane Stress, principal stress, maximum principal shear stress, Mohr strain. | **18%** | **08** |
| 2 | **Strain Energy**<br>Strain energy, strain energy stored in a body when load is applied gradually, suddenly and with impact, strain energy stored in a bar due to shear stress. | **09%** | **04** |
| 3 | **Theories of Failure**<br>Maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, total strain energy theory, shear strain energy theory, graphical representation and derivation of equation for each and their application to problems relating to two-dimensional stress systems only. | **18%** | **08** |
| 4 | **Torsion**<br>Derivation of equation of torsion, assumptions, Applications of torsion equation to solid & hollow circular shaft, torsional rigidity, power transmitted by a shaft. | **07%** | **03** |
| 5 | **Stresses in Beams**<br>Flexural Stresses, Theory of simple bending, assumptions, derivation of equation of bending, neutral axis determination, section modulus, bending stresses in symmetrical and unsymmetrical sections, composite beams (flitched beams). Shear Stresses and derivation of formula, shear stress distribution across various beam sections. | **20%** | **09** |
| 6 | **Columns**<br>Eulers Column theory with assumptions, crippling load of a column subjected to different boundary conditions (both ends hinged, both ends fixed, one end fixed with other end free, one end fixed with other end hinged), Effective length of a column. | **13%** | **06** |
| 7 | **Deflection of Beams**<br>Equation of elastic curve, double integration method, Macaulay's method, Slope and deflection for standard loading cases (simply supported beam carrying central point load, eccentric point load, uniformly distributed load; cantilever subjected to point load at free end, uniformly distributed load). | **15%** | **07** |

**i. Text Book and Reference Book:**

1. Mechanics of Materials by R. C. Hibbeler | Pearson Education | 9th, Pub. Year 2018
2. Mechanics of Solids by B.C. Punamia | Laxmi publications Private limited.
3. Strength of Materials by By S. Ramamrutham | Dhanpat Rai Publishing Company (P) Limited.
4. Mechanics of Materials by Timoshenko and Gere | Van Nostrand Reinhold Co.
5. Engineering Solid Mechanics by By L.S Srinath | Tata McGraw Hill

**j. Experiment List:**

| Sr. NO. | Experiment List |
|---|---|
| 1 | Fundaments of SF, BM, CG and M.I. |
| 2 | Problems on principal stress and principal strain using analytical and graphical method (Mohr's circle). |
| 3 | Problems on torsion of shaft. |
| 4 | Problems on stresses in beams and distribution diagrams. |
| 5 | Problems on strain energy and impact load. |
| 6 | Problems on deflection of beam. |
| 7 | Problems on theories of failure and their applications. |
| 8 | Exercise on columns subjected to different boundary conditions |
| 9 | Study of Universal Testing Machine |
| 10 | Study of Torsion Testing Machine |

**(8)**

**a. Course Name:** Dynamics of Machines
**b. Course Code:** 303109259
**c. Prerequisite:** Basic knowledge of Mechanism and Machines, Differential equations, complex number and modelling of system.
**d. Rationale:** Dynamics of Machine subjects are integral to engineering education, offering insights into the forces and motions that influence mechanical systems. This knowledge is crucial for designing efficient and safe machines, predicting and preventing failures, and fostering advancements in automation and robotics. Mastery of machine dynamics equips engineers with essential skills for addressing real-world challenges in various industries.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Develop the ability to analyse unbalanced forces in rotating and reciprocating mass systems, allowing for a comprehensive understanding of the impact on machine components and overall system behaviour. |

| | |
|---|---|
| **CLOBJ 2** | Acquire practical skills to implement a variety of methods for balancing rotating and reciprocating masses, with a focus on solving real-world engineering problems. |
| **CLOBJ 3** | Gain a thorough understanding of the dynamic characteristics of mechanical devices, enabling the assessment of system stability, response to external forces, and overall performance under different operating conditions |
| **CLOBJ 4** | Develop the capability to formulate mathematical models for diverse vibratory systems, providing a theoretical foundation for predicting and analysing the behaviour of mechanical systems subjected to dynamic forces. |
| **CLOBJ 5** | Familiarize oneself with different vibration and frequency measuring instruments, understanding their functionalities and applications |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Investigate unbalanced forces in rotating and reciprocating mass system |
| **CLO 2** | Implement various methods of balancing of rotating and reciprocating masses to real world problem. |
| **CLO 3** | Identify the vibrating characteristics of mechanical devices. |
| **CLO 4** | Analyse the mathematical model of single and multidegree of freedom system. |
| **CLO 5** | Relate the mode shapes of multidegree of freedom system. |
| **CLO 6** | Explain the various type of frequency measuring instruments. |

**g. Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **-** | **0** | **3** | **20** | **20** | **-** | **60** | **-** | **100** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| **Sr. No.** | **Content** | **Weightage** | **Teaching Hours** |
|---|---|---|---|
| **1** | **Balancing of Rotating Masses**<br>Concept of static and dynamic balancing, Analysis of effect of unbalanced masses in single and multiple planes in rotating elements. | **16%** | **7** |

| | | | |
|---|---|---|---|
| **2** | **Balancing of Reciprocating Parts**<br>Introduction, Partial balancing of single cylinder engine, Effects of unbalanced forces in reciprocating locomotive (Swaying Couple, Variation in tractive forces, hammer blow), Balancing of primary and secondary forces in multi-cylinder in line engines, Radial engine, V-Engine. | **24%** | **12** |
| **3** | **Introduction to Mechanical Vibrations**<br>Simple harmonic motion, concept of natural frequency, resonance, types of vibrations, Basic elements of vibration, Concept of degrees of freedom (DOF), equivalent stiffness of spring combinations, Various Methods to find natural vibration for single degree of freedom (Equilibrium method, Energy Method, Rayleigh's method.) | **15%** | **6** |
| **4** | **Single Degrees of Freedom System**<br>Undamped free vibrations, equivalent systems, determination of natural frequency, damping coefficient, damping factor, damping effects: under, over and critically damped system, damped natural frequency and logarithmic decrement. Analytical solution of Forced vibrations with harmonic excitation system and vector representation, Magnification Factor, Response of rotating unbalance system, Transmissibility, Concept of vibration isolation. | **25%** | **12** |
| **5** | **Transverse Vibration & Torsional Vibrations**<br>Transverse vibrations of beams, whirling of shaft with a single disc with and without damping, Rayleigh method to find frequency of shaft under transverse point loads. Torsional vibrations, torsionally equivalent system, stepped shafts, two rotors. | **15%** | **6** |
| **6** | **Vibration & Frequency Measuring Instruments**<br>Vibrometer, Accelerometer, Fullerton tachometer, Frahm tachometer, Introduction of FFT analyser. | **5%** | **2** |

**i. Text Book and Reference Book:**


1. "Theory of Machine", S. S. Rattan, Tata McGraw Hill, New Delhi.
2. "Theory of Machine ", P.L. Ballaney, Khanna Publishers, New Delhi
3. "Mechanical Vibration", G K Groover, Nem chand Publisher.

**(9)**

a. **Course Name:** Dynamics of Machine Lab
b. **Course Code:** 303109260
c. **Prerequisite:** Fundamental understanding of Mechanisms and Machines, proficiency in Differential Equations, adeptness with Complex Numbers, and capability in System Modelling.
d. **Rationale:** In the Dynamics of Machine lab, experiments serve as invaluable hands-on experiences, allowing engineers to apply theoretical knowledge to real-world scenarios. These experiments not only deepen understanding of forces and motions in mechanical systems but also provide practical skills essential for innovation in automation, robotics, and machine design.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Apply principles of mass balancing to rotating and reciprocating masses. |
| **CLOBJ 2** | Conduct thorough static and dynamic force analyses, mastering the equilibrium of forces in mechanical systems. |
| **CLOBJ 3** | Explore and experiment with a variety of vibratory systems, gaining practical insights into their behaviour and characteristics. |
| **CLOBJ 4** | Analyse and comprehend the dynamics of different vibration types, fostering a comprehensive understanding of mechanical vibrations and their applications. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Conduct static and dynamic force analysis on mechanical system consist of rotating and reciprocating masses. |
| **CLO 2** | Verify the natural frequency of single and multi-degree of freedom system. |
| **CLO 3** | Calculate the design parameters of damped free vibration. |
| **CLO 4** | Interpret the frequency response curve of forced damped vibratory system. |
| **CLO 5** | Differentiate the mode shapes of multi degree of freedom system. |
| **CLO 6** | Demonstrate various type of frequency measuring instruments. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **0** | **-** | **2** | **1** | **-** | **-** | **20** | **-** | **30** | **50** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**

1. "Theory of Machine", S. S. Rattan, Tata McGraw Hill, New Delhi.
2. "Theory of Machine ", P.L. Ballaney, Khanna Publishers, New Delhi
3. "Mechanical Vibration", G K Groover, Nem chand Publisher
4. "Theory of Machines and Mechanisms", J.E. Shigley and J.J. Uicker, McGraw-Hill, 1995.

**i. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| **1** | Study of static balancing of rotating mass system. |
| **2** | Performance to calculate frequency and time period of pendulum system. |
| **3** | Performance to calculate frequency and time period of longitudinal vibration of spring. |
| **4** | Equivalent spring mass system |
| **5** | Performance to calculate time period of single rotor system. |
| **6** | Performance to calculate time period of two rotor system |
| **7** | Performance on free damped vibration of torsional system. |
| **8** | Performance to study lateral vibration of beam system. |
| **9** | Demonstration of whirling speed of shaft |
| **10** | To study the reciprocating balancing in case of multi cylinder inline engine. |

**(10)**

**a. Course Name:** Professional Grooming & Personality Development
**b. Course Code:** 303193252
**c. Prerequisite:** Knowledge of English language in practical life
**d. Rationale:** Knowledge and application of English, Aptitude and Management Skills are crucial for better employability as well as professionalism

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Write professional emails, memos, and reports with clarity and conciseness. |
| **CLOBJ 2** | Understand and practice professional etiquette in various business settings. |
| **CLOBJ 3** | Demonstrate skills in resolving conflicts and negotiating effectively. |
| **CLOBJ 4** | Use digital communication tools and platforms effectively. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Cultivate essential soft skills for personal effectiveness and professional growth in both academic and workplace settings. |
| **CLO 2** | Practice professional etiquette and collaborative behavior in organizational environments. |
| **CLO 3** | Participate effectively in oral organizational communication through clear speaking, active listening, and appropriate interaction in group settings. |
| **CLO 4** | Analyze texts using appropriate reading comprehension strategies. |
| **CLO 5** | Develop assertive and professional ideas for effective communication in academic and workplace environments. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Internal Evaluation | | | ESE | | Total |
| L | T | P | C | MSE | CE | P | Theory | P | |
| 0 | 2 | 0 | 2 | - | - | - | - | - | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Self-Development and Assessment**: Various self-assessments for personal and professional development skills that are relevant to career development:<br>Change, Grow, Persist, Prioritize, Read, Learn, Listen, Record, Remember, Guess, Think, Communicate, Relate, and Dream | 25% | 4 |
| 2 | **Corporate Etiquette**:<br>Tips and guide to develop personality and gain various etiquettes manners, case studies and activities.<br>• Telephone etiquette<br>• Etiquette for foreign business trips<br>• Etiquette for small talks<br>• Respecting privacy<br>• Learning to say 'No' | 25% | 4 |
| 3 | **Public Speaking**:<br>It's process of communicating information to an audience and is helpful in career advancement. Effective Public speaking skills includes:<br>• Choosing appropriate pattern<br>• Selecting appropriate method<br>• Art of persuasion | 20% | 4 |

| | | | |
|---|---|---|---|
| | • Making speeches effective<br>• Delivering different types of speeches | | |
| **4** | **Reading Skills Activity & Reading Comprehension**: Aims to improve students' Comprehensive Skills in English Language by getting them involved in reading activity and providing practice for reading comprehension. | **15%** | **2** |
| **5** | **Listening Skills- Inquiry Based Listening Questions**: Aims to improve students' listening skills in English Language providing them practice of various types of inquiry based listening tracks. Students will listen and will be able to find out details from the conversations. | **15%** | **1** |

**a. Text Book and Reference Book:**


1. "Understanding and Using English Grammar", Betty Azar & Stacy Hagen; Pearson Education
2. "Business Correspondence and Report Writing ", SHARMA, R. AND MOHAN, K.
3. "Communication Skills", Kumar S and Lata P; New Delhi Oxford University Press
4. "Technical Communication: Principles and Practice" Sangeetha Sharma, Meenakshi Raman; Oxford University Press
5. "On Writing Well", William Zinsser; Harper Paperbacks,2006; 30th anniversary edition.

**Semester 5**

**(1)**

a. **Course Name: Heat Transfer**
b. **Course Code:** 303109301
c. **Prerequisite:** Basic knowledge of Thermodynamics & Elements of Mechanical Engineering.
d. **Rationale:** Heat transfer is the exchange of thermal energy between the physical systems, depending on the temperature and pressure, by dissipating heat. It allows the designer to basically know the rate of heat transfer as well as size, flow rates required to get desired flow heat transfer, in short it helps the designer to design a Heat exchange device used in various fields of engineering.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Understanding Fundamental Principles & concepts of heat transfer, including the three modes of heat transfer (conduction, convection, radiation) and their underlying principles. |
| **CLOBJ 2** | Develop the ability to analyse heat transfer problems analytically using mathematical equations, applying principles such as Fourier's Law, Newton's Law of Cooling, and Stefan-Boltzmann Law. |
| **CLOBJ 3** | Apply mathematical methods, such as differential equations and integrals, to solve heat transfer problems in various scenarios, including steady-state and transient conditions. |
| **CLOBJ 4** | Differentiate and evaluate the dominant mode of heat transfer in different situations, understanding when conduction, convection, or radiation plays a significant role. |
| **CLOBJ 5** | Apply heat transfer principles to engineering problems, including designing heat exchangers, thermal insulation systems, HVAC systems, and other practical applications in industry and technology. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Explain conduction, convection and radiation modes of heat transfer. |
| **CLO 2** | Solve conduction heat transfer problem under steady and transient conditions. |
| **CLO 3** | Calculate effectiveness and efficiency of fins. |
| **CLO 4** | Analyze convection heat transfer in internal and external flow applications. |
| **CLO 5** | Determine radiation heat transfer between surfaces using Radiation properties and laws. |
| **CLO 6** | Calculate effectiveness of heat exchanger using LMTD & NTU method. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **0** | **0** | **3** | **20** | **20** | **-** | **60** | **-** | **100** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Topic | Weightage | Teaching Hrs. |
|---|---|---|---|
| **1** | **Introduction:** Heat, modes of heat transfer and their applications, Thermal conductivity, effect of temperature on thermal conductivity of different solids, liquids and gases, General laws of heat transfer, Difference between Heat Transfer and Thermodynamics, Combined modes of heat transfer. | **7%** | **4** |
| **2** | **Conduction:** Thermal diffusivity, Derivation of heat balance equation- Steady one-dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, composite wall, electrical analogy of heat transfer & thermal Resistance, Critical thickness of radius/insulation for cylinder and sphere, Overall heat transfer coefficient. | **15%** | **9** |
| **3** | **Extended Surface:** Types of fins, heat flow through rectangular fin, infinitely long fin, Fin insulated at the tip and fin losing heat at the tip, efficiency and effectiveness of fin. | **10%** | **3** |
| **4** | **Transient /Unsteady State Heat Conduction:** Transient /Unsteady State Heat Conduction, Lumped System Analysis, Criteria for lumped system analysis, Biot number & Fourier Number, two-dimensional conduction solutions for both steady and unsteady heat transfer approximate solution to unsteady conduction heat transfer by the use of Heissler charts. | **10%** | **4** |
| **5** | **Convection & Two-phase Heat Transfer:** Heat convection, basic equations: Newton's law of cooling, Dimensional analysis applied to forced and free convection, dimensionless numbers and their physical significance, empirical correlations for free convection and applications. Empirical correlations for forced convection and applications. Continuity, momentum and energy equations, thermal and hydrodynamic boundary layer, Von-Karman integral momentum equation, Flow over plates, Flow across cylinders and spheres, Flow in tubes. Boiling regimes and boiling curve of water, Condensation heat transfer, PCM Materials for heat transfer. | **20%** | **12** |

| | | | |
|---|---|---|---|
| **6** | **Thermal Radiation:** Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the Radiosity method, radiation shield. | **18%** | **6** |
| **7** | **Heat Exchangers:** Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and Effectiveness & minus; NTU methods, Concept of heat pipe, TEMA Standards. | **20%** | **7** |

**i. Text Book and Reference Book:**


1. Heat & Mass Transfer P.K. Nag, Tata McGraw Hill New Delhi.
2. Heat & Mass Transfer –A Practical Approach Yunus A Cengel, Tata McGraw Hill.
3. Basics of Heat and Mass transfer Dr. D. S. Kumar; S. K. Kataria and Sons Publishers.
4. Heat & Mass Transfer R.K. Rajput, S. Chand & Co. New Delhi.


**(2)**

**a. Course Name:** Heat Transfer Lab

**b. Course Code:** 303109302

**c. Prerequisite:** Knowledge of Basic Thermodynamics

**d. Rationale:** Heat transfer is the exchange of thermal energy between physical systems, depending on the temperature and pressure, by dissipating heat. It allows the designer to basically know the rate of heat transfer and size, flow rates required to get desired flow heat transfer, in short it helps designer to design a Heat exchange device used in various fields of engineering.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Understanding Fundamental Principles & concepts of heat transfer, including the three modes of heat transfer (conduction, convection, radiation) and their underlying principles. |
| **CLOBJ 2** | Develop the ability to analyse heat transfer problems analytically using mathematical equations, applying principles such as Fourier's Law, Newton's Law of Cooling, and Stefan-Boltzmann Law. |
| **CLOBJ 3** | Apply mathematical methods, such as differential equations and integrals, to solve heat transfer problems in various scenarios, including steady-state and transient conditions. |
| **CLOBJ 4** | Differentiate and evaluate the dominant mode of heat transfer in different situations, understanding when conduction, convection, or radiation plays a significant role. |
| **CLOBJ 5** | Apply heat transfer principles to engineering problems, including designing heat exchangers, thermal insulation systems, HVAC systems, and other practical applications in industry and technology. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Analyse thermal conductivity of material based on various Geometrical Configurations |
| **CLO 2** | Evaluate convective heat transfer coeffcient using Empirical corelations. |
| **CLO 3** | Determine emissivity of test plate using Radiation laws. |
| **CLO 4** | Analyse performance of heat exchangers based on LMTD and NTU effectiveness method. |

**g. Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **0** | **-** | **2** | **1** | **-** | **-** | **20** | **-** | **30** | **50** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**

1. Heat & Mass Transfer P.K. Nag, Tata McGraw Hill New Delhi.
2. Heat & Mass Transfer –A Practical Approach Yunus A Cengel, Tata McGraw Hill.
3. Basics of Heat and Mass transfer Dr. D. S. Kumar; S. K. Kataria and Sons Publishers.
4. Heat & Mass Transfer R.K. Rajput, S. Chand & Co. New Delhi.

