ST. JOHN CAMPUS - PALGHAR

ALDEL EDUCATION TRUST

# St. John College of Engineering and Management

**Autonomous Institute**

**(A Christian Religious Minority Institution)**

Approved by AICTE and DTE, Affiliated to University of Mumbai / MSBTE

DTE Code : 3218 AICTE Permanent ID : 1-4790201

NAAC Accredited with Grade 'A+', Three Programs NBA Accredited

# Autonomy Syllabus Scheme of BE / B.Tech in Mechanical Engineering (Semester: III, IV, V, VI, VII & VIII)

## As Per NEP 2020

St. John College of Engineering & Management

## Academic Year 2026-27

## AUTONOMY SCHEME

| Sr. No. | Heading | Particulars |
|---|---|---|
| 1 | Title of the Course | Mechanical Engineering |
| 2 | Eligibility for Admission | As per the Institute Examination Ordinance |
| 3 | Theory Passing Marks (IAE / ESE) | 40% |
| 4 | Continuous Assessment (CA) / Oral / Practical | 40% |
| 5 | To be implemented from Academic Year | With effect from Academic Year: 2026-27 |
| 6 | Total Credits | Maximum 168 |
| 7 | Honor / Minor Courses offered | • Additional Credits: 18<br>• Offered via MOOCs |
| 8 | Eligibility Criteria for Honor / Minor | • Students with no backlog in semester I, II and III.<br>• The CGPI based on Semester I, II and III of the students must be 6.75 and above.<br>• For Direct Second Year (DSE) Students – No backlog in semester III and CGPI must be 6.75 and above. |

## Preface

University Grants Commission vide Letter No. F. 2–10/2023 (AC–Policy) dated 19th January 2024 conferred the autonomous status to St. John College of Engineering and Management, Village Vevoor, Manor Road, Palghar (East), 401404 affiliated to University of Mumbai for a period of 10 years from the academic year 2024-2025 to 2033-2034 as per clause 7.5 of the UGC (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations 2023. Designing the curriculum as an autonomous institution raises challenges pertaining to maintaining quality engineering education.

Systematic approach has been adapted in the design and implementation of curriculum with the intent of ensuring quality education catering to the sensitive needs of a learner, society, and industry. The curriculum is aligned with NEP and UGC guidelines as per Government of Maharashtra guidelines for autonomous institutions Government Resolution dated 4th July 2023.

Based on recent recommendations of the GR, holistic curriculum for 2026-30, a "H-Tree Model" of Engineering Education is offered. A unique "H-Tree Model" of Engineering Education Curriculum is followed and curriculum is designed to systematically develop IQ (Intelligence Quotient), PQ (Physical Quotient), EQ (Emotional Quotient), and SQ (Spiritual Quotient) of a learner. This curriculum aims at the development of an all-rounded personality with holistic approach to education in which a learner receives 34% teacher-led learning, 15% peer learning, 26% self-learning, and 25% experiential learning. The curriculum model is outcome based that focuses on learning by doing. Curriculum is designed to provide multiple learning opportunities for students to acquire and demonstrate competencies for rewarding careers. It ensures multiple choices to a leaner acquiring skills through systematic planning. It has 7 verticals aligned to GR recommendations with strong science and mathematics foundation and program core, sequel of electives, multidisciplinary minor courses, humanities & management courses, and sufficient experiential learning through projects and semester-long industry/research internship along with employable skill-based courses. A learner gets an opportunity to acquire skills through NSDC aligned courses during summer vacations. As per NEP 2020, the curriculum follows the Multiple Entry and Multiple Exit (MEME) framework, enabling students to earn appropriate qualifications at different stages. Students completing the prescribed credits may exit after the First Year with a Certificate in faculty, Second Year with a Diploma in faculty, Third Year with a B.Sc. in Engineering, and Fourth Year with a B.E./B.Tech. Degree (with MDM / with Honours in Emerging Area with MDM / Honours with Research and MDM / with MDM and with Emerging Minor, as applicable). The respective exit requires fulfilment of prescribed credits and NSQF-aligned job-role certification at Level 4.0 after First Year, Level 5.0 after Second Year, and Level 5.5 after Third Year.

The curriculum balances contact hours and total credits of the entire program. The total credits are 168, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore, in the present curriculum, skill-based laboratories, mini-projects, multi-disciplinary projects, and internships are made mandatory across all disciplines of engineering, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the scheme and syllabus are in line with AICTE model curriculum. SJCEM: R-25 (Second Year) and SJCEM: R-24C (Third and Final Year) curriculum will be implemented for Mechanical Engineering from the academic year 2026-27.

**Nomenclature**

| Abbreviation | Title |
|---|---|
| BSC | Basic Science Courses |
| ESC | Engineering Science Courses |
| PCC | Program Core Courses |
| PEC | Program Elective Courses |
| MDM | Multidisciplinary Minor |
| OE | Open Elective |
| SC | Skill Courses |
| LLC | Liberal Learning Courses |
| VSEC | Vocational and Skill Enhancement Course |
| VEC | Value Education Course |
| SEC | Skill Enhancement Courses |
| AEC | Ability Enhancement Course |
| IKS | Indian Knowledge System |
| CC | Co-curricular Courses |

**Credit Specification:**

- Theory: 1 credit = 15 hours of teaching
- Lab: 1 Credit = 30 hours of lab work.
- Workshop Based Activities: 1 Credit = 30 hours of hands-on activities related to vocation/professional practice/skill based
- Seminar/Group Discussion: 1 Credit = 15 hours of participation
- Community Engagement Projects: 1 Credit = 30 hours of contact time along with 15 hours of activities preparation, report writing, independent reading etc.(Total 45 hours)

**Dr. Kishor Rambhad**
**BoS Chairman**

**Dr. Kamal Shah**
**Principal**

## Evaluation and Assessment Scheme

### A. Internal Assessment Examination (IAE)

| Theory Credit | Component | Details | Marks | Duration |
|---|---|---|---|---|
| 2 or 3 | IAE 1 | Covers any 3 Course Outcomes (COs) | 20 Marks | 1 Hour |
| | IAE 2 | Covers remaining 3 Course Outcomes (COs) | 20 Marks | 1 Hour |
| 1 | IAE 1 | Covers any 3 Course Outcomes (COs) | 10 Marks | 30 Minutes |
| | IAE 2 | Covers remaining 3 Course Outcomes (COs) | 10 Marks | 30 Minutes |

### B. End Semester Theory Examination (ESE)

| Theory Credits | Component | Details | Marks | Duration |
|---|---|---|---|---|
| 2 or 3 | ESE | Based on entire syllabus | 60 Marks | 2 Hours |
| 1 | ESE | Based on entire syllabus | 30 Marks | 1 Hour |

### C. Continuous Assessment (CA)

| Component | Details | Marks |
|---|---|---|
| Experiments / Tutorials | 8 to 10 experiments covering all COs | 10 Marks |
| Attendance | Theory & Practical attendance | 05 Marks |
| Teacher Assessment Examination (TAE) | Anyone/more activity from listed options | 10 Marks |

**TAE Activity Options**

| Sr. No. | Activity |
|---|---|
| 1 | Assignment |
| 2 | Case Study |
| 3 | Debate |
| 4 | Solution for Social Problems |
| 5 | Field Visit |
| 6 | Group Project |
| 7 | Flip Classroom |
| 8 | Topic Review |
| 9 | Quiz |
| 10 | Mind Mapping |
| 11 | Research Paper Review |
| 12 | Any other (as per subject need) |

### D. Oral & Practical Examination

| Component | Details | Marks |
|---|---|---|
| Practical / Implementation/ written test | Based on Experiments performed | 15 Marks |
| Oral Exam | Based on Syllabus / Experiments | 10 Marks |

## SUSTAINAGLE DEVELOPMENT GOALS (SDGs)



# Bachelor of Technology
# In
# Mechanical Engineering

## Second Year
## Semester – III

## SJCEM: R–25

## Effective from Academic Year

## 2026-27

**Program Structure for Second Year Mechanical Engineering**
**(With Effect from 2026-27)**
**Semester-III**

| Course Code | Vertical | Course Name | Contact Hrs | | | Credit Allotted | | | Total Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Th | Tut | Pr | Th | Tut | Pr | |
| 25MEPCC301 | PCC | Mathematics for Mechanical Engineering | 3 | - | - | 3 | - | - | 3 |
| 25MEPCC302 | PCC | Thermal Science and Engineering | 3 | - | - | 3 | - | - | 3 |
| 25MEPCC303 | PCC | Mechanics of Materials | 3 | - | 2 | 3 | - | 1 | 4 |
| 25MEPCC304 | PCC | Conventional and Digital Fabrication | 3 | - | 2 | 3 | - | 1 | 4 |
| 25MEPCC305 | PCC | Material Science and Engineering | 2 | - | 2 | 2 | - | 1 | 3 |
| 25MEPCC306 | PCC | Solid Modeling and 3D Printing Lab | - | - | 2 | - | - | 1 | 1 |
| 25MEVEC301 | VEC | Universal Human Values | 2 | 1 | - | 2 | 1 | - | 3 |
| 25MEAEC301 | AEC | Employability Enhancement Program -I (Communication) | - | 1 | - | - | 1 | - | 1 |
| | | **Total** | **16** | **2** | **8** | **16** | **2** | **4** | **22** |

| Course Code | Vertical | Course Name | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Theory | | | Practical | | Total |
| | | | IAE 1 | IAE 2 | ESE | CA | Or / Pr | |
| 25MEPCC301 | PCC | Mathematics for Mechanical Engineering | 20 | 20 | 60 | - | - | 100 |
| 25MEPCC302 | PCC | Thermal Science and Engineering | 20 | 20 | 60 | - | - | 100 |
| 25MEPCC303 | PCC | Mechanics of Materials | 20 | 20 | 60 | 25 | 25 | 150 |
| 25MEPCC304 | PCC | Conventional and Digital Fabrication | 20 | 20 | 60 | 25 | 25 | 150 |
| 25MEPCC305 | PCC | Material Science and Engineering | 20 | 20 | 60 | 25 | - | 125 |
| 25MEPCC306 | PCC | Solid Modeling and 3D Printing Lab | - | - | - | 25 | - | 25 |
| 25MEVEC301 | VEC | Universal Human Values | 10 | 10 | 30 | 25 | - | 75 |
| 25MEAEC301 | AEC | Employability Enhancement Program -I (Communication) | - | - | - | 25 | - | 25 |
| | | **Total** | **110** | **110** | **330** | **150** | **50** | **750** |

# Syllabus

# for

# Second Year Mechanical Engineering

# Semester – III

# SJCEM : R–25

# (With Effect from 2026-27)

| Course Title: Mathematics for Mechanical Engineering | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** III | | | **Term:** Odd | | | | **Course Code:** 25MEPCC301 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | - | 3 | - | - | 3 | 20 | 20 | 60 | - | - | 100 |
| **Sustainable Development Goals Mapped:** 4, 8, 9, 11, 12 | | | | | | | | | | | | |

**Course Objectives:** The course is aimed

1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2. To study the Matrix algebra and its application in engineering problems.
3. To familiarize with the concepts of statistics and sampling theory for data analysis.
4. Demonstrate the Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.

**Course Outcomes:** At the end of the course students will be able to:

1. Apply the Laplace and Inverse Laplace transform techniques used in solving various engineering problems.
2. Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat equation.
3. Apply the concepts of eigenvalues and eigenvectors to solve engineering problems.
4. Apply the concept of Correlation and Regression to the engineering problems in data Science, machine learning and AI.
5. Demonstrate the validity of testing the hypothesis to arrive at a decision regarding the population through a sample.
6. Expand the periodic function by using Fourier series for real life problems and complex engineering problems

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Laplace Transforms**<br>Introduction, Definition, Existence conditions, basic properties, Inverse Laplace transform and properties, Convolution Theorem and properties, Applications of Laplace transforms to solve initial and boundary value problems involving Ordinary Differential Equations.<br>**Self-learning topics**: Second Shifting theorem, Heaviside's Unit Step function, Dirac Delta Function. | 10 | 1 | 3 |
| **II** | **Partial Differential Equations**<br>Introduction of Partial Differential Equations-Heat equation, Wave equation, Laplace equation, Crank Nicholson method, Bender Schmidt method<br>**Self-learning Topics:** Analytical methods of solving two- and three-dimensional problems. | 6 | 2 | 3 |
| **III** | **Linear Algebra (Matrices)**<br>Characteristic equation, Eigenvalues and Eigenvectors, Properties of Eigenvalues and Eigenvectors. (No theorems/ proof), Cayley-Hamilton theorem (without proof): Application to find the inverse of the given square matrix and to determine the given higher | 7 | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| | degree polynomial matrix. Similarity of matrices, Diagonalization of matrices.<br>**Self-learning Topics**: Functions of square matrix, Minimal polynomial and Derogatory matrix | | | |
| **IV** | **Statistical Techniques**<br>Karl Pearson's Coefficient of correlation (r), Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems), Lines of regression, Fitting of first- and second-degree curves.<br>**Self-learning Topics:** Covariance, fitting of exponential curve. | 8 | 4 | 3 |
| **3V** | **Sampling Theory**<br>Introduction, Parameter and Statistics, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom, Students' t-distribution (Small sample). Test the significance of mean and Difference between the means of two samples. Chi-square test: Test of goodness of fit and independence of attributes (Contingency table).<br>**Self-learning Topics**: F-test, Test of significance of large samples, Proportion test, Survey based project. | 7 | 5 | 2 |
| **VI** | **Fourier Series:**<br>Dirichlet's conditions, Definition of Fourier series, Fourier series of periodic functions with period $2\pi$ and $2l$, Fourier series of even and odd functions, Half range Sine and Cosine Series.<br>**Self-learning Topics:** Parseval's Identity, Complex form of Fourier Series, orthogonal and orthonormal set of functions, Fourier Transform.<br>**Advanced Topic**: Numerical Methods using Python for Engineering Applications | 7 | 6 | 3 |

**Reference Books:**

1. Advanced Engineering Mathematics, C. Ray Wylie, Louis C. Barrett, McGraw-Hill Book Co., New York, 6th Edition.
2. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.

**Text Books:**

3. Higher Engineering Mathematics, Dr. B.S. Grewal, Khanna Publication, 44th Edition.
4. Linear Algebra & its applications, David C. Lay, Pearson Publication, 3rd Edition.
5. Introductory Probability and Statistical Applications, B L Mayer, Wiley Eastern Limited, 2nd Edition.

**Useful links:**

https://archive.nptel.ac.in/courses/111/103/111103021/#
http://archive.nptel.ac.in/courses/111/106/111106139/
https://archive.nptel.ac.in/courses/111/101/111101164/

| Course Title: Thermal Science and Engineering | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** III | | | **Term:** ODD | | | | **Course Code:** 25MEPCC302 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | - | 3 | -- | - | 3 | 20 | 20 | 60 | -- | -- | 100 |
| **Sustainable Development Goals Mapped:** 4, 7, 8, 9, 11, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To familiarize the concepts of Energy in general and Heat and Work in particular
2. To study the fundamentals of quantification and grade of energy
3. To study the effect of energy transfer on properties of substances in the form of charts and diagrams
4. To familiarize the application of the concepts of thermodynamics in vapour power and gas power cycles.

**Course Outcomes:**

At the end of the course students will be able to:

1. Demonstrate application of the laws of thermodynamics to a wide range of systems.
2. Compute heat and work interactions in thermodynamic systems
3. Apply Second Law principles, and critically analyse the concept of perpetual motion machines while distinguishing between reversible and irreversible processes.
4. Compute thermodynamic interactions using the steam table and Mollier chart
5. Compute efficiencies of vapor power cycles.
6. Compute efficiencies of gas power cycles.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Basic concepts and properties:** Introduction, thermodynamic system, control volume, macroscopic and microscopic approaches, properties and state of a system, point and path functions, thermodynamic equilibrium, process and cycle, quasi-static process, intensive and extensive properties. Zeroth law of thermodynamics, Thermodynamic heat and work. Ideal gas, Equation of state, universal gas constant, Enthalpy, **Self-learning topics**: Specific heat at constant volume and constant pressure, change in internal energy. P-V diagrams. temperature scales, temperature measurement, pressure measurement | 8 | 1 | 2 |
| II | **First Law of Thermodynamics:** Law of conservation of energy, Joule's experiment, first law applied to closed system, first law applied to open system. **First law applied to flow processes:** steady-state steady flow process, mass balance and energy balance in steady flow process, steady flow energy equation and its application to nozzles and diffusers, throttling valve, turbines, compressors, pumps and heat exchangers. **Self-learning topics**: Energy-a property of system, internal energy: a function of temperature, heat & work transfer during various non-flow processes. | 8 | 2 | 3 |

| | | | | |
|---|---|---|---|---|
| III | **Second Law of Thermodynamics:** Limitations of First Law, Thermal reservoirs, Kelvin-Plank & Clausius statements, Heat engines, Refrigerator & Heat pump, Perpetual motion machines, Reversible & Irreversible processes,<br>**Entropy:**<br>Clausius theorem, Entropy is property of a system, Temperature-Entropy diagram, Clausius inequality, Increase of entropy principle, Tds relations, Entropy change During a process.<br>**Self-learning topics**:<br>**Availability:**<br>High grade and low-grade energy, Available and Unavailable energy, Dead State, | 8 | 3 | 4 |
| IV | **Properties of steam**: Advantages and applications of steam, Phase change process of water, Saturation pressure and temperature, Terminology associated with steam, Different types of steam. Property diagram: T-v diagram, p-v diagram, p-T diagram, Critical and triple point, T-s and an h-s diagram for water, Calculation of various properties of wet, dry and superheated steam using the steam table and Mollier chart**.**<br>**Self-learning topics**:<br>**Phases of Matter**: Solid, liquid, gas, and phase transitions (melting, freezing, vaporization, condensation, sublimation, and deposition). | 7 | 4 | 3 |
| V | **Vapor power cycles:** Principal components of a simple steam power plant, Carnot cycle and its limitations as a vapour cycle, Rankine cycle with different turbine inlet conditions, Mean temperature of heat addition, Reheat Rankine Cycle,<br>**Self-learning topics:** Modified Rankine cycle, | 7 | 5 | 3 |
| VI | **Gas Power cycles:** Nomenclature of a reciprocating engine, Mean effective pressure, Assumptions, derivation and efficiency calculation of air Standard Cycle, Otto cycle, Diesel Cycle and Dual cycle, Comparison of Otto and Diesel cycle for same compression ratio,<br>**Self-learning topics:** p-v and T-s diagram of Brayton cycle, Sterling Cycle, Ericsson Cycle, Lenoir cycle, and Atkinson cycle (Only theory).<br>**Advanced Topic:** Energy Systems, Exergy Analysis and Sustainable Power Generation | 7 | 6 | 3 |

**Reference Books:**

1. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael A. Boles, 9th edition, McGraw Hill, 2019.
2. Thermodynamics by Onkar Singh, 4th Edition New Age International, 2018.
3. Engineering Thermodynamics by P Chattopadhyay, 2nd edition, Oxford University Press India, 2016
4. Basic Engineering Thermodynamics by Rayner Joel, 5thedition, Longman Publishers, 1996.
5. Basic and Applied Thermodynamics, Nag P. K., 4th Edition, Tata McGraw-Hill, 2014.
6. Thermodynamics by C P Arora,1st Edition TMH, 2017.
7. Engineering Thermodynamics Through Examples by Y V C Rao, Universities Press (India) Pvt Ltd., 2003.

8. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., 9th Edition John Wiley& Sons, 1985.
9. Thermodynamics by J P Holman, 4th Edition McGraw-Hill & Co, 1987.

**Text Books:**

1. Thermal Engineering, Mahesh Rathore, 5th Edition, Tata McGraw Hill, 2010.
2. Engineering Thermodynamics by P K Nag, 6th Edition, McGraw Hill, 2017.
3. Fundamentals of Engineering Thermodynamics by Moran &Shapiro, Eighth Edition, Wiley,2014.

**Useful Links**

1. https://nptel.ac.in/courses/112/105/112105266/
2. https://nptel.ac.in/courses/112/103/112103275/
3. https://nptel.ac.in/courses/112/105/112105220/
4. https://nptel.ac.in/courses/101/104/101104063/

| Course Title: Mechanics of Materials | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** III | | | **Term:** ODD | | | | **Course Code:** 25MEPCC303 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | 2 | 3 | -- | 1 | 4 | 20 | 20 | 60 | 25 | 25 | 150 |
| **Sustainable Development Goals Mapped:** 4, 8, 9, 11, 12 | | | | | | | | | | | | |

**Course Objectives:**

1. To understand stress-strain behavior under different loading conditions.
2. To draw shear force and bending moment diagrams for various beams.
3. To calculate stresses, deflections, and torsion in structural members.
4. To learn strain energy methods and principal stress analysis.

**Course Outcomes:** At the end of the course students will be able to:

1. Demonstrate fundamental knowledge about various types of loading and stresses induced.
2. Calculate, develop and analyze the SFD and BMD for various types of beams.
3. Analyze the bending and shear stresses induced in the beam.
4. Analyze effect of impact & twisting of components.
5. Compute Stresses induced in cylindrical shape components and Analyse buckling phenomenon in columns.
6. Compute Principal Stress & strain energy for a given system.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **1.1 Stress and Strain:** Definition, Stress- strain, uni-axial, bi-axial and tri-axial stresses, tensile & Compressive stresses, shear Stress-Elastic limit, Hooke's Law. Poisson's Ratio, Modulus of elasticity, Modulus of rigidity, Bulk modulus, Yield stress, Ultimate stress. Factor of safety, state of simple shear, relation between elastic constants, Volumetric Strain, Volumetric strain for tri-axial loading, **Self-learning topics:** Deformation of tapering members, bars of varying sections, composite sections, Thermal Stress, | 8 | 1 | 2 |
| II | **2.1 Shear Force and Bending Moment:** Definition of beam Types of beams Concept of shear force and bending moment S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, U.D.L., uniformly varying loads and combination of these loads Point of contra flexure. **Self-learning topics:** Identifying points of zero shear force and maximum/minimum bending moments. | 8 | 2 | 4 |
| III | **3.1 Bending Stress in Beams:** Theory of Pure Bending, Assumptions, Flexural formula for straight beams, moment of resistance, bending stress distribution, Section modulus for different sections, beams for uniform strength, Fletched beams. **Self-learning topics:** | 7 | 3 | 4 |

| | | | | |
|---|---|---|---|---|
| | **Shear Stress in Beams:**<br>Distribution of shear stress, across plane sections used commonly for Structural purposes, shear connectors. | | | |
| IV | **4.1 Torsion:**<br>Torsion of circular shafts-solid and hollow, stresses in shafts when Transmitting power, shafts in series and parallel.<br>**4.2 Deflection of Beams:**<br>Differential equation for Double integration method, Maxwell's reciprocal theorems and Macaulay's methods –Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, uniformly distributed load.<br>**Self-learning topics:** Conjugate beam method, Superposition method. | 7 | 4 | 4 |
| V | **5.1 Thin Cylindrical and Spherical Shells:**<br>Cylinders and Spheres due to internal pressure. Cylindrical Shell with hemi-spherical End.<br>**5.2 Columns and Struts:**<br>Buckling load, Types of end conditions for column, Euler's column theory and its limitations, Rankine- Gordon Formula.<br>**Self-learning topics:** Study real-life applications: columns in buildings, trusses. | 8 | 5 | 4 |
| VI | **6.1 Strain Energy:**<br>Strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to bending and torsion.<br>**6.2 Principal Stresses and Strains:**<br>Introduction-stress on an inclined section of a bar under axial loading- compound stresses-Normal and tangential stresses on an inclined plane for biaxial stresses by using Mohr's circle method<br>**Self-learning topics:** Strain energy density.<br>**Advanced Topic:** Introduction to Finite Element Method (FEM) | 7 | 6 | 3 |

| Exp. No. | List of Experiments | COs |
|---|---|---|
| 1. | Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity). | 1 |
| 2. | Tension test on aluminium bar (stress-strain behaviour, determination of yield strength and modulus of elasticity). | 1 |
| 3. | Compression test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity). | 2 |
| 4. | Compression test on aluminium bar (stress-strain behaviour, determination of yield strength and modulus of elasticity). | 2 |
| 5. | Torsion test on mild steel bar / cast iron bar. | 3 |
| 6. | Impact test on metal specimen (Izod test) | 3 |
| 7. | Impact test on metal specimen (Charpy test) | 4 |
| 8. | Hardness test on metals - Brinell Hardness Number | 4 |
| 9. | Hardness test on metals - Rockwell Hardness Number | 5 |
| 10. | Flexural test on beam (central loading). | 5 |
| 11. | Flexural test on beam (eccentric loading). | 5 |
| 12. | To evaluate the strain energy stored in a circular shaft under torsional loading. | 6 |

| | | |
|---|---|---|
| 13. | To determine the location and magnitude of principal stresses using photoelastic models under polarized light | 6 |
| 14. | To construct Mohr's circle and determine the normal and tangential stresses on inclined planes. | 6 |
| 15. | To visualize and calculate strain energy density distribution using software tools (e.g., ANSYS, SolidWorks Simulation). | 6 |

**Reference Books:**

1. Strength of Materials by W.Nash, Schaum's Outline Series, McGraw Hill Publication, Special Indian Edition, 2013
2. Mechanics of Materials, Beer, Ferdinand P., R. Johnston, J. Dewolf, and D.Mazurek. McGrawHill. 2006
3. Strength of Materials by R. Subramanian, Oxford University Press, Third Edition 2016
4. Elements of Strength of Materials by Timoshenko and Youngs, Affiliated East -West Press, 2003

**Text Books:**

1. Strength of Materials, Uday Shanker Dixit, Nelson Muthu, S.M. Kamal, AICTE, 2023.
2. Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd, 2012
3. Strength of Materials by R. Subramanian, Oxford University Press, Third Edition, 2016

**Useful Links**

1. http://www.nptelvideos.in/2012/11/strength-of-materials-prof.html
2. https://swayam.gov.in/nd1_noc20_ce34

| Course Title: Conventional and Digital Fabrication | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** III | | | **Term:** Odd | | | | **Course Code:** 25MEPCC304 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | 2 | 3 | -- | 1 | 4 | 20 | 20 | 60 | 25 | 25 | 150 |
| **Sustainable Development Goals Mapped: 4, 8, 9, 12** | | | | | | | | | | | | |

**Course Objectives:**

1. To familiarize with the various production processes used on shop floors.
2. To study appropriate production processes for a specific application.
3. To introduce to the learner various machine tools used for manufacturing
4. To familiarize with principle and working of non-traditional manufacturing and additive manufacturing.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Demonstrate an understanding of casting and welding process
2. Understand milling machines and operations, cutters and indexing for gear cutting.
3. Understand the various metal forming processes, working principles and applications.
4. Apply mathematical techniques to generate, transform and manipulate objects, different curves, surfaces and solids.
5. Develop Part programs for NC-CNC Machines.
6. Illustrate principles and working of non-traditional manufacturing and Additive manufacturing.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| 1 | **Metal Casting:**<br>**Casting process:** principle, patterns, allowances, Gating system & risers, Casting defects and remedies, Applications, Sand moulding and machine moulding, Special casting processes centrifugal, die-casting and investment. (Numerical)<br>Basic Principle of Welding Technology, Classification of welding processes, Arc welding – types, gas welding and equipment, types of flames, Resistance welding, Solid state welding, Thermit welding, welding defects causes and remedies, Soldering, brazing and braze welding. (Numerical)<br>**Self-learning topics:** Use of adhesives for joining, types of adhesives, applications | 8 | 1 | L2 |
| 2 | **Machine Tools and Machining Processes:**<br>Lathe Machines, Milling Machines, Drilling Machines, and Grinding Machines, Broaching machines, Lapping/Honing machines (Super Finishing Operations) and turning/shaping/slotting/planning Machines.<br>**Tool Engineering:** Geometry and nomenclature of single point cutting tool, Speed, feed, depth of cut, Taylor's tool life equation, Concept of chip formation and types of chips. [Numerical]<br>**Self-learning topics:** Gear manufacturing processes. | 8 | 2 | L3 |
| 3 | **Metal Forming:**<br>Hot working and cold working, strain hardening, recovery, | 8 | 3 | |

| | | | | |
|---|---|---|---|---|
| | recrystallization, and grain growth.<br>**Rolling and Forging:**<br>Principle of rolling, Types of rolling mills, Forces and Geometrical Relationships in Rolling, Rolling Defect. Principle of forging, Open and Close Die Forging Processes, Smith forging, drop forging, roll forging and rotary forging, Force analysis (Numerical)<br>**Extrusion and Drawing:** Introduction and Classification, hot extrusion and cold extrusion, forward extrusion and backward extrusion, Impact extrusion, Hydrostatic Extrusion, Forces in extrusion. Force analysis (Numerical). Drawing and its types: Wire drawing and tube drawing. Force analysis (Numerical).<br>**Sheet metal operations**, spring back effect, stamping operations, blanking, piercing, coining, embossing, bending and spinning.<br>**Self-learning topics:** Forging and Drawing defects**.** | | | L3 |
| 4 | **CAD/CAM** in product lifecycle Types of modeling: Wireframe, Surface, Solid modeling Constructive Solid Geometry (CSG) & Boundary Representation (B-Rep) Parametric and feature-based modeling (concept) Geometric modeling:<br>**Curves**: Bezier, Hermite, B-spline (basic equations & properties) Surface representation (Intro)<br>**2D transformations**: Translation, Scaling, Rotation, Reflection Homogeneous coordinate system (basic concept)<br>**Self-learning topics:** 3D transformations | 7 | 4 | L4 |
| 5 | **Computer Numeric Control of Machine Tools**: CNC machining practices and programming: setup, and operation of two- and three axis CNC machines programming using manual part programming method, Canned Cycles.<br>**Self-Learning**: - DNC Machines. | 7 | 5 | L3 |
| 6 | **Non-Conventional Material Removal Processes**:<br>Ultrasonic Machining (USM), Water-Jet Machining & Abrasive-Jet Machining, Chemical Machining, Electrochemical Machining (ECM), Electrical-Discharge Machining (EDM), High-Energy-Beam Machining, Laser-beam machining (LBM), Electron-beam machining (EBM).<br>**Additive Manufacturing**: Introduction, additive manufacturing processes (SLA, LOM, SLS, FDM, 3D printing), Working principle, features, models & specification of process, application, advantages and disadvantages.<br>**Self-learning topics:** Rapid Tooling and STL format.<br>**Advanced topic: - "Digital Twin in Manufacturing and Smart Production Systems"** | 7 | 6 | L2 |
| **Total** | | | | |

| Sr No. | List of Experiment | COs |
|---|---|---|
| **1** | To Prepare Pattern of given Drawing | CO1 |
| **2** | To Prepare Mold of given Pattern | CO1 |
| **3** | To Prepare casting of given mold. | CO1 |

| | | |
|---|---|---|
| **4** | Study of Safety & Working instruction in a Machine shop. | CO2 |
| **5** | To perform different welding operation on given sample material | CO2 |
| **6** | Manufacturing of spur gear on milling machine. | CO3 |
| **7** | One Job consisting of Plain and Taper Turning operations performed on mild steel, cylindrical components on lathe Machine. | CO3 |
| **8** | Study on Drilling machine and Milling. | CO3 |
| **9** | To perform forging operation for given sample material. | CO4 |
| **10** | To perform rolling operation for given sample material. | CO4 |
| **11** | To perform sheet metal forming operation on given sample material. | CO5 |
| **12** | To perform blanking/ coining / piercing operation for given sample material. | CO5 |
| **13** | Industrial Visit on Machine tool technology | CO6 |
| **14** | Demonstration on different operations performed on Mild Steel component using CNC lathe Machine. | CO6 |
| **15** | Demonstration on different operations performed on Mild Steel component using CNC milling Machine. | CO6 |
| **16** | Demonstration on 3D printing | CO6 |

**Reference Books:**

1. G. Boothroyd & W.A. Knight, "Fundamental of Machining and Machine Tools", third edition", CRC.
2. W. A. J. Chapman, "Workshop Technology- Part I, II and III", Edward Arnold. 2021
3. CAD/CAM: Theory and Practice, Ibrahim Zeid, R Sivasubramanian, Mc Graw-Hill. 2023.
4. Computer Numerical Control Concepts and Programming, Warren S. Seames, Vengage Learning, 2020.

**Text Books:**

1. Milton C. Shaw, "Metal Cutting Principles", OXFORD University Press. 2019
2. CAD/CAM: Computer Aided Design and Manufacturing, Mikell P. Groover, Emory W. Zimmers, Pearson Education India, 2016.
3. P.N. Rao, CAD/CAM Principles and Applications, Tata McGraw Hill Publications, Third Edition, 2019.

**Useful Links:**

**https://onlinecourses.nptel.ac.in/noc25_me11/preview**
**https://onlinecourses.nptel.ac.in/noc25_mm01/**
**https://onlinecourses-archive.nptel.ac.in/noc18_me05/preview**
**https://onlinecourses-archive.nptel.ac.in/noc18_me06/**

| Course Title: Material Science and Engineering | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** III | | | **Term:** Odd | | | **Course Code:** 25MEPCC305 | | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE1** | **IAE2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 2 | -- | 2 | 2 | -- | 1 | 3 | 20 | 20 | 60 | 25 | -- | 125 |

**Sustainable Development Goals Mapped: 4, 8, 9, 11, 12, 13**

**Course Objectives:**

1. To understand structure -property correlation in materials
2. To draw and interpret various phase diagrams and their importance to decide properties and applications of the materials.
3. To apply heat treatment process to acquire desired properties and applications in a given material or alloys.
4. To study mechanical behavior of materials
5. To study the role of advanced materials and their processing method

**Course Outcomes:** At the end of the course students will be able to:

1. Understand the concept of crystal structure and types of defects in it.
2. Identify the various classes of materials and comprehend their properties.
3. Apply phase diagram concepts to engineering applications.
4. Apply particular heat treatment for required property development.
5. Identify the probable mode of failure in materials and suggest measures to prevent them.
6. Choose or develop new materials for better performance