**i. Experiment List:**

| **Exp. No.** | **Name of the Experiment** |
|---|---|
| **1** | Introduction to heat transfer. |
| **2** | To determine the Thermal conductivity of composite wall |
| **3** | To determine the thermal conductivity of lagged pipe. |
| **4** | To determine the thermal conductivity of metal rod. |
| **5** | To determine the thermal conductivity of given insulating powder |
| **6** | To determine surface heat, transfer co-efficient by natural convection. |
| **7** | To determine the heat transfer coefficient of air by forced convection. |
| **8** | To find the emissivity of a given test plate with respect to the black plate. |
| **9** | To determine film Heat Transfer co-efficient in unsteady state Heat transfer. |
| **10** | To determine effectiveness of plate type heat exchanger |

**(3)**

a. **Course Name:** Automation and Control
b. **Course Code:** 303109303
c. **Prerequisite:** Knowledge of Measurement Systems and Metrology
d. **Rationale:** The main objective of this course is to introduce students to the concepts of automation and control in mechanical engineering, and to enable them to design, analyze, and implement automation and control systems.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Articulate the key concepts of automation and control systems, emphasizing their importance in industrial applications and their role in enhancing efficiency and control. |
| **CLOBJ 2** | Demonstrate proficiency in using measurement systems to quantify and analyze a range of process parameters, including temperature, pressure, displacement, speed, flow, level, humidity, and pH in diverse industrial processes. |
| **CLOBJ 3** | Apply mathematical modelling techniques, including Laplace Transformations and Transfer Functions. |
| **CLOBJ 4** | Gain proficiency in comprehending and interpreting Programmable Logic Controller (PLC) programs, specifically focusing on understanding and analysing ladder logic diagrams commonly used in industrial automation. |
| **CLOBJ 5** | Analyse and evaluate the components and functionality of drive systems in Computer Numerically Controlled (CNC) machines and electric systems. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Classify control systems and elements of automation using block diagrams for industrial automation systems. |
| **CLO 2** | Evaluate measurement systems based on specifications and principles for process variables. |
| **CLO 3** | Derive mathematical models of mechanical and electrical systems using Laplace transforms. |
| **CLO 4** | Design PID-based process control systems and special control structures for desired control performance. |
| **CLO 5** | Describe logic control and sequence using structured RLL. |
| **CLO 6** | Select appropriate CNC machine components and electrical drives in automation systems. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **0** | **0** | **4** | **20** | **20** | **-** | **60** | **-** | **100** |

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| **1** | **Introduction to automation and control systems**<br>Definition and importance of automation and control systems, Block Diagram and its elements, Classification of control systems, Architecture of industrial automation systems. | **10%** | **05** |
| **2** | **Measurement Systems:**<br>Measurement Systems Specifications, Temperature Measurement, Pressure and Force Measurement, Displacement and Speed Measurement, Flow Measurement, Measurement of Level, Humidity and PH. | **20%** | **10** |
| **3** | **Mathematical Modelling of Physical Systems:**<br>Elements of Mechanical and Electrical Systems and their mathematical modelling, Analogous Systems, Laplace Transformations and Transfer Function. | **10%** | **05** |
| **4** | **Process Control:**<br>Introduction to Process Control, P-I-D Control, Controller Tuning, Implementation of P-I-D Controllers, Special Control Structures: Feedforward and Ratio Control, Cascade Control. | **15%** | **06** |
| **5** | **Programmable Logic Control Systems:**<br>Introduction to Sequence/Logic Control and Programmable Logic Controllers, The Software Environment and Programming of PLCs, Formal Modelling of Sequence Control Specifications and Structured RLL Programming, The PLC Hardware Environment. | **20%** | **08** |
| **6** | **CNC Machines and Actuators:**<br>Introduction to Computer Numerically Controlled (CNC) Machines, CNC Machines: Interpolation, Control and Drive. | **10%** | **05** |
| **7** | **Electrical Drives:**<br>Step Motors: Principles, Construction and Drives, DC Motor Drives, Induction Motor Drives, BLDC Motor Drives. | **15%** | **06** |

**i. Text Book and Reference Book:**


1. Mechanical and industrial measurements, Process Instrumentation and Control by Er. R.K. Jain, Khanna Publication
2. Mechanical Measurements and Instrumentation, A. K. Sawhney, Dhanpat Rai Publication
3. Instrumentation, measurement & analysis, B.C. Nakra & K.K. Choudhary, Tata

**(4)**

a. **Course Name:** Automation and Control Lab
b. **Course Code:** 303109304
c. **Prerequisite:** Knowledge of Measurement Systems and Metrology
d. **Rationale:** The main objective of this course is to introduce students to the concepts of automation and control in mechanical engineering, and to enable them to design, analyze, and implement automation and control systems.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Define fundamental concepts of automation and control, emphasizing practical applications and demonstrations to enhance understanding. |
| **CLOBJ 2** | Develop the capability to choose and effectively utilize measurement systems, showcasing proficiency in analysing and measuring diverse process parameters within real-world contexts. |
| **CLOBJ 3** | Apply mathematical modeling techniques to represent physical systems, specifically focusing on the design and implementation of feedback control systems. |
| **CLOBJ 4** | Apply foundational knowledge in PLC programming, demonstrating proficiency in creating ladder logic diagrams. |
| **CLOBJ 5** | Apply theoretical knowledge to identify, analyze, and comprehend the components and operations of drive systems in CNC machines and electric systems. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Examine open-loop and closed-loop systems using block diagrams. |
| **CLO 2** | Develop ladder logic diagrams for basic sequence control applications. |
| **CLO 3** | Design PID controllers for effective process control. |
| **CLO 4** | Simulate feedback control systems using MATLAB/Simulink. |
| **CLO 5** | Evaluate temperature, displacement, speed, and fluid level using appropriate sensors. |
| **CLO 6** | Demonstrate stepper and DC motor working using microcontrollers for automation. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| 0 | - | 2 | 1 | - | - | 20 | - | 30 | 50 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**

1. Mechanical and industrial measurements, Process Instrumentation and Control by Er. R.K. Jain, Khanna Publication
2. Mechanical Measurements and Instrumentation, A. K. Sawhney, Dhanpat Rai Publication
3. Instrumentation, measurement & analysis, B.C. Nakra & K.K. Choudhary, Tata McGraw Hill.
4. Linear Control Systems with MATLAB Applications by B.S. Manke, Khanna Publication
5. Control System, Gopal M., Tata McGraw Hill.
6. Control System engineering, by U.A. Patel, Mahajan Publication.

**i. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| **1** | Introduction to block diagrams and their elements. |
| **2** | Analysis of open-loop and closed-loop control systems. |
| **3** | Introduction to PLC programming and ladder logic diagrams. |
| **4** | Design and implementation of P-I-D controllers. |
| **5** | Analysis and design of feedback control systems using MATLAB/Simulink. |
| **6** | Introduction to CNC machines and their control systems. |
| **7** | Measurement of temperature using thermocouples and RTDs. |
| **8** | Measurement of displacement and speed using LVDTs and tachometers. |
| **9** | Measurement of level using float switches and ultrasonic sensors. |
| **10** | Control of stepper motor and DC motor using microcontroller. |

**(5)**

**a. Course Name:** Applied Thermodynamics

**b. Course Code:** 303109305

**c. Prerequisite:** Inclination to learn Thermodynamics

**d. Rationale:** The course focuses on the study of thermodynamic cycles related to energy conversion, steam turbines, compressible flow and nozzles, air compressors, jet propulsion, refrigerants, psychrometry, and wind tunnel is crucial in the field of engineering. It equips students with knowledge and skills required to design, operate, and optimize a wide range of engineering systems that are critical in energy generation, propulsion, and air conditioning systems.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Gain a comprehensive understanding of the principles, properties, and classifications of gas turbines, steam turbines, air compressors, and wind tunnels to facilitate the analysis and categorization of these systems in engineering applications |
| **CLOBJ 2** | Evaluate and analyze the thermodynamic performance and efficiency of Brayton cycle, Rankine cycle, compressors, and steam turbines to assess their effectiveness in energy conversion processes. |

| | |
|---|---|
| **CLOBJ 3** | Demonstrate comprehension of power-generating and consuming devices, as well as the functioning of nozzles and jet engines in the context of energy conversion systems. |
| **CLOBJ 4** | Apply acquired knowledge of performance parameters, psychrometry, refrigerants, wind tunnels, and rotary air compressors to effectively address and solve engineering tasks and challenges. |
| **CLOBJ 5** | Explore and engage in discussions regarding the latest innovations in combined cycle technology, multistage compressors, supersonic wind tunnels, and jet engines to remain current with emerging advancements in these fields. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Apply the knowledge of gas power cycle and vapour power cycles for thermal analysis. |
| **CLO 2** | Analyze the behaviour of compressible flows in nozzles. |
| **CLO 3** | Describe the working principle and operation of compressors and steam turbines. |
| **CLO 4** | Compare the performance of prime movers for different thermal systems. |
| **CLO 5** | Recognize the concepts of Refrigeration, Psychrometry, Fuels and Combustion for thermodynamic analysis. |

**g. Teaching & Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **-** | **0** | **3** | **20** | **20** | **-** | **60** | **-** | **100** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| **Sr. No.** | **Content** | **Weightage** | **Teaching Hours** |
|---|---|---|---|
| **1** | **Gas power cycles:** Air standard Brayton cycle, open and closed cycle, actual Brayton cycle, effect of reheat, regeneration and intercooling, reheat and regeneration, reheat and intercooling, optimum pressure ratio for maximum thermal efficiency, work ratio, effect of operating variables on the thermal efficiency and work ratio, irreversibility and losses, compressor and turbine efficiency, An overview of Stirling, Erricson, Atkinson and Lenoir cycle (only p-v and T-s diagram). | **15%** | **7** |

| | | | |
|---|---|---|---|
| **2** | **Vapor power cycles:** Limitations of Carnot vapour power cycle, Rankine cycle; p-v, T-s and h-s diagrams, performance parameters; Thermal efficiency, Heat rate, Back work ratio, Work ratio, Specific steam consumption, parametric analysis for performance improvement in Rankine Cycle, mean temperature of heat addition, reheat Rankine cycle, ideal regenerative cycle, practical regenerative cycle, reheat-regenerative cycle, feed water heaters | **20%** | **9** |
| **3** | **Steam Turbine:**<br>Principle of operation, types of steam turbines Impulse turbine: De-Laval turbine, compounding of steam turbines: Pressure compounded impulse turbine (Reateu Stage), Velocity compounded impulse turbine (Curtis Turbine), Pressure-velocity compounded impulse turbine, velocity diagram and calculations for impulse turbines, condition for maximum efficiency, Reaction turbines: degree of reaction, Parson's reaction turbine (50% reaction turbine), governing of steam turbine – throttle, nozzle and bypass governing, Losses in steam turbine | **20%** | **9** |
| **4** | **Compressible flow and Nozzles:**<br>Introduction, nozzle and diffuser, velocity of sound, Mach number, subsonic and supersonic flows, isentropic stagnation state and stagnation properties, one dimensional steady isentropic flow in nozzle, area velocity relationship, critical properties-choking in isentropic flow, Effect of back pressure on the performance of nozzle<br>Flow.<br>Shock waves and expansion waves: Development of a shock waves, governing equation- Fanno line & Rayleigh line; Prandtl-Meyer relation properties across normal shock- Mach number, static pressure, temperature and density normal shock flow.<br>Wind tunnel and its classification | **20%** | **9** |
| **5** | **Air Compressors:** Classification of air compressors Reciprocating Compressors: Working of reciprocating compressor with and without clearance -equation of work, isothermal efficiency, volumetric efficiency, Effect of Pressure Ratio on Volumetric Efficiency. Actual Indicator diagram, Free air delivery, Multistage reciprocating air compressors, Ideal Intermediate Pressure for minimum work. Rotary compressor: Introduction, types of rotary compressor; Roots blower, Screw (Lysholm) type, Vane type compressor | **15%** | **7** |
| **6** | **Jet propulsion:** Introduction, early aircraft engines, types of aircraft engines, Jet engine performance | **10%** | **4** |

| | | | |
|---|---|---|---|
| | parameters; Thrust, Specific fuel consumption (SFC), Efficiencies. Ramjet engine **Refrigerants and Psychrometry:** Refrigerants and its properties, Properties of atmospheric air, psychrometric chart, psychrometric processes. | | |

**i. Text Book and Reference Book:**

1. "Applied Thermodynamics " by Onkar Singh.
2. "Basic and Applied Thermodynamics" by Nag, P.K.
3. "Thermodynamics: An Engineering Approach" by Michael A. Boles and Yunus A Çengel.
4. "Turbines, Compressors and Fans " by Yahya S. M.
5. “Gas Turbines”, by Ganehsan V.

**(6)**

**a. Course Name:** Applied Thermodynamics lab

**b. Course Code:** 303109306

**c. Prerequisite:** Inclination to learn Thermodynamics

**d. Rationale:** The course focuses on the study of thermodynamic cycles related to energy conversion, steam turbines, compressible flow and nozzles, air compressors, jet propulsion, refrigerants, psychrometry, and wind tunnel is crucial in the field of engineering. It equips students with knowledge and skills required to design, operate, and optimize a wide range of engineering systems that are critical in energy generation, propulsion, and air conditioning systems. Understanding these systems is essential to improve their performance, efficiency, and reliability in meeting the growing energy demands of the world.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Develop a thorough understanding of the principles, properties, and classifications of gas turbines, steam turbines, air compressors, and wind tunnels for effective analysis in engineering applications. |
| **CLOBJ 2** | Analyze the efficiency of Brayton and Rankine cycles, compressors, and steam turbines in energy conversion. |
| **CLOBJ 3** | Demonstrate understanding of power devices, nozzles, and jet engines in energy conversion systems. |
| **CLOBJ 4** | Apply knowledge to address engineering challenges using parameters, psychrometry, refrigerants, wind tunnels, and rotary compressors. |
| **CLOBJ 5** | Stay current with innovations in combined cycles, multistage compressors, supersonic wind tunnels, and jet engines through exploration and discussion. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Determine the critical pressure ratio and the choking effect for convergent and divergent nozzles. |
| **CLO 2** | Calculate the efficiency of two stage reciprocating air compressor. |

| | |
|---|---|
| **CLO 3** | Demonstrate the operation of IC Engine, Refrigeration System and Wind tunnel. |
| **CLO 4** | Determine the properties of steam and fuel. |
| **CLO 5** | Use psychometric charts to get the air conditioning properties. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 0 | - | 2 | 1 | - | - | 20 | - | 30 | 50 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**


1. "Applied Thermodynamics " by Onkar Singh.
2. "Basic and Applied Thermodynamics" by Nag, P.K.
3. "Thermodynamics: An Engineering Approach" by Michael A. Boles and Yunus A Çengel.
4. "Turbines, Compressors and Fans " by Yahya S. M..
5. “Gas Turbines”, by Ganehsan V.


**i. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| **1** | To Study the Gas Turbine. |
| **2** | Study of Vapor Power System. |
| **3** | Study of the Steam Turbines. |
| **4** | To study the performance of the nozzle, and show its characteristic for fluid pressure difference. |
| **5** | Study of two stage reciprocating air compressor. |
| **6** | To determine the dryness fraction of steam. |
| **7** | To determine the relative humidity of atmospheric air. |
| **8** | Demonstration of subsonic wind tunnel. |
| **9** | To calculate the pressure distribution and pressure coefficient over circular cylinder. |
| **10** | To study the functioning and operation of Ramjet combustion system. |

**(7)**

a. **Course Name:** Industrial Engineering and Project Management
b. **Course Code:** 303109307
c. **Prerequisite:** Basic knowledge of mathematics, Production systems and its peripherals
d. **Rationale:** Industrial Engineering and Project Management provides well-rounded skill set those bridges technical expertise with managerial acumen. This course offers knowledge about tools and techniques for solving various issues related to production even to deal with new project too.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Understand the plant layout, productivity factors, work study methodologies, and the importance of ergonomics, enabling students to contribute to organizational efficiency. |
| **CLOBJ 2** | Understand the Production Planning and Control, including production systems, forecasting methods, job sequencing, and process planning components, enabling students to contribute to efficient and effective manufacturing operations. |
| **CLOBJ 3** | Understand the assembly line balancing methods, production management concepts including MRP and BOM, and the practical applications of break-even analysis in decision-making, enabling students to contribute to efficient and cost-effective production processes within organizational settings. |
| **CLOBJ 4** | Students should have a comprehensive understanding of project management fundamentals, the use of MS Project as a tool, and network analysis methods. |
| **CLOBJ 5** | Apply the network analysis methods to plan, execute, and control projects effectively in diverse professional settings. |
| **CLOBJ 6** | Students should have a solid understanding of the foundational concepts of logistics and supply chain management, the interconnectedness of different supply chain components, and the challenges and strategies associated with managing global supply chains. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Discuss the fundamentals of plant location, plant layout and material handling equipments. |
| **CLO 2** | Apply method study and work measurement techniques for better productivity. |
| **CLO 3** | Illustrate planning, scheduling and sequencing operations for shop floor. |
| **CLO 4** | Calculate network analysis problems by PERT and CPM. |
| **CLO 5** | Explain the concept of Supply Chain Management. |

| | |
|---|---|
| **CLO 6** | Explain Industrial Legislation. |

### g. Teaching & Examination Scheme:

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 2 | 1 | | 3 | 20 | 20 | 50 | 60 | - | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

### h. Course Content:

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Industrial Engineering**<br>Meaning and Scope of Industrial Engineering in Indian Industries. Role of Industrial Engineer in Industry 4.0 | 5% | 01 |
| 2 | **Site selection and Facility Planning**<br>Facility location selection criteria, Types of plant layout, Computerized plant layout optimization techniques, Material Handling Equipment. | 10% | 02 |
| 2 | **Productivity and Work Study**<br>**Productivity:** Factors affecting productivity, measurement of productivity, Causes of low productivity, methods of increasing productivity.<br>**Work Study:** Purpose, scope and developments, Effect of work study on Productivity, Method Study, Work Measurement<br>**Ergonomics:** Importance on ergonomics, Normal and maximum working area, Domains of Ergonomics | 25% | 08 |
| 3 | **Production Planning and Control**<br>Introduction to P.P.C., functions and objectives of P.P.C, Types of production systems and their characteristics.<br>**Forecasting:** Forecasting and its types, Methods of sales forecasting with examples.<br>**Sequencing:** Introduction to Job Sequencing – n Jobs, One machine –n Jobs, Johnson's rule, Two machines – n Jobs, Three machines – n jobs with examples<br>**Process Planning:** Loading and Scheduling, Routing, and Gantt chart, Dispatching, work order and follow-up.<br>**Assembly line Balancing:** Line of Balance, Methods of line balancing with examples<br>**Production Management:** Introduction to MRP and MRP-II; Bill of materials; | 30% | 10 |

| | | | |
|---|---|---|---|
| | **Break even analysis:** Introduction and applications, BEA concepts, make or buy decisions. | | |
| **4** | **Project Management**<br>Characteristics of projects, Definition and objectives of Project Management, Stages of Project Management, Project Planning Process, MS Project.<br>**Network analysis methods:** Terms used in network analysis, Network or arrow diagram, Fulkerson's rule, Programme evaluation and review technique (PERT), Critical path method (CPM), Crashing of activity. | **25%** | **08** |
| **5** | **Logistics and Supply Chain Management**<br>Concepts, definitions, and scope of logistics and supply chain management. interrelationships between different components of the supply chain. Overview of Global Supply Chain management | **5%** | **01** |

**i. Text Book and Reference Book:**


1. Industrial Engineering and Production Management by Martand Telsang, S Chand & company
2. Industrial Engineering and Production Management by M. Mahajan, Dhanpat Rai & Co
3. Modern production and Operations Management By Buffa.E.S. and Sarin, R.K. & John Wiley & Sons,
4. Industrial Engineering and Management by Dr. B. Kumar, Khanna Publishers
5. Introduction to Work study International Labour Organisation, Geneva


**j. Experiment List:**

| Sr. NO. | Experiment List |
|---|---|
| 1 | Case study on Location decision and site selection. |
| 2 | Exercise on Computerized Plant Layout optimization techniques. |
| 3 | Exercise on Production planning and Control: Planning, scheduling and sequencing problems. |
| 4 | Exercise on forecasting problem by applying different techniques. |
| 5 | Exercise on Assembly line balancing. |
| 6 | Exercise on Project Management |
| 7 | Case study on Supply chain management. |
| 8 | Performance to calculate normal and maximum working area in accordance with Ergonomics. |
| 9 | Industrial Legislation. |
| 10 | Presentation on Specified Topic. |

**(8)**

a. **Course Name:** Machine Design - I
b. **Course Code:** 303109309
c. **Prerequisite:** Basic Strength of Material, Mechanics of solid.
d. **Rationale:** Undergraduate students are first introduced to the principles of machine design in order to create safe, durable, effective, and efficient machines and also to advance the fields of technology and engineering innovation.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | To leverage expertise in material science for the purpose of identifying and applying suitable materials in the design and manufacturing of machine components, ensuring optimal functionality, performance, durability, and efficiency. |
| **CLOBJ 2** | To comprehensively explain the array of failure modes exhibited by machine components under different loading conditions, elucidating the correlation between specific loads and types of failures |
| **CLOBJ 3** | Utilize the principles of stress analysis, encompassing both static and fluctuating loads, to engineer and optimize machine components, ensuring their structural integrity, performance, and longevity |
| **CLOBJ 4** | Develop efficient designs for components within diverse mechanical systems, employing comprehensive knowledge of engineering principles and cutting-edge technologies to optimize functionality, reliability, and performance |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Describe the mechanical design process with focus on standardization, size selection, materials, and manufacturing considerations. |
| **CLO 2** | Apply failure theories to design joints and levers subjected to static and fatigue loading. |
| **CLO 3** | Design threaded, riveted, welded joints and springs for given loading and functional requirements. |
| **CLO 4** | Evaluate shafts, keys, and couplings under various loading conditions for strength and rigidity. |
| **CLO 5** | Analyze the stresses in cylinders and pressure vessels using appropriate equations and design standards. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **3** | **1** | **-** | **4** | **20** | **20** | **50** | **60** | **0** | **150** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| **1** | **Introduction**<br>Mechanical design process, standardization and selection of preferred sizes, materials and manufacturing considerations in machine design. | **5%** | **3** |
| **2** | **Design Against Static and Fatigue Loading**<br>Design of simple cotter joint, design of knuckle joint. Design of various levers including Rocker arm and Bell Crank lever.<br>Cyclic stresses, fatigue and endurance limit, S/N and SNP diagrams, stress concentration factor, mitigation of stress concentration, notch sensitivity, design for finite and infinite life, Soderberg, Goodman & Gerber criteria. | **20%** | **10** |
| **3** | **Design of Joints and Spring**<br>Threaded Joints, Basic Types of Screw Fastening, Cap Screws, Setscrews, Bolt of Uniform Strength, Terminology of Screw Threads, stresses in screwed threads, Torque Requirement for Bolt Tightening.<br>Rivets and riveted joints, Types of failure, Strength equations, efficiency of joint and Eccentric Loading Riveted Joint. Welded joints, representation of welds on drawings, Strength equations and Eccentric loading welded joint. Classification of springs, helical Spring: Style of ends, stresses, correction factors and deflection, design against static and fluctuating loads, concentric springs, surge phenomenon. Helical torsion spring, Multi-Leaf Spring: Terminology, Design of multi-leaf spring. | **30%** | **15** |
| **4** | **Design of Shaft, Keys and Couplings**<br>Design of shaft & axles on basis of bending, torsion & combined loading, shaft design on the basis of rigidity, effect of keyways, types of keys, design of square key, rectangular key. Design of muff or sleeve coupling, clamp coupling, flange coupling, and bushed-pin type coupling. | **25%** | **10** |
| **5** | **Design of Cylinders &Pressure Vessels**<br>Thin cylinders and spherical vessels, thick cylinders: principal stresses in cylinder subjected to internal/external pressure, lame's equation, clavarino's equations, autofrettage, compounding of cylinders, introduction to design codes. | **20%** | **7** |

**i. Text Book and Reference Book:**

1. Machine Design Sadhu Singh; Khanna Publishers
2. Design of Machine Elements V B Bhandari; McGraw Hill.
3. Machine Design, R. S Khurmi and J. K Gupta; S. Chand Publication
4. Machine Design: Fundamentals and Applications P C Gope; 1/e PHI.
5. Fundamentals of Machine Component Design R C Juvinall; 1/e PHI
6. Machine Design: An Integrated Approach R L Norton, Pearson

**j. Experiment List:**

| Sr. NO. | Experiment List |
|---|---|
| 1 | Exercise based on design considerations and material selection. |
| 2 | Design problems of cotter joints, knuckle joints and levers in general purpose machine. |
| 3 | Exercise to design welded and riveted joints. |
| 4 | Design problems of fatigue loading for machine element. |
| 5 | Exercise to design helical spring and leaf spring for automobile. |
| 6 | Design problems for Shaft, Keys and Couplings. |
| 7 | Design of Pressure Vessel. |
| 8 | Analysis of Pressure Vessel using ANSYS. |

**(9)**

**a. Course Name:** Professionalism & Corporate Ethics
**b. Course Code:** 30319304
**c. Prerequisite:** Basic knowledge of ethics, corporate etiquettes and understanding of the fundamentals of communication are essential.
**d. Rationale:** Interpersonal skills and ethics are essential for placemen
**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Define and articulate the principles of professionalism in a corporate context. |
| **CLOBJ 2** | Develop the ability to analyse ethical dilemmas and make informed decisions. |
| **CLOBJ 3** | Apply ethical decision-making models to real-world business scenarios |
| **CLOBJ 4** | Evaluate the impact of corporate activities on various stakeholders, including the community and the environment. |
| **CLOBJ 5** | Understand and practice proper business etiquette in various communication channels. |
| **CLOBJ 6** | Develop skills in resolving conflicts ethically and professionally. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Apply test-taking strategies effectively to prepare for the competitive examinations. |
| **CLO 2** | Create brochures following standard layout, structure, and language |
| **CLO 3** | Write clear and concise minutes for various types of meetings. |
| **CLO 4** | Interpret audio and written materials using listening and reading comprehension strategies. |
| **CLO 5** | Present viewpoints clearly and professionally in group discussions. |

**g. Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **0** | **1** | **0** | **1** | - | - | - | - | - | **100** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination.

**h. Course Content:**

| **Sr. No.** | **Content** | **Weightage** | **Teaching Hours** |
|---|---|---|---|
| **1** | **Ethics in Engineering**:<br>• Scope of engineering ethics<br>• Accepting & sharing responsibility<br>• Responsible professionals and ethical corporations<br>• Resolving ethical dilemmas<br>• Case studies | **20%** | **5** |
| **2** | **Group Discussion**:<br>• Communication core<br>• Definition, types, process, guidelines<br>• Mock round -1 | **10%** | **3** |
| **3** | **Introduction to B-School Tests**:<br>Students will be able to solve verbal questions from the following exams. In these sessions students will learn to distinguish between national & international level of Management exam. CAT & GPAT | **15%** | **2** |
| **4** | **Listening Skills- Advanced Level**:<br>Demonstrate ability to listen more than two minutes of audio clips &solve questions based on it. | **10%** | **1** |
| **5** | **Preparing Brochures**:<br>Students will learn how to establish the purpose of writing & determineaudience they are writing for. | **15%** | **2** |

| | | | |
|---|---|---|---|
| **6** | **Agenda & Minutes of Meeting**:<br>Students will be able to explain what an agenda & minutes of meetingare and why they are useful. | **10%** | **1** |
| **7** | **Reading Comprehension; Intermediate level**:<br>Students will develop their ability to skim for main idea(s). They willable to make use of contextual clues to infer meaning of unfamiliarwords from context and will be able to solve questions based on it. | **10%** | **1** |

### i. Text Book and Reference Book:


1. "Business Correspondence and Report", Writing SHARMA, R. AND MOHAN, K.
2. "Ethics in Engineering Practice and Research", Caroline Whitbeck, Cambridge University Press
3. "Technical Communication: Principles and Practice", Sangeetha Sharma, Meenakshi Raman; Oxford University Press
4. "How to prepare for verbal ability and reading comprehension for the CAT", Arun Sharma, Meenakshi Upadhyay, TATA McGraw HILL

## Semester 6

**(1)**

a. **Course Name:** Computer Aided Design
b. **Course Code:** 303109351
c. **Prerequisite:** Basics of Engineering Graphics and Fundamentals of Programming
d. **Rationale:** This course aims at introducing students to the use of computers in the different phases of product design viz. conceptualization, geometric modeling, graphical representation and machine learning as well as to the application of modern computer-based simulation tools.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Recall and describe the stages of the product life cycle, basic 2D and 3D modeling principles, and specifications of a CAD workstation. |
| **CLOBJ 2** | Explain geometric transformations (translation, rotation, and scaling, shearing, reflection) and differentiate between curve types (Hermite cubic spline, Bezier) and surfaces in CAD. |
| **CLOBJ 3** | Use modeling and analysis software to generate 2D drafts and 3D models of mechanical components, creating assemblies with constraints and bills of material. |
| **CLOBJ 4** | Interpret industrial drawings, evaluate surface and solid modeling methods, and assess the impact of collaboration and data exchange standards on CAD file sharing. |
| **CLOBJ 5** | Synthesize knowledge to design visually appealing 3D models and assemblies, apply CAD standards to engineering drawings, and explore connections between CAD and machine learning, understanding classification techniques. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Define the key concepts of CAD systems. |
| **CLO 2** | Apply 2D and 3D transformations for geometric modelling in computer graphics. |
| **CLO 3** | Explain 3D models and assemblies in CAD software. |
| **CLO 4** | Interpret engineering design drawings for accurate reading of technical documents. |
| **CLO 5** | Identify the differences between Machine Learning and Artificial Intelligence. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 3 | 0 | 0 | 3 | 20 | 20 | 0 | 60 | - | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination.

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Introduction to CAD**<br>Product Life Cycle, Concept of Computer Aided Design, Introduction to 2D and 3D modeling, Workstation Specification, Sequential and concurrent engineering. Basic concepts of Drafting, General commands for drafting. Line Drawing Algorithm. | 13% | 06 |
| 2 | **Computer Graphics and Geometric Modeling**<br>2D and 3D Transformations Translation, Rotation, Scaling, Shearing and Reflection. Curve's introduction: Analytic curves, synthetic curves, Hermite cubic spline, Bezier curve, B-spline curve. Surface's introduction: Surface entities, analytic surfaces, synthetic surfaces such as Hermite cubic, Bezier, B-spline. Solid's introduction: Geometry and topology, solid entities, sweeps, solid manipulation, CSG and B-rep, faceted models i.e. STL, HSD i.e. Feature based models. | 27% | 12 |
| 3 | **Assembly Design, Constraints, CAD Standards and Rendering Techniques**<br>Creating 3D models of individual components, Assembling Components together to create a larger structure or product. Defining assembly constrains. Creating assemblies, exploded views, and adding motion and animation to the assembly, Brief outline of Data Exchange Standard. Collaboration and sharing of CAD files, Introduction to Rendering Techniques, Volume Rendering. | 27% | 12 |
| 4 | **Engineering Design Reading**<br>Concepts of Design reading, Dimensioning and annotating drawings, Title block and basic symbols, Bill of Material and BOM balloons. | 18% | 08 |
| 5 | **Overview of Machine Learning** | 15% | 07 |

| | | | |
|---|---|---|---|
| | Definition of Machine Learning, Difference Between Machine Learning and Artificial Intelligence, Application of Machine Learning, Classification of Machine Learning, Introduction to Data in Machine Learning, Overview on Statistical Methods for Analysis. | | |

**i. Text Book and Reference Book:**

1. CAD/CAM Theory & Practice (TextBook) By Ibrahim Zeid | Tata McGraw Hill.
2. CAD/CAM Principles by C. McMohan and J. Browne | Pearson Education | Second Edition.
3. Computer Graphics by Donald Hearn & M. Pauline Baker | PHI,2011 | Second Edition

**(2)**

**a. Course Name:** Computer Aided Design Lab

**b. Course Code:** 303109352

**c. Prerequisite:** Basics of Engineering Graphics and Fundamentals of Programming

**d. Rationale:** This course aims at introducing students to the use of computers in the different phases of product design viz. conceptualization, geometric modeling, graphical representation and machine learning as well as to the application of modern computer-based simulation tools.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Recall and describe the stages of the product life cycle, basic 2D and 3D modeling principles, and specifications of a CAD workstation. |
| **CLOBJ 2** | Explain geometric transformations (translation, rotation, and scaling, shearing, reflection) and differentiate between curve types (Hermite cubic spline, Bezier) and surfaces in CAD. |
| **CLOBJ 3** | Use modeling and analysis software to generate 2D drafts and 3D models of mechanical components, creating assemblies with constraints and bills of material. |
| **CLOBJ 4** | Interpret industrial drawings, evaluate surface and solid modeling methods, and assess the impact of collaboration and data exchange standards on CAD file sharing |
| **CLOBJ 5** | Synthesize knowledge to design visually appealing 3D models and assemblies, apply CAD standards to engineering drawings, and explore connections between CAD and machine learning, understanding classification techniques. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Identify software packages and design certification requirements to understand their role in CAD. |
| **CLO 2** | Draft 2D drawings using CAD software. |
| **CLO 3** | Model feature-based 3D drawings. |
| **CLO 4** | Generate assembly and exploded assembly drawings to create detailed representations. |

| | |
|---|---|
| **CLO 5** | Analyze a case study on CAD implementation in industry. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 0 | - | 2 | 1 | - | - | 20 | - | 30 | 50 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**


1. CAD/CAM Theory & Practice (TextBook) By Ibrahim Zeid | Tata McGraw Hill.
2. CAD/CAM Principles by C. McMohan and J. Browne | Pearson Education | Second Edition.
3. Computer Graphics by Donald Hearn & M. Pauline Baker | PHI,2011 | Second Edition
4. CAD/CAM: Computer Aided design and Manufacturing by Mikell Groover and Zimmer, Pearson Education
5. CAD/CAM: Computer Aided Design and Computer Aided Manufacturing by P K Jain, S Chand & Co.


**i. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| **1** | Study of Software packages and design certification. |
| **2** | Exercise to draft 2D drawing. |
| **3** | Exercise to model feature-based 3D drawing. |
| **4** | Exercise to design 3D models |
| **5** | Exercise to generate Assembly Drawing. |
| **6** | Exercise to generate exploded assembly drawing and bill of material. |
| **7** | Exercise to generate Industrial drawing and reading |
| **8** | Case study on Implementation of CAD in industry. |

**(3)**

**a. Course Name:** Machine Design II

**b. Course Code:** 303109353

**c. Prerequisite:** Strength of Material, Machine Design I

**d. Rationale:** The course is designed to give the detailed design of power transmission system, supporting element and its selection.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Describe and demonstrate a comprehensive understanding of the operational mechanisms employed by various power transmission devices, Explaining their working principles, applications, and relative advantages in different mechanical systems. |
| **CLOBJ 2** | Examine the operational performance of machine elements, including bearings, gears, and belts, through comprehensive analysis, to understand their functionality and performance in diverse mechanical systems. |
| **CLOBJ 3** | Design efficient power transmission devices tailored to diverse engineering applications, integrating principles of mechanical design, material science, and operational requirements to achieve optimal performance, reliability, and functionality in specific contexts. |
| **CLOBJ 4** | Design various components within an Internal Combustion Engine, applying in-depth knowledge of forces and stresses, to meticulously design each part, ensuring resilience, durability, and optimal performance under diverse operational conditions |

### f. Course Learning Outcomes:

| | |
|---|---|
| **CLO 1** | Apply gear design principles to spur, helical, and bevel gears based on geometry, kinematics, and material properties. |
| **CLO 2** | Evaluate the performance and selection of journal, ball, and roller bearings using load, lubrication, and life rating criteria. |
| **CLO 3** | Design multi-speed gearboxes using standard step ratios, ray diagrams, and kinematic layouts. |
| **CLO 4** | Select appropriate belt, chain, and rope drives based on stress analysis, efficiency, and application requirements. |
| **CLO 5** | Analyze forces and stresses to determine dimensions of critical engine components like piston, connecting rod, and crankshaft. |

### g. Teaching & Examination Scheme:

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **1** | **-** | **4** | **20** | **20** | **50** | **60** | **-** | **150** |

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Design of Gear Drives**<br>Gear terminology, Kinematics of gear drive, Standard system of gear tooth, Gear materials, Design of Spur, helical and bevel gears. | **30%** | **12** |
| 2 | **Design of Bearings**<br>Materials and selection of bearings, Working conditions for the bearings, Hydrodynamic lubrication theory for journal bearings, Design factors, Design procedure, Design of bearings, Ball and roller bearings, Load and life rating. | **20%** | **10** |
| 3 | **Design of Gear Box**<br>Geometric progression- standard step ratio, multi speed gear box, structure diagram, Ray diagram, kinematic diagram. | **10%** | **5** |
| 4 | **Design of Power Transmission Systems**<br>Introduction and applications of power transmission systems. Types of power transmission devices, advantages and disadvantages, components of belt drive, mechanism of belt drive, Belt Materials, Types of belts and pulleys and their selection, Stresses in belts, Transmission efficiencies, Design/selection of flat belt drive, design/selection of V-belt drive, Design of Chain drives and wire ropes. | **20%** | **10** |
| 5 | **Design of Engine Parts**<br>Components of I.C. engine, materials for engine components, working conditions, Forces and stresses acting on various engine components, Design of cylinder and cylinder liner, Design of piston, Design of Connecting Rod, Design of crank shafts, Design of crank pins. | **20%** | **8** |

**i. Text Book and Reference Book:**


1. Design of Machine Elements V B Bhandari; McGraw Hill.
2. Machine Design: Fundamentals and Applications P C Gope; 1/e PHI.
3. Machine Design: An Integrated Approach R L Norton, Pearson
4. Hand book of Mechanical Design By Maitra G.M., Prasad L.V | Tata McGraw-Hill,1985
5. Mechanics of Materials By E J Hearn | BH


**j. Experiment List:**

| Sr. NO. | Experiment List |
|---|---|
| 1 | Exercise based on various terminologies related to gears, gearboxes, internal combustion engine. |
| 2 | Exercise to design spur gear and helical gear. |
| 3 | Exercise to design bevel gear. |

| | |
|---|---|
| 4 | Exercise on selection of rolling contact bearing for domestic appliance. |
| 5 | Exercise to design sliding contact bearing. |
| 6 | Exercise to design gearbox. |
| 7 | Exercise to design belt and chain drives. |
| 8 | Exercise to design I.C Engine component. |
| 9 | Exercise based on modeling and analysis on designed component. |

**(4)**

a. **Course Name:** Employability Skills
b. **Course Code:** 303193353
c. **Prerequisite:** Basics of English and Gist to Learn Employability Skills.
d. **Rationale:** The course aims to instill the skills required by the students to excel in the dynamic market and earn reputable employment. The student will be able to learn the basics required for appearing in placements and clearing their way to get a good job after completing this course.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Develop and practice English language skills through an IELTS mock test, focusing on listening, speaking, reading, and writing components to enhance employability. |
| **CLOBJ 2** | Acquire the ability to create a functional resume and cover letter that effectively showcases skills and experiences, aiding in job, college, or scholarship applications. |
| **CLOBJ 3** | Train students in various interpersonal skills through advanced group discussions, preparing them for employment or educational admission processes. |
| **CLOBJ 4** | Equip students with the necessary skills for personal interviews by reviewing common questions, understanding employer expectations, and practicing case interviews to enhance their readiness for employment opportunities. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Apply test strategies and language skills to perform confidently in IELTS examinations |
| **CLO 2** | Design and compose professional resumes that effectively highlight their skills and experiences. |
| **CLO 3** | Identify key stages and expectations of the job interview process. |
| **CLO 4** | Enhance employability skills by actively participating in and reflecting on mock group discussions and interviews. |
| **CLO 5** | Demonstrate essential soft skills such as communication, teamwork, and adaptability during job interviews. |

**g. Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | |
|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | **ESE** | **Total** |

| | | | | T | CE | P | Theory | P | |
|---|---|---|---|---|---|---|---|---|---|
| - | 1 | - | 1 | - | 100 | - | - | - | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **IELTS Mock Test**<br>To develop students English Learning and improve their employment prospects. To create opportunity for students to study around the globe & give them Practice on: Listening Speaking Reading Writing. | 25% | 5 |
| 2 | **Resume Building**<br>Cover letter & Resume Writing Students will create a functional resume along with cover letter that they will be able to use when applying for a job, college or a scholarship. | 25% | 2 |
| 3 | **Advanced Group Discussion: Mock Round**<br>To provide students with an avenue to train themselves in various interpersonal skills. To prepare students for the Group Discussion after the written test for employment or for admission to educational institutes. To generate new ideas or new approaches for solving a problem. To reach a solution on an issue of concern. | 25% | 4 |
| 4 | **Personal Interview: Mock Round**<br>Preparing for the Interview Review Question Employer's Expectation Case Interview. | 25% | 4 |

**i. Text Book and Reference Book:**

1. "Business Correspondence and Report", Writing by SHARMA, R. AND MOHAN, K.
2. "Communication Skills and Soft Skills", By Suresh Kumar, Pearson Publication, 2010

**(5)**

**a. Course Name:** Internal Combustion Engine
**b. Course Code:** 303109381
**c. Prerequisite:** Basic Knowledge of Thermodynamics
**d. Rationale:** The course is designed to give the detailed understanding of various system of internal combustion engine, its measurement techniques. Also, the subject gives details about the performance and emission parameters.
**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Define key components of modern IC engines and apply design knowledge to solve fundamental engineering problems. |
| **CLOBJ 2** | Articulate how each system contributes to the holistic operation and performance of an internal combustion engine. |
| **CLOBJ 3** | Develop proficiency in analysing the influence of parameters like air-fuel ratio and injection timing on homogeneous combustion in both SI and CI engines. |
| **CLOBJ 4** | Master the evaluation of engine performance by assessing the influence of diverse operating parameters through dynamometer results. |
| **CLOBJ 5** | Acquire expertise in analysing and interpreting analytical data to evaluate efficiency, emissions, and overall performance of internal combustion engines. |
| **CLOBJ 6** | Recognize and analyse key market trends that shape the future of internal combustion engine technology. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Recognize the need of major components and systems for IC Engines. |
| **CLO 2** | Familiarize with the operating characteristics of IC engine. |
| **CLO 3** | Explain the working of IC engine systems and its sub components. |
| **CLO 4** | Illustrate the stages of combustion and knocking effect in IC Engines. |
| **CLO 5** | Categorize the control strategies for IC engines emission as per the Bhart Stage Protocol. |
| **CLO 6** | Identify key market trends influencing the future development of IC engine technology. |

**g. Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **0** | **-** | **3** | **20** | **20** | **-** | **60** | **-** | **100** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| **Sr. No.** | **Content** | **Weightage** | **Teaching Hours** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **1** | **IC Engine Fundamentals & Testing Methods:** Basic components and terminology of IC engines, working of four stroke/two stroke - petrol/diesel engine, classification and application of IC engines, Relatives merits & demerits and comparison of SI & CI engines. Engine power, efficiencies, engine performance characteristics, variables affecting performance of IC engine, methods of improving engine performance, Measurement of indicated power, brake power, fuel consumption, Measurement of friction power, Calculation of brake thermal efficiency, Heat balance sheet of IC Engines. | **18%** | **8** |
| **2** | **Fuel Air Cycle & Actual Cycle:** Assumptions for fuel–air cycles, Reasons for variation of specific heats of gases, change of internal energy and enthalpy during a process with variable specific heats, isentropic expansion with variable specific heats, effect of variable specific heats on Otto, Diesel and Dual cycle, dissociation, comparison of air standard and fuel air cycles, effect of operating variables, comparison of air standard and actual cycles, effect of time loss, heat loss and exhaust loss in Petrol and Diesel engines, Valve Timing diagrams. | **15%** | **6** |
| **3** | **Fuel Supply System of IC Engine:** Important qualities of IC engine fuels, rating of fuels, Octane No & Cetane No., Carburetion, Stoichiometric A/F ratio, Mixture requirement for different loads and speeds, simple carburettor and its working, types of carburettors, MPFI systems, types of injection systems in CI engine, fuel pumps and injectors, types of nozzles, spray formation. | **15%** | **7** |
| **4** | **Ignition System:** Requirement, Battery and magneto ignition system, spark plug, firing order, quality, quantity & hit and miss governing | **5%** | **3** |
| **5** | **Combustion in IC Engine:** Combustion equations, Enthalpy of formation, Adiabatic flame temperature, Stages of combustion in SI Engine, Flame Propagation, Knocking in SI Engine, Combustion stages of CI engine, Knocking in CI Engine, Effects & Control of Knocking, Requirements of good combustion chamber, Types of combustion chamber for SI & CI Engines. | **15%** | **7** |
| **6** | **Engine Cooling & Lubrication system:** Requirement of Cooling & Lubrication System, Lubrication system wet sump and dry sump, crankcase ventilation, Types of cooling systems liquid and air cooled, thermos-syphon cooling system, forced & pressurized cooling system, | **10%** | **4** |

| | | | |
|---|---|---|---|
| | comparison of liquid and air-cooled systems, Properties of good coolant and lubricants. | | |
| **7** | **Engine Emission & Control:** Sources of Air Pollution in IC engine, major types of pollutants, Different Control Methods for Pollution of SI & CI engines, Catalytic Convertors, Exhaust gas re-circulation, Chemical methods of pollution control, Emission Norms in India. | **10%** | **4** |
| **8** | **Latest Development in IC Engine:** Bio Fuel Operated Engine, Direct Injection Engine, Low Temperature Diesel Combustion Engine, Bi-Fuel and Dual Fuel Technology, VCR Engine, VVT Engine, HCCI Engine, Hybrid Vehicle, Fuel Cell Technology, Hydrogen operated engine technology. | **12%** | **6** |

**i. Text Book and Reference Book:**

1. "Internal Combustion Engines (Text-Book)" By Ganesan. V.
2. "A course in Internal Combustion Engines (Text-Book)" By Mathur. M. L, & Sharma. R. P.
3. "Internal Combustion Engine Fundamentals" By John B. Heywood.
4. "A Course in Internal Combustion Engines (Text-Book)" By V.M. Domkundwar.
5. "The Internal Combustion Engine", By C. F. Taylor and E. S. Taylor.