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Crystal structure and their defects:**<br>1. Concepts of crystals- Crystalline and Non-crystalline Materials Unit cell, Crystal structures of metals, Crystal systems, Crystallographic planes and directions,<br>2. Crystal Defects: Crystal Imperfections-definition, classification and significance of imperfections -point defects, line defects, Surface defects and volume defects.<br>**Self-learning topics:** Importance of dislocations in deformation and its mechanisms. Critical Resolved shear stress, Slip and twinning systems | 4 | 1 | 2 |
| II | Engineering Materials:<br>1. Classification of Metals: Introduction to engineering materials – significance of structure property correlations in all classes of engineering materials,<br>2. Plain carbon steels, cast irons: Types and applications. 3. Engineering Non-Metals: Polymers Composites and Ceramics their types and applications. Their advantages over metallic materials,<br>**Self-learning topics:** Processing of polymers, composites and ceramics: Through injection molding | 5 | 2 | 2 |
| III | **Interpretation and analysis of Phase Diagrams:**<br>1. Mechanism of Crystallization- Nucleation-Homogeneous and Heterogeneous Nucleation and Growth.<br>2. Classification of Alloys based on phases and phase | 6 | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| | diagram-Binary alloy phase diagram – Isomorphous, Eutectics type I and II, Peritectic 2.3 Iron Iron carbide phase diagram – Invariant reactions – microstructural changes of hypo and hyper-eutectoid steel, cast irons<br>**Self-learning topics:** Solidification of metals and - alloys– Cooling curves | | | |
| IV | **TTT Diagram and Heat Treatment Processes:**<br>1. TTT and CCT Diagram: TTT and CCT diagram, Hardenability and its tests<br>2. Heat treatment: Overview – Objectives – Thorough treatments: Annealing and types, normalizing, hardening and tempering, austempering and martempering – microstructure changes<br>3. Surface hardening processes: Carburizing –, nitriding – cyaniding and carbonitriding, induction and flame hardening, Laser and Electron beam hardening<br>**Self-learning topics:** Alloy steels-Stainless steels, Tool steels, Maraging steels | 5 | 4 | 3 |
| V | **Mechanical Behavior of material and failures:**<br>1. Strengthening mechanisms in materials<br>2. Fracture of metals – Ductile Fracture, Brittle Fracture, Ductile to Brittle Transition Temperature (DBTT), Griffith's criteria and Orowan's modification<br>3. Fatigue – Endurance limit of ferrous and non-ferrous metals -Fatigue test, S-N curves, factors affecting fatigue, structural changes accompanying fatigue;<br>**Self-learning topics:** Creep – mechanism of creep – stages of creep and creep test, creep resistant materials. | 6 | 5 | 4 |
| VI | **Introduction to Advanced Materials and NDT Testing :**<br>1. Nano Materials: Introduction, Concepts, synthesis of nanomaterials, examples, applications and Nano composites<br>2. Introduction to Smart materials: Classification, Shape Memory Alloys and its applications<br>3. Introduction to Smart Materials: Overview of the different types of Smart Materials, Smart materials used.1 in structures, smart material for sensors, actuators controls, memory and energy storage and their inter-relationships<br>**Self-learning topics:** Non-destructive Testing of Materials-ultrasonic testing, radiographic methods, magnetic particle testing<br>**Advanced Topic:** Sustainable materials and green manufacturing concepts. | 4 | 6 | 5 |

| Sr. No. | List of Experiments | COs |
|---|---|---|
| 1 | Study of metallurgical microscope | CO1 |
| 2 | Study of crystal structure of metallic materials | CO1 |
| 3 | Metallographic sample preparation and etching | CO1, CO2 |
| 4 | Study of Fe-$Fe_3C$ Equilibrium Diagram | CO3 |
| 5 | Microstructures of plain carbon steels | CO2,CO3 |
| 6 | Microstructures of cast irons | CO2,CO3 |
| 7 | Study of Time –Temperature Transformation(TTT) Diagram. | CO4 |
| 8 | Annealing, Normalizing and Hardening of medium carbon steel and | CO4 |

| | | |
|---|---|---|
| | observation of microstructures | |
| 9 | Study of tempering characteristics of hardened steel | CO4 |
| 10 | Determination of hardenability of steel using Jominy end Quench Test | CO4 |
| 11 | Fatigue test – to determine number of cycles to failure of a given material at a given stress | CO5 |
| 12 | Study of Nano-materials. | CO6 |
| 13 | Draw and compare the shadowgraph of a given objects using optical comparator/ | CO5, CO6 |

**Reference Books:**

**1.** Callister's Materials Science and Engineering, 2nd edition by R. Balasubramanium Wiley India Pvt. Ltd, 2014

**Text Books:**

1. Introduction to Materials Science for Engineers; 8th Edition by James F. Shackelford, Pearson, 2020
2. Introduction to Physical Metallurgy,2nd edition by Sidney Avner, Tata McGraw Hill 3. Mechanical Metallurgy, 3rd edition by GH Dieter, Tata McGraw Hill, 2017
3. Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th Edition by William D. Callister, Jr., David G. Rethwisch, Wiley & Sons. 2016
4. Materials Science and Engineering,6th edition by V. Raghavan, Prentice Hall India (PHI), 2015.

**Useful Links :**

https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm09/
https://nptel.ac.in/courses/113/102/113102080/
https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm09/
https://nptel.ac.in/content/syllabus_pdf/113104074.pdf
https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_09_m.pd

| Course Title: Solid Modeling and 3D Printing Lab | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** III | | | **Term:** Even | | | | **Course Code:** 25MEPCC306 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | | | | | | |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | **IAE1** | **IAE2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| - | - | 2 | | - | 1 | 1 | - | - | - | 25 | - | 25 |
| **Sustainable Development Goals Mapped:** 4, 8, 9, 11, 12 | | | | | | | | | | | | |

**Course Objectives:**

1. To introduce students to the fundamental concepts of solid modeling and parametric design using modern CAD tools.
2. To familiarize students with 3D printing technologies, processes, and materials, enabling them to design and produce functional prototype

**Course Outcomes:** Learner will be able to…

1. Students will be able to create complex 3D models and assemblies using solid modeling software with parametric capabilities.
2. Students will be able to understand and apply 3D printing techniques to fabricate physical models from digital designs using appropriate materials and methods.

**Lab Contents:**

| SR. NO. | List of Experiments | LOs |
|---|---|---|
| 1 | Introduction to Solid Modeling Software | 1 |
| 2 | Parametric Modeling | 1 |
| 3 | Assembly of Multiple Components | 1 |
| 4 | Drafting and detailing of 3D Models | 1 |
| 5 | Introduction to 3D Printing Technology | 2 |
| 6 | Slicing Software for 3D Printing. | 2 |
| 7 | 3D Printing of a Simple Component | 2 |
| 8 | Complex Surface Modeling for (For generating 3D printing Model) | 2 |
| 9 | 3D Printing with Different Materials | 2 |
| 10 | Design and Print a Functional Part | 2 |

**Reference Books**

1. Machine Drawing by N.D. Bhatt – Charotar Publishing House, 2022
2. A Textbook of Machine Drawing by Laxminarayan and M.L. Mathur – Jain Brothers Delhi, 2020.
3. Machine Drawing by Kamat and Rao, 2021
4. Machine Drawing by M.B. Shah, 2018'
5. Machine Drawing by K.I. Narayana, P. Kannaiah, K. Venkata Reddy, New Age International 2017.
6. CNC Technology and Programming, Krar, S., and Gill, A., McGraw Hill Publishers, 2016
7. CAD/CAM Principles and Applications, P. N. Rao, Tata McGraw Hill Publications,2015.

**NPTEL Course Links:**

1. NPTEL Video Course:
   https://archive.nptel.ac.in/courses/112/105/112105211/

| Course Title: Universal Human Values | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** III | | | **Term:** Odd | | | | **Course Code:** 25MEVEC301 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 2 | 1 | - | 2 | 1 | - | 3 | 10 | 10 | 30 | 25 | - | 75 |
| **Sustainable Development Goals Mapped:** 3, 4, 5, 8, 10, 12, 13, 16 | | | | | | | | | | | | |

**Course Objectives:**

1. To become more aware of themselves, and their surroundings (family, society, nature).
2. To become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. To become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
4. To apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

**Course Outcomes:**

At the end of the course students will be able:

1. To appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To practice plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with nature.

| Module | Contents | Hours | Cos |
|---|---|---|---|
| I | **Introduction to Value Education** | **6** | |
| | • Understanding Value Education<br>• Self-exploration as the Process for Value Education- Continuous Happiness and Prosperity – the Basic Human Aspirations<br>• Right Understanding, Relationship and Physical Facility<br>• Happiness and Prosperity – Current Scenario<br>• Method to Fulfil the Basic Human Aspirations | | CO1 |
| II | **Harmony in the Human Being** | **6** | |
| | • Understanding Human being as the Co-existence of the Self and the Body<br>• Distinguishing between the Needs of the Self and the Body<br>• The Body as an Instrument of the Self<br>• Understanding Harmony in the Self<br>• Harmony of the Self with the Body<br>• Programme to Ensure self-regulation and Health | | CO1 |
| III | **Harmony in the Family and Society** | **6** | |
| | • Harmony in the Family – the Basic Unit of Human Interaction | | CO2 |

| | | | |
|---|---|---|---|
| | • Values in Human-to-Human Relationship<br>• 'Trust' – the Foundational Value in Relationship<br>• 'Respect' – as the Right Evaluation<br>• Understanding Harmony in the Society<br>• Vision for the Universal Human Order | | |
| IV | **Harmony in the Nature (Existence)** | **5** | |
| | • Understanding Harmony in the Nature<br>• Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature<br>• Realizing Existence as Co-existence at All Levels<br>• The Holistic Perception of Harmony in Existence | | CO2 |
| V | **Implications of the Holistic Understanding** | **4** | |
| | • Natural access acceptance of Human Values<br>• Definitiveness of (Ethical) Human Conduct<br>• A Basis for Humanistic Education,<br>• Humanistic Constitution and Universal Human Order | | CO3 |
| VI | **Professional Ethics** | **3** | |
| | • Competence in Professional Ethics<br>• Holistic Technologies, Production Systems and Management Models-Typical Case Studies<br>• Strategies for Transition towards Value-based Life and **Profession** | | CO3 |

**List of Tutorials**

| Sr. No. | Topic | Hrs. | COs |
|---|---|---|---|
| 1 | Sharing about oneself | 1 | CO1 |
| 2 | Exploring human consciousness | 1 | CO1 |
| 3 | Exploring natural acceptance | 1 | CO1 |
| 4 | Exploring the difference of needs of self and body | 1 | CO1 |
| 5 | Exploring sources of imagination in the self | 1 | CO1 |
| 6 | Exploring harmony of self with the body | 1 | CO2 |
| 7 | Exploring the feeling of trust | 1 | CO2 |
| 8 | Exploring the feeling of respect | 1 | CO2 |
| 9 | Exploring systems to fulfill human goal | 1 | CO2 |
| 10 | Exploring the four orders of nature | 1 | CO2 |
| 11 | Exploring coexistence in existence | 1 | CO3 |
| 12 | Exploring ethical human conduct | 1 | CO3 |
| 13 | Exploring humanistic models in education | 1 | CO3 |
| 14 | Exploring steps of transition towards universal human order | 1 | CO3 |
| | **Total Hours** | **14** | |

**Reference Books:**

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.

6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

**Text Books:**

1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2 nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

**Useful Links:**

1. https://www.youtube.com/watch?v=PXSEpPFCn38

| Course Title: Employability Enhancement Program -I (Communication) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** III | | | **Term:** Odd | | | | **Course Code:** 25MEAEC301 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| -- | 1 | -- | -- | 1 | -- | 1 | -- | -- | -- | 25 | -- | 25 |

**Sustainable Development Goals Mapped:** 4, 5, 8, 10, 16

**Course Objectives:**

1. To train students on grooming and their all-round development.
2. To instil confidence amongst learners about interviewing influential personnels.

**Course Outcomes:**

At the end of the course students will be able to:

1. Understand and demonstrate improved formal dressing and appearance.
2. Apply ideas, ask insightful questions and build connections through interview experiences.
3. Develop required vocabulary and updated knowledge of the current affairs at a global level.
4. Apply ethical behavioural skills at both academic as well as in professional life.

| Tut. No. | List of Tutorials | Hours | COs |
|---|---|---|---|
| | **Speaking Skills** | | |
| 1. | Role Play | 01 | CO1 |
| 2. | Poster Presentation (Group): Assignment 5 **(Copilot)** | 01 | CO1 |
| 3. | Interviewing an influential person with Jio tag photo or video: Assignment 8 **(AI Tool: Chat GPT/Podcast)** | 01 | CO2 |
| 4. | Story Telling with moral/value | 01 | CO1 |
| 5. | Impromptu /Extempore | 01 | CO3 |
| | **Reading Skills** | | |
| 6. | Summarization of any unseen passage Assignment 2 **(AI Tool: Grammarly)** | 01 | CO4 |
| 7. | Book Review Writing Assignment 4 | 01 | CO1 |
| 8. | Reading Newspaper Article | 01 | CO2 |
| | **Writing Skills** | | |
| 9. | Vocabulary Building: Crossword | 1 | CO3 |
| 10. | One Word Substitution, Collocation, Phrases & Idioms- Assignment 1 | 1 | CO3 |
| 11. | Expansion of an Idea- Assignment 3 | 1 | CO3 |
| 12. | Behavioural Ethics: Ethical Code of Conduct: Assignment 6 | 1 | CO4 |
| 13. | Dress & Appearance: Assignment 7 | 1 | CO1 |
| 14. | Paragraph Writing **(AI Tool: Plagiarism Checkers)** | 1 | CO4 |
| 15. | Dialogue Writing (Formal) | 1 | CO2 |

**Evaluation and Assessment Scheme:**

Assignments + Attendance = 05 + 05=10 Marks

Poster Presentation =05 Marks
Interviewing an Influential person = 05 Marks
Role Play = 05 Marks
Assessment: There is internal assessment only

**Reference Books:**

1. M Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill, 2008
2. Gadyalji Vaishali K, Communication Skills, Nandu Publications, 2010
3. Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2007
4. Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2008
5. Raman Meenakshi & Sharma Sangeeta, Technical Communication Principles and Practice, Oxford University Press, 2015
6. Raman Meenakshi & Singh Prakash, Business Communication, Oxford University Press, 2008
7. Locker O Kitty & Kaczmarek Kyo Stephen, Business Communication Building Critical Skills, McGraw Hill Education Private Limited, 2007
8. Chaturvedi P D & Chaturvedi Mukesh, Business Communication Concepts, Cases and Applications, Pearson Education, 2008
9. Luthans Fred, Organizational Behavior An Evidence-Based Approach, McGraw Hill Education Private Limited, 2013

**Text Books:**

1.M Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill, 2008

**Useful Links:**

**Speaking Skills**

https://youtu.be/iNxl16ZkM-A?si=_smlyYEtxvHBD40S
https://youtu.be/EhgKvPWn9Vc?si=vboPgmmIyyVqsrcI
https://youtu.be/ftwVrEF_OlQ?si=sYiKRfg_xX1erVf6
https://youtu.be/TKfwenWIHhk?si=xn8GDiZIBYKB14M4
https://youtu.be/pbhK_OhMgA4?si=DeROjEtA6V__w5dL
https://youtu.be/a2dTNAryZ8g?si=6tA9U-ZAX4wQBi_x
https://youtu.be/QBnGmmBAgyc?si=JGm-TpmrslhE-ZB8
https://youtu.be/EhgKvPWn9Vc?si=vboPgmmIyyVqsrcI
https://youtu.be/z9F68dJSbOE?si=VVMrBOeNnc5XNln8

**Reading Skills**

https://youtu.be/KadZ3KYzM0I?si=XRmUOk2O8UmoMfEK
https://youtu.be/kCthrwUz68w?si=L4U4TJjuO72Us_dD
https://youtu.be/tpHp8oEHANQ?si=R-YOMfSa5LIuyXMR

**Writing Skills**

https://youtu.be/Zx-JcXsbUqQ?si=ysfXU8ZR4UM3U22P
https://youtu.be/5o_oph2vhGM?si=_4D6h8ZMiYSe0ZV4

# Bachelor of Technology
# In
# Mechanical Engineering

## Second Year
## Semester – IV

## SJCEM : R–25

## Effective from Academic Year

## 2026-27

**Program Structure for Second Year Mechanical Engineering**
**(With Effect from 2026-27)**
**Semester-IV**

| Course Code | Vertical | Course Name | Contact Hrs | | | Credit Allotted | | | Total Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Th | Tut | Pr | Th | Tut | Pr | |
| 25MEPCC401 | PCC | Fluid Mechanics and Hydraulic Machines | 3 | - | 2 | 3 | - | 1 | 4 |
| 25MEPCC402 | PCC | Metrology and Mechanical Measurement | 2 | - | 2 | 2 | - | 1 | 3 |
| 25MEPCC403 | PCC | Industrial Electronics | 2 | - | 2 | 2 | - | 1 | 3 |
| 25MEPCC404 | PCC | Kinematics & Dynamics of Machines | 3 | - | 2 | 3 | - | 1 | 4 |
| 25MEPCC405 | PCC | Python Programming Lab | - | - | 2 | - | - | 1 | 1 |
| 25MEAEC401 | AEC | Employability Enhancement Program -II (Communication) | - | - | 2 | - | - | 1 | 1 |
| 25MEVSE401 | VSEC | Employability Enhancement Program -III (Industry Certification) | - | - | 2 | - | - | 1 | 1 |
| 25MDM401X | MDM | Multidisciplinary Minor | 3 | - | 2 | 3 | - | 1 | 4 |
| 25MEOJT401 | OJT | Internship-I | - | - | 3 | - | - | 1 | 1 |
| 25MEVEC401 | VEC | Environmental Studies | 1 | - | - | G | - | - | G |
| | | **Total** | **14** | **-** | **19** | **13** | **-** | **9** | **22** |

| Course Code | Vertical | Course Name | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Theory | | | Practical | | Total |
| | | | IAE 1 | IAE 2 | ESE | CA | Or / Pr | |
| 25MEPCC401 | PCC | Fluid Mechanics and Hydraulic Machines | 20 | 20 | 60 | 25 | - | 125 |
| 25MEPCC402 | PCC | Metrology and Mechanical Measurement | 20 | 20 | 60 | 25 | - | 125 |
| 25MEPCC403 | PCC | Industrial Electronics | 20 | 20 | 60 | 25 | 25 | 150 |
| 25MEPCC404 | PCC | Kinematics & Dynamics of Machines | 20 | 20 | 60 | 25 | - | 125 |
| 25MEPCC405 | PCC | Python Programming Lab | - | - | - | 25 | - | 25 |
| 25MEAEC401 | AEC | Employability Enhancement Program -II (Communication) | - | - | - | 25 | - | 25 |
| 25MEVSE401 | VSEC | Employability Enhancement Program -III (Industry Certification) | - | - | - | - | 25 | 25 |
| 25MDM401X | MDM | Multidisciplinary Minor | 20 | 20 | 60 | 25 | | 125 |
| 25MEOJT401 | OJT | Internship-I | - | - | - | - | 25 | 25 |
| 25MEVEC401 | VEC | Environmental Studies | - | - | - | - | - | G |
| | | **Total** | **100** | **100** | **300** | **175** | **75** | **750** |

**Multidisciplinary Minor**

| Semester | MDM | Course Code | Vertical | Course Name |
|---|---|---|---|---|
| IV | Additive Manufacturing | 25MDM401AM | MDM | Additive Manufacturing Technologies |
| IV | Energy Engineering | 25MDM401EE | MDM | Renewable Energy Sources |

# Syllabus

# for

# Second Year Mechanical Engineering

# Semester – IV

# SJCEM : R–25

# (With Effect from 2026-27)

| Course Title: Fluid Mechanics & Hydraulic Machines | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** IV | | | **Term:** Even | | | | **Course Code:** 25MEPCC401 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **Theory** | | | | **Practical** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | **IAE1** | **IAE2** | **ESE** | **CA** | **Or / Pr** | |
| **3** | **--** | **2** | **3** | **--** | **1** | **4** | **20** | **20** | **60** | **25** | **-** | **125** |

**Sustainable Development Goals Mapped:** 4, 6, 7, 8, 9, 11, 12, 13

**Course Objectives:**

1. To understand the basic principles of fluid mechanics
2. To identify various types of flows
3. To understand boundary layer concepts and flow through pipes
4. To evaluate the performance of hydraulic turbines and pumps

**Course Outcomes:** Learner will be able to…

1. Explain the effect of fluid properties on a flow system.
2. Identify type of fluid flow patterns and describe continuity equation.
3. Analyse a variety of practical fluid flow and measuring devices and utilize fluid mechanics principles in design.
4. Identify and understand various characteristics of the flow in pipes & fundamental characteristics of a boundary layer
5. Analyse an appropriate turbine with reference to given situation in power plants.
6. Estimate performance parameters of a given Centrifugal & Reciprocating Pump

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Fluid Statics:** Definition of fluid, fluid properties such as viscosity, vapour pressure, compressibility, etc. pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, pressure measurement by simple and differential manometers. Buoyancy force Hydrostatic forces on the plane and curved surfaces.<br>**Self- Learning**: Surface tension & Capillarity | 7 | 1 | 2 |
| II | **Fluid Kinematics:** Eulerian and Lagrangian approach to solutions; Velocity and acceleration in the Eulerian flow field; Definition of streamlines, path lines and streak lines; types of fluid flows; Definition of control volume and control surface, circulation, vorticity. Understanding of differential and integral methods of analysis. Definition and equations for stream function, velocity potential function in rectangular co-ordinates<br>**Self- Learning:** Rotational and Irrotational flows. | 7 | 2 | 2 |
| III | **Fluid Dynamics:** Concept of control volume and control surface, Importance of Reynolds Transport theorem (RTT) and its derivation (No numerical). Forces acting on fluid in motion, Euler's equation in Cartesian coordinates, Expression of Bernoulli's equation from principle of energy conservation and by integration of Euler's equation. Application of Bernoulli's equation in Orifice meter, Venturi meter, and Pitot tube. Momentum of fluid in motion: impulse momentum relationship and its applications for determination of thrust for pipe bend.<br>**Self- Learning:** Rotameter | 8 | 3 | 4 |

| | | | | |
|---|---|---|---|---|
| IV | **Flow through pipes** : Reynolds experiment, Head loss in pipes due to friction (Darcy-Weisbach equation), Loss of energy in pipe (major and minor), Hydraulic gradient and Energy gradient line, Pipes in series and parallel.<br>**Boundary Layer Flows:** Concept of boundary layer and definition of boundary layer thickness, displacement, momentum and energy thickness; Growth of boundary layer, laminar and turbulent boundary layers<br>**CFD:** Introduction, necessity, limitations, the philosophy behind CFD, applications.<br>**Self- Learning:** Concept of equivalent pipe. | 7 | 4 | 2 |
| V | **Basics of Turbo Machinery:** Hydrodynamic force of jets on stationary and moving flat, inclined and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.<br>**Hydraulic Turbines:** Classification of turbines, Head and efficiency, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine- working principles, work done, efficiencies, hydraulic design Draft tube theory and deficiency.<br>**Performance of hydraulic Turbines**: Selection of type of turbine, cavitation, surge tank, water hammer.<br>**Self- Learning:** Geometric similarity, unit and specific quantities | 9 | 5 | 4 |
| VI | **Centrifugal pumps:** Classification of Pumps , working, work done-barometric head – losses and efficiencies specific speed – pumps in series and parallel, performance characteristic curves, NPSH<br>**Types of Positive Displacement Pump:**<br>Reciprocating pumps: Working, Discharge, slip, Indicator Diagram.<br>**Self-Learning :** Use of Air Vessel in Reciprocating Pump<br>**Advanced Topic:** Advanced CFD concepts and governing equations (Navier–Stokes basics) | 7 | 6 | 3 |

**Lab Contents:**

| Sr. No. | List of Experiments | COs |
|---|---|---|
| 1 | Measurement of water pressure by using U-tube Manometer & discharge of water by using a measuring tank and stopwatch | CO1 |
| 2 | Measurement of total energy available at different sections of a pipe layout to verify Bernoulli's theorem. | CO2 |
| 3 | Measurement of discharge through pipe using Venturimeter | CO3 |
| 4 | Measurement of discharge through a pipe provided with sharp edged circular orifice | CO3 |
| 5 | Calculation of Darcy's friction factor 'f' in pipes of different diameters for different discharges | CO4 |
| 6 | Determination of minor frictional losses in sudden expansion, sudden contraction, elbow and bend in a pipe | CO4 |
| 7 | Determination of the force exerted and work done by a jet on flat plate | CO5 |
| 8 | Determination of overall efficiency of Pelton turbine using Pelton wheel test rig | CO5 |
| 9 | Trial on Reaction turbine | CO5 |

| | | |
|---|---|---|
| 10 | Study Experiment based on locations and specifications of Pelton wheel/ Kaplan/ Francis/ any other turbine used in India or Abroad. (Open-Ended Experiments) | CO5 |
| 11 | Determination of overall efficiency of Centrifugal pump using Centrifugal pump test rig | CO6 |
| 12 | Determination of overall efficiency and percentage slip of Reciprocating pump using Reciprocating pump test rig | CO6 |
| 13 | Study Experiment based on the range of products, manufacturer and technical specifications of Centrifugal/ reciprocating/ multistage pumps/ submersible pumps/any other pump. (Open-Ended Experiments) | CO6 |

**Text Books:**

1. A textbook of Fluid Mechanics by R K Bansal, Laxmi Publication, 1st Edition, 9th Edition, 2015.
2. Introduction to Fluid Mechanics and Fluid Machines by S. K. Som and Gautam Biswas, 3rd Edition, 2011
3. Hydraulics, fluid mechanics and Hydraulic machinery MODI and SETH, 22nd Edition, 2018

**Reference Books**

1. Fluid Mechanics by Yunus A Cengel and John M Cimbala, Tata McGraw Hill Education, 3rd Edition 2024
2. Fluid Mechanics and Machinery by C S P Ojha, Chandramouli and R Berndtsson, Oxford University Press, 1st Edition, 2010.
3. Fluid Mechanics by Frank M. White, McGraw Hill Education, 8th Edition, 2016.
4. Fundamentals of Fluid Mechanics by Bruce Munson, John Wiley and sons, 9th Edition 2020.
5. Introduction to Fluid Mechanics by Fox and McDonald, John Wiley and sons, 9th Edition 2020.
6. Fluid Mechanics by Victor Streeter, Benjamin Wylie and K W Bedford, McGraw Hill Education, 10th Edition 2017.
7. Fluid Mechanics and Machinery by D. Rama Durgaiah, New Age International, 2006
8. . Hydraulic Machines by Banga & Sharma, Khanna Publishers,2011

**NPTEL Course Links:**

https://nptel.ac.in/courses/112105182/ -Introduction to Fluid Machines and Compressible Flow
http://fm-nitk.vlabs.ac.in/# - Fluid Mechanics Lab, NITK Surathkal
https://fmc-nitk.vlabs.ac.in/fluid-machinery/ - Fluid Machinery Lab, NITK Surathkal
https://nptel.ac.in/courses/112/106/112106303/ - Introduction to Turbomachines, IIT Madras
https://nptel.ac.in/courses/112/106/112106200/ - Fluid Dynamics and Turbomachines, IIT Madras

| Course Title: Metrology and Mechanical Measurements | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester: IV** | | | **Term: Even** | | | | **Course Code: 25MEPCC402** | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme:** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **Theory** | | | **Practical** | | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | **IAE-1** | **IAE-2** | **ESE** | **CA** | **Or/Pr** | |
| **2** | **--** | **2** | **2** | **--** | **1** | **3** | **20** | **20** | **60** | **25** | **-** | **125** |
| **Sustainable Development Goals Mapped:** 4, 8, 9, 11, 12 | | | | | | | | | | | | |

**Course Objectives:**

1. To study the principles of precision measuring instruments & their significance.
2. To familiarize with gear teeth and threads measuring instruments/ equipment's.
3. To impart knowledge of architecture of the measurement system.
4. To deliver the working principle of a mechanical measurement system.

**Course Outcomes:**

1. Recognize and apply concepts of metrology, standards, types of measurements, instrument characteristics, and sources of errors.
2. Select suitable measuring instruments and apply calibration techniques to achieve accurate and precise measurements.
3. Apply limits, fits, tolerances, gauges, and comparators in inspection and quality control processes.
4. Measure angular components, screw threads, and gear parameters using appropriate instruments and methods.
5. Analyze mechanical measurement systems and evaluate static and dynamic characteristics of instruments.
6. Use different transducers and instruments for measurement of displacement, strain, pressure, flow, and temperature in engineering systems.

**Course Contents:**

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Introduction to Metrology:**<br>1. Definition of Metrology, objective and types of Metrology, Need of inspection, Methods of measurements.<br>2. Standards: Definition and characteristics of Line standard, End standard and Wavelength standard.<br>3. Types of Errors and its sources in Measurements,<br>**Self-learning topic**: Factors affecting on accuracy. | **5** | **1** | **3** |
| **II** | **Gauges and Comparators:**<br>2.1 Limits, fits and tolerances of interchangeable manufacture, Elements of interchangeable system, Hole based and shaft based systems, Tolerance grades, Types of fits, General requirements of Go & No go gauging, Taylor's principle, Design of Go & No go gauges.<br>2.2 Comparators: Definition, Requirement of a good comparator, Classification, Use of comparators, Working principle (Merits and Demerits) of Dial indicator and Pneumatic Comparator (Air Gauge),<br>2.3 Case Study on Interchangeability<br>**Self-learning topic**: Selective Assembly,. | **5** | **2** | **3** |

| | | | | |
|---|---|---|---|---|
| **III** | **Angular, Screw Thread and Gear Tooth Measurements:**<br>1. Angle measurement: Instruments used in Angular Measurements: Angle Gauges (No Numerical), Bevel Protractor, sine bar. Principle of Working of Angle Dekkor.<br>2. Screw thread Measurements: Screw thread terminology, measurement of different elements such as major diameter, minor diameter, effective diameter, pitch, thread angle. Best wire size, Two wire method, Working principle of floating carriage micrometer, Errors in threads, screw thread gauges,<br>3. Gear tooth Measurement terminology, Measurement of tooth thickness: Gear tooth vernier, Constant chord method, Addendum comparator method and Base tangent method, Measurement of tooth profile, Profile projector.<br>4. Case Study on Coordinate Tool maker's microscope or projector, Involute tester, Measurement of pitch, Measurement Machine (CMM)<br>**Self-learning topic**: Profile projector | **6** | **3** | **3** |
| **IV** | **Mechanical Measurement:**<br>1. Characteristics of instruments – Static characteristics: Least count (resolution), Range and Span, Accuracy and Precision, Reliability, Calibration, Hysteresis, Dead Zone, Drift, Sensitivity, Threshold, Repeatability, Reproducibility, Linearity, Amplification, Magnification. Dynamic characteristics: Speed of response, Fidelity, Overshoot.<br>**Self-learning topic:** Types of inputs: Desired, interfering and modifying inputs. | **4** | **4** | **3** |
| **V** | **Displacement, Strain Gauges and Pressure Measurement:**<br>1. Displacement Measurement: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder), 2. Strain Measurement: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, torque sensors<br>3. Pressure Measurement: Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements,<br>Case Study on Strain gauge based load cells<br>**Self-learning topic**: Ionization and Thermal Conductivity gauges | **6** | **5** | **4** |

| | | | | |
|---|---|---|---|---|
| **VI** | **Flow and Temperature Measurement:**<br>1. Flow Measurement: Bernoulli flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter<br>2. Temperature Measurement: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples,<br>**Self-learning topic:** Pyrometers and their applications<br>**Advanced Topic:** IoT-based measurement and monitoring systems | **4** | **6** | **3** |

**Laboratory Content**

| Sr. No. | List of Experiments | COs |
|---|---|---|
| 1 | Experiments on linear and angular measurement using Vernier calliper, micrometer . | CO1 |
| 2 | Measurement of dimensions of component using vernier height gauge, vernier depth gauge, micrometer and inside micrometer. | CO1 |
| 3 | Measurement of unknown angle of a component using Bevel Protractor and verification by Sine bar. | CO1, CO2 |
| 4 | Experiments on screw thread measurement using screw thread micrometer, Floating carriage | CO2 |
| 5 | Experiments on measurement of gear parameters using Gear tooth Vernier calliper . | CO1,CO3 |
| 6 | Experiments on surface measurement by using Surface roughness tester. | CO3 |
| 7 | Experiments on linear / angular measurements of screw / gear /single point tool using Optical profile projector . | CO4 |
| 8 | Experiment using Mechanical Comparator. | CO4 |
| 9 | Measurement of speed of rotating shaft by stroboscope or inductive pick up. | CO4 |
| 10 | Measurement of displacement by using Linear Variable Displacement Transducer (LVDT). | CO5 |
| 11 | Measurement of temperature by thermocouple and Verification by thermometer. | CO6 |
| 12 | Measurement of flow rate of liquid by rotameter. | CO6 |
| 13 | Experiments on measurement of pressure by gauges or sensors like vacuum Gauges, pressure gauge, piezoelectric sensors, strain gauge sensors etc. | CO6 |

**Text/Reference Books:**

1. Engineering. Metrology, I.C. GUPTA, Dhanpat Rai Publications.
2. Engineering Metrology and Measurement, N V Raghavendra and Krishnamurthy, Oxford University Press,
3. METROLOGY AND MEASUREMENTS" Anand K Bewoor and Vinay A Kulkarni,Tata McGraw-Hill Education Private Limited, New Delhi , India ISBN (13): 978-0-07-014000-4 (2017)

4. Engineering. Metrology, R. K. Jain, Khanna Publisher.
5. Measurement Systems: Applications and Design, by EO Doebelin,5th Edition, McGraw Hill
6. Mechanical Engineering Measurements, A. K. Sawhney, Dhanpat Rai & Sons, New Delhi
7. Mechanical and Industrial Measurements, R K Jain,, Khanna Publication, New Delhi ISBN: 8174091912 (1995)
8. Engineering Metrology & Instrumentation, R,K. Rajput, S.K. Kataria and Sons ISBN:9788185749822 (2009)"
9. Instrumentation & Mechanical Measurements, A. K. Thayal
10. Modem Control engineering: by K. Ogata, Prentice Hall
11. Mechanical Measurements, Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard , Pearson Prentice Hall ISBN:9780136093763 (2013)

| Course Title: Industrial Electronics | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** IV | | | **Term:** Even | | | | **Course Code:** 25MEPCC403 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or / Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 2 | -- | 2 | 2 | -- | 1 | 3 | 20 | 20 | 60 | 25 | 25 | 150 |
| **Sustainable Development Goals Mapped:** 4, 7, 8, 9, 11, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To develop fundamental knowledge of semiconductor devices and analog circuits used in industrial electronics.
2. To understand sensors, actuators, and electric drives used in mechanical and industrial systems.
3. To introduce microprocessors, microcontrollers, and IoT-based platforms for industrial applications.

To provide knowledge of industrial automation systems and PLC-based control for real-world applications.