**(6)**

**a. Course Name:** Internal Combustion Engine Lab
**b. Course Code:** 303109382
**c. Prerequisite:** Basic Knowledge of Thermodynamics
**d. Rationale:** The course is designed to give the detailed understanding of various system of internal combustion engine, its measurement techniques. Also, the subject gives details about the performance and emission parameters.
**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | To investigate and clarify the differences between Spark Ignition (SI) and Compression Ignition (CI) engines. |
| **CLOBJ 2** | To showcase the operational principles and key components of diverse systems within IC engines, demonstrating their functionality. |
| **CLOBJ 3** | Proficiently evaluate diverse performance parameters of both Spark Ignition (SI) and Compression Ignition (CI) engines. |
| **CLOBJ 4** | Measure and describe various fuel attributes so as to assess their effect on engine efficiency and emissions. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Develop the skills to run the IC engines. |

| | |
|---|---|
| **CLO 2** | Identify the key performance and emission parameters for IC engine. |
| **CLO 3** | Test the IC engine for various specific conditions suggested by IS standards. |
| **CLO 4** | Demonstrate the various systems used for IC engine. |
| **CLO 5** | Analyze the performance parameters of SI and CI engines for different engine technologies. |

### g. Teaching & Examination Scheme:

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 0 | - | 2 | 1 | - | - | 20 | - | 30 | 50 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination.

### h. Text Book and Reference Book:


1. Internal Combustion Engines (Text Book) by Ganesan. V | Tata-McGraw Hill Publishing Co., New Delhi.
2. A course in Internal Combustion Engines (Text Book) by Mathur. M. L, & Sharma. R. P. | Dhanpat Rai Publications Pvt. Ltd., 1998.
3. Internal Combustion Engine Fundamentals by John B. Heywood |, McGraw-Hill International Edition, Automotive technology series
4. A Course in Internal Combustion Engines (Text Book) by V.M. Domkundwar | Dhanpatrai & Co, New Delhi
5. The Internal Combustion Engine by C. F. Taylor and E. S. Taylor | 1984


### i. Experiment List:

| Exp. No. | Name of the Experiment |
|---|---|
| **1** | Determination of Valve timing diagram of SI & CI engine |
| **2** | Study of Supercharging & Turbo charging of IC Engine and its effect on IC engine performance. |
| **3** | Measurement of Fuel Properties. |
| **4** | Demonstration of Fuel Supply and Ignition System of IC engine |
| **5** | Demonstration of Cooling and Lubrication System of IC engine |
| **6** | Performance of 4-Stroke Multi Cylinder Petrol Engine. |
| **7** | Performance of 4-Stroke Multi Cylinder Diesel Engine |
| **8** | Preparation of Heat Balance Sheet for 4-S Petrol & Diesel Engine |

| Exp. No. | Name of the Experiment |
|---|---|
| **9** | Determination of Friction Power of multi cylinder engine using morse test/motoring test |
| **10** | Emission measurement of multi cylinder petrol/diesel engine using exhaust gas analyzer. |
| **11** | Performance analysis of VCR engine. |
| **12** | Performance and Emission analysis of Biofuel/CNG operated engine technology |

**(7)**

a. **Course Name:** Advanced Manufacturing Technology
b. **Course Code:** 303109383
c. **Prerequisite:** Manufacturing Process and Manufacturing Technology.
d. **Rationale:** The course is designed to give the detailed understanding of various advanced welding techniques, Forming Methods. It also intends to introduce the Additive manufacturing types.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Analyse and apply principles of welding metallurgy, including heat-affected zone characteristics and weldability of various materials. |
| **CLOBJ 2** | Apply rapid prototyping techniques, from design procedures to cost estimation, for efficient product development. |
| **CLOBJ 3** | Design virtual prototypes using software tools, considering material selection and design for assembly. |
| **CLOBJ 4** | Evaluate the suitability of different additive manufacturing processes for specific contexts. |
| **CLOBJ 5** | Define and analyse unconventional forming methods, such as high energy rate forming and explosive forming. |
| **CLOBJ 6** | Apply advanced forming methods in practical scenarios and assess their relevance in manufacturing processes. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Describe solid state and high energy rate Welding Processes. |
| **CLO 2** | Identify Welding Defects attributed to welding techniques, methods, materials and joints. |
| **CLO 3** | Familiarize Process parameters for Rapid Prototyping. |
| **CLO 4** | Apply virtual prototyping techniques to prepare product and generate STL files. |
| **CLO 5** | Explain RP/AM technologies and recent developments. |
| **CLO 6** | Identify methods used in Unconventional Forming processes. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Theory Marks | | | Practical Marks | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 3 | - | 0 | 0 | 20 | 20 | - | 60 | - | 100 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Welding Metallurgy and Design:** Welding metallurgy and design-Heat affected zone and its characteristics-Weldability of steels, Stainless steel, aluminum and Titanium Alloys-Hydrogen Embitterment-Lamellar Tearing-Residual Stress-Heat transfer and solidification-Analysis of stresses in welded structures-pre and post welding heat treatments- weld joint design - welding defects - testing of weldment. Special welding processes-Friction welding- Friction stir welding – Explosive welding, Diffusion bonding, High frequency, Induction welding, Ultrasonic Welding-Electron beam welding-Laser beam welding. Automation in welding-Welding Robots - Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding. | 28% | 12 |
| 2 | **Rapid Prototyping:** Process requirements for Rapid Prototyping - Product Prototyping and Product Development - Prototyping - Need for Prototyping - Issues in Prototyping - Conducting Prototyping - Design Procedure - Prototype Planning and Management - Product and Prototype Cost Estimation - Fundamentals of Cost Concepts - Prototype Cost Estimation - Cost Complexities - Prototype Design Methods - Prototype Design tools - Morphological Analysis - Functional Efficiency Technique – Paper. Prototyping - Selecting a Prototype - Learning from Nature. | 20% | 9 |
| 3 | **Virtual Prototyping, Materials Selection & Procedure for Prototyping:** Using Commercial Software for Virtual Prototyping - Prototyping | 20% | 9 |

| | | | |
|---|---|---|---|
| | Materials - Material Selection Methods - Rapid Prototyping Overview - Rapid Prototyping Cycle - Rapid Prototyping Procedure - STL files - Converting STL File from Various CAD Files - Controlling Part Accuracy in STL Format - Slicing the STL File - Case Studies in Design for Assembly, product optimization for actual and support materials. Design thinking. Inputs for AM - Understanding the various inputs types. | | |
| **4** | **Types of Additive Manufacturing Process:** Types of AM Process - Stereolithography -- Fused Deposition Modelling - Selective Laser Sintering - 3D Printing Process, Polyjet printing -- Laminated Object Manufacturing - Electron Beam Melting Process -- History - Operation - Advantages and Disadvantages - Applications - Relation to Other AM Technologies - (applies to all the process) - Direct Laser Deposition. | **20%** | **9** |
| **5** | **Unconventional Forming Methods:** Unconventional forming - High energy rate forming - Explosive forming - Magnetic Pulse forming - Electro hydraulic forming. | **12%** | **6** |

**i. Text Book and Reference Book:**

1. “Mechanical Metallurgy” by George E. Dieter; McGraw Hill
2. "Signals and Systems" by Simon Haykin and Barry Van Veen.
3. “Welding processes and technology (Textbook)” by Dr. R. S. Parmar; Khanna Publishers" Linear Systems and Signals" by B.P. Lathi.
4. “Rapid prototyping: Principles and Applications” by Chua C.K., Leong K.F. and LIM C.S; World Scientific publications; 3, 2010

**(8)**

**a. Course Name:** Advanced Manufacturing Technology Lab

**b. Course Code:** 303109384

**c. Prerequisite:** Knowledge of Manufacturing Process and Manufacturing Technology

**d. Rationale:** The course is designed to give the detailed understanding of various advanced welding techniques, Forming Methods. It also intends to introduce the Additive manufacturing Types.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Develop a comprehensive understanding of welding toughness principles. |
| **CLOBJ 2** | Apply friction stir welding techniques for joining similar metals. |
| **CLOBJ 3** | Analyze and interpret macro and microstructures of welded joints. |
| **CLOBJ 4** | Evaluate welded joint quality, emphasizing toughness assessment. |
| **CLOBJ 5** | Master additive manufacturing, showcasing competence in 3D printing technology and innovative material forming methods. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Analyze the Impact of Welding Parameters on mechanical properties |
| **CLO 2** | Optimize Welding Parameters for Enhanced Performance of friction stir welding |
| **CLO 3** | Optimize 3D Printing Parameters for printing a 3D model. |
| **CLO 4** | Differentiate Between Additive Manufacturing Methods based principle and materials. |
| **CLO 5** | Apply Virtual Prototyping Techniques for effective Design Validation. |
| **CLO 6** | Compare Magnetic Pulse Forming with Other Forming Techniques. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 0 | 0 | 2 | 1 | 0 | 0 | 20 | 0 | 30 | 50 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**


5. “Mechanical Metallurgy” by George E. Dieter; McGraw Hill
6. "Signals and Systems" by Simon Haykin and Barry Van Veen.
7. “Welding processes and technology (Textbook)” by Dr. R. S. Parmar; Khanna Publishers” Linear Systems and Signals" by B.P. Lathi.
8. “Rapid prototyping: Principles and Applications” by Chua C.K., Leong K.F. and LIM C.S; World Scientific publications; 3, 2010


**i. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| **1** | Determination of Toughness of the Weld Zone. |
| **2** | Determination of Toughness of the HAZ Zone. |
| **3** | Joining of Similar metals using Friction Stir Welding |
| **4** | Development of Macro and Micro structure of Welded Joints. |
| **5** | Preparation of Parul University Logo using 3D Printer |
| **6** | Study of Types of Additive Manufacturing Methods. |
| **7** | Preparation of STL File for the give CAD model. |
| **8** | Production of Component using Magnetic Pulse Forming. |

**(9)**

a. **Course Name:** - Oil Hydraulics and Pneumatics
b. **Course Code:** 303109385
c. **Prerequisite:** Fluid Mechanics Fundamental
d. **Rationale:** This course aims to provide an understanding of the principles and applications of hydraulic and pneumatic systems. This will be useful in applying the knowledge of hydraulics and pneumatics in industrial applications.

e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Understand the fundamental principles of oil hydraulics and pneumatics in industrial applications. |
| **CLOBJ 2** | Demonstrate proficiency in designing and analysing hydraulic and pneumatic systems. |
| **CLOBJ 3** | Apply knowledge of fluid power components to solve engineering problems in oil hydraulics and pneumatics. |
| **CLOBJ 4** | Evaluate the efficiency and performance of hydraulic and pneumatic systems through practical experiments and simulations. |
| **CLOBJ 5** | Develop the ability to troubleshoot and maintain oil hydraulic and pneumatic systems in a variety of industrial settings. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Explain hydraulic and pneumatic systems. |
| **CLO 2** | Evaluate the performance of hydraulic system components. |
| **CLO 3** | Demonstrate pneumatic system components and circuits. |
| **CLO 4** | Elaborate control valve functions in fluid power systems. |
| **CLO5** | Describe safety measures and maintenance practices. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **0** | **0** | **3** | **20** | **20** | **0** | **60** | **0** | **100** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| **1** | **Introduction to Oil Hydraulics and Pneumatics**<br>Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Pascal's law, hydrostatic law, pressure measurements through Piezometer and U-Tube manometer. | **20%** | **7** |
| **2** | **Hydraulic Systems**<br>Hydraulic fluids and their properties, Components of hydraulic systems: pumps, valves, actuators, and reservoirs, Hydraulic circuits and their analysis, Hydraulic motors and their applications. | **25%** | **12** |
| **3** | **Pneumatic Systems**<br>Pneumatic fluids and their properties, Components of pneumatic systems: compressors, valves, actuators, and reservoirs, Pneumatic circuits and their analysis, Pneumatic motors and their applications | **25%** | **10** |
| **4** | **Control Components**<br>Control valves and their functions, Pressure control valves and their applications, Flow control valves and their applications, Directional control valves and their applications. | **20%** | **10** |
| **5** | **Safety and Maintenance of Hydraulic and Pneumatic Systems**<br>Safety measures while working with hydraulic and pneumatic systems, Maintenance of hydraulic and pneumatic systems, Troubleshooting and fault diagnosis of hydraulic and pneumatic systems. | **10%** | **6** |

**i. Text Book and Reference Book:**


1. Industrial Hydraulics (Textbook) Pippengar, John J. and Hicks, Tyler G; Tata Mc Graw-Hill
2. Oil Hydraulic Systems (Textbook) S R Majumdar, Tata McGraw-Hill
3. Basic Pneumatic Systems, Principle and Maintenance S R Majumdar; McGraw-Hill
4. Fluid Power: Generation, Transmission and Control Jagadeesh T, Thammaiah Gowda; Wiley

**(10)**

a. **Course Name:** Oil Hydraulic and Pneumatic Lab
b. **Course Code:** 303109386
c. **Prerequisite:** : Fluid Mechanics Fundamentals
d. **Rationale:** This course aims to provide an understanding of the principles and applications of hydraulic and pneumatic systems. This will be useful in applying the knowledge of hydraulics and pneumatics in industrial applications.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Compare mechanical, electrical, hydraulic, and pneumatic systems used in industries, outlining their distinct features and applicability. |
| **CLOBJ 2** | Describe the functions and interrelations of pumps, actuators, valves, and reservoirs within hydraulic systems. |
| **CLOBJ 3** | Develop and analyse hydraulic circuits using simulation software, demonstrating competence in design and functionality assessment. |
| **CLOBJ 4** | Construct hydraulic speed-controlling circuits using a hydraulic trainer to showcase practical application and control mechanisms. |
| **CLOBJ 5** | Calculate and evaluate torque, power, and efficiencies within hydraulic systems, demonstrating quantitative estimation skills and system evaluation. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Describe various power transmission systems. |
| **CLO 2** | Develop hydraulic circuits using simulation software. |
| **CLO 3** | Demonstrate hydraulic speed control circuits and their performance. |
| **CLO 4** | Develop pneumatic circuits for single-and double-acting cylinders. |
| **CLO 5** | Explain faults in hydraulic and pneumatic circuits, ensuring efficient system operation. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **0** | **0** | **2** | **1** | **0** | **0** | **20** | **0** | **30** | **50** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Text Book and Reference Book:**

1. Industrial Hydraulics (Textbook) Pippengar, John J. and Hicks, Tyler G; Tata Mc

Graw-Hill
2. Oil Hydraulic Systems (Textbook) S R Majumdar; Tata McGraw-Hill
3. Basic Pneumatic Systems, Principle and Maintenance S R Majumdar; McGraw-Hill
4. Fluid Power: Generation, Transmission and Control Jagadeesha T, Thammaiah Gowda; Wiley

**i. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| **1** | Study of Power transmission systems used in industries and their comparison – mechanical, electrical, hydraulic and pneumatic systems. |
| **2** | Study of different types of hydraulic components such as pumps, actuators, valves, and reservoirs |
| **3** | Design and analysis of hydraulic circuits on Simulation package |
| **4** | Development of hydraulic speed-controlling circuits using hydraulic trainer |
| **5** | Estimation of torque, power and efficiencies in hydraulic systems |
| **6** | Study of different types of pneumatic components such as compressors, actuators, valves, and reservoirs |
| **7** | Development of pneumatic circuit to understand working of Single Acting Cylinder. |
| **8** | Design and Development of pneumatic circuit to perform automatic to and fro motion of Double Acting Cylinder using 5/3 DCV |
| **9** | Understanding logic elements and their applications in pneumatic systems |
| **10** | Identification and troubleshooting of faults in hydraulic and pneumatic circuits |

**(11)**

a. **Course Name:** Power Plant Engineering
b. **Course Code:** 303109387
c. **Prerequisite:** Basic Thermodynamics, Applied Thermodynamics, Heat Transfer
d. **Rationale:** This course attempts to provide basic knowledge of the technologies available at power plant level and would also acquaint with the latest technological advances taking place in this sector.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Understand the fundamental principles of thermodynamics, heat transfer, fluid mechanics, and mechanics relevant to power plant operations. |
| **CLOBJ 2** | Explore different types of power plants including fossil fuel-based (coal, oil, natural gas), nuclear, renewable energy (solar, wind, hydro, geothermal), hybrid systems and hydrogen power plant. |
| **CLOBJ 3** | Comprehend the processes involved in energy conversion, including combustion, steam generation, gas turbines, and other methods used to convert various forms of energy into electricity. |
| **CLOBJ 4** | Apply the principles of energy conversion processes in different types of power plants, such as combustion, steam generation, and gas turbines, to solve engineering problems. |
| **CLOBJ 5** | Analyse and evaluate the efficiency and performance of power plants using thermodynamic calculations, heat rate analysis, and optimization techniques. |
| **CLOBJ 6** | Assess the environmental impact of power generation and propose strategies for emissions control, regulation compliance, and sustainable operation. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Evaluate thermodynamic enhancements in Rankine cycles and modern subsystems of coal-fired thermal power plants. |
| **CLO 2** | Assess Brayton cycle performance and system interdependencies in gas turbine, combined-cycle, and IGCC plants. |
| **CLO 3** | Describe different technologies for hydrogen fuel production and storage. |
| **CLO 4** | Elaborate multiple nuclear reactor designs and safety protocols within plant layouts and operations. |
| **CLO 5** | Explain various renewable energy systems-hydro, wind, solar, geothermal, biogas, fuel cells into cohesive power-generation. |
| **CLO 6** | Analyze economic metrics, load-management schemes, and pollution-control measures across diverse power-plants. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **3** | **1** | **-** | **4** | **20** | **20** | **50** | **60** | **-** | **150** |

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| **1** | **Coal based thermal power plants**<br>Rankine cycle and its improvisations, layout of modern thermal power plant, site selection criteria, High Pressure Boilers, Super critical boilers, FBC boilers, Steam turbines, Steam Condensers & Cooling Towers, steam rate and heating rate, Combined Cycle Power Plant - Binary Cycles and Cogeneration systems, subsystems of thermal power plants - Fuel and Ash handling, Draught system, Feed water treatment. | **40%** | **12** |
| **2** | **Gas turbine and combined cycle power plants**<br>Brayton cycle, Components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems. | **10%** | **3** |
| **3** | **Hydrogen power plant**<br>Need of hydrogen, Property of Hydrogen, Converting a gas turbine to a hydrogen turbine power plant, Hydrogen Production and Storage. | **10%** | **3** |
| **4** | **Nuclear Power Plant**<br>Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants. | **15%** | **5** |
| **5** | **Power from Renewable Energy**<br>Hydroelectric power plants, Principle, Construction and working of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems. | **15%** | **5** |
| **6** | **Energy, Economic and Environmental Issues of Power Plants**<br>Power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants. | **10%** | **2** |

**i. Text Book and Reference Book:**


1. Power Plant Engineering (TextBook) By P.K. Nag | McGraw-Hill, New Delhi
2. Power Plant Technology By El-Wakil | McGraw-Hill , New Delhi Fundamentals of Electrical Engineering, By Leonard S. Bobrow, Oxford University Press, Pub. Year 1996

3. Thermal Engineering By R. K. Rajput | Laxmi Publication. Basic Electrical Engineering, By D. P. Kothari and I. J. Nagrath, Tata McGraw Hill, Pub. Year, 2010
4. Hydrogen and Fuel Cells: Emerging Technologies and Applications By Bent

**j. Experiment List:**

| Sr. No. | Experiment List |
|---|---|
| 1 | Study of fuel and ash handling system. |
| 2 | Study of draught system & feed water treatment. |
| 3 | Study of Combined Cycles, Integrated Gasifier based Combined Cycle (IGCC) systems. |
| 4 | Study hydrogen power plant |
| 5 | Study of safety measures for nuclear power plants. |
| 6 | Study of Renewable Energy for Power generation. |
| 7 | Study of Energy, Economic of Power Plants. |
| 8 | Study of Environmental Issues of Power Plants. |

**(12)**

**a. Course Name:** Product Development and Value Engineering

**b. Course Code:** 303109388

**c. Prerequisite:** Knowledge of Design principles, Industrial Engineering

**d. Rationale:** Product design & development through engineering aspects always remain challenging to engineers. The aim of present course is to introduce the students about the basic product design process based on mechanical aspects applying innovative thinking and fundamentals of mechanical engineering.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Understand product design, factors influencing it, and the product consumption cycle. Gain exposure to essential software tools in product design. |
| **CLOBJ 2** | Develop an understanding of the product development process, life cycle, and effective resource allocation for successful planning. |
| **CLOBJ 3** | Acquire creative thinking skills, utilize TRIZ, and navigate concept selection and testing processes in product design. |
| **CLOBJ 4** | Apply product and pricing strategies, delve into quality considerations, and explore the designer's role in addressing customer requirements and market dynamics. |

### f. Course Learning Outcomes:

| | |
|---|---|
| **CLO 1** | Define the fundamentals of product design, innovation, and consumption cycles. |
| **CLO 2** | Outline the product life cycle and steps in development planning. |
| **CLO 3** | Apply techniques for gathering design information and generating, selecting, and testing concepts. |
| **CLO 4** | Analyze product strategies, customer needs, and quality dimensions. |
| **CLO 5** | Evaluate materials, manufacturing methods, and ergonomic considerations in product design. |
| **CLO 6** | Develop cost-effective design solutions using value engineering principles. |

### g. Teaching & Examination Scheme:

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **-** | **2** | **4** | **20** | **20** | **20** | **60** | **30** | **150** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