**Course Outcomes:**

1. Explain the characteristics and applications of semiconductor devices and analyse basic rectifier circuits.
2. Apply operational amplifiers and IC 555 timer in designing basic electronic circuits.
3. Identify and classify sensors and actuators and explain their role in industrial measurement and control systems.
4. Select suitable motors and drives for different industrial applications based on system requirements.
5. Utilize microprocessor and microcontroller architecture and interfacing techniques for basic industrial applications.
6. Apply industrial automation concepts to analyse and implement simple automation systems using PLC and real-world applications.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Semiconductor Devices:** Review of diodes, V-I characteristics and Applications of diode, Zener diode, LED, photodiode; SCR V-I characteristics, UJT triggering circuit, basics of Gate Turn Off (GTO).<br>**Rectifier:** Half and Full wave-controlled Rectifier.<br>**Self-Learning**: Characteristics of Power BJT, power MOSFET, IGBT; Comparison of SCR, Triac, Power BJT, power MOSFET, IGBT | 05 | CO1 | 4 |
| II | **Operational amplifiers and 555 Timer:** Operational amplifier circuits, Ideal OPAMP behaviors, common OPAMP ICS; Basic OPAMP circuits- Inverting amplifier, non-inverting amplifier, Voltage follower (Buffer), Comparator, IC-555 timer-Operating modes: monostable, a stable multivibrator<br>**Self-Learning**: Industrial application (Instrumentation Amplifier). | 05 | CO2 | 3 |
| III | **Sensors and Actuators:** Introduction, classification and characteristics of sensors – active, passive, Analog, digital; Temperature sensors (RTD, Thermistor, Thermocouple), | 05 | CO3 | 2 |

| | | | | |
|---|---|---|---|---|
| | Proximity sensors/Displace sensor (Inductive, Capacitive, Ultrasonic), Level sensors, Gas Sensor. **Self-Learning:** Industrial applications of sensors and actuators in process control and automation. | | | |
| IV | **Motors:** Review and comparison of DC motors and AC induction motors, Basic principles of speed control of AC induction motor, Basics of BLDC motor, Linear Actuator motor, Servo Motor; Motor Specifications, suitability of each motor for various industrial applications, Selection and sizing of motors for different applications. **Self-Learning**: Applications for pumps, conveyors, machine tools, Microcontroller based speed control for Induction Motor. | 05 | CO4 | 3 |
| V | **Microprocessor and Microcontrollers:** Overview of generic microprocessor: architecture and functional block diagram, Comparison of microprocessor and microcontroller. **IOT microcontroller:** Introduction to Arduino board, pin configuration, programming environment, analog and digital interfacing using Arduino. Features of ESP32, NodeMCU and RaspberryPI. **Self-Learning**: Applications of microcontroller: Temperature measurement, Speed Measurement using Proximity Sensor. | 05 | CO5 | 3 |
| VI | **Introduction to Industrial Automation:** Definition and need of automation, Types: Fixed, Programmable, Flexible, Advantages and limitations. Block diagram and working. **PLC**: Introduction and need of PLC, Basic architecture **Industrial Automation Applications:** Conveyor belt system, Water level control system, Temperature control system, **Self-Learning:** Traffic light control **Advanced Topic:** Smart sensors and connected devices in automation | 05 | CO6 | 3 |

**Lab Contents:**

| Sr. No. | List of Experiment | COs |
|---|---|---|
| 1. | To obtain V-I characteristics, holding and latch current of given SCR. | CO1 |
| 2. | To construct a relaxation oscillator using UJT and trace the waveform and measure the frequency. | CO1 |
| 3. | Study and characteristics of LDR, Thermistor, and Ultrasonic sensor. | CO3 |
| 4. | To construct Inverting Amplifier. | CO2 |
| 5. | To construct Non-Inverting Amplifier. | CO2 |
| 6. | To study of a stable multivibrator using IC 555. | CO2 |
| 7. | Interfacing of IR sensor with Arduino and display output. | CO3, CO5 |
| 8. | Study Servo Motor with Arduino. | CO4, CO5 |
| 9. | Interfacing of temperature sensor (DHT22) with Arduino and display output. | CO3, CO5 |
| 10. | Speed control of DC motor | CO6 |
| 11. | Speed control of induction motor | CO4 |

| | | |
|---|---|---|
| 12. | Study of displacement measurement using LVDT. | CO3, CO5 |
| 13. | To implement a simple ON/OFF control system using a switch or sensor for controlling a load (lamp/motor). | CO6 |
| 14. | To design and implement a temperature-controlled system for automatic operation of a fan or heater. | CO6 |
| 15. | To develop an automatic water level control system using level sensors and a pump. | CO6 |

**Reference Books:**

1. S. Salivahanan and S. Arivazhagan, "Digital Circuit and Design" ,Oxford Education, Fifth Edition,2018.
2. John H. Davies, MSP430 Microcontroller Basics, Newnes; 1 edition, 2008.
3. Biswanath Paul, *Industrial Electronics and Control,*3rd Edition,PHI Learning Pvt. Ltd,2014.
4. David A. Bell, *Operational Amplifiers and Linear ICs*,3rd Edition, Oxford University Press,2010
5. W. D. Stevenson, Elements of Power System, 4 Edition TMH

**Text Books:**

1. R. P. Jain, Modern Digital Electronics, Tata McGraw Hill Education, Third Edition 2003.
2. Richard C. Dorf and James A. Svoboda "Introduction to Electric Circuits, 9th Edition, 2013.
3. Paul Horowitz and Winfield Hill "The Art of Electronics", 3rd Edition, 2015.
4. Ned Mohan "Power Electronics: Converters, Applications, and Design", 4th Edition, 2023.
5. RK Rajput, A Text Book of Power System engineering, Laxmi Publication, published in 2016
6. Mehta V.K., Principles of Power System, S Chand, 2005 version.

**Useful Links:**

| Sr. No. | Website |
|---|---|
| 1 | https://www.nptel.ac.in |
| 2 | https://www.udemy.com |
| 3 | https://www.coursera.org |

| Course Title: Kinematics & Dynamics of Machines | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** IV | | | **Term:** Even | | | | **Course Code:** 25MEPCC404 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or / Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | 2 | 3 | - | 1 | 4 | 20 | 20 | 60 | 25 | - | 125 |
| **Sustainable Development Goals Mapped:** 4, 8, 9, 11, 12 | | | | | | | | | | | | |

**Course Objectives:**

1. To acquaint with basic concept of kinematics and kinetics of machine elements
2. To acquaint with working principles and applications of Governors / Gyroscope.
3. To familiarize with basics of mechanical vibrations.
4. To study the balancing of mechanical systems.

**Course Outcomes:** After completion of this course, learner will be able to…

1. Understand the various concepts related to machines and mechanisms.
2. Apply the kinematic analyses in existing real-life mechanisms.
3. Demonstrate working Principles of different types of governors and Gyroscopic effects on the mechanical systems.
4. Determine natural frequency of element/system.
5. Determine vibration response of mechanical elements / systems.
6. Demonstrate basic concepts of balancing of forces and couples.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Machines and mechanisms:** Introduction, Link, Kinematic pair, Types of motion, Classification of kinematic pairs, Kinematic chain, Linkage, Mechanism and machine, Degrees of freedom (mobility), Kinematic inversion, Inversions of slider crank chain, Double slider-crank chain **Self-Learning:** Steering Gear Mechanism - Ackerman, Davis steering gears | 6 | CO1 | 2 |
| II | **Velocity Analysis of Mechanisms** Velocity analysis by relative velocity method (Graphical approach) **Acceleration Analysis of Mechanisms** Acceleration analysis by relative method including pairs involving Coriolis acceleration (Graphical approach) **Self-Learning:** Kennedy's Theorem, Angular Velocity ratio Theorem. | 8 | CO2 | 3 |
| III | **Governors and Gyroscopes:** **Governors:** Introduction to Centrifugal and Inertia governors, Study and Force analysis of Porter and Hartnell governors including Performance characteristics. **Gyroscope:** Introduction, Gyroscopic couple, Effect of gyroscopic couple on an airplane, Effect of gyroscopic couple on a naval ship during steering, pitching, and rolling. **Self-Learning:** Study and Analysis Stability of a two-wheel and Four-Wheel vehicle taking a turn (Theoretical treatment only) | 8 | CO3 | 2 |

| | | | | |
|---|---|---|---|---|
| IV | **Concepts of Vibration:** Vibration and oscillation, causes and effects of vibrations, Importance of study of vibrations, Vibration parameters - springs, mass, damper, degree of freedom, vibration classification.<br>**Free Undamped Single Degree of Freedom Vibration System:** Methods for formulation of differential equations by Newton, Energy, Lagrangian and Rayleigh's method.<br>**Self-Learning:** Motion- periodic, non-periodic, Longitudinal, transverse, torsional vibration system. | 8 | CO4 | 3 |
| V | **Free Damped Single Degree of Freedom Vibration System:** Introduction to different methods of damping, Study of Viscous damped system (under damped, critically damped, over damped) Logarithmic decrement.<br>**Forced Damped Single Degree of Freedom Vibration System:** Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation, Force Transmissibility, Motion transmissibility<br>**Self-Learning:** Study of conditioning monitoring and fault diagnosis. | 8 | CO5 | 3 |
| VI | **Balancing:**<br>Static and dynamic balancing, balancing of rotating masses in single and several planes, primary and secondary balancing of reciprocating masses.<br>**Self-Learning:** Introduction to Balancing machines – Types, Classification and Methods.<br>**Advanced Topic**: Condition monitoring techniques | 7 | CO6 | 2 |

**Lab Contents:**

| Sr. No. | List of Experiments | COs |
|---|---|---|
| 1 | Kinematic analysis of existing or real-life mechanisms with computer assisted software. | CO2 |
| 2 | Experiments on Governors- Porter Governor, Hartnell Governor. | CO3 |
| 3 | Determine natural frequency and nodal points for single rotor and two-rotor vibratory system. | CO4 |
| 4 | Determine natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel. | CO4 |
| 5 | Determination of damping coefficient of any system/media. | CO5 |
| 6 | Measurement of vibration response of a system. | CO5 |
| 7 | Experimental balancing of single and multi-rotor system. | CO6 |
| 8 | To study and demonstrate various types of mechanisms | CO1 |
| 9 | To study and demonstrate various types of inversions. | CO1 |
| 10 | Experiment on Gyroscope. | CO3 |
| 11 | Experiment on whirling of shaft. | CO6 |

**Reference:**

1. Mechanical Vibrations- Schaum's outline series, William W.Seto, McGraw Hill.,2022
2. Theory of Machines by P.L.Bellaney Khanna publication, NewDelhi. 15th edition, 2019

3. Mechanical Vibrations by S.S.Rao, 8th edition, Pearson Education Mechanical Vibraitons by G.K.Grover.,2019
4. Theory of Machines Thomas Bevan CSB Publishers & Distributors, 2013
5. Theory of Vibration with Applications, by W. Thomson, fourth edition, Pearson Education.,2012

**Text Books:**

1. S.S. Ratan, "Theory of Machines", Tata McGraw Hill, 2022
2. Ghosh and A.K. Mallik, "Theory of Mechanisms and Machines", East-West Press, 2020

**Useful Links**

1. https://nptel.ac.in/courses/112/105/112105268/
2. https://www.youtube.com/playlist?list=PLYRGB44zNZWVibVLmWANp-7obQzOhJLRt
3. http://www.nptelvideos.in/2012/12/kinematics-of-machines.html
4. https://nptel.ac.in/courses/112/101/112101096/ - Dynamics of Machines, IIT Bombay.
5. https://nptel.ac.in/courses/112/107/112107212/ - Introduction to Mechanical Vibration, IIT Roorkee

| Course Title: Python Programming Lab | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** IV | | | **Term:** Odd | | | | **Course Code:** 25MEPCC405 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| - | - | 2 | - | - | 1 | 1 | - | - | - | 25 | -- | 25 |
| **Sustainable Development Goals Mapped:** 4, 8, 9, 11, 12 | | | | | | | | | | | | |

**Course Objectives:**

1. To introduce students to the fundamentals of programming using Python.
2. To develop logical thinking and structured problem-solving skills.
3. To enable students to apply Python programming in basic mechanical engineering problems.
4. To familiarize students with Python libraries useful in computation, visualization, and data analysis.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Understand the basic syntax, variables, and data types in Python and set up the programming environment.
2. Implement conditional statements, loops, and functions for solving logical problems.
3. Apply Python data structures and file handling techniques to organize and process data.
4. Use NumPy for performing mathematical operations relevant to mechanical systems.
5. Visualize engineering data using Matplotlib for analysis and interpretation.
6. Develop basic simulations and solve mechanical engineering problems using Python.

| Module | Lab Content | Hours | COs |
|---|---|---|---|
| 1 | **Introduction to Python**<br>• Overview of Programming and Python – Installation and Environment Setup<br>• Basic Syntax, Variables, Data Types (int, float, string, bool) | 4 | 1 |
| 2 | **Control Structures and Functions**<br>• Conditional Statements (if, elif, else)<br>• Loops – for, while<br>• Functions and Scope of Variables | 6 | 2 |
| 3 | **Data Structures and File Handling**<br>• Lists, Tuples, Sets, Dictionaries<br>• File Input/Output – Reading and Writing Files<br>• String Manipulations and Formatting | 6 | 3 |
| 4 | **Numerical and Scientific Computation**<br>• Introduction to NumPy – Arrays, Vectorized Operations<br>• Mathematical Functions – linspace, arange, mean, std, dot, cross | 4 | 4 |
| 5 | **Data Visualization and Plotting**<br>• Introduction to Matplotlib – Line, Bar, Scatter, Histogram plots<br>• Visualization of Mechanical Data – Stress-Strain Curves, Time-Displacement | 4 | 5 |

| | | | |
|---|---|---|---|
| 6 | **Applications in Mechanical Engineering**<br>• Solving Linear Algebraic Equations (Mechanical Systems)<br>• Introduction to SimPy – Simple simulations (e.g., piston motion, thermal cycles)<br>• Basic 2D Geometry Handling and Curve Plotting for Mechanism Design | 6 | 6 |

| Sr No. | List of Experiment | COs |
|---|---|---|
| **1** | Accept and display mechanical component details. | 1 |
| **2** | Calculate area, perimeter, and volume of basic mechanical shapes. | 1 |
| **3** | Use conditional logic to determine phase change of a substance. | 2 |
| **4** | Generate multiplication tables and factorials using loops. | 2 |
| **5** | Create a unit conversion program using functions. | 2 |
| **6** | Store and analyze temperature readings using lists. | 3 |
| **7** | Use dictionaries to manage material properties. | 3 |
| **8** | Store and retrieve part specs using file I/O. | 3 |
| **9** | Calculate work done using force and displacement arrays. | 4 |
| **10** | Simulate stress-strain data and calculate Young's Modulus. | 4 |
| **11** | Solve linear equations (e.g., beam support reactions). | 4 |
| **12** | Plot velocity-time and displacement-time graphs. | 5 |
| **13** | Plot torque vs RPM graph. | 5 |
| **14** | Plot cooling curve. | 5 |
| **15** | Visualize thermal expansion. | 5 |
| **16** | Animate simple harmonic motion. | 5 |
| **17** | Simulate piston motion using kinematics. | 6 |
| **18** | Simulate thermodynamic processes (e.g., PV diagram). | 6 |
| **19** | Plot pressure loss vs flow rate. | 6 |
| **20** | Mini Project: Develop a full Python-based analysis tool. | 6 |

**Reference Books:**

1. Python Programming: An Introduction to Computer Science**,** John Zelle, Franklin Beedle & Associates, 2017

2. Automate the Boring Stuff with Python, Al Sweigart, No Starch Press, 2020
3. Python for Engineers and Scientists, Sandeep Nagar, Apress, 2018
4. Python Programming for Beginners: A Step-by-Step Guide, Jason Cannon, Independently Published, 2021
5. Python for Mechanical and Aerospace Engineering, Alex Kenan, CreateSpace Independent Publishing, 2020

**Text Books:**

1. Numerical Python: A Practical Techniques Approach for Industry, Robert Johansson, Apress, 2019
2. Matplotlib for Python Developers, Sandro Tosi, Packt Publishing, 2015
3. A Beginner's Guide to Python for Physical Modeling, Jesse M. Kinder and Philip Nelson, Princeton University Press, 2021
4. Python Crash Course, Eric Matthes, No Starch Press, 2019
5. Scientific Programming with Python, Claes Johnson, Self-published (available online), 2011

**Useful Links:**

1. NPTEL – Python for Data Science: https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2. NPTEL – Programming in Python:

   https://onlinecourses.swayam2.ac.in/cec22_cs20/preview

| Course Title: Employability Enhancement Program-II (Communication) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** IV | | | **Term:** Even | | | | **Course Code:** 25MEAEC401 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme:** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| - | - | 2 | - | - | 1 | 1 | - | - | - | 25 | - | 25 |
| **Sustainable Development Goals Mapped:** 4, 5, 8, 10, 16 | | | | | | | | | | | | |

**Objectives:**

1. To understand the importance of active listening in effective communication.
2. To cultivate effective inter-personal skills and employment skills for organizational development.

**Outcomes:**

After successful completion of the course, learner will be able to …

1. Understand the importance of active listening and social etiquette for effective communication.
2. Enhance written communication, official and technical skills
3. Strengthen their personal and professional relationship in career building.
4. Ace their employability Skills through personal SWOT, Group Discussion and Resume Writing

| Module | Contents | Hours | COs |
|---|---|---|---|
| I | **Listening & Social Skills**<br>• Importance of Listening, Difference between hearing & listening<br>• Types of Listening<br>• Barriers of Listening<br>• Listening (Audios/Videos)<br>• Etiquette-Social Etiquette, Dining Etiquette, Telephonic Etiquette, Email Etiquette<br>• Reading Comprehension Skills | 6 | CO1 |
| II | **Proposal & Report Writing**<br>• Letter Writing: Permission Letter, Leave Letter, Apology Letter<br>• Meetings – Notice, Agenda & Minutes<br>• Introduction to Proposal Writing<br>• Parts of a Proposal<br>• Types of Proposal: Research, Business<br>• What is Technical paper writing in IEEE?<br>• Types of Paper Writing: Journal, Conference Paper<br>• Writing a Review Paper | 8 | CO2 |
| III | **Interpersonal Skills**<br>• Presentation Skills: Power Point, Demo Presentation<br>• Managerial Skills: Time Management, Goal Setting, Decision Making, Conflict Resolution, Team Building, Leadership, Emotional Intelligence, Critical Thinking, Assertiveness, Negotiation | 8 | CO3 |
| IV | **Employability Skills**<br>• SWOT Analysis: Personal & Organizational<br>• Verbal Aptitude Test | 8 | CO4 |

| | | | |
|---|---|---|---|
| | • Group Discussion Skills: Types of GD, Do's and Don'ts, Tips for cracking a GD<br>• Resume Writing<br>• Interview Techniques | | |

| Sr. No. | List of Experiments / Tutorials | COs |
|---|---|---|
| 1 | Listening Activity | CO1 |
| 2 | Comprehending Unseen Passages | CO1 |
| 3 | Writing Email Etiquette/Do's & Don'ts of Email Writing | CO1 |
| 4 | Meeting and Documentation- Notice, Agenda & Minutes | CO2 |
| 5 | Letter Writing- Permission, Leave & Apology | CO2 |
| 6 | PPT Presentation on any Technical Topic (Group Activity) | CO2/3 |
| 7 | Case Study Based GD-1 | CO3 |
| 8 | Case Study -2 | CO3 |
| 9 | SWOT Analysis: Personal | CO4 |
| 10 | Resume Writing | CO 4 |

**Reference Books:**

1) M Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill, 2008
2) Gadyalji Vaishali K, Communication Skills, Nandu Publications, 2010
3) Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2007
4) Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2008
5) Raman Meenakshi & Sharma Sangeeta, Technical Communication Principles and Practice, Oxford University Press, 2015
6) Raman Meenakshi & Singh Prakash, Business Communication, Oxford University Press, 2008
7) Luthans Fred, Organizational Behavior An Evidence-Based Approach, McGraw Hill Education Private Limited, 2013
8) Locker O Kitty & Kaczmarek Kyo Stephen, Business Communication Building Critical Skills, McGraw Hill Education Private Limited, 2007
9) Chaturvedi P D & Chaturvedi Mukesh, Business Communication Concepts, Cases and Applications, Pearson Education, 2008

**Useful links**

https://youtu.be/TTARLuquJeE
https://youtu.be/jPj0Z2lb8jg
https://youtu.be/2nEvKZ4SG2c

PD & Social Etiquette
https://youtu.be/wPorhmnMDdc
https://youtu.be/n6F5icYGnSg

7Cs of Effective Communication
https://youtu.be/XuGCDRNIU-M

Letter Writing
https://youtu.be/ci47OQLFjao
https://youtu.be/uj6rlM62Bqk

Motivational Speech
https://youtu.be/xrEq-1UujOo

https://youtu.be/W7BW9gv_OkU

Reading Comprehension
https://youtu.be/3yYjYvdcCw8

Public Speaking Tips
https://youtu.be/UNGla--HOXQ

BARRIERS TO COMMUNICATION a case study
https://youtu.be/k9KK_0zr3LU

| Course Title: Employability Enhancement Program-III (Industry Certification) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester: IV** | | | **Term: Even** | | | | **Course Code:** 25MEVSE401 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| - | - | 2 | - | - | 1 | 1 | - | - | - | - | 25 | 25 |
| **Sustainable Development Goals Mapped:** 4, 5, 8, 9, 10, 12, 17 | | | | | | | | | | | | |

**Introduction**

As global competition intensifies, industries seek candidates who are not only skilled but also adaptable and ready to meet the demands of an evolving workforce. To bridge the gap between academic learning and industry expectations, SJCEM has introduced certification courses aimed at preparing students for impactful internships. These courses provide students with essential knowledge and skills, empowering them to excel in professional environments and increase their employability.

**Objectives:** The objectives of this course are to

1. Develop Professional Skills
2. Enhance Technical Competency
3. Cultivate Problem-Solving Abilities
4. Promote Ethical and Professional Conduct
5. Familiarize with Industry Standards and Expectations
6. Prepare for a Transition from Classroom to Workplace

**Outcomes:** After completion of this course, students will be able to

1. Communicate and Collaborate Effectively
2. Acquire Job-Ready Technical Skills
3. Enhanced Critical Thinking and Problem-Solving
4. Understand Ethical and Professional Standards
5. Use Industry Tools and Standards
6. Industry Integration effectively

**Certification Guidelines:**

The general procedure for organizing certification courses is as follows:

1. **Identification of Industry Partners**
   Industries have been identified to provide in-house certification courses in various domains. Students are regularly informed and encouraged to pursue these certification courses.
2. **Selection of Certification Domain**
   Students can choose two domains of their interest for the certification course and express their willingness to pursue the certification.
   Following combination of domains are offered in the even semesters:

| | | | | | | |
|---|---|---|---|---|---|---|
| SQL + Dotnet | AR-VR | Angular API Development | Metaverse | Software Testing | Data Analytics with Power BI & Advance MS Excel | Flutter |
| Mernstack | Applied Machine Learning with Python | Prompt Engineering & AI | Generative AI & LLM Application | IOT | Cyber Security | CCNP |
| Robotics and AI | **SolidWorks** | **Creo** | Digital Twin | Electrical Vehicles | BIM | Revit |

3. **Allocation of Tracks**
   Each track can accommodate a maximum of 60 students or as per the availability of maximum seats. Allocation will be based on a first-come first-served basis. However, the institute reserves the right to reassign tracks as per the requirement.
4. **Course Duration**
   Students have to complete the certification course, which has a minimum duration of 30 hours.
5. **Oral & Practical Exam**
   Based on the entire syllabus, oral (20 marks) & practical/implementation (30 marks) examination will be conducted. Grades will be assigned as per the examination rules.

**Note:** A minimum of 90% attendance is required to award the certificate. If a student fails to meet this requirement, the student needs to re-register for the course internally or externally until successfully completed.

| Course Title: Internship-I | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** IV | | | **Term:** Even | | | | **Course Code:** 25MEOJT401 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| - | - | 3 | - | - | 1 | 1 | - | - | - | - | 25 | 25 |

**Sustainable Development Goals Mapped:** "SDG mapping for internship will be based on the organization, work domain, and activities carried out by the student."

**Introduction**

The rise in global competition has prompted organizations to devise strategies to have a talented and innovative workforce to gain a competitive edge. Developing an internship policy is an impactful strategy for creating a future talent pool for the industry. The internship (a form of experiential learning) program helps fresh pass–outs in gaining professional know-how and benefits corporate sectors. The internship also enhances the student's employability skills passing out from Technical Institutions.

**Objectives:**

1. Integration of workshop with workplace in physical and/or hybrid model.
2. Developing research aptitude in emerging technologies
3. Enhance entrepreneurial capabilities and professional competency
4. Development of decision-making and teamwork skills
5. Cultivate a sense of Social Imagery and Citizenship Responsibility

**Outcomes:** After completion of this course, students will be able to

1. Apply practical skills effectively in physical and hybrid workplace settings.
2. Conduct and communicate research on emerging technologies.
3. Demonstrate creative problem-solving and an entrepreneurial mindset.
4. Meet industry standards with strong communication and technical skills.
5. Collaborate effectively and make informed decisions within teams.

**Internship Guidelines:**

- The students should apply for internships of their choice with the permission of the Institute.
- The internship duration ranges from 4 to 6 weeks and is scheduled during the summer vacation period for students
- Industry will confirm the training slots and the number of seats allocated for internships via confirmation letter/ email.
- Students on joining Training at the concerned Industry / Organization, submit the Joining Report/Letters / Email.
- Students undergo industrial training at the concerned Industry / Organization.
- Training and placement team will visit the industry and evaluate(s) the performance of students regularly and evaluation Report of the students is submitted in department office/TPO with the consent of Industry persons/ Trainers.
- Students will submit training report after completion of internship.
- Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.
- It will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary.
- Project/Case study/Completion of assigned task by industry undertaken during the internship
- Employer feedback

- Training Certificate to be obtained from industry followed by the presentation in the department.

| Course Title: Additive Manufacturing Technologies | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** IV | | | **Term:** Even | | | | **Course Code:** 25MDM401AM | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | 2 | 3 | - | 1 | 4 | 20 | 20 | 60 | 25 | - | 125 |

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

**Course Objectives:**

1. To introduce the fundamental principles, evolution, and need for Additive Manufacturing (AM) in modern product development.
2. To provide an understanding of various AM process classifications, working principles, and process chains involved in part fabrication.
3. To familiarize students with materials, equipment, and software used in different AM systems and their industrial applications.
4. To develop the ability to analyze, compare, and select suitable AM technologies for specific engineering applications considering design, cost, and sustainability.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1 Analyze the parameters affecting in Vat Photo polymerization Processes.
2 Analyze the parameters affecting in Material Jetting Processes.
3 Analyze the parameters affecting in Extrusion-Based polymer AM Processes.
4 Analyze the parameters affecting in Powder Bed Fusion polymer AM Processes.
5 Suggest post processing technique to finish the job.
6 Compare and select appropriate polymer based Additive manufacturing process for part under consideration.

| Module | Content | Hours | COs |
|---|---|---|---|
| 1 | **Introduction to Additive Manufacturing**<br>Definitions, Geometric and Material Capabilities of Additive Manufacturing, Classification of Additive Manufacturing based on ASTM and Feed Stock Materials, Generic Additive Manufacturing Process, Other Related Technologies, Applications of Additive Manufacturing.<br>**Introduction to Polymer 3D Printing**<br>Polymer Additive Manufacturing Technology Landscape, Exciting Technological Developments in Polymer 3D Printing, Polymer 3D Printing Trends, Opportunities and Applications. | 8 | 1 |
| 2 | **Liquid Additive Manufacturing** | 8 | 2 |

| | | | |
|---|---|---|---|
| | Introduction, Classification: Photo Polymerization and Rapid Freezing, Working Principle and Sub-systems, Stereolithography (SLA): Working Principle, Architecture of equipment, Subsystems, Laser Beam, Laser Curing Mechanisms, Galvanometer, Recoating System.<br>**Other Liquid Additive Manufacturing Processes:** Digital Light Processing, Object Polyjet, Autostrade's E-Dart, Solid Ground Curing (SGC), Micro-stereolithography, Robotic – SLA, Other Processes. | | |
| 3 | **Material Jetting AM Processes**<br>Introduction, Working Principle, Architecture of Equipment, Materials, Process Parameters, Process Capabilities, Applications, Case Studies. | 8 | 3 |
| 4 | **Extrusion-Based AM Processes**<br>Fused Deposition Modelling (FDM)/ Fused Filament Fabrication (FFF): Introduction, Working Principle, Architecture of Equipment, Materials, Process Parameters and Modelling, Plotting and Path Control, Bio-Extrusion, Contour Crafting, Process Capabilities, Applications, Case Studies. | 7 | 4 |
| 5 | **Powder Bed Fusion AM Processes**<br>**Selective Laser Sintering (SLS):** Introduction, Working Principle, Architecture of Equipment, Materials, Powder Fusion Mechanism, Process parameters and Modelling, Powder Handling, Commercial Machines, Process Capabilities, Applications, Case Studies.<br>**Multi Jet Fusion:** Introduction, Working Principle, Architecture of Equipment, Materials, Process parameters, Process Capabilities, Applications, Case Study. | 7 | 5 |
| 6 | **Post-Processing in Polymer Additive Manufacturing**<br>Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-Thermal and Thermal Techniques. | 7 | 6 |
| **Total** | | **45** | |

| Sr No. | List of Experiment | COs |
|---|---|---|
| **1** | Geometric modeling of an Engineering component, demonstrating skills in sketching commands of creation (line, arc, circle etc.) modification (Trim, move, rotate etc.) and viewing using (Pan, Zoom, Rotate etc.) | 1 |
| **2** | Demonstrating modeling skills using commands like Extrude, Revolve, Sweep, Blend, Loft etc. Mesh of curves, free form surfaces etc. Feature manipulation using Copy, Edit, Pattern, Suppress, History operations etc. | 1 |
| **3** | Assembly: Constraints, Exploded views, interference check. Drafting (Layouts, Standard & Sectional Views, Detailing & Plotting). | 2 |
| **4** | CAD Modelling for additive manufacturing. | 2 |
| **5** | STL file: Introduction, Data Structure, ASCII, Binary, Resolution, Tolerances, Manipulation of STL files | 3 |
| **6** | Slicing of corrected STL files. | 3 |

| | | |
|---|---|---|
| **7** | Tool Path Planning | 4 |
| **8** | Introduction to 3D Printing Software, process parameters for Additive Manufacturing Technology (CURA, GRABCAD) | 4 |
| **9** | Identification of problems associated with STL file. | 5 |
| **10** | Printing polymer models using 3D printer. | 5 |
| **11** | Post processing of printed part and measurement of dimensional accuracy, surface quality and mechanical properties of printed model. | 6 |
| **12** | Industrial Visit and Report on visit to AM facility. | 6 |

**Reference Books:**

1. Rapid Prototyping: Laser-based and Other Technologies, Patri K. Venuvinod and Weiyin Ma, Springer, 2004.
2. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer 2001.
3. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons, 2006.

**Text Books:**

1. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W Rosen, Brent Stucker, Springer, 2015, 2nd Edition.
2. 3D Printing and Additive Manufacturing: Principles & Applications, Chua Chee Kai, Leong Kah Fai, World Scientific, 2015, 4th Edition.

**Useful Links:**

1. https://www.nist.gov/additive-manufacturing
2. https://www.metal-am.com/
3. http://additivemanufacturing.com/basics/
4. https://www.3dprintingindustry.com/
5. https://www.thingiverse.com/

| Course Title: Renewable Energy Sources | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** IV | | | **Term:** Even | | | | **Course Code:** 25MDM401EE | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | 2 | 3 | - | 1 | 4 | 20 | 20 | 60 | 25 | - | 125 |

**Course Objectives:**

1. To introduce the fundamental principles and importance of renewable energy sources in the global energy context.
2. To understand the working principles, components, and applications of various renewable energy conversion systems.
3. To develop analytical skills to estimate the performance and efficiency of solar, wind, and biomass systems.
4. To provide hands-on experience through laboratory experiments and simulation tools for renewable energy systems.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Explain the classification, significance, and potential of different renewable energy resources.
2. Analyze solar radiation data and estimate solar energy availability for specific locations.
3. Explain the working principles and performance characteristics of solar PV and thermal systems
4. Evaluate the performance and energy yield of wind and biomass energy systems.
5. Conduct simple experiments and use web-based tools (e.g., PVGIS) for renewable energy estimation.
6. Integrate knowledge of multiple renewable sources to propose sustainable hybrid energy solutions.

| Module | Content | Hours | COs |
|---|---|---|---|
| 1 | **Introduction to Renewable Energy**<br>Energy scenario; limitations of fossil fuels; classification of renewable sources; global and Indian renewable potential; need for sustainable energy systems. | 7 | 1 |
| 2 | **Solar Radiation and Measurement**<br>Solar geometry, declination, solar time, angle of incidence, beam and diffuse radiation, instruments for measuring solar radiation (pyranometer, pyrheliometer). | 7 | 2 |
| 3 | **Solar Energy Conversion Systems**<br>a) Solar Thermal Systems: Flat plate collector, concentrating collector, performance parameters and efficiency. (b) Solar PV Systems: PV cell working principle, I–V characteristics, module configurations, and performance estimation. | 8 | 3 |
| 4 | **Wind and Biomass Energy Systems** | 8 | 4 |

| | | | |
|---|---|---|---|
| | Wind energy principles, power in wind, turbine characteristics, Betz limit, site selection. Biomass resources, biogas production process, types of digesters, and performance parameters. | | |
| 5 | **Energy Estimation and Simulation Tools** Introduction to PVGIS and NREL solar databases; calculation of solar energy potential and PV system sizing using simulation tools. | 8 | 5 |
| 6 | **Hybrid Energy Systems and Future Trends** Overview of hybrid (solar–wind–biomass) systems, integration challenges, and smart microgrid applications; future energy trends and sustainability goals. | 7 | 6 |
| **Total** | | **45** | |

| Sr No. | List of Experiment | COs |
|---|---|---|
| **1** | Study of various renewable energy sources and their characteristics. | 1 |
| **2** | Measurement of solar radiation using pyranometer/pyrheliometer. | 1 |
| **3** | Determination of solar angles and plotting daily/seasonal variation. | 2 |
| **4** | Performance test on flat plate solar collector. | 2 |
| **5** | Study and I–V characteristics of solar PV module under varying irradiance. | 3 |
| **6** | Performance estimation of a wind turbine using given wind data. | 3 |
| **7** | Study of biogas plant and estimation of gas yield from feedstock. | 4 |
| **8** | Use of PVGIS or RETScreen software for solar potential estimation at local site. | 4 |
| **9** | Comparative analysis of standalone vs. hybrid renewable systems using spreadsheet model. | 5 |
| **10** | Mini project or case study on local renewable energy application. | 6 |

**Reference Books:**

1. Twidell & Weir, Renewable Energy Resources, Taylor and Francis.
2. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University Press.
3. Tiwari & Ghosal, Renewable Energy Resources: Basic Principles and Applications, Narosa Publishing.

**Text Books:**

1. G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers.
2. S. P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill.
3. B. H. Khan, Non-Conventional Energy Resources, McGraw Hill Education.

**Useful Links:**

1. https://re.jrc.ec.europa.eu/pvg_tools/en/ – PVGIS Solar Estimation
2. https://www.nrel.gov/– NREL Renewable Resource Data
3. https://www.nptel.ac.in/– NPTEL Courses on Renewable Energy

| Course Title: Environmental Studies | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester: IV** | | | **Term: Even** | | | | **Course Code:** 25MEVEC401 | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE-1** | **IAE-2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 1 | - | - | G | - | - | G | - | - | - | - | - | G |

## Course Objectives

1 Introduce students to the multidisciplinary nature of environmental studies and the relationship between humans, population, health, and the environment.
2 Develop an understanding of natural resources, ecosystem functions, biodiversity, and their conservation for ecological balance.
3 Familiarize students with the causes, effects, and control measures of environmental pollution, waste generation, and natural disasters.
4 Promote awareness of sustainable development, environmental ethics, environmental legislation, and individual responsibilities toward environmental protection.