### h. Course Content:

| **Sr. No.** | **Content** | **Weightage** | **Teaching Hours** |
|---|---|---|---|
| **1** | **Introduction to Product Design and Design Thinking**<br>Definition of Product Design, Design by Evolution and Innovation, Factors of Product Design, Product Consumption cycle, Introduction to useful software. | **10%** | **5** |
| **2** | **Product Development Plan**<br>Introduction, Product Life cycle, Planning of product development process, resource allocation. | **10%** | **3** |
| **3** | **Gathering Information**<br>Data, Information, and knowledge, types of design information, sources of information. | **10%** | **5** |
| **4** | **Concept Generation, Selection and Testing**<br>Introduction to creative thinking. Information gathering, TRIZ, Concept selection process, Concept testing process. | **10%** | **5** |
| **5** | **Product Design Practice and Industry**<br>Introduction, Product Strategies, Pricing Strategy for Product, Product Quality Strategy, Product Luxuriousness, Product Utility Strategy, Product & Market, 3S. | **20%** | **9** |

| | | | |
|---|---|---|---|
| | Standardization, Designer Role in product design, Issues arises to Industrial designer. Contribution by Designer; Customer Requirement, Maslow s hierarchy of human needs, Garvin's 8 basic dimensions of quality; classifying customer requirement, KANO diagram, Team Behaviour and tools, UX/UI and IIOT. | | |
| **6** | **Embodiment Design**<br>Introduction, Product Architecture, Parametric Design, Dimension and Tolerance Analysis, Introduction to various types of materials, Material selection, Design for Manufacturing, Design for Assembly, Design for Environment. Ergonomic Consideration in Product Design. Product Development Economics. | **20%** | **9** |
| **7** | **Value Engineering**<br>Introduction, Cost reduction techniques, value, Value Engineering Program (VEP), Advantages of Value Engineering, Concept of Value Engineering, FAST Diagram. | **20%** | **9** |

**i. Text Book and Reference Book:**

1. Product Design and Manufacturing by A. K. Chitale, R. C. Gupta | PHI Learning Pvt. Ltd
2. Product Design and Development (TextBook), by Ulrich K. T, and Eppinger S.D, | Tata McGraw Hill
3. Product Design, by Kevin N. Otto, Kristin L. Wood | Pearson education, 2009
4. Engineering Design by George E. Dieter and Linda C. Schmidt | McGraw Hill Higher Education
5. Value Engineering A how to Manual by S. S. Iyer | New age International Publishers

**j. Experiment List:**

| Sr. No. | Experiment List |
|---|---|
| 1 | Introduction about various tools and techniques used in product design. |
| 2 | Case study on use of voice of customer in product design and development. |
| 3 | Prepare FAST Diagram for a real product. |
| 4 | Prepare Kano diagram for knowing customer needs. |
| 5 | Case study on Product Design Specification, applicable standards and Preparing House of Quality. |
| 6 | Study applications of DFM, DFA and DFE. |
| 7 | Apply concept of product design and value engineering on a given product. |
| 8 | Use of UI/UX and IIOT in product design and development |

**(13)**

a. **Course Name:** Quality Management Techniques
b. **Course Code:** 303109389
c. **Prerequisite:** Basic knowledge of Total Quality management
d. **Rationale:** The objective of this subject is to incorporate the basic concepts of quality & learn about different quality control tools and techniques. The subject also complies with Total Quality Management (TQM) philosophy that is widely adopted by the different business organizations and industries. In addition, the subject will focus on Quality Management Systems (QMS) like ISO standards. This course will enable the students to apply the concepts of Quality and to use Quality control tools and techniques to attain quality assurance in the industries.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Gain a comprehensive understanding of fundamental quality concepts and principles |
| **CLOBJ 2** | Develop proficiency in applying quality management tools and techniques to enhance manufacturing and service processes |
| **CLOBJ 3** | Acquire the skills to effectively implement quality knowledge within organizational contexts for continuous improvement |
| **CLOBJ 4** | Understand Total Quality Management (TQM) principles to drive continuous improvement in organizational processes |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Describe the fundamentals of quality and Total Quality Management. |
| **CLO 2** | Apply statistical quality control tools and techniques for inspection and quality improvement |
| **CLO 3** | Explain about the trends in quality engineering and quality management. |
| **CLO 4** | Demonstrate Quality management tools and techniques. |
| **CLO 5** | Describe National and International quality awards. |
| **CLO 6** | Discuss Quality Management system and ISO standards. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **1** | **0** | **4** | **20** | **20** | **50** | **60** | **-** | **150** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Introduction to Quality**<br>Definition of Quality, Evolution of Quality, Dimensions of Quality, Quality Assurance, Quality of Design, Quality of Conformance, Quality of performance, Quality characteristic, Quality functions, Quality Control and inspection, Quality Policy, Quality Gurus. | **15%** | **4** |
| 2 | **Total Quality Management (T.Q.M.)**<br>Quality function development (QFD), Process capability, Control chart for variable- X bar & R chart, and their applications. Control Chart for Attributes: P, np, C. Control charts Quality circles, Acceptance sampling plans, & Sampling methods. Process Concept, Meaning and Importance of Continuous Improvement Process, Elements of Continuous Improvement, Juran Trilogy, Concept of Muda, Japanese 5S principles, Kaizen, PDCA Cycle and Other Improvement Strategies | **25%** | **8** |
| 3 | **Contemporary Trends in Quality Engineering & Management**<br>Lean Manufacturing, Agile Manufacturing, Bench Marking, Definition of Benchmarking, Reasons for Benchmarking, Types of Benchmarking, Benchmarking Process, Advantages of Benchmarking, Limitations of Benchmarking Business Process Re-engineering (BPR), Six Sigma - Basic Concept, Principle, Methodology, Implementation, Scope, Advantages and Limitations. | **20%** | **6** |
| 4 | **Just in Time (JIT) & Total Productive Maintenance (TPM)**<br>Just in time (JIT) Production system, Advantages and Limitations of JIT, KANBAN System, Introduction to Total Productive Maintenance: Content, methods and Advantages | **10%** | **3** |
| 5 | **Quality Engineering and Management Tools, Techniques & Standards**<br>7 QC tools, 7 New Quality Management Tools, Poka-Yoke, Cost of Quality: Categories of Cost of Quality, Models of Cost of Quality, Optimizing Costs, Preventing Cost of Quality Technique, Introduction to National and International Quality Awards: (Malcolm Baldrige National Quality Award – MBNQA, The Deming Prize, Rajiv Gandhi National Quality Award, IMC Ramakrishna Bajaj National Quality Awards, Quality Bodies in India, EFQM award). | **20%** | **6** |
| 6 | **Quality Management Systems** | **10%** | **3** |

| | | | |
|---|---|---|---|
| | Quality Management System, Quality Management Principles, ISO 9001 ISO 9000, ISO 9000:2000, ISO 14000, other quality systems. Structure, Quality Audits, ISO Registrations, Requirements, Benefits of ISO registration, Examples of ISO Standard Application | | |

**i. Text Book and Reference Book:**


1. "Total Quality Management", (Textbook) By Dale H. Besterfield, Pearson Education.
2. "Total Quality Management" by Dr. S. Kumar
3. "Statistical Quality Control (Textbook)", By M. Mahajan, Dhanpat Rai & Co.

## Semester 7

**(1)**

a. **Course Name:** Computer Aided Manufacturing
b. **Course Code:** 303109401
c. **Prerequisite:** Fundamental Knowledge of Manufacturing Process and Computer Aided Design
d. **Rationale:** The course is designed to give the detailed understanding of various fundamentals of Computer Aided Manufacturing, CNC Programming and related logics. Also the subject gives details about the FMS and CIM.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Explain the basic structure, codes, and principles of CNC part programming. |
| **CLOBJ 2** | Describe various CNC tools, tool holders, and their operational features. |
| **CLOBJ 3** | Develop and simulate CNC part programs for different machine operations. |
| **CLOBJ 4** | Explain the components and working of Flexible Manufacturing Systems for material handling. |
| **CLOBJ 5** | Understand computer-based tools used for production planning and control in industries. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Explain fundamental CAM systems and their role in modern manufacturing. |
| **CLO 2** | Identify CNC machine elements and tooling systems for precision machining. |
| **CLO 3** | Develop CNC part programs using G and M codes for turning and milling. |
| **CLO 4** | Analyze Flexible Manufacturing System layouts with automated handling and tool management. |
| **CLO 5** | Elaborate variant and generative CAPP techniques within a CIM environment. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **-** | **0** | **3** | **20** | **20** | **-** | **60** | **-** | **100** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Introduction to CAM and NC.**<br>Introduction to CAM, Nature & type of manufacturing system, NC, CNC and DNC systems. | **10%** | **4** |
| 2 | **Elements of CNC machine**:<br>Slide ways, motion transmission elements, Automatic tool changers and multiple pallet systems, feedback devices – encoders and transducers, sensors, actuators, Spindle drives and axes drives, axis designation, Tooling for CNC machines-Tool preset and qualified tools, work and tool holding devices. | **30%** | **18** |
| 3 | **Fundamentals of Part Programming:**<br>Manual part programming for lathe and milling machine operations, subroutines, do loops, canned cycles, and parametric subroutines. ISO G and M codes for turning and milling-meaning and applications of important codes Computer-assisted programming languages, Automatically Programmed Tools language. | **25%** | **10** |
| 4 | **Flexible Manufacturing System**:<br>Concept of FMS, types of flexibility, FMS lay out and advantages. Automated material handling systems, ASRS, AGVs, Cellular manufacturing, tool management, flexible assembly systems | **20%** | **7** |
| 5 | **Computer Integrated Manufacturing and Computer Aided Process Planning**:<br>Scope, need and benefits of CIM, CIM wheel, CIM database and database management systems, Approaches to process planning, variant and generative CAPP, application and benefits. | **15%** | **6** |

**i. Text Book and Reference Book:**


1. Automation, Production Systems and Computer Integrated Manufacturing (TextBook) By Mikell P. Groover | Prentice Hall of India, New Delhi, 2003 by Alan V. Oppenheim and Alan S. Willsky.
2. Numerical Control & Computer Aided Manufacturing (TextBook) By T.K. Kundra, P.N.Rao, N.K. Tewari | Tata Mcgraw-Hill Publishing Company Limited, Pub. Year 1987
3. CNC Programming (TextBook) (TextBook) By Dr S K Sinha.
4. An Introduction to Automate process planning systemsBy Tien-Chien Chang, Richard A. Wysk | Prentice Hall,, Pub. Year 2005

**(2)**

a. **Course Name:** Computer Aided Manufacturing Lab
b. **Course Code:** 303109402
c. **Prerequisite:** Fundamental Knowledge of Manufacturing Processes and Computer Aided Design.
d. **Rationale:** The course is designed to give the detailed understanding of various fundamentals of Computer Aided Manufacturing, CNC Programming and related logics. Also the subject gives details about the FMS and CIM.

e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Explain the basic structure, codes, and principles of CNC part programming. |
| **CLOBJ 2** | Describe various CNC tools, tool holders, and their operational features. |
| **CLOBJ 3** | Develop and simulate CNC part programs for different machine operations. |
| **CLOBJ 4** | Explain the components and working of Flexible Manufacturing Systems for material handling. |
| **CLOBJ 5** | Understand computer-based tools used for production planning and control in industries. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Demonstrate the various components of Computer Integrated Manufacturing (CIM). |
| **CLO 2** | Demonstrate the procedure for setting part origins on CNC turning and vertical machining centers. |
| **CLO 3** | Simulate manual part programs using linear and radial interpolation. |
| **CLO 4** | Demonstrate various CNC canned cycles on a Vertical Machining Center (VMC). |
| **CLO 5** | Elaborate computer-aided production management tools for manufacturing processes. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **0** | **-** | **2** | **1** | **-** | **-** | **20** | **-** | **30** | **50** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**

1. Automation, Production Systems and Computer Integrated Manufacturing (TextBook) By Mikell P. Groover | Prentice Hall of India, New Delhi, 2003by Alan V. Oppenheim and Alan S. Willsky.
2. Numerical Control & Computer Aided Manufacturing (TextBook) By T.K. Kundra, P.N.Rao, N.K. Tewari | Tata Mcgraw-Hill Publishing Company Limited, Pub. Year 1987
3. CNC Programming (TextBook) (TextBook) By Dr S K Sinha.
4. An Introduction to automate process planning systemsBy Tien-Chien Chang, Richard A. Wysk | Prentice Hall,, Pub. Year 2005

**i. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| 1 | To Demonstrate various components of computer integrated manufacturing. |
| 2 | To demonstrate CNC turning centre and learn to set part origin on CNC turning centre. |
| 3 | To demonstrate vertical machining centre and learn to set part origin on vertical machining centre. |
| 4 | To prepare and simulate manual part program for job using Linear And Radial Interpolation. |
| 5 | To prepare a manual part program for CNC Milling centre and simulate using simulator software. |
| 6 | To prepare a part program for a job using G81, G82, G83 drilling canned cycle on VMC. |
| 7 | To prepare a part program for a job using G85, G86 boring cycles and G84 tapping cycle on VMC. |
| 8 | Exercise on Cellular Manufacturing – Rank order Clustering. |
| 9 | Quantitative Analysis of Flexible Manufacturing System - Bottleneck Model. |
| 10 | To prepare a material requirement plan and overview computer aided production Management. |

**(3)**

a. **Course Name:** - Finite Element Methods
b. **Course Code:** 303109403
c. **Prerequisite:** Basic knowledge of Mechanics of Solids and preliminary understanding of mathematical concept such Calculus, Differential Equations, Vector and tensor analysis.
d. **Rationale:** This course empowers students to approximate solutions for complex differential equations via the Finite Element Method. It also enables applying this method to analyse heat flow and stress analysis of complex mechanical elements.

e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | To provide foundational knowledge of Finite Element Analysis (FEA) and its application to different types of structural elements such as bars, beams, and plane elements. |
| **CLOBJ 2** | To enable students to understand the computational procedures and implementation techniques involved in linear FEA for stress, displacement, and thermal analysis. |
| **CLOBJ 3** | To equip students with the skills to formulate and assemble element-level and global stiffness equations for various FEA problems. |
| **CLOBJ 4** | To develop analytical abilities for interpreting FEA results, including error estimation and validation of modeling and discretization strategies. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Formulate finite element models under defined boundary and initial conditions using Galerkin, Variational and Rayleigh-Ritz methods. |
| **CLO 2** | Solve 1D structural problem for bars and trusses using FEM and shape function. |
| **CLO 3** | Evaluate 2D finite element models under plane stress and plane strain conditions using triangular, quadrilateral, and isoparametric elements. |
| **CLO 4** | Apply finite element techniques under beam and shaft loading conditions using Hermite shape functions and direct stiffness method. |
| **CLO 5** | Analyze steady-state heat transfer behaviour under conduction and convection conditions using one-dimensional finite element formulation |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **0** | **0** | **3** | **20** | **20** | **0** | **60** | **0** | **100** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| **1** | **Introduction to Finite Element Method**<br>General steps of the finite element method. Engineering applications of finite element method. Advantages of the Finite Element Method. Mathematical foundation: Mathematical model of the engineering problem, Development of governing equations, Boundary and Initial value problems, Galerkin and Rayleigh-Ritz method. Basics of Finite Element Method: Finite element terminology (nodes, elements, Degrees of freedom, loads & constraint), Discretization and element equations, Assembly of element equations, Natural and essential boundary conditions, Solution of system of equations. | **25%** | **12** |
| **2** | **One Dimensional Analysis**<br>One dimensional second order equation, Primary and secondary variables, Discretization using 1D elements, Linear and higher elements, Derivation of shape functions and its properties, Formulation of elemental stiffness matrix and load vector, Assembly of elemental matrices, Properties of global stiffness matrix, half bandwidth, Boundary conditions elimination method and penalty approach, Symmetric boundary conditions. One-Dimensional Elements Analysis of Bars and Trusses. | **20%** | **9** |
| **3** | **Two-Dimensional Analysis**<br>Two dimensional equations, Types of 2D elements: triangular, quadrilateral and higher order elements, Derivation of shape functions and its properties, Formulation of elemental stiffness matrix and load vector, Assembly of elemental matrices, Properties of global stiffness matrix, Plane stress and plane strain problems, Plate and shell elements. Concept of Iso-parametric Elements Terms: Iso-parametric, super-parametric and sub-parametric. | **20%** | **9** |
| **4** | **FEM analysis of Beams and Shafts**<br>Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler-Bernoulli beam theory, Examples on cantilever beams, propped cantilever beams, Numerical problems on simply supported, fixed straight and | **20%** | **9** |

| | | | |
|---|---|---|---|
| | stepped beams using direct stiffness method with concentrated and uniformly distributed load. FEM analysis of Torsion of Shafts: Finite element formulation of shafts, determination of stress and twists in circular shafts. | | |
| **5** | **Heat Transfer analysis by FEM**<br>Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, 1D finite element formulation using vibration method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins. | **15%** | **6** |

**i. Text Book and Reference Book:**

1. Finite Element Methods in Engineering (TextBook) By Belegundu A.D., Chandrupatla, T.R. | Prentice Hall India
2. Text book of Finite Element Analysis (TextBook) By Seshu P., | PHI
3. Finite Element Procedures in Engineering Analysis (TextBook) By Bathe K.J., Cliffs, N.J. | PHI Learning, Eastern Economy Editions

**(4)**

**a. Course Name:** Finite Element Methods Lab
**b. Course Code:** 303109404
**c. Prerequisite:** Basic knowledge of Mechanics of Solids and preliminary understanding of mathematical concept such Calculus, Differential Equations, Vector and tensor analysis.
**d. Rationale:** This course empowers students to approximate solutions for complex differential equations via the Finite Element Method. It also enables applying this method to analyze heat flow and stress analysis of complex mechanical elements.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | To familiarize students with industry-standard Finite Element Analysis software for solving real-world engineering problems. |
| **CLOBJ 2** | To develop competence in modeling, analyzing, and validating 1D structural and thermal systems using FEA tools. |
| **CLOBJ 3** | To impart skills required for solving plane truss structures using FEA software and interpreting the results effectively. |
| **CLOBJ 4** | To train students in performing FEA of beam structures under different loading and boundary conditions, with a focus on result verification and validation. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Apply Finite Element Analysis software to perform basic engineering simulations. |
| **CLO 2** | Solve one-dimensional structural and thermal problems using FEA software. |
| **CLO 3** | Analyze plane truss problems and verify solutions using FEA tools. |
| **CLO 4** | Evaluate beam problems under various boundary and loading conditions using FEA software. |
| **CLO 5** | Validate the plate and shell problem using FEM and ANSYS. |

**g. Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **0** | **0** | **2** | **1** | **0** | **0** | **20** | **0** | **30** | **50** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**


1. Finite Element Methods in Engineering (TextBook) By Belegundu A.D., Chandrupatla, T.R. | Prentice Hall India
2. Text book of Finite Element Analysis (TextBook) By Seshu P., | PHI
3. Finite Element Procedures in Engineering Analysis (TextBook) By Bathe K.J., Cliffs, N.J. | PHI Learning, Eastern Economy Editions


**i. Experiment List:**

| **Exp. No.** | **Name of the Experiment** |
|---|---|
| 1 | Introduction to Finite Element Analysis software. |
| 2 | Solve 1D – Structural and thermal problems and verify using FEA software. |
| 3 | Solve Plane truss problems and verify using FEA software. |
| 4 | Solve Beam problems with different boundary and loading conditions and verify using FEA software. |
| 5 | Solve 2D problems using different element types and verify using FEA software. |
| 6 | Solve 3D problems using FEA software. |

| Exp. No. | Name of the Experiment |
|---|---|
| 7 | Solve plate and shell problems using FEA software. |
| 8 | Calculation of static stress concentration factor for a plate with centre hole subjected to axial loading in tension and verify using FEA software. |

**(5)**

a. **Course Name:** Refrigeration and Air Conditioning
b. **Course Code:** 303109431
c. **Prerequisite:** Knowledge of Thermodynamics, Fluid Mechanics Heat and Mass Transfer
d. **Rationale:** The course on Refrigeration and Air Conditioning (RAC) is designed to provide students with a comprehensive understanding of the fundamental principles and practical applications of cooling technologies. Given the widespread use of refrigeration and air conditioning systems in residential, commercial, and industrial sectors, this course plays a critical role in preparing students for careers in HVAC (Heating, Ventilation, and Air Conditioning), energy systems, and thermal management. This course bridges the gap between core thermodynamic theory and real-world applications, making it essential for mechanical engineering students pursuing careers in HVACR industries, energy efficiency consulting, and sustainability-focused engineering roles.

e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Understand the fundamental principles of refrigeration and air conditioning systems, including various thermodynamic cycles such as vapor-compression and absorption refrigeration. |
| **CLOBJ 2** | Analyze and evaluate the performance of refrigeration and air conditioning systems using parameters such as Coefficient of Performance (COP), refrigerant properties, and energy efficiency metrics. |
| **CLOBJ 3** | Demonstrate knowledge of refrigerants, their thermodynamic properties, environmental impact (ODP, GWP), and current regulations governing their use. |
| **CLOBJ 4** | Apply psychrometric principles to analyze air conditioning processes and determine the thermal comfort parameters for indoor environments. |
| **CLOBJ 5** | Design and select key system components, including compressors, condensers, evaporators, expansion devices, and air distribution systems, for both refrigeration and air conditioning applications. |
| **CLOBJ 6** | Use practical laboratory skills to assemble, operate, and troubleshoot basic RAC systems, enhancing their understanding of system behavior and diagnostics. |
| **CLOBJ 7** | Evaluate the energy efficiency and environmental impact of RAC systems and explore techniques for improving performance and sustainability. |

| | |
|---|---|
| **CLOBJ 8** | Apply safety standards and best practices in the handling of refrigeration systems and refrigerants during lab and field work. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Describe the fundamentals of refrigeration and air Conditioning. |
| **CLO 2** | Identify the properties of refrigerants and their environmental impacts. |
| **CLO 3** | Determine COP and cooling capacity of refrigeration system. |
| **CLO 4** | Apply psychometric principles to air Conditioning processes involved in HVAC. |
| **CLO 5** | Design duct layouts and air conditioning systems for human comfort. |
| **CLO 6** | Recognize the applications of refrigeration and air conditioning in core sector industries. |