## Course Outcomes

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

1 Explain the multidisciplinary nature of environmental studies and the relationship between population, human health, and the environment.
2 Identify natural resources, associated environmental problems, and appropriate resource conservation strategies.
3 Describe the structure, functions, and characteristics of terrestrial and aquatic ecosystems.
4 Explain the types, values, importance, and conservation strategies of biodiversity at global, national, and local levels.
5 Analyze the causes, effects, and control measures of environmental pollution and explain waste and disaster management practices.
6 Apply the principles of sustainable development, environmental ethics, resource conservation, and environmental legislation to address environmental issues.

| Module No | Title of Module | Syllabus Content | No of Hrs | CO Mapping |
|---|---|---|---|---|
| Module 1 | The Multidisciplinary Nature of Environmental Studies | Definition, scope and importance. Need for public awareness, Role of information technology in environment and human health. Human population and the environment: Population growth, variation among nations. Population Explosion- family welfare program. Environment and human health Women and child welfare | 03 | CO1 |

| | | | | |
|---|---|---|---|---|
| Module 2 | Natural Resources | Renewable and non-renewable resources. Natural resources & associated problems:<br>a) Forest resources:<br>b) Water resources: Natural resources & associated problems<br>c) Mineral resources:<br>d) Food resources:<br>e) Energy resources: Role of an individual in conservation of natural resources:<br>f) Equitable use of resources for sustainable lifestyles. | 04 | CO2 |
| Module 3 | Ecosystems | Concepts of an ecosystem. Introduction, types, characteristic features, structure and function of the following ecosystem:<br>a. Forest ecosystem<br>b. Grassland ecosystem<br>c. Desert ecosystem<br>d. Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries). Case study on various ecosystems in India. | 05 | CO3 |
| Module 4 | Biodiversity and its Conservation | Introduction-Definition: genetic species and ecosystem diversity. Bio-geographical classification of India Value of biodiversity : Consumptive use, productive use, social, ethical, aesthetic and option values, Bio-diversity at global, national, local levels India as a mega diversity nation Case study on Bio diversity in India. | 05 | CO4 |
| Module 5 | Environmental Pollution Definition | Causes, effects and control measures of:<br>a) Air pollution<br>b) Water pollution<br>c) Soil pollution.<br>Solid waste management: Causes, effect and control measures of urban and industrial wastes. Role of an individual in prevention of pollution, Case study on Pollution Disaster management: floods, earthquake, cyclone and landslides. Carbon Credits for pollution prevention | 05 | CO5 |
| Module 6 | Social Issues and Environment | From unsustainable to sustainable development Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Environmental ethics: issues and possible solution. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. | 04 | CO6 |

| | | | | |
|---|---|---|---|---|
| | | Consumerism and waste products. Environment protection act. Public awareness Case study on Environmental Ethics | | |

**Text Book:**

1. Environmental Science: Towards a Sustainable Future, G. Tyler Miller and Scott Spoolman, 13th Edition, Cengage Learning 2021
2. Environmental Management: Text and Cases, Bala Krishnamoorthy, 3rd Edition, PHI Learning, Publication Year: 2016
3. Green IT: Concepts, Technologies, and Best Practices, Markus Allemann, Springer 2008
4. Sustainable IT: Slimming Down and Greening Up Your IT Infrastructure, David F. Linthicum, IBM Press 2009
5. Environmental Modelling: Finding Solutions to Environmental Problems, David L. Murray, Cambridge University Press 2016
6. Remote Sensing and Image Interpretation, Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman, 9th Edition, John Wiley & Sons 2020
7. Business Ethics: Concepts and Cases, Manuel Velasquez, Pearson 2012

**Online References:**

| Sr. No. | Website Name |
|---|---|
| 1 | Centre for Science and Environment (CSE), Website: cseindia.org |
| 2 | Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India |
| 3 | CSIR-National Environmental Engineering Research Institute (NEERI) |

**Reference Book:**

1. Environmental Law and Policy in India, Shyam Divan and Armin Rosencranz, 2nd Edition, Oxford University Press 2018
2. The International Handbook of Environmental Laws, David Freestone and Jonathon L. Rubin, Edward Elgar Publishing 2000
3. E-Waste Management: Challenges and Opportunities in Developing Countries, Ruediger Kuehr and Ram K. Jain, Springer 2008
4. The E-Waste Handbook: Managing Electronic Waste, Klaus Hieronymi, Ruediger Kuehr, and Ram K. Jain, Earthscan 2009
5. Environmental Ethics: An Introduction, J. Baird Callicott, University of Georgia Press1999

# Bachelor of Technology
# In
# Mechanical Engineering

## Third Year
## Semester – V

## SJCEM : R–24C

## Effective from Academic Year

## 2026-27

**Scheme of Third Year Mechanical Engineering**
**(With Effect from 2026-27)**
**Semester V**

| Course Code | Vertical | Course Name | Contact Hrs | | | Credit Allotted | | | Total Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Th | Tut | Pr | Th | Tut | Pr | |
| 24MEPCC501C | PCC | Heat and Mass Transfer | 3 | - | 2 | 3 | - | 1 | 4 |
| 24MEPCC502C | PCC | Design of Mechanical Elements-I | 3 | - | - | 3 | - | - | 3 |
| 24MEPEC501XC | PEC | Professional Elective - I | 3 | - | 2 | 3 | - | 1 | 4 |
| 24MEPEC502XC | PEC | Professional Elective - II | 3 | - | - | 3 | - | - | 3 |
| 24MDM501XC | MDM | Multidisciplinary Minor | 3 | - | 2 | 3 | - | 1 | 4 |
| 24OE501XC | OE | Open Elective - I | 3 | - | - | 3 | - | - | 3 |
| 24MEVSE501C | VSEC | Employability Enhancement Program – IV (Finite Element Analysis Lab) | - | - | 2 | - | - | 1 | 1 |
| | | **Total** | 18 | - | 8 | 18 | - | 4 | **22** |

| Course Code | Vertical | Course Name | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Theory | | | Practical | | Total |
| | | | IAE 1 | IAE 2 | ESE | CA | Or/Pr | |
| 24MEPCC501C | PCC | Heat and Mass Transfer | 20 | 20 | 60 | 25 | 25 | 150 |
| 24MEPCC502C | PCC | Design of Mechanical Elements-I | 20 | 20 | 60 | - | - | 100 |
| 24MEPEC501XC | PEC | Professional Elective- I | 20 | 20 | 60 | 25 | 25 | 150 |
| 24MEPEC502XC | PEC | Professional Elective- II | 20 | 20 | 60 | - | - | 100 |
| 24MDM501XC | MDM | Multidisciplinary Minor | 20 | 20 | 60 | 25 | - | 125 |
| 24OE501XC | OE | Open Elective- I | 20 | 20 | 60 | - | - | 100 |
| 24MEVSE501C | VSEC | Employability Enhancement Program – IV (Finite Element Analysis Lab) | - | - | - | 25 | - | 25 |
| | | **Total** | 120 | 120 | 360 | 100 | 50 | **750** |

**Multidisciplinary Minor**

| Semester | MDM | Course Code | Vertical | Course Name |
|---|---|---|---|---|
| V | Additive Manufacturing | 24MDM501AMC | MDM | Additive Manufacturing Applications |
| V | Energy Engineering | 24MDM501EEC | MDM | Solar and Wind Energy Systems |

**Professional Elective Courses**

| Semester | PEC | Professional Elective-I/III/V | | Professional Elective-II/IV/VI | |
|---|---|---|---|---|---|
| | | Track 1(T1) | Track 2 (T2) | Track 3 (T3) | Track 4 (T4) |
| | | Thermal and Fluid Science | Energy conservation and alternate energy | Mechanical Design | Manufacturing and Production |
| Sem V | Professional Elective I/II | Internal Combustion Engine | Renewable Energy Sources | Finite Element Analysis | Industrial Robotics and Automation |
| Sem VI | Professional Elective III/IV | HVAC and Cryogenics Systems | Energy System Modeling and Analysis | Advanced Vibration | Production Planning and Scheduling |
| Sem VII | Professional Elective V/VI | Computational Fluid Dynamics | Energy Audit and Management | Mechanical System Design | Artificial Intelligence and Machine Learning in Mechanical Systems |
| | | Aerospace Engineering | Fuel cells and hydrogen technology | Design of Automobile Components | Biomedical Engineering |
| | | Power Plant Engineering | Solar Energy | Machinery Diagnostics | Operation Research |

**Professional Electives Courses**

| Semester | Professional Elective - I | |
|---|---|---|
| | Track 01 | Track 02 |
| | Thermal and Fluid Science | Energy conservation and alternate |

| | | | | |
|---|---|---|---|---|
| | | | **energy** | |
| **Sem V** | 24MEPEC5011C | Internal Combustion Engine | 24MEPEC5012C | Renewable Energy Sources |

| **Semester** | **Professional Elective - II** | | | |
|---|---|---|---|---|
| | **Track 03** | | **Track 04** | |
| | **Mechanical Design** | | **Manufacturing and Production** | |
| **Sem V** | 24MEPEC5021C | Finite Element Analysis | 24MEPEC5022C | Industrial Robotics and Automation |

**Open Elective Courses**

| **Semester \ Track** | **Track 1: Entrepreneurship** | **Track 2: Research Methodology** | **Track 4: Foreign Language** | **Track 5: Business Management** |
|---|---|---|---|---|
| **Sem V** | Design Thinking | Research Methodology | Foreign Language - I<br>Japanese L1<br>German L1 | Basics of Marketing Management |
| **Sem VII** | Organizational Behaviour | Publication Guidelines and Selection of Publishers | Foreign Language - II<br>Japanese L2<br>German L2 | Basics of Finance Management |
| **Sem VIII** | Finance and Accounting | Intellectual Property Rights | Foreign Language - III<br>Japanese L3<br>German L3 | Basics of HR Management |

**Open Elective -I**

| **Semester** | **Track 1: Entrepreneurship** | **Track 2: Research Methodology** | **Track 4: Foreign Language** | **Track 5 : Business Management** |
|---|---|---|---|---|
| **Sem V** | 24OE5011C<br>Design Thinking | 24OE5012C<br>Research Methodology | 24OE50131C<br>Foreign Language (Japanese-L1)<br>24OE50132C<br>Foreign Language (German-L1) | 24OE5014C<br>Basics of Marketing Management |

# Syllabus

# for

# Third Year Mechanical Engineering

# Semester – V

# SJCEM : R–24C

# (With Effect from 2026-27)

| Course Title: Heat and Mass Transfer | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** V | | | **Term:** Odd | | | | **Course Code:** 24MEPCC501C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **Theory** | | | | **Practical** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | **IAE1** | **IAE2** | **ESE** | **CA** | **Or/Pr** | |
| 3 | -- | 2 | 3 | -- | 1 | 4 | 20 | 20 | 60 | 25 | 25 | 150 |
| **Sustainable Development Goals Mapped:** 4, 7, 8, 9, 11, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To provide fundamental knowledge of the physical mechanisms of heat transfer modes—conduction, convection, and radiation—and their governing laws and applications in engineering systems.
2. To enable students to analyze and solve steady and unsteady heat conduction problems in various geometries including the use of fins and numerical methods.
3. To impart understanding of convection and radiation heat transfer, including external and internal flow analysis, use of dimensionless numbers, and heat exchange between surfaces.
4. To introduce the concepts of phase change heat transfer (boiling and condensation), heat exchanger design, and provide exposure to mass transfer basics for real-world thermal system applications.

**Course Outcomes:** Learner will be able to…

1 Explain the basic concepts and modes of heat transfer, including thermal resistance and thermal contact resistance, and distinguish between heat transfer and thermodynamics.
2 Apply the generalized heat conduction equations and analyze steady-state heat conduction through walls, cylinders, and spheres with and without internal heat generation.
3 Determine temperature distribution and performance of extended surfaces (fins), and analyze unsteady state heat transfer using lumped system analysis and Heisler charts.
4 Analyze free and forced convection for external and internal flows using dimensionless numbers and boundary layer concepts.
5 Evaluate radiation heat transfer between black and non-black surfaces using radiation laws, view factors, and electrical network analogy; understand the basics of mass transfer.
6 Analyze boiling and condensation phenomena and evaluate the performance of heat exchangers using LMTD and effectiveness-NTU methods.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Basic concepts of heat transfer:** Define heat transfer and its importance in engineering applications, Difference between heat transfer and Thermodynamics, Physical Mechanism of modes of heat transfer, Governing laws of heat transfer, Conduction mode: Thermal conductivity, Thermal diffusivity, Convection mode: Free and Forced convection, Heat transfer Coefficient, Radiation mode: Emissivity, transmissivity, reflectivity, absorptivity, Black body, Grey body, Opaque body, Steady and unsteady heat transfer, One dimensional, two dimensional and three dimensional heat transfer, Thermal resistance concept in heat | 07 | 1 | 2 |

| | | | | |
|---|---|---|---|---|
| | transfer,<br>**Self-Learning:** Thermal contact resistance | | | |
| II | **Conduction:** Assumptions in heat conduction, Generalized heat conduction equation in rectangular, cylindrical coordinates, Initial and boundary conditions, Steady state heat conduction through plane wall, Composite wall, cylinder, composite cylinder wall, sphere, Internal Heat generation concept, in plane wall & solid cylinder Critical radius of insulation in cylinder and sphere<br>**Self-Learning:** Heat conduction with heat generation in Solid Sphere | 08 | 2 | 4 |
| III | **Heat transfer from Extended Surface:** Types of extended surface and its significance, Governing differential equation for fin and its solution, Fin performance: Fin effectiveness and Fin efficiency, Thermo Well<br>**Unsteady state heat transfer:** Applications of unsteady state heat transfer, Lumped system Analysis, Criteria for lumped system analysis: characteristic length, Biot Number, Thermal time constant and Response of a thermocouple, Heisler Charts<br>**Numerical methods in heat transfer:** Significance of numerical methods in heat transfer, Finite difference formulation of differential equations.<br>**Self-Learning:** One-dimensional heat conduction | 07 | 3 | 3 |
| IV | **Convection:** Determination of heat transfer coefficient, Dimensional Analysis, Dimensionless numbers in free and forced convection and their significance<br>**External Flow:** Velocity Boundary layer and Thermal Boundary layer, Laminar and turbulent flow over a flat plate, Flow across cylinder and sphere, Flow across bank of tubes<br>**Internal Flow:** Velocity Boundary layer and Thermal Boundary layer, Laminar and Turbulent flow in tubes, General thermal analysis:<br>**Self-Learning:** Constant heat flux and constant surface temperature. | 07 | 4 | 4 |
| V | **Radiation:** Basic laws of radiation, Black body radiation, Planck's law, Kirchhoff's law, Wein displacement law, Lambert cosine law, Radiation intensity, Radiation heat exchange between black bodies, Shape factor algebra, Radiation heat exchange between nonblack bodies, Electrical network approach for radiation heat exchange: Radiosity and irradiation, Radiation shield<br>**Mass Transfer**: Introduction to Mass Transfer, governing equations of mass transfer.<br>**Self-Learning:** Mass transfer coefficient | 08 | 5 | 5 |
| VI | **Boiling and Condensation:** Boiling heat transfer, Pool boiling: different regimes and pool boiling curve, Flow boiling: Different Regimes and Boiling curve, Condensation heat transfer, Film condensation, Dropwise Condensation<br>**Heat Exchangers:** Types of heat exchangers, Overall heat transfer coefficient, Fouling factor, Analysis of heat exchangers, LMTD, Effectiveness –NTU method, Correction factor, Effectiveness of heat exchangers | 08 | 6 | 4 |

| | | | | |
|---|---|---|---|---|
| | **Self-Learning:** Heat Pipe: Introduction and application<br>**Advanced Topic:** Heat transfer enhancement techniques in heat transfer | | | |

| Sr. No. | List of Experiments | COs |
|---|---|---|
| 1. | Measurement of thermal conductivity of metal rod | CO1 |
| 2. | Measurement of thermal conductivity of insulating material | CO2 |
| 3. | Measurement of thermal conductivity of liquid | CO2 |
| 4. | Determination of fin efficiency and fin effectiveness | CO3 |
| 5. | Measurement of heat transfer coefficient in natural convection | CO4 |
| 6. | Measurement of heat transfer coefficient in forced convection | CO4 |
| 7. | Verification of Stefan Boltzmann Law | CO5 |
| 8. | Measurement of Emissivity of Grey surface | CO5 |
| 9. | Estimation of overall heat transfer coefficient and effectiveness of double pipe heat exchanger (parallel flow and Counter flow arrangement) | CO6 |
| 10. | Industrial visit to demonstrate thermal devices (Compulsory) | All COs |

**Text Books:**

1. Heat Transfer by J. P. Holman, McGraw Hill Education, 10th Edition, 2010
2. Heat and Mass Transfer by R. K. Rajput, S. Chand Publishing, Revised Edition, 2008
3. Heat and Mass Transfer by P. K. Nag, McGraw Hill Education, 3rd Edition, 2011
4. A Textbook on Heat Transfer by S. P. Sukhatme, Orient Blackswan, 4th Edition, 2005

**Reference Books:**

1 Introduction to Thermodynamics and Heat Transfer by Yunus A. Cengel, McGraw Hill Education, 2nd Edition, 2007
2 Fundamentals of Heat and Mass Transfer by Frank P. Incropera and David P. DeWitt, Wiley, 8th Edition, 2017
3 Heat Transfer by P. S. Ghoshdastidar, Oxford University Press, 2nd Edition, 2012
4 Heat and Mass Transfer by R. Rudramoorthy and K. Mayilswamy, Pearson, 2nd Edition, 2022
5 Engineering Heat and Mass Transfer by Mahesh M. Rathore, Laxmi Publications, 4th Edition, 2023

**Links for online NPTEL/SWAYAM courses:**

1. https://archive.nptel.ac.in/courses/112/108/112108149/ - Heat and Mass Transfer Web , IISC Bangalore
2. https://archive.nptel.ac.in/courses/112/101/112101097/ - Heat and Mass Transfer, IITB

| Course Title: Design of Mechanical Element - I | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** V | | | **Term:** Odd | | | | **Course Code:** 24MEPCC502C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme:** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **Theory** | | | | **Practical** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |

**Sustainable Development Goals Mapped:** 4, 8, 9, 11, 12

**Course Objectives:**

1. To study basic principles of machine design
2. To familiarize with use of design data books & various codes of practice
3. To acquaint with functional and strength design principles of important machine elements
4. To familiarize selection of standard elements such as rolling contact bearings, belts etc.
5. To make conversant with preparation of working drawings based on designs

**Course Outcomes:** Learner will be able to…

1. Apply machine design principles and failure theories.
2. Design joints and power screws under static loads.
3. Analyze components under fluctuating loads and fatigue.
4. Design shafts and couplings for power transmission.
5. Design springs under static and dynamic loads.
6. Design clutches and brakes for torque transmission.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **1.1 Mechanical Engineering Design :** Design methods, Aesthetic and Ergonomics consideration in design, Material properties and their uses in design, Manufacturing consideration in design, Design consideration of casting and forging, Basic principle of Machine Design, Modes of failures, Factor of safety, Design stresses, Theories of failures (Selection in the process of designing)<br>**1.2 Thick Cylinders:** Design of thick cylinders subjected to an internal pressure using Lame's equation<br>**Self- Learning**: Standards, I.S. Codes, Preferred Series and Numbers | 8 | 1 | 3 |
| II | **2.1 Design against static loads:** Socket and Spigot Cotter joint, Knuckle joint, Bolted and welded joints under eccentric loading; Power Screw- Screw Jack.<br>**Self- Learning:** Buckling in the column. | 8 | 1 | 5 |
| III | **3.1 Design against fluctuating loads:** variable stresses, reversed, repeated, fluctuating stresses. Fatigue failure: static and fatigue stress concentration factors, Endurance limit : estimation of endurance limit, Design for finite and infinite life, Soderberg and Goodman design criteria,<br>**Self- Learning:** Design of mechanical element for finite life | 5 | 2 | 4 |

| | | | | |
|---|---|---|---|---|
| | using graphical method. | | | |
| IV | **4.1 Design of Shaft:** power transmitting, power distribution shafts, Module (excluding crankshaft) under static and fatigue criteria.<br>**4.2 Couplings:** Classification of coupling, Design of Flange couplings,<br>**Self- Learning:** Bush pin type flexible couplings. | 8 | 2 | 5 |
| V | **5.1 Design of Helical Springs**: Helical compression, Tension Springs under Static and Variable loads,<br>**5.2 Design of Leaf Springs**: Introduction, Nipping of the leaf spring derivation of leaf spring for max deflection, and complete design of Leaf springs.<br>**Self- Learning:** Stress Analysis of leaf spring using Ansys. | 8 | 3 | 5 |
| VI | **6.1 Design of Clutches**: Introduction, types, Basic theory of plate and type clutches, Design of single plate, multi-plate and with spring, lever design and thermal, wear considerations.<br>**6.2 Design of Brakes**: Design of single shoe brake & double shoe brake.<br>**Self-Learning:** Design of centrifugal clutch<br>**Advanced Topic:** Stress, strain, and fatigue analysis using simulation tools | 8 | 4 | 5 |

**Text Books:**

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication, 2017
2. Design of Machine Elements by Spotts, 2019.
3. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication, 2020
4. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education, 2020.