**g. Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **-** | **-** | **3** | **20** | **20** | **-** | **60** | **-** | **100** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| **Sr. No.** | **Content** | **Weightage** | **Teaching Hours** |
|---|---|---|---|
| **1** | **Fundamental and History of Refrigeration and Air Conditioning** Brief history and need of refrigeration and air conditioning, methods of producing cooling, ton of refrigeration, coefficient of performance | **7%** | **2** |
| **2** | **Refrigerants** History of refrigerant development, classifications, nomenclature, desirable properties, environmental issues, secondary refrigerants,future industrial refrigerants. | **10%** | **3** |
| **3** | **Air Cycle Refrigeration Systems**<br>Reversed Carnot cycle and its limitation, Bell-Coleman cycle, aircraft refrigeration, working and analysis of Simple;<br>Bootstrap; Reduced ambient and Regenerative air refrigeration systems | **10%** | **5** |

| | | | |
|---|---|---|---|
| **4** | **Vapour Compression Refrigeration System** Comparison of Vapour Compression Cycle and Gas cycle, Ideal refrigeration cycle – Reversed Carnot cycle and maximum COP, Deviations of practical cycles fromCarnotcycle,Standard vapour compression refrigeration cycle,ph diagram, T-S diagram, COP of VCRS, analysis of the simple cycle, factors affecting the performance of the cycle, actual cycle. Multi-Pressure Systems: Multi stage or compound compression: two stage compression with flash intercooler, two stage compression system with flash gas removal, two stage compression system with flash chamber as a liquid sub-cooler, two stage compression system with water sub-cooler and water inter cooler; Multi-Evaporator system: Multi-evaporators at same temperature with single compressor and expansion valve, Multi-evaporators at different temperatures with individual expansionvalve and back pressurevalves, Multi-evaporators at differenttemperatures with multiple expansionvalve and back pressurevalves, Multi-evaporators operating at different temperatures with individual compressors and individual expansionvalves. Compound compression-multiple evaporators at different temperatures with individual expansion valves, Cascade refrigeration systems | **24%** | **13** |
| **5** | **Vapour Absorption Refrigeration Systems**<br>Desirable characteristics of refrigerant, selection of pair, practical H2O -NH3 cycle, LiBr – H2O system and its<br>working, h-x diagram and simple calculation of various process like adiabatic mixing and mixing with heat transfer,<br>throttling, Electrolux refrigeration system* | **9%** | **4** |
| **6** | **Components of Refrigeration System**<br>Compressors:types,constructionandworking;Condenser,Expansiondevices and Evaporator | **5%** | **2** |
| **7** | **Psychrometry**<br>Dalton's law of partial pressure, Properties of moist air, temperature and humidity measuring instruments, psychrometric chart, psychrometric processes such as sensible heating and cooling, heating and humidification cooling and dehumidification, chemical dehumidification, adiabatic saturation. | **10%** | **5** |
| **8** | **Human Comfort and Air Conditioning Systems** Human Comfort and Air Conditioning Systems: Selection of inside<br>design conditions, thermal comfort, heat balance equation for a human being, factors affecting thermal comfort, effective temperature, comfort chart and factors governing effective temperature, selection of outside design<br>Conditions.<br>**Air Conditioning Systems:**<br>Classifications, system components, all air; all water; and air-water systems, room air conditioners, packaged air | **10%** | **6** |

| | | | |
|---|---|---|---|
| | Conditioning plant, central air conditioning systems, split air conditioning systems.<br>Cooling Load Analysis – Site survey, outdoor and indoor design conditions, classification of loads, cooling load<br>Calculation. | | |
| **9** | **Duct design and Air distribution**<br>Function; classification and economic factors influencing duct layout, equal friction method of duct design, Requirements of air distribution system, air distribution, grills, outlets, application, location. | **10%** | **4** |
| **10** | **Applications of Refrigeration and Air Conditioning**<br>**Comfort Air conditioning:**<br>Residential air conditioning, Commercial air conditioning, Industrial airconditioning.<br>**Industrial Refrigeration:**<br>Chemical and process industries, Automotive, Dairy plants, Petroleum refineries. Food processing and food chain and Miscellaneous | **5%** | **3** |

**i. Text Book and Reference Book:**

1. Refrigeration and Air Conditioning by Arora C. P; Tata McGraw-Hill
2. Refrigeration and Air Conditioning by R.K Rajput; S.K.Kataria & Sons
3. Refrigeration and Air Conditioning by Stocker W.F. and J. W. Jones; McGraw-Hill
4. Refrigeration and Air Conditioning, Manohar Prasad; Willey Eastern Ltd, 1983
5. Refrigeration & Air Conditioning by Arora and Domkundwar, Dhanpatrai Company, New Delhi

**(6)**

**a. Course Name:** Refrigeration and Air conditioning Lab

**b. Course Code:** 303109432

**c. Prerequisite:** Knowledge of Thermodynamics, Fluid Mechanics Heat and Mass Transfer

**d. Rationale:** The Refrigeration and Air Conditioning (RAC) Lab is an essential practical component that complements the theoretical knowledge gained in the classroom. It provides students with hands-on experience in operating, analyzing, and troubleshooting refrigeration and air conditioning systems.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Identify and describe the function and construction of key components used in refrigeration systems such as compressors, condensers, evaporators, and expansion devices. |
| **CLOBJ 2** | Evaluate the performance of a heat pump test rig and interpret results to understand the principles of heating and cooling using reversed thermodynamic cycles. |
| **CLOBJ 3** | Analyze the operation of a vapor compression refrigeration system, conduct trials, and calculate key performance indicators such as Coefficient of Performance (COP) and system efficiency. |

| | |
|---|---|
| **CLOBJ 4** | Conduct experiments on a vapor absorption refrigeration system and compare its operation and efficiency with vapor compression systems. |
| **CLOBJ 5** | Assess the performance of a window air conditioning unit, including measurements of air temperature, humidity, and energy consumption. |
| **CLOBJ 6** | Perform testing and evaluation on a cascade refrigeration system to understand low-temperature applications and multistage refrigeration principles. |
| **CLOBJ 7** | Interpret psychrometric charts and analyze different psychrometric processes including sensible heating/cooling, humidification, dehumidification, and mixing of air streams. |
| **CLOBJ 8** | Perform practical psychrometric processes using a mini air conditioning system, and measure parameters affecting human comfort and indoor air quality. |
| **CLOBJ 9** | Understand and apply duct design methods, including velocity reduction and equal friction methods, for efficient air distribution system planning. |
| **CLOBJ 10** | Conduct a basic cooling load calculation for air-conditioned spaces using established methods, considering internal and external heat gains. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Demonstrate components of refrigeration and air Conditioning system. |
| **CLO 2** | Evaluate the performance of Heat pump, vapour compression and cascade refrigeration systems based on COP and refrigeration capacity. |
| **CLO 3** | Analyze the principles, working, and limitations of vapour absorption refrigeration systems. |
| **CLO 4** | Plot psychometric processes on a psychometric chart. |
| **CLO 5** | Analyze the performance of the air-conditioning process using a test rig under varying operating conditions. |
| **CLO 6** | Evaluate cooling load calculations for HVAC system. |

**g. Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **-** | **-** | **2** | **1** | **-** | **-** | **20** | **-** | **30** | **50** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Experiment List:**

| Sr. No. | Experiment Name |
|---|---|
| 1 | To study the different components of refrigeration system. |
| 2 | Performance on Heat Pump Test rig. |
| 3 | Performance on vapour compression test rig. |
| 4 | Trial on vapour absorption refrigeration system. |
| 5 | Performance Analysis of window air conditioner. |
| 6 | Performance on Cascade refrigeration system. |
| 7 | To study different Psychometric process and charts. |
| 8 | To perform different psychometric processes on mini air conditioning system. |
| 9 | To study Duct Design methods. |
| 10 | Study of cooling load calculation |

a. **Course Name:** Automobile Engineering
b. **Course Code:** 303109435
c. **Prerequisite:** Basic knowledge of mechanical systems and components, including engines and thermodynamics. Familiarity with fundamentals of physics and engineering mechanics is recommended.
d. **Rationale:** Automobile Engineering is a vital subject that provides foundational and advanced knowledge of vehicle systems, components, and technologies. It equips students with the skills to understand, analyze, and evaluate automotive design and performance. With the growing focus on electric and hybrid vehicles, this subject bridges traditional mechanical systems with modern innovations, preparing students for evolving industry demands.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | To understand the historical development, classification, and basic structure of automobiles. |
| **CLOBJ 2** | To study the transmission system, its necessity, functionality, and comparison across vehicle segments. |
| **CLOBJ 3** | To learn the design and functional principles of steering and suspension systems. |
| **CLOBJ 4** | To analyze the construction and working of the front axle, suspension mechanisms, and steering alignment. |
| **CLOBJ 5** | To evaluate braking systems, wheels, tires, and modern vehicle technologies including hybrid and electric vehicles. |
| **CLOBJ 6** | To gain knowledge of electrical components like batteries, lighting, and advanced safety and accessory systems in automobiles. |

### f. Course Learning Outcomes:

| | |
|---|---|
| **CLO 1** | Explain the functions of structural parts such as frame, chassis, and body. |
| **CLO 2** | Explain the necessity and working of transmission system. |
| **CLO 3** | Describe the components and principles of steering and suspension system. |
| **CLO 4** | Describe drive systems, differentials, and their parts for different types of vehicles. |
| **CLO 5** | Explain the construction and working of automobile braking systems. |
| **CLO 6** | Understand Working of batteries, lighting systems, safety features, and accessories. |

### g. Teaching & Examination Scheme:

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **-** | **0** | **3** | **20** | **20** | **-** | **60** | **-** | **100** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

### h. Course Content:

| **Sr. No.** | **Content** | **Weightage** | **Teaching Hours** |
|---|---|---|---|
| **1** | **Introduction & Automobile Performance**: Development of automobile, classification of automobiles, main parts of automobiles, vehicle assemblies, specifying an automobile, resistance to the motion of the vehicle. Chassis, Frame & Body: Types of frames, engine location, Comparison of front and rear mounting of engine, arrangement of clutch assembly, gearbox, propeller shaft with universal joints. front and rear differentials, rear,front and four wheel drives, their relative merits, types of chassis, pre requirements of body, types of bodies & their construction. | **15%** | **7** |
| **2** | **Transmission System:** Clutch : Necessity of a clutch, requirements of a good clutch, constructional features and working of different types of clutch used in automobiles, effect of misalignment and mis- adjustment of components, fluid coupling. Gear Box: Functions of gearbox, need of gear box, gears & gear ratios, principle of gearing, types of gear boxes, manual gearboxes, sliding mesh/ constant mesh/ synchro mesh type gear box, transfer case of 4 wheel drive vehicle. Automatic Transmission : Basic devices used in | **20%** | **8** |

| | | | |
|---|---|---|---|
| | automatic transmission, principle of epicyclic gearing ,torque converter, free wheel clutch, over speed drive and its working, semi/fully automatic transmission, continuously variable transmission(CVT). | | |
| **3** | **Drive line System:** Properller Shaft: Propeller shafts and their types, fluid drive and fluid flywheel, universal joints, hotchkiss drive, torque tube drive, whirling of propeller shaft. Differential: Principle of the differential, locking differential, limited slip differential Final Drive and Rear Axle: Final drives and its types, hypoid type final drive, rear axle, rear axle drives,rear axle shaft supporting, rear axle casing, axle breather, oil retention. | **15%** | **7** |
| **4** | **Axle, Suspension and Steering System:** Front Axle: Types, construction, components and their functions Principle of Suspension Syetm, Types of Suspension system, Conventional and Independent front and rear suspension system, spring, rubber and air suspensions, automatic/hydro suspension system, shock absorbers. Steering layout, types of steering gears, steering linkages, steering mechanism, definitions and significance of camber, caster, king pin inclination, toe in and toe out on turn, steering ratio, under steering and over steering, power assisted steering, steering geometry, wheel alignment. | **15%** | **8** |
| **5** | **Braking System, Wheel & Tyres:** Brakes: Principle, braking distance, braking efficiency ,weight transfer, wheel skidding, principle and working of various types of brakes (like drum/disc/mechanical/hydraulic etc.), power assisted brakes, hand brake, anti-lock brake systems (ABS). Wheels & Tyres : Types of wheels, wheel dimensions, types of tyres (conventional tubed tyre/tubeless tyre), comparison of radial and bias ply tyres, tyre materials, considerations in tyre design, tyre wear indicators, nitrogen tyres, factors affecting tyre life. Modern Vehicles: Construction and operational features of four wheelers available in Indian market, introduction to electric vehicles & hybrid vehicles. | **20%** | **8** |
| **6** | **Lighting System & Accessories:** Battery: Construction, Types of Batteries, Working, Battery Testing Lighting System: Wiring system, head lights, head lights, indicating lights. Accessories like direction indicators, hazard flashes, horn, speedometer, tachometer, wind screen wiper, wind screen washer.<br>Safety System :<br>Central locking system, power windows, and vehicle tracking system. Safety provisions like air bags/ safety belts | **15%** | **7** |

**i. Text Book and Reference Book:**

1. "Automobile Engineering Vol- I & II", by Dr. Kirpal Singh, Standard Pub.& Dist
2. "Automobile Engineering Vol- I & II" by Dr. K.M.Gupta, Umesh Pub.
3. "Automobile Engineering" by R. B. Gupta, Satya Prakashan
4. "Automobile Technology" by Dr.N.K.Giri, Khanna Publications.
5.

**a. Course Name:** Automobile Engineering Lab

**b. Course Code:** 303109436

**c. Prerequisite:** Basic understanding of automobile systems and mechanical components is essential. Familiarity with power transmission, dynamics, and vehicle design principles will enhance learning in lab experiments.

**d. Rationale:** The Automobile Engineering Lab offers practical experience with vehicle systems and components, reinforcing theoretical knowledge. It prepares students to analyze and improve vehicle performance in real-world settings.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | To familiarize students with standard vehicle terminologies and specifications used in the automotive industry. |
| **CLOBJ 2** | To provide hands-on experience in understanding and demonstrating key power transmission components. |
| **CLOBJ 3** | To develop the ability to measure and evaluate wheel balancing and its effect on vehicle performance. |
| **CLOBJ 4** | To study and explain the functional aspects of essential automobile systems through practical exposure. |
| **CLOBJ 5** | To analyze the effect of vehicle shape, features, and load conditions on aerodynamic performance using applied knowledge. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Understand the Vehicle Specification and Terminologies. |
| **CLO 2** | Demonstrate the working of Power Transmission Component. |
| **CLO 3** | Carryout Wheel Balancing test on Automotive Vehicle. |
| **CLO 4** | Describe the Working of Automobile Systems. |
| **CLO 5** | Evaluate resistance for aerodynamics on automobile vehicle. |
| **CLO 6** | Understand Lightning system of Automobile vehicle. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | Evaluation Scheme |
|---|---|

| L | T | P | C | Internal Evaluation | | | ESE | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | | MSE | CE | P | Theory | P | |
| 0 | - | 2 | 1 | - | - | 20 | - | 30 | 50 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**

1. "Automobile Engineering Vol- I & II", by Dr. Kirpal Singh, Standard Pub.& Dist
2. "Automobile Engineering Vol- I & II" by Dr. K.M.Gupta, Umesh Pub.
3. "Automobile Engineering" by R. B. Gupta, Satya Prakashan
4. "Automobile Technology" by Dr.N.K.Giri, Khanna Publications

**i. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| 1 | To Study the layout of Vehicle, Power Transmission And Motion Flow. |
| 2 | To Study About Chassis, Frame And Body In Automobile Vehicles. |
| 3 | Demonstration of Different types of Clutches Used In Automobile. |
| 4 | Demonstration of different types of Gear Boxes. |
| 5 | Demonstration of Automatic Transmission System. |
| 6 | Demonstration of Different Suspension Systems of An Automobile. |
| 7 | Demonstration of Different Types of Automobile Brakes. |
| 8 | Demonstration of Wheel Balancing And Alignment. |
| 9 | Demonstration of the Front Axle And Steering Mechanism in Automobile Vehicles. |
| 10 | Demonstration of Propeller Shaft Drive, Differentials And Rear Drive. |
| 11 | Demonstration of Battery and Wiring System of Automobile Vehicle. |

a. **Course Name:** Renewable Energy Engineering
b. **Course Code: 303109437**
c. **Prerequisite:** Knowledge of Basic Mechanical Engineering, Thermodynamics, and Heat Transfer.
d. **Rationale:** This course will give a fundamental understanding of various renewable energy sources like solar energy, wind energy, energy from biomass, geothermal energy, and energy from the ocean. The Students will learn the process of evaluating different renewable energy sources like Solar energy, Wind energy, Bioenergy, etc
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Explain the concepts of energy and power and their importance in everyday life. |
| **CLOBJ 2** | Describe various renewable energy sources such as solar, wind, bioenergy, tidal, ocean thermal, and geothermal energy. |
| **CLOBJ 3** | Evaluate different energy conversion techniques and assess their suitability for solar, wind, and bioenergy systems. |
| **CLOBJ 4** | Interpret the performance characteristics of solar and wind energy systems under various operating conditions. |
| **CLOBJ 5** | Identify recent trends and market developments in the renewable energy sector. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Discuss the current significance of renewable energy globally and in India. |
| **CLO 2** | Describe the fundamentals and working principles of solar energy systems. |
| **CLO 3** | Describe the working of wind energy conversion systems. |
| **CLO 4** | Compare different types of biogas plants and fuel cells based on design, operation, and applications. |
| **CLO 5** | Explain working principle of ocean energy devices and their applications in energy conversion. |
| **CLO 6** | Explain the working of different types of geothermal System. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Evaluation** | | | **ESE** | | **Total** |
| | | | | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **0** | **0** | **3** | **20** | **20** | **-** | **60** | **-** | **150** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Scenario of Renewable Energy Sources**<br>Brief history and need of renewable energy, in India and around the World – Potentials – Achievements /Applications. | **3%** | **2** |
| 2 | **Solar Energy**<br>Solar Radiation Geometry, Solar radiation - Outside the earth's atmosphere and at the earth's surface, Instruments for measurement of solar radiation and sunshine, local solar time, derived solar angles, sunrise, sunset, and day length.<br>Solar Thermal Energy – Fundamentals of Solar Thermal collectors, Different Concentrated solar thermal collectors,<br>Performance analysis of Flat Plate type Collector, Solar Water heater, Solar Air heater/dryer, Solar Thermal Energy Storage, Solar Distillation, Solar Process heating, Solar cooling.<br>Solar Photovoltaic – Solar Cell fundamentals, Solar PV Cell, Solar PV Module, Solar PV Panel, Solar PV Array, Solar Cell characteristic, Materials used in Solar Cells. | **35%** | **16** |
| 3 | **Wind Energy**<br>Introduction, power in wind, power coefficient, windmills- types, design consideration, performance, site selection, advantages and disadvantages, applications, wind energy development in India. | **20%** | **9** |
| 4 | **Bio Energy & Hydrogen**<br>Bio Energy<br>Introduction, types of biogas plants, biogas generation, factors affecting biogas generation, design consideration, advantages and disadvantages, site selection, applications, the scope of biogas energy in India, biomass energy, and energy plantation.<br>Fuel Cell & Hydrogen generation:<br>Introduction, Design principle and operation of fuel cell, Types and applications of Fuel cells, Hydrogen generation. | **17%** | **8** |
| 5 | **Ocean Energy**<br>Introduction, OTEC principle, open and closed cycle OTEC system, Energy from tides estimation of tidal power, tidal power plants, wave energy, wave energy conversion devices. Site requirements, advantages and disadvantages of Ocean Energy. | **15%** | **6** |
| 6 | **Geothermal Energy** | **10%** | **4** |

| | | | |
|---|---|---|---|
| | Introduction, Vapor dominated system; Liquid dominated system, Binary Cycle, Hot Dry Rock resources, Magma Resources, Geothermal Energy in India. | | |

**i. Text Book and Reference Book:**

1. Solar Energy: Principles of Thermal Collections and Storage (TextBook) By S.P. Sukhatme | McGraw Hill Publishing Co. "Total Quality Management" by Dr. S. Kumar
2. Renewable Energy Resources and Emerging Technologies (TextBook) By D. P. Kothari, K. C. Singal, R. Ranjan | PHI Learning Pvt. Ltd., Pub. Year 2011
3. Non-Conventional Energy Resources By B. H. Khan | Tata Mc Graw Hill Publishing Co. Ltd, New Delhi
4. Non-Conventional Energy Sources by G D Rai, Khanna Publishers, Delhi. (TextBook)

**a. Course Name:** Renewable Energy Engineering Lab

**b. Course Code:** 303109438

**c. Prerequisite:** Knowledge of Basic Mechanical Engineering, Thermodynamics, and Heat Transfer.

**d. Rationale:** This course will give a fundamental understanding of various renewable energy sources like solar energy, wind energy, energy from biomass, geothermal energy, and energy from the ocean. The Students will learn the process of evaluating different renewable energy sources like Solar energy, Wind energy, Bioenergy, etc

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Explain the concepts of energy and power and their importance in everyday life. |
| **CLOBJ 2** | Describe various renewable energy sources such as solar, wind, bioenergy, tidal, ocean thermal, and geothermal energy. |
| **CLOBJ 3** | Evaluate different energy conversion techniques and assess their suitability for solar, wind, and bioenergy systems. |
| **CLOBJ 4** | Interpret the performance characteristics of solar and wind energy systems under various operating conditions. |
| **CLOBJ 5** | Identify recent trends and market developments in the renewable energy sector. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Analyze the Performance of Solar Radiation Measuring Instruments. |
| **CLO 2** | Evaluate the Efficiency of Solar Thermal Systems. |
| **CLO 3** | Evaluate the current-voltage (I-V) and power-voltage (P-V) characteristics of photovoltaic modules. |
| **CLO 4** | Solve numerical problems related to wind power and wind energy systems. |

| | |
|---|---|
| **CLO 5** | Discuss Operating Parameters for Ocean and Geothermal System. |
| **CLO 6** | Demonstrate the working of biogas plant. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 0 | 0 | 2 | 1 | - | - | 20 | - | 30 | 50 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**


1. Solar Energy: Principles of Thermal Collections and Storage (TextBook) By S.P. Sukhatme | McGraw Hill Publishing Co. "Total Quality Management" by Dr. S. Kumar
2. Renewable Energy Resources and Emerging Technologies (TextBook) By D. P. Kothari, K. C. Singal, R. Ranjan | PHI Learning Pvt. Ltd., Pub. Year 2011
3. Non-Conventional Energy Resources By B. H. Khan | Tata Mc Graw Hill Publishing Co. Ltd, New Delhi
4. Non-Conventional Energy Sources by G D Rai, Khanna Publishers, Delhi. (TextBook)


**j. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| 1 | Case study on different renewable energy sources. |
| 2 | Performance on different instruments for measurement of Solar Radiation. |
| 3 | Performance on Sun shine recorder for measurement of bright sun shine hours. |
| 4 | Exercise based on concepts of solar energy. |
| 5 | Evaluation of the efficiency of solar thermal system with fixed input parameters. |
| 6 | Demonstrate the I-V and P-V characteristics of PV modules with varying radiation and temperature levels. |
| 7 | Comparative study of horizontal axis and vertical axis windmills. |
| 8 | Comparative study of different biogas energy generation plants. |
| 9 | Case study of Ocean Thermal Energy Conversion systems and geothermal energy. |
| 10 | Case study of Fuel cell & Hydrogen generation in Industry. |

a. **Course Name:** Industrial Robotics
b. **Course Code: 303109439**
c. **Prerequisite:** Knowledge of basic concepts related to transformation matrices and zeal to learn the subject.
d. **Rationale:** To impart widespread acquaintance of robotic system along with different configurations, their kinematics, singularity problems, dynamics, Trajectory planning and real field applications of them.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | To understand the fundamental concepts, structure, and configurations of industrial robotic systems |
| **CLOBJ 2** | To analyse robot motion and pose using coordinate transformations and homogeneous matrices. |
| **CLOBJ 3** | To apply kinematic modelling techniques including DH parameters for forward and inverse kinematics. |
| **CLOBJ 4** | To examine velocity, static, and dynamic behaviour of robotic manipulators. |
| **CLOBJ 5** | To understand robotic sensors, trajectory planning methods, and industrial applications of robots. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Identify the key components of robotic manipulators, including links, joints, degrees of freedom, and end effectors. |
| **CLO 2** | Model direct and inverse kinematics of robotic manipulators using Denavit-Hartenberg (DH) representation |
| **CLO 3** | Analyze velocity of rigid bodies in robotic manipulators using transformation matrix and evaluate Jacobian singularities. |
| **CLO 4** | Describe the dynamic properties of robotic systems using Lagrangian and Newton-Euler formulations in relation to kinematics and dynamics. |
| **CLO 5** | Explain the principles and functions of robotic sensors, grippers, and vision systems, along with their industrial applications |
| **CLO 6** | Analyze robotic trajectories using joint space and cartesian space techniques. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **3** | **0** | **0** | **3** | **20** | **20** | **-** | **60** | **-** | **100** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **General considerations of Robotic Manipulator**<br>Robot anatomy: Links, Joint and joint notations scheme, Degrees of freedom; Arm and wrist configurations, End effectors; Coordinate frames, Mapping between: Rotated frames, translated frames, rotated and translated frames; Description of robotic pose in a space; Homogeneous transformation and inverting a homogeneous transformation; Orientation with RPY and Euler angles (Forward and inverse formulations. | **20%** | **9** |
| 2 | **Kinematics of Robotic Manipulators**<br>Direct Kinematics, Kinematic Modelling of the Manipulator; Denavit Hartenberg (DH) Representation; Inverse Kinematic; Manipulator Work space, Solvability of inverse kinematic models: Existence of Solution, Multiplicity of Solutions; Solution Techniques, Guidelines for Closed form Solution. | **20%** | **9** |
| 3 | **Differential Motion and Statics**<br>Linear and Angular Velocity of a rigid body; Relation between transformation matrix and angular velocity; Mapping velocity vectors; Linear and Angular velocity of a link; Manipulator Jacobian; Jacobian Singularities; Static analysis of robots. | **20%** | **8** |
| 4 | **Differential Motion and Statics**<br>Linear and Angular Velocity of a rigid body; Relation between transformation matrix and angular velocity; Mapping velocity vectors; Linear and Angular velocity of a link; Manipulator Jacobian; Jacobian Singularities; Static analysis of robots. | **10%** | **5** |
| 5 | **Robotics Sensors, Grippers and Vision Sensors**<br>Acoustic, Optic, Pneumatic, Force/ Torque sensors; Properties of Sensors, Robotic Vision systems, Industrial Applications of Vision based robotic systems. Robotic grippers and their design criteria. | **15%** | **6** |
| 6 | **Trajectory Planning**<br>Steps in trajectory planning; various terminologies; Joint space techniques; point to point motion with via points; Linear function with parabolic blends; Cartesian space techniques, Parametric description of straight and circular path. | **10%** | **5** |
| 7 | **Robot Applications**<br>Industrial, Material Handling, Processing, Assembly: Peg in hole, Compliance, Inspection, Surgical, Space and | **5%** | **3** |

| | | | |
|---|---|---|---|
| | Military applications; Principles for robot application and application planning. | | |

**i. Text Book and Reference Book:**

1. Robotics and Control By R K Mittal, I. J. Nagrath| McGraw Hill Publishing Co.
2. Introduction to Robotics (Mechanics and Control) By John J. Craig, Addison – Wesley | PHI Learning Pvt. Ltd., Pub. Year 2011
3. Industrial Robotics Technology: Programming and Applications By M. P. Groover, Mitchell Weis, Roger, N. Nagel, G. Nicholas and Odrey | Tata Mc Graw Hill Publishing Co. Ltd, New Delhi

**a. Course Name:** Industrial Robotics Lab

**b. Course Code:** 303109440

**c. Prerequisite:** Knowledge of basic concepts related to transformation matrices and zeal to learn the subject.

**d. Rationale:** To impart widespread acquaintance of robotic system along with different configurations, their kinematics, singularity problems, dynamics, Trajectory planning and real field applications of them.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | To understand the fundamental concepts, structure, and configurations of industrial robotic systems |
| **CLOBJ 2** | To analyse robot motion and pose using coordinate transformations and homogeneous matrices. |
| **CLOBJ 3** | To apply kinematic modelling techniques including DH parameters for forward and inverse kinematics. |
| **CLOBJ 4** | To examine velocity, static, and dynamic behaviour of robotic manipulators. |
| **CLOBJ 5** | To understand robotic sensors, trajectory planning methods, and industrial applications of robots. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Analyze Degree of Freedom (DOF) of robotic systems |
| **CLO 2** | Illustrate the characteristics of basic robot joints using advanced simulation software |
| **CLO 3** | Calculate end-effector position of open and closed-loop configurations by direct kinematic computation |
| **CLO 4** | Determine the required joint parameters for open and closed-loop configurations using inverse kinematics computation |
| **CLO 5** | Visualize robot motion using DH parameters |
| **CLO 6** | Simulate the trajectory to ensure accurate path following by the robot. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 0 | 0 | 2 | 1 | - | - | 20 | - | 30 | 50 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Text Book and Reference Book:**


1. Robotics and Control By R K Mittal, I. J. Nagrath| McGraw Hill Publishing Co.
2. Introduction to Robotics (Mechanics and Control) By John J. Craig, Addison – Wesley | PHI Learning Pvt. Ltd., Pub. Year 2011
3. Industrial Robotics Technology: Programming and Applications By M. P. Groover, Mitchell Weis, Roger, N. Nagel, G. Nicholas and Odrey | Tata Mc Graw Hill Publishing Co. Ltd, New Delhi


**j. Experiment List:**

| Exp. No. | Name of the Experiment |
|---|---|
| 1 | Interpret different Robotic systems, various configurations and perform DOF calculations. |
| 2 | Elaborate basic robot Joints and its simulation using high end computer software. |
| 3 | Compute direct kinematics for open/closed loop configurations analytically/simulation/coding. |
| 4 | Compute inverse kinematics for open/closed loop configurations analytically/simulation/coding. |
| 5 | Perform coding and simulation of direct kinematics for open/closed loop configurations along with work space generation using high end software. |
| 6 | Formulate DH parameters of robot configuration and its simulation using open source software. |
| 7 | Prepare a code for Lagrangian formulation of the given configuration and validate it using simulation software. |
| 8 | Prepare a code for Newtonian formulation of the given configuration and validate it using simulation software. |
| 9 | Design a trajectory for a specific task as given by instructor. |
| 10 | Perform stimulation of a trajectory planning of a robot. |

| Exp. No. | Name of the Experiment |
|---|---|
| 11 | Classify various robotic sensors along with specifications and their applications area. |

a. **Course Name:** Energy Conservation and Management
b. **Course Code:** 303109343
c. **Prerequisite:** Fundamentals of Thermodynamics and Environmental Studies
d. **Rationale:** The Knowledge of Energy Conservation and Management is essential to address rising energy demand, reduce operational costs, and minimize environmental impact. It equips students with practical skills to optimize energy use, comply with regulations, and support sustainable development.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Understand the global and national energy scenario and recognize the environmental impacts of energy use, along with relevant energy policies and regulation |
| **CLOBJ 2** | Conduct different types of energy audits using appropriate methodologies, tools, and instruments, and apply concepts of energy monitoring, targeting, and benchmarking using systems like EMIS. |
| **CLOBJ 3** | Analyze electrical energy consumption in systems such as motors and lighting, and propose energy-efficient alternatives and conservation techniques, including LED technology and motor efficiency improvements. |
| **CLOBJ 4** | Evaluate thermal energy systems like boilers, furnaces, HVAC, and waste heat recovery systems to identify opportunities for energy conservation and enhanced efficiency. |
| **CLOBJ 5** | Understand international frameworks and mechanisms such as the UNFCCC, Kyoto Protocol, and Clean Development Mechanism. |
| **CLOBJ 6** | Apply financial and economic analysis techniques to evaluate energy conservation projects, including payback period, NPV, IRR, ROI, life cycle costing, and performance contracts. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Discuss the global and national energy scenarios, policies, and regulatory frameworks related to energy conservation and environmental impact |
| **CLO 2** | Evaluate energy auditing methods, monitoring techniques, and management systems for effective energy and cost optimization. |
| **CLO 3** | Analyze energy efficiency opportunities in electrical systems including billing, motors, and lighting technologies. |
| **CLO 4** | Assess energy efficiency measures in thermal systems including boilers, furnaces, cogeneration, HVAC, and waste heat recovery. |

| | |
|---|---|
| **CLO 5** | Explain climate change protocols and their relevance to environmental sustainability. |
| **CLO 6** | Evaluate energy project economics using financial and risk analysis techniques. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Internal Evaluation | | | ESE | | Total |
| | | | | MSE | CE | P | Theory | P | |
| 2 | 1 | 0 | 3 | 20 | 20 | 50 | 60 | - | 150 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Introduction**<br>Introduction to energy & power scenario of world, National Energy consumption data and environmental aspects associated with energy utilization. Energy conservation Act 2001, Schemes of Bureau of Energy Efficiency, Star rating on appliances, Electricity Act 2003, Integrated energy policy, National action plan on climate change. | 10% | 3 |
| 2 | **Financial Management and Energy Targeting Energy Audit:**<br>Need, types of Energy Audit, methodology of Energy Audit, role of energy managers, instruments of energy auditing, Energy management (audit) approach understanding energy costs, Bench marking. Energy Monitoring and Targeting: Definition, elements of monitoring & targeting, cumulative sum of differences (CUSUM). Energy Management Information Systems (EMIS). | 20% | 7 |
| 3 | **Energy Efficiency and conservation in Electrical Systems**<br>Components of EB billing, Concept, Electric motors-motor efficiency computation, energy efficient motors, Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting. | 20% | 6 |
| 4 | **Energy Efficiency and conservations in Thermal Systems**<br>Boilers, Furnaces, Co-Generation system, Steam Systems, waste heat recovery systems, Heating, ventilation and air | 20% | 7 |

| | | | |
|---|---|---|---|
| | conditioning (HVAC) system, Insulation and refractories system. | | |
| **5** | **Energy and Climate Change**<br>United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), Prototype Carbon Fund (PCF). | **10%** | **2** |
| **6** | **Energy Economics**<br>Financial analysis techniques; Time value of money, Discount period, payback period, internal rate of return ,Return on Investment, net present value, risk and sensitivity analysis, Life Cycle costing, Energy performance contract and energy service companies | **20%** | **5** |

**i. Text Book and Reference Book:**


1. Industrial Energy Management Systems (Textbook) By Arry C. White, Philip S. Schmidt, David R. Brown | Hemisphere Publishing Corporation
2. Design and Management for Energy Conservation (Text Book) By Callaghan P.W. | Pergamon Press, Oxford, 1981.
3. Energy Management (Text Book), By W.R.Murphy, G.Mckay.
4. Bureau of Energy Efficiency Reference book: No.1, 2, 3, 4


**j. List of Tutorial:**

| Tut. No. | Name of the Tutorial |
|---|---|
| 1 | Current Energy scenario and Energy conservation act 2001. |
| 2 | Evaluate energy Efficiency in Electric motor and lighting system. |
| 3 | Energy audit instruments for performance testing. |
| 4 | Perform Detail Energy Audit of a Building/laboratory. |
| 5 | Case study on performance of any one thermal Utility. |
| 6 | To Identify Energy conservation opportunities in various thermal Systems. |
| 7 | To Analyze Economics of Financial system using various financial Analysis Techniques |
| 8 | Case Study on role of energy conservation on Climate change for sustainable Environment. |

a. **Course Name:** Waste to Energy Conversion
b. **Course Code:** 303109444
c. **Prerequisite:** : Knowledge of Basic Mechanical Engineering and Engineering Thermodynamics.
d. **Rationale:** This course provides knowledge of utilization, pertinent technologies, centralized and decentralized systems and environmental impact of the energy from waste.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Focuses on the operations of Waste to Energy plants, linking to waste management principles, energy conversion technologies, and waste options. |
| **CLOBJ 2** | Involves analysing waste management systems, including waste classification, management methods, and environmental impacts. |
| **CLOBJ 3** | Focuses on techno-economic feasibility, leveraging knowledge of conversion technologies, waste options, and environmental factors. |
| **CLOBJ 4** | Involves applying knowledge to planning and operations, especially regarding waste characterization, technological setups, and operational processes. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Apply the knowledge about the operations of Waste to Energy Plants. |
| **CLO 2** | Analyse the various aspects of Waste to Energy Management Systems. |
| **CLO 3** | Carry out Techno-economic feasibility for Waste to Energy Plants. |
| **CLO 4** | Apply the knowledge in planning and operations of Waste to Energy plants. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **2** | **1** | **0** | **3** | **20** | **20** | **50** | **60** | **0** | **150** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

| **Sr. No.** | **Content** | **Weightage** | **Teaching Hours** |
|---|---|---|---|
| **1** | **Introduction**<br>The Principles of Waste Management and Waste Utilization. Waste Management Hierarchy and 3R | **10%** | **3** |

| | | | |
|---|---|---|---|
| | Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source. | | |
| **2** | **Waste Sources & Characterization**<br>Waste production in different sectors such as domestic, industrial, agriculture, post-consumer, waste etc. Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization. Waste Selection criteria. | **15%** | **4** |
| **3** | **Technologies for Waste to Energy**<br>Biochemical Conversion – Energy production from organic waste through anaerobic digestion and fermentation.<br>Thermo-chemical Conversion – Combustion, Incineration and heat recovery,<br>Pyrolysis, Gasification and other newer technologies. | **20%** | **6** |
| **4** | **Waste to Energy Options**<br>Landfill gas, collection and recovery. Refuse Derived Fuel (RDF) – fluff, briquettes, pellets.<br>Alternate Fuel Resource (AFR) – production and Industrial applications.<br>Energy from Plastic Wastes – Non-recyclable plastic wastes for energy recovery. | **20%** | **6** |
| **5** | **Centralized and Decentralized Waste to Energy Plants**<br>Waste activities – collection, segregation, transportation and storage requirements.<br>Industry Specific Applications – In-house use – sugar, distillery, pharmaceuticals, Pulp and paper, refinery and petrochemical industry.<br>Centralized and Decentralized Energy production, distribution and use. | **20%** | **6** |
| **6** | **Environmental Implications**<br>Environmental standards for Waste to Energy Plant operations and gas clean-up. Savings on non-renewable fuel resources. Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms. | **15%** | **3** |

**i. Text Book and Reference Book:**


1. Handbook of Solid Waste Management and Waste Minimization Technologies By Nicholas P. Cheremisinoff, Butterworth-Heinemann, Pub. Year 2003
2. Solid Waste Engineering By William A. Worrell And P. Aarne Vesilind | Cengage Learning | Second Edition, Pub. Year 2012
3. Waste-to-Energy in Austria – White Book – Figures, Data Facts | 2nd edition,

Pub. Year 2010
4. Report of the task Force on Waste to Energy, Niti Ayog (Formerly Planning Commission), Pub. Year 2014
5. Biogas Technology - A Practical Hand Book By Khandelwal, K. C. and Mahdi, S. S. | Tata McGraw Hill Publishing Co. Ltd., Pub. Year 1983
6. Biomass Conversion and Technology By C. Y. WereKo-Brobby and E. B. Hagan | John Wiley & Sons, Pub. Year 1996
7. Wealth from Waste: Trends and Technologies By Banwari Lal and Patwardhan | TERI Press
8. Fundamentals of waste and Environmental Engineering By S.N Mukhopadhyay | TERI Press

**j. List of Tutorials:**

| Tut. No. | Name of the Tutorial |
|---|---|
| 1 | Study of waste management and waste utilization. |
| 2 | Study of waste sources and characterization. |
| 3 | Study of Biochemical and Thermochemical Conversion. |
| 4 | Study of Alternative fuel resource and energy from plastic wastes. |
| 5 | Case studies on Centralized and Decentralized Waste to Energy Plants in India. |
| 6 | Study of environmental implications for waste to energy plants. |
| 7 | Case studies on Global Best Practices in Waste to energy production distribution and use. |
| 8 | Case studies on Indian Scenario on Waste to Energy production distribution and use in India. |

a. **Course Name:** Industry 4.0
b. **Course Code:** 303109445
c. **Prerequisite:** : Basic knowledge of Computer, Internet and Manufacturing
d. **Rationale:** The course will prepares students for the digital transformation of manufacturing by integrating IoT, AI, and smart technologies. It equips them to solve real-world industrial problems, enhance productivity, and drive innovation, ensuring they are ready to meet modern industry demands with efficiency, adaptability, and technical competence.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Understand the integration of digital technologies such as IoT, AI, and automation to improve efficiency, productivity, and quality in manufacturing systems. |
| **CLOBJ 2** | Analyze and apply smart manufacturing principles to enhance flexibility, reduce costs, and support innovation in dynamic industrial environments. |
| **CLOBJ 3** | Understand the impact of Industry 4.0 on competitiveness, economic growth, and customer satisfaction through real-world applications and case studies. |
| **CLOBJ 4** | Develop skills to adapt to modern industrial challenges by leveraging digital transformation tools and concepts. |
| **CLOBJ 5** | Foster innovation and strategic thinking to contribute effectively to digitalized supply chains and connected industrial ecosystems. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Know about Industry 4.0 and its scope. |
| **CLO 2** | Understand paradigm of the Smart Factory. |
| **CLO 3** | To structure, prepare and present scientific and technical documentation. |
| **CLO 4** | Implement Artificial intelligence tool to solve the industrial problem. |
| **CLO 5** | Apply learned skills to approach problems that exist in real life. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Examination Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Marks** | | | **External Marks** | | **Total** |
| **L** | **T** | **P** | **C** | **T** | **CE** | **P** | **T** | **P** | |
| **2** | **1** | **0** | **3** | **20** | **20** | **50** | **60** | **-** | **150** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

| Sr. No. | Content | W | T |
|---|---|---|---|
| 1 | **Introduction to Industry 4.0:** Introduction to Sensing & Actuation, Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, Lean Production Systems, Smart and Connected business perspective. | **18** | **5** |
| 2 | **Basic principles and Technologies of a Smart Factory** Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Big Data and Advanced Analysis, Introduction to FDM machine, Customization of products, Digital Twins, Cloud Computing / Cloud Manufacturing, Security issues within Industry 4.0 networks | **20** | **6** |
| 3 | **AI and AR VR Insights in Industry 4.0:** AI Environment Challenges in AI, Current work in AI for environment, Customer Experience (CX) and the use of AI in industries, Future challenges in AI, Augmented reality characteristics, Difference between Augmented Reality and Virtual Reality, AR technological components, Importance of AR, Real world uses of AR, Software tools available for AR | **20** | **6** |
| 4 | **Basics of Industrial Internet of Things (IIOT) :** Introduction, Industrial Internet system, Industrial process, Key enablers of IIOT, Cyber Security | **20** | **6** |
| 5 | **Supply Chain Management:** Overview and principles, Use of AI and IoT in optimizing production processes, Case studies of successful implementations, Supply Chain 4.0, Integration of digital technologies in supply chain management, Predictive analytics for demand forecasting, block chain in logistics, Smart Products and Services, Product lifecycle management in the digital age, Customization and personalization through data analytics | **22** | **7** |

**h. Text Book and Reference Book:**


1. The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics by Christoph Jan Bartodziej.
2. Industry 4.0: Concepts, Processes and Systems by Hema Gurung and Ravi Kant.
3. Systems Foundations for Industry 4.0 by Adediran Badiru and Ojo Omitaomu.
4. Industry 4.0 for Manufacturing Systems by Anika Wankhede, K.E.K. Sahlot, and J.R. Gopinath.
5. Handbook of Industry 4.0 and SMART Systems by Diego Galar Pascual, Pasquale Daponte, and Uday Kumar.
6. Industry 4.0, Smart Manufacturing, and Industrial Engineering by P. Kumar, A. Tyagi, N. Tiwari, and G. Ahmad.

**i. Tutorial List:**

| Sr. No. | Tutorial List |
|---|---|
| 1. | Industry 4.0 Essentials and Case Studies. |
| 2. | Practical Implementation of IoT in Industry 4.0. |
| 3. | Robotic Automation in Manufacturing in Industry 4.0. |
| 4. | Hands on 3D Printing |
| 5. | AR VR Applications in Manufacturing |
| 6. | Hands on VR experience in Welding |
| 7. | Cyber security Challenges in Industry 4.0: Case Study Review |
| 8. | Supply Chain Management :Case Study Review |

**a. Course Name:** Nanomaterials and Surface Engineering

**b. Course Code:** 303109448

**c. Prerequisite:** Knowledge of basic engineering science and fundamentals of materials.

**d. Rationale:** The course is designed to offer an advanced exploration of Nanotechnology and Nanoscience, enabling students to grasp the intricacies of materials at the nanoscale. By integrating engineering and nanotechnology tools, the course empowers students to tackle complex industrial challenges with innovative solutions. Through a focus on surface engineering, students gain insights into the manipulation of material properties for enhanced functionality and performance. This approach fosters a deep understanding of how nanomaterials interact at interfaces, crucial for designing novel technologies and materials. Ultimately, the subject equips engineering students with the expertise needed to drive forward technological innovation and address pressing industrial demands in today's rapidly evolving landscape.

**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Explain the fundamental properties, structure-mechanism-property-performance relationship of nanostructures and nanomaterials. |
| **CLOBJ 2** | Classify and describe various nanostructured catalytic materials such as nanostructured metals, ceramics, colloids, and porous materials. |
| **CLOBJ 3** | Demonstrate an understanding of various nanomaterial synthesis techniques, including template-based synthesis, sol-gel techniques, electrospinning, and chemical conversion. |
| **CLOBJ 4** | Characterize and differentiate nanoporous materials like silicon, zeolites, mesoporous materials, and carbon nanotubes, along with their unique properties and applications. |
| **CLOBJ 5** | Describe the physicochemical properties of supercritical fluids and their applications in nanomaterial synthesis, purification, and extraction. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Understand difference between properties Nano material and conversion materials |
| **CLO 2** | Understand about materials and their properties at the atomic level, including an understanding of the intimate relationship between scale and size, nanostructure and the properties of materials |
| **CLO 3** | Understand the application of Nanomaterials |
| **CLO 4** | Understand the template based Nano synthesis. |
| **CLO 5** | Understand the physical, chemical and mechanical properties of nanomaterial |

**g. Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Examination Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Marks** | | | **External Marks** | | **Total** |
| | | | | **T** | **CE** | **P** | **T** | **P** | |
| **2** | **1** | **0** | **3** | **20** | **20** | **50** | **60** | **-** | **150** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

| **Sr. No.** | **Content** | **W** | **T** |
|---|---|---|---|
| **1** | **Introduction:** Overview of properties of nanostructures and nanomaterials, Performance of nanomaterials based on size, structure-mechanism- property-performance pathway. | **10** | **4** |
| **2** | **Important catalytic materials:** Nanostructured metals like Pt, Pd and Fe, nanostructured ceramics like silica, silicate and alumina, pillared clays, colloids and porous materials (viz. mesoporous materials) | **20** | **6** |
| **3** | **Synthesis of Nano Structure:** Template based nano synthesis, Electrochemical deposition and Electrophoretic deposition, Sol gel technique, Colloidal dispersion filling, Melt and solution filling, Deposition by centrifugation, Converting through chemical reactions, Electro spinning | **20** | **6** |
| **4** | **Nanoporous Materials:** Silicon, Zeolites, mesoporous materials, nanomembranes and carbon nanotubes, AgX photography, and transparent conducting oxides, molecular sieves, nanosponges | **20** | **6** |
| **5** | **Supercritical Fluids:** | **10** | **4** |

| | | | |
|---|---|---|---|
| | Introduction, Physicochemical Properties, Solubility, Viscosity, Diffusion, Thermal Conductivity, Applications, Purification and Extraction of SF, Synthesis processes of SF. | | |

**h. Text Book and Reference Book:**


1. Nanostructured Materials and Nanotechnology, Hari Singh Nalwa; Academic PressInc.(London)
2. Nanomaterials, Nanotechnologies and Design: An Introduction to Engineers and Architects, D.Michael Ashby, Paulo Ferreira, Daniel L. Schodek, Butterworth-Heinemann
3. Chemistry of Nanomaterials: Synthesis, properties & applications CNR Rao,; A Muller & AK Cheetham; Volume-I
4. Principles of Colloid and Surface Chemistry Paul C. Hiemenz, Marcel Dekker; 2nd
5. Handbook of Nanophase and Nanostructured Materials Eds: Z.L. Wang, Y. Liu, Z. Zhang; Kluwer Academic/Plenum Publishers,
6. Handbook of Nanoceramics and their Based nanodevices: yTseung-Yuen Tsengand Hari Singh Nalwa; American Scientific Publishers
7. Nanostructures & Nanomaterials: Synthesis, Properties &Applications G. Cao; Imperial College Press


**i. Tutorial List:**

| Sr. No. | Tutorial List |
|---|---|
| 1. | Evaluate the challenges and future prospects associated with the widespread adoption of nanostructured materials in various industries. |
| 2. | Provide examples of catalytic materials used in industrial processes, environmental remediation, and energy conversion/storage applications, discussing their mechanisms and performance. Also provide Evaluate the challenges associated with the design and optimization of catalytic materials for specific reactions and propose potential strategies to overcome these challenges. |
| 3. | Explore the role of various parameters such as temperature, pressure, reaction time, and precursor concentration in controlling the size, shape, and morphology of nanostructures during synthesis. Also propose potential research directions for further improving the efficiency, reproducibility, and scalability of nanostructured material synthesis techniques. |
| 4. | Provide examples of industrial applications of supercritical fluids, such as supercritical fluid extraction (SFE) for natural product extraction, supercritical fluid chromatography (SFC) for analytical separations, and supercritical fluid deposition (SFD) for thin film fabrication. |
| 5. | Investigate the industrial applications of nano porous materials in areas such as gas separation, water purification, chemical sensing, catalysis, and energy storage, providing examples and discussing the specific advantages offered by nano porous materials in each application. Also examine the challenges associated with scaling up nano porous materials synthesis for industrial production, considering factors such as reproducibility, cost-effectiveness, and sustainability. |

| | |
|---|---|
| 6. | Examine the mechanisms of desorption and the factors influencing desorption kinetics, such as temperature, pressure, and surface coverage. Propose potential research directions for further advancing our understanding of surface phenomena and their applications in fields such as materials science, nanotechnology, and environmental science. |

a. **Course Name:** Operation Research
b. **Course Code:** 303109446
c. **Prerequisite:** : Knowledge of Statistics and Mathematics
d. **Rationale:** Operation Research and Optimization Technique is the essential for developing and understanding about commonly used quantitative techniques. This course develops ability of a person to use intelligent application of appropriate tools to complex decision making problem.
e. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Explain the basic concepts, scope, characteristics, and limitations of Operations Research, along with its various phases of implementation. |
| **CLOBJ 2** | Formulate and solve linear programming problems using graphical, simplex, Big-M, and two-phase methods, including sensitivity analysis and duality. |
| **CLOBJ 3** | Utilize methods like North-West Corner Rule, Least-Cost Method, MODI, Hungarian Method, and solve advanced problems such as Traveling Salesman Problem (TSP). |
| **CLOBJ 4** | Demonstrate an understanding of game theory concepts, solve two-person zero-sum games, and apply replacement models to optimize equipment replacement decisions. |
| **CLOBJ 5** | Apply queuing theory concepts and inventory control techniques (including EOQ and ABC analysis) to solve real-world operational problems. |

f. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Assess the real world problems and formulate mathematical models to find optimum solution. |
| **CLO 2** | Analyze problems using linear programming and other mathematical programming algorithms. |
| **CLO 3** | Construct an inventory control model based upon given data. |
| **CLO 4** | Estimate manufacturing resource and just-in-time for proper planning. |

g. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Examination Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **L** | **T** | **P** | **C** | **Internal Marks** | | | **External Marks** | | **Total** |
| | | | | **T** | **CE** | **P** | **T** | **P** | |
| **2** | **1** | **0** | **3** | **20** | **20** | **50** | **60** | **-** | **150** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

| Sr. No. | Content | W | T |
|---|---|---|---|
| 1 | **Basics of operation research**<br>Definition, characteristics, phases, scope and limitations of OR | 6 | 2 |
| 2 | **Linear programming**<br>Formulation of Linear programming problem, Graphical method Simplex method, Big-M method, Two phase method, Special cases in graphical and simplex method. Duality, Sensitivity analysis. | 25 | 8 |
| 3 | **Transportation model**<br>North-West Corner rule, Least-cost method, Vogel's approximation method, Degeneracy in transportation problem, stepping stone method, Modified Distribution Method (MODI's method), Unbalanced Supply And Demand. Assignment model Hungarian method for solution, non-square matrix, restriction on assignments, Maximization problem, Traveling Salesman Problem (TSP) | 25 | 7 |
| 4 | **Games theory**<br>Terms used in game theory, Two person zero sum games, pure strategy, matrix reduction by dominance, mixed strategies (2x2, 2xn, mx2, 3x3 games) Algebraic, arithmetic and graphical method. | 12 | 4 |
| 5 | **Replacement models**<br>Introduction, Reasons for Replacement of Equipment, Emergence of Equipment Replacement, Replacement Models, Sudden Failure Items. | 12 | 3 |
| 6. | **Queuing models**<br>Elements of Queuing System, Characteristics of Waiting Lines, Service Discipline, Service Mechanism, Standard Queuing Models. | 10 | 3 |
| 7. | **Inventory Control**<br>Inventory classification, Different cost associated to Inventory, Economic order quantity, Inventory models with deterministic demands, ABC analysis. | 10 | 3 |

**h. Text Book and Reference Book:**


1. Operations Research by R. Pannerselvam, Prentice Hall of India.
2. Operations Research by D.S. Hira and P.K. Gupta, S. Chand Publications.
3. Quantitative Techniques in Management by N.D. Vohra, Tata McGraw Hill.
4. Introduction to Operations Research by Hiller and Libermann, Tata McGraw Hill.
5. Operations Research: An Introduction by Taha Hamdy, Prentice Hall India.

6. Operation Research: Theory and Application by J.K.Sharma, Macmillan India Ltd.
7. Engineering Optimization: Theory and Practice, Singiresu S. Rao, John Wiley & Sons.

**j. Tutorial List:**

| Sr. No. | Tutorial List |
|---|---|
| 1. | Introduction to Operation Research. |
| 2. | Exercise on Linear Programming- Formulation & Graphical Method. |
| 3. | Exercise on Linear Programming: Simplex Methods. |
| 4. | Exercise on Transportation and Assignment Problems. |
| 5. | Solve Problems on Game Theory. |
| 6. | Solve Problems on Replacement Models. |
| 7. | Solve Problems on Queuing Models. |
| 8. | Solve Problems on Inventory Models. |
| 9. | Solve Problems on Optimization Techniques. |

**a. Course Name:** Electric Vehicles
**b. Course Code:** 303109447
**c. Prerequisite:** : Fundamentals of IC Engine and Automobile
**d. Rationale:** This comprehensive course offers an in-depth exploration of Electric Vehicles (EVs), equipping you with the knowledge and understanding to thrive in this rapidly evolving industry. Demystify the technology behind EVs, gain insights into vehicle dynamics, and explore the intricate components that power these revolutionary machines.
**e. Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Explain the history, classification, components, and general layout of Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs), including their types and real-world examples. |
| **CLOBJ 2** | Calculate the various forces acting on a vehicle (aerodynamic drag, rolling resistance, hill climbing, acceleration), and model real-world conditions to assess the power and energy requirements of EVs and HEVs. |
| **CLOBJ 3** | Describe battery fundamentals, including types (Lead-Acid, Nickel-based, Lithium-Ion), characteristics, charging methods, and the role of Battery Management Systems (BMS). |
| **CLOBJ 4** | Compare various electric motor types (Induction, Permanent Magnet, BLDC, SRM) used in EVs, and determine their suitability through motor selection, sizing, and RPM/torque calculations. |
| **CLOBJ 5** | Explain the functions of various controllers (DC and AC controllers), including their components (resistors, inductors, capacitors, diodes, transistors) and their role in efficient EV operation. |

**f. Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Describe the basic components and types of electric vehicles (EVs) based on their structure and working principles. |
| **CLO 2** | Explain the fundamental principles of vehicle dynamics with respect to motion, forces, and stability analysis. |
| **CLO 3** | Illustrate the fundamental concepts of battery operation including charging/discharging characteristics and efficiency. |
| **CLO 4** | Interpret the working principles of electric motors and their suitability for electric vehicle (EV) applications based on performance characteristics and application requirements. |
| **CLO 5** | Explain the types of electric vehicle (EV) controllers and their roles in managing power flow and enhancing system performance. |

**g. Teaching & Examination Scheme:**

| Teaching Scheme | | | | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Internal Marks | | | External Marks | | Total |
| L | T | P | C | T | CE | P | T | P | |
| 2 | 1 | 0 | 3 | 20 | 20 | 50 | 60 | - | 150 |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

| Sr. No. | Content | W | T |
|---|---|---|---|
| 1 | **Introduction and Hybrid Power Train:** History, Basics of Electric Vehicles, Components of Electric Vehicle, General Layout of EV, EV classification: Battery Electric Vehicles (BEVs), Fuel-Cell Electric Vehicles (FCEVs) Hybrid Powertrain: Series HEVs, Parallel HEVs, Series–Parallel HEVs, Complex HEVs, Operating Modes, Degree of Hybridization, Comparison of HEVs, Plug-in Hybrid Electric Vehicles (PHEVs) Real Life examples of HEVs, Compare and contrast the performance of ICE vehicles, HEVs and EVs, Advantages & Disadvantages of EV, National Policy for adoption of EVs, Overview of Tesla car. | 20 | 6 |
| 2 | **Vehicle Dynamics** Introduction, Forces Acting on a Rolling Vehicle, Aerodynamic Drag (Fad), Rolling Resistance (Frr), Hill Climbing (Fhc), Linear Acceleration (Fla), Angular Acceleration (Fωa), Tractive Force (Fte), Power Required for Rolling Motion, Power Required for Real-World Designs, Power Required for Air Resistance and Rolling Resistance, Power Required for Hill Climbing, Power Required for Acceleration, Modeling Real-World Conditions, Modeling v | 25 | 8 |

| | | | |
|---|---|---|---|
| | and a over Time, Modeling ψ over Time, Modeling Energy, Efficiency, and Range. | | |
| **3** | **Batteries:** Introduction, Battery Fundamentals, Lead-Acid Battery, Nickel Based Battery, Lithium-Ion Batteries, Battery Characteristics: Cost, Energy Storage/Charge Capacity, Battery Life, Energy Density, Specific Power, State of Charge and Depth of Discharge, Cell and Battery Voltages, Charge and Energy Efficiency, Battery Temperature, Battery Electric Vehicle Charging, Charging Level, Charging Connectors, Charging Process. Introduction to Battery management system. | **20** | **6** |
| **4** | **Electric Motors :** Types of motors used in EV, Construction - Working operation - characteristics of Induction motors, permanent magnet motors, BLDC motor, SRM motor, Comparison of all motors, Selection and sizing of Motor, RPM and Torque calculation of motor Motor Controllers Component sizing, Physical locations. | **20** | **6** |
| **5** | **Controllers:** Introduction, Circuit Elements, Resistors, Inductors. Capacitors, Diodes, Transistors, Controllers, Step-Down DC Controllers Step-Up/Down DC Controllers, AC Controllers. | **15** | **4** |

**h. Text Book and Reference Book:**


1. The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics by Christoph Jan Bartodziej.
2. Industry 4.0: Concepts, Processes and Systems by Hema Gurung and Ravi Kant.
3. Systems Foundations for Industry 4.0 by Adediran Badiru and Ojo Omitaomu.
4. Industry 4.0 for Manufacturing Systems by Anika Wankhede, K.E.K. Sahlot, and J.R. Gopinath.
5. Handbook of Industry 4.0 and SMART Systems, by Diego Galar Pascual, Pasquale Daponte, and Uday Kumar.
6. Industry 4.0, Smart Manufacturing, and Industrial Engineering, by P. Kumar, A. Tyagi, N. Tiwari, and G. Ahmad.


**k. Tutorial List:**

| Sr. No. | Tutorial List |
|---|---|
| 1. | Demonstration of EV Components and Systems. |
| 2. | Exploring Hybrid Power Technologies. |
| 3. | Case Study on EV Batteries. |
| 4. | EV Charging and Management. |
| 5. | Analysis of EV Motors. |
| 6. | EV Controller : Types, Construction and Working. |

a. **Course Name:** Industrial Safety and Maintenance Engineering
a. **Course Code:** 303109449
b. **Prerequisite:** Zeal to Learn the Subject
c. **Rationale:** This course equips individuals with the knowledge and skills to ensure the safety and efficiency of industrial facilities, protecting employees and assets while optimizing operations. It helps prevent accidents, maintain equipment, and reduce costs associated with downtime and repairs.

d. **Course Learning Objective:**

| | |
|---|---|
| **CLOBJ 1** | Describe the principles and functions of maintenance management and **outline** industrial practices adopted for effective maintenance activities. |
| **CLOBJ 2** | Apply the concepts of predictive maintenance and condition monitoring to diagnose equipment performance in industrial applications. |
| **CLOBJ 3** | Analyse vibration and noise data to predict potential equipment failures and develop preventive maintenance strategies to optimize asset lifespan. |
| **CLOBJ 4** | Apply the concepts of failure patterns and evaluate system reliability for series, parallel, and mixed configurations. |
| **CLOBJ 5** | Explain industrial safety principles and identify safety hazards, standards, and control measures used to prevent accidents in engineering environments. |

e. **Course Learning Outcomes:**

| | |
|---|---|
| **CLO 1** | Explain the principles, functions and practices adapted in industry for the successful management of maintenance activities. |
| **CLO 2** | Apply the knowledge of Predictive maintenance and conditioning monitoring concepts for industrial applications. |
| **CLO 3** | Use vibration and noise as tools to predict failures for preventive maintenance and help optimize the lifespan of industrial assets. |
| **CLO 4** | Apply the concept of failure pattern, system reliability: Series, Parallel and Mixed. |
| **CLO 5** | Explain the safety engineering aspects in industry. |

f. **Teaching & Examination Scheme:**

| **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Internal Evaluation** | | | **ESE** | | **Total** |
| **L** | **T** | **P** | **C** | **MSE** | **CE** | **P** | **Theory** | **P** | |
| **2** | **1** | **0** | **3** | **20** | **20** | **50** | **60** | **-** | **150** |

**L-** Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

g. **Course Content:**

| Sr. No. | Content | Weightage | Teaching Hours |
|---|---|---|---|
| 1 | **Objective of Maintenance**<br>Importance of Maintenance, Types of maintenance – Breakdown, preventive and predictive maintenance – Repair cycle - Repair Complexity, Lubrication and Lubricants. Maintenance of Mechanical transmission systems and process plants. | **24%** | **8** |
| 2 | **Predictive Maintenance**<br>Vibration and noise as maintenance tool - wear debris analysis - Condition monitoring concepts applied to industries - Total Productive Maintenance (TPM) - Economics of Maintenance- Basics of Computer aided maintenance | **22%** | **6** |
| 3 | **Reliability**<br>Definition, concept of reliability-based design, failure rate, MTTF, MTBF, failure pattern, Breakdown Analysis: FTA, FMTA, FMECA, system reliability: Series, Parallel and Mixed configurations - Availability and Maintainability concepts- Applications. | **22%** | **6** |
| 4 | **Safety and Productivity**<br>Causes of accidents in industries – accident reporting and investigation - measuring safety performance – Safety organizations and functions - Factories act and rules. | **16%** | **5** |
| 5 | **Safety Codes and Standards**<br>General Safety considerations in Material Handling equipment - Machine Shop machineries-pressure vessels and pressurized pipelines – welding equipment – operation and inspection of extinguishers – prevention and spread of fire–emergency exit facilities. | **16%** | **5** |

**h. Text Book and Reference Book:**


1. Reliability Engineering By Srinath LS | Affiliated East-West Press Pvt Ltd, Delhi
2. Industrial Safety By Ronald P. Blake | Prentice Hall, New Delhi, 1973
3. Maintenance Engineering By H.P.Garg | S. Chand and Company
4. Reliabilty Engineering By Balagurusamy. E. | Tata Mcgraw Hill Publishing Company


**i. Experiment List:**

| Sr. No. | Experiment List |
|---|---|
| 1 | Study about maintainability. |

| | |
|---|---|
| 2 | Study about wear and service life of equipment. |
| 3 | Study about maintenance and repair of production equipment. |
| 4 | Study about restoring of the guide ways of machine tools. |
| 5 | To study maintenance planning and scheduling. |
| 6 | Study about preventive maintenance. |
| 7 | Study about industrial safety. |
| 8 | Study about accidents and industrial hazards. |
| 9 | Study about safety measurement |
| 10 | Study about legal aspect of safety and safety education. |