**Reference Books**

1. Machine Design by Pandya & Shah, Charotar Publishing, 2017.
2. Mechanical Engineering Design by J.E.Shigley, McGraw Hill, 2020
3. Recommended Data Books - PSG, 2017.
4. Machine Design by Reshetov, Mir Publication, 2016.
5. Machine Design by Black Adams, McGraw Hill, 2008.
6. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill, 2019.
7. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas & Co, 2009.
8. 11.Recommended Data Books – Design Data: Data Book of Engineers by PSG College, KalaikathirAchchagam, 2017

**NPTEL Course Links:**

https://nptel.ac.in/courses/112/105/112105124/
https://nptel.ac.in/courses/112/106/112106137/

| Course Title: Internal Combustion Engine | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** V | | | **Term:** ODD | | | | **Course Code:** 24MEPEC5011C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total** | **IAE** | **IAE** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | **Credit** | **1** | **2** | | | | |
| 3 | - | 2 | 3 | - | 1 | 4 | 20 | 20 | 60 | 25 | 25 | 150 |

**Sustainable Development Goals Mapped:** 4, 9, 7, 13, 12, 3, 11

**Course Objectives:**

1. To enable the students understand various working cycles, basic components of IC engine, cooling, lubrication and Fuel supply system of IC engine.
2. To enable the students to familiarize with combustion (normal and abnormal) phenomenon in SI and CI engine.
3. To update the knowledge in Alternate fuel, engines exhaust emission and engine testing.
4. To enable the students to understand recent advancement used in IC engine

**Course Outcomes:**

After completing this course, students will be able to:

1. Analysis of air standard cycle and description of 2 stroke and 4 stroke engine
2. Understand basic fuel, Alternate fuels and fuel supply system in IC engine
3. Understand combustion phenomenon in in SI and CI engine.
4. Analysis and testing of internal combustion engine.
5. Illustrate emission norms its emission control for engine.
6. Comprehend the different technological advances in engines.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Introduction to Internal Combustion Engine:** Introduction, Definition and Function of IC Engine, Various nomenclature of IC Engine, Classification of IC Engine, Engine components and their material, Working of Otto cycle, Diesel cycle and dual cycle on basis of PV Diagram and T-s diagram, Theoretical and actual valve timing diagram of 4-Stroke SI and CI Engine, Comparison of SI and CI engines, comparison of two stroke and four stroke (Numerical on-air standard cycle) **Self-learning topics:** Atkinson cycle, Stirling cycle, Brayton cycle. Fuel air cycle, assumptions in fuel air cycle analysis, Composition of cylinder gases | 8 | 1 | 4 |
| II | **Fuels & Fuel Supply System** **Fuels:** Important qualities of SI and CI engine fuels, Rating of SI & CI engine fuels, Mixture requirement for different loads and speeds, Alternative fuels used for IC engine (Ethanol, Methanol, Hydrogen, LPG, CNG, Bio gas and Bio-diesel, Hybrid vehicle). **Fuel Supply System in S.I. & C.I. Engine -** Types of fuel supply used, working of simple carburetor and its limitations, Gasoline | 8 | 2 | 2 |

| | | | | |
|---|---|---|---|---|
| | Injection -advantages and disadvantages. Types of Gasoline Injection – TBI, MPFI, GDI, C.I. Engine Fuel supply system components of Fuel injection system., D.I. systems and CRDI, types of nozzles. (Numerical on carburetor and fuel injection system)<br>**Self-learning topics:** Need, requirement and types of Engine cooling lubrication and system. | | | |
| III | **Combustion in S.I. Engines:** Introduction, Stages of combustion in SI Engine, flame front propagation, factors affecting flame front propagation, Abnormal combustion in SI Engine, Factor responsible for abnormal combustion and its control.<br>**Combustion in C. I. Engines:** Charge motion within the cylinder, Air swirl, Methods to generate air swirl, Stages of combustion in C. I. engines, Ignition delay period, factors affecting delay period, Abnormal combustion CI Engine, Factor responsible for abnormal combustion and its control.<br>**Self-learning topics:** Supercharging and turbocharging in IC engines | 8 | 3 | 2 |
| IV | **Testing of Internal Combustion Engine:** Definitions of important engine characteristics of engines Brake, Torque & Power, Mechanical efficiency, Mean effective pressure, Specific fuel consumption and efficiency, Volumetric efficiency. Testing - Measurement of friction power, indicated power (indicator diagram), Brake power, various types of absorption dynamometer, Fuel consumption measurement, Air consumption measurement methods, Engine efficiencies. Variables affecting engine performance characteristics. Heat balance sheet. (Numerical on engine performance and heat balance sheet)<br>**Self-learning topics:** Governing of C I Engines: Quality, Quantity and Hit and Miss governing, | 8 | 4 | 4 |
| V | **Engine Emission:** Constituents of exhaust emission. Factors responsible for formation of NOx, HC, CO and particulate emissions, Methods of controlling emission, Exhaust-Gas recirculation (EGR), Evaporation emission control system. After exhaust treatment system - Secondary air injection system, Catalytic converter. Introduction to Euro norms and Bharat Stage norms, Diesel smoke and its control.<br>**Self-learning topics:** Comparison of SI and CI emission. Effect of engine emission on environment and human health. | 8 | 5 | 3 |
| VI | **Electronic system:** Electronic Control module (ECM), Inputs and output signals of ECM, Various Sensors -Throttle Position, Inlet Air Temperature, Coolant Temperature, Crankshaft Position, Camshaft Position, Mass Air flow, Manifold absolute pressure, Oxygen sensors their function, construction and importance. | 5 | 6 | 2 |

| | | | | |
|---|---|---|---|---|
| | **Self-learning topics:** Trouble Shooting and Overhauling of Engines.<br>**Advanced topic:** Homogeneous Charge Compression Ignition (HCCI) engines, and AI-based engine performance optimization. | | | |

| Sr. No. | List of Experiments | CSs |
|---|---|---|
| 1. | To demonstrate IC Engine to Determine Brake Power, Indicated Power, and Mechanical Efficiency (Petrol Engine) | 1 |
| 2. | To study Construction and Working of Four-Stroke and Two-Stroke SI & CI Engines | 1 |
| 3. | To demonstrate IC Engine to Determine Brake Power, Indicated Power, and Mechanical Efficiency (Single cylinder Diesel Engine) | 2 |
| 4. | To study of CI Engine Fuel Injection Systems | 2 |
| 5. | To study Alternative Fuels | 2 |
| 6. | To demonstrate IC Engine to Determine Brake Power, Indicated Power, and Mechanical Efficiency (Multi-cylinder Petrol Engine) | 3 |
| 7. | To Prepare Heat Balance Sheet Based on engine performance Experimental Data | 3 |
| 8. | To study the Combustion Characteristics in Compression Ignition (CI) Engine | 4 |
| 9. | Various Performance tests: Morse Test and William Line Plot | 4 |
| 10. | Measurement and Analysis of Exhaust Emissions of a Petrol (SI) Engine Using Exhaust Gas Analyzer | 5 |
| 11. | Measurement and Analysis of Exhaust Emissions of a Diesel Engine (CI) Engine Using Exhaust Gas Analyzer | 6 |
| 12. | To Study Various Sensors Used in Electronic Engine Control Systems | 6 |
| 13. | To Study the Construction, Working, and Importance of Oxygen Sensors in Electronic Engine Control Systems | 6 |

**Reference Books:**

1. V. Ganesan, Internal Combustion Engine, 4th edition, McGraw Hill Publishing Co., 2017.
2. R. K. Rajput, A Textbook of Internal Combustion Engines, 2nd Edition, Laxmi Publication, 2016
3. Heywood, J. B, , Internal Combustion Engine Fundamentals, McGraw Hill Publishing Co., New York, 1990.
4. Sharma, S. P, Chandramohan, Fuels and Combustion, Tata McGraw Hill Publishing Co, 1987.
5. Mathur and Sharma, A course on Internal combustion Engines, Dhanpat Rai & Sons, 1998.

**Text Books:**

1. Pulkrabek, W. W., Engineering Fundamentals of the Internal Combustion Engine, Prentice-Hall of India Private Limited, 2002.
2. Prof. P.L. Ballaney, Internal Combustion Engines, Khanna Publications, Delhi, India
3. R.K. Mohanty, A Text Book of Internal Combustion Engines, Standard Book House, Delhi, India

**Useful Links**

1. https://nptel.ac.in/courses/112104033
2. https://onlinecourses.nptel.ac.in/noc24_me38/preview
3. https://archive.nptel.ac.in/courses/112/103/112103262/

| Course Title: Renewable Energy Sources | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** V | | | **Term:** Odd | | | | **Course Code:** 24MEPEC5012C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **Theory** | | | | **Practical** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | |
| 3 | -- | 2 | 3 | -- | 1 | 4 | 20 | 20 | 60 | 25 | 25 | 150 |

**Sustainable Development Goals Mapped:** 7, 9, 12, 13, 14, 15

**Course Objectives:**

1. To provide students with an understanding of the current global and national energy scenarios, and the role of renewable energy in developing a sustainable energy model.
2. To enable students to comprehend the fundamental principles, performance, and applications of solar energy systems including both solar thermal and photovoltaic technologies.
3. To impart knowledge on the working principles, design considerations, and performance evaluation of wind, biomass, and hydrogen-based energy systems.
4. To familiarize students with emerging renewable energy sources such as geothermal and ocean energy, and their potential for future sustainable development.

**Course Outcomes:** Learner will be able to…

1 Understand the current global and national energy scenarios and apply the fundamentals of solar geometry to estimate solar radiation on various surfaces.
2 Analyse the working principles and performance of flat plate and concentrating collectors and apply knowledge of solar thermal devices for practical applications.
3 Understand the principle of photovoltaic conversion and evaluate the performance and economic feasibility of different photovoltaic systems.
4 Analyse the working and performance characteristics of horizontal and vertical axis wind energy systems and assess their environmental impact.
5 Understand biomass and hydrogen energy technologies and apply design considerations for biogas plants and fuel cell-based power generation
6 Explain the principles of geothermal and ocean energy conversion systems and evaluate their potential for sustainable energy generation in India.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Energy Scenario**<br>Global and National current energy scenarios, Prospects of renewable energy sources and renewable energy's role in developing sustainable model.<br>**Solar Geometry**<br>Solar radiation terms, solar geometry, earth sun angles, attenuation and measurement of solar radiation on horizontal and inclined surfaces, methods of solar radiation estimation.<br>**Self-Learning:** Shadow Analysis | 07 | 1 | 3 |

| | | | | |
|---|---|---|---|---|
| II | **Solar Thermal Energy:**<br>Introduction and working principle of flat plate collectors, thermal Performance analysis of flat plate collectors, concentrating collectors, Solar thermal devices- Solar air heater and different types of solar air heaters, solar water heater and different types of solar water heaters, solar dryers, solar pond, solar distillation, solar still, solar cooker. Solar space heating & cooling, solar refrigerator, solar thermal energy storage systems.<br>**Self-Learning:** Installation and maintenance criteria of solar thermal systems. | 08 | 2 | 4 |
| III | **Solar Photovoltaic Energy:**<br>Principle of photovoltaic conversion Photovoltaic generation: Introduction, silicon p-n junction, photon absorption, solar radiation input, photovoltaic circuit properties and loads. Crystal structures and orientations, forbidden energy gaps, dynamics of electrons and holes, carrier density, carrier transport, generation and recombination of carriers due to light, direct and in-direct band gap semiconductors, basic device physics, p-n junction diode, solar cell output parameters. Photovoltaic power generation systems, Off-grid systems, Grid connected systems, Organic solar cells, Electrochemical energy storage: Batteries. Solar energy benefits, environmental benefits, solar energy cost and economic impact, understanding the cost of solar energy, economics of installing solar panel<br>**Self-Learning:** Different types of batteries | 07 | 3 | 5 |
| IV | **Wind Energy**<br>Basic components and working principle of wind energy conversion systems, wind data and site selection considerations, various types of wind energy conversion systems, constructional features of horizontal and vertical axis wind machines, performance analysis of horizontal and vertical axis wind machines. Estimation of power output- betz limits, Environmental impacts of wind energy.<br>**Self-Learning:** Lift and Drag Force . | 07 | 4 | 4 |
| V | **Energy from Biomass:**<br>Introduction of bioenergy, conversion technologies, gasification, types of biogas generation plants, design and construction details of biogas plant (KVIC), site selection, digester design consideration, filling a digester for starting, maintaining biogas production, utilization of biogas.<br>**Hydrogen Energy:**<br>Introduction and application, General introduction to infrastructure requirement for hydrogen production, dispensing & utilization. Principles of fuel cells, types of fuel cells, power generation by fuel cells, applications of fuel cells.<br>**Self-Learning:** Hydrogen Storage | 08 | 5 | 3 |
| VI | **Geothermal Energy:**<br>Introduction to geothermal technologies and methods of extracting geothermal energy, prospects of geothermal energy in India.<br>**Ocean Energy:**<br>Wave energy characteristics and wave energy conversion devices, | 08 | 6 | 5 |

| | | | | |
|---|---|---|---|---|
| | tide energy & conversion devices, Ocean Thermal Energy Conversion (OTEC) systems.<br>**Self-Learning: D**esalination using OTEC<br>**Advanced Topic:** Hybrid renewable energy systems (solar–wind–battery integration), and AI/ML-based energy forecasting and optimization for renewable energy systems. | | | |

| Sr. No. | List of Experiments | COs |
|---|---|---|
| 1. | Calculate Per Capita Energy Consumption for Residence, Maharashtra, India and Global Energy Demand. | CO1 |
| 2. | Analyse Performance of Solar FPC. | CO2 |
| 3. | Demonstration of Solar Air Heater | CO2 |
| 4. | Experiment on "VI-Characteristics and Efficiency of Solar Photovoltaic Panel | CO3 |
| 5. | Shadow Analysis of given object | CO3 |
| 6. | Simulation study on Solar PV Energy System. | CO3 |
| 7. | Demonstration of Wind Turbine | CO4 |
| 8. | Demonstration of Biogas Digester | CO5 |
| 9. | Simulation study on Wind Energy Generator. | CO4 |
| 10. | Case Study on Green Hydrogen Production and Fuel Cell Integration in Public Transport | CO5 |
| 11. | Case Study on Biogas Generation from Agricultural Waste in Rural India | CO5 |
| 12. | Case Study on the Puga Geothermal Project – Potential and Challenges | CO6 |
| 13. | Industrial visit to demonstrate thermal devices (Compulsory) | All COs |

**Text Books:**

1. Non-conventional Energy Sources", G.D. Rai, 6th Edition, Khanna Publishers
2. Renewable Energy: Power for a Sustainable Future", Edited by Godfrey Boyle, 3rd Edition 2012.
3. Renewable Energy Sources", J W Twidell& Anthony D. Weir, 3rd Edition 2015, ELBS Pub.

**Reference Books:**

1. Solar Energy: Principles of Thermal Collection and Storage", SP Sukhatme and J K Nayak, 4th Edition, Tata Mcgraw Hill Publishing Co. Ltd
2. Solar Energy: Fundamentals and Applications", H.P. Garg& Jai Prakash, First Revised Edition, Tata McGraw-Hill Education.

3. Wind Power Technology by Joshua Earnest and Sthuthi Rachel, PHI Learning, 3rd Edition, 2019.
4. Renewable Energy Resources by John Twidell and Tony Weir, Taylor & Francis, 3rd Edition, 2021.
5. Energy Conversion Systems by R.D. Begamudre, New Age International Publishers, 2nd Edition, 2000.
6. Solar Photovoltaics: Fundamentals, Technologies and Applications by Chetan Singh Solanki, PHI Learning, 3rd Edition, 2015.
7. Wind and Solar Power Systems: Design, Analysis, and Operation by Mukund R. Patel, CRC Press, 3rd Edition, 2021.
8. Wind Energy Explained: Theory, Design and Application by J.F. Manwell, J.G. McGowan, and A.L. Rogers, Wiley, 3rd Edition, 2017.

**Links for online NPTEL/SWAYAM courses:**

https://nptel.ac.in/courses/103103206 - Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems, IIT Guwahati

https://nptel.ac.in/courses/103107157 - Technologies For Clean And Renewable Energy Production, IIT Roorkee

| Course Title: Finite Element Analysis | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** V | | | **Term:** ODD | | | | **Course Code:** 24MEPEC5021C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | - | 3 | - | - | 3 | 20 | 20 | 60 | - | -- | 100 |
| **Sustainable Development Goals Mapped:** 4, 9, 11, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To understand the concepts of FEA and its applicability to different engineering field problems.
2. To understand the representation of the physical model into an equivalent FEA model andsteps to solve it.
3. To acquaint with application of numerical techniques for solving problems.

**Course Outcomes:**

At the end of the course students will be able to:

1. Solve differential equations using weighted residual methods.
2. Develop the finite element equations to model engineering problems governed by second order differential equations
3. Apply the basic finite element formulation techniques to solve engineering problems by using one dimensional elements.
4. Apply the basic finite element formulation techniques to solve engineering problems by using two dimensional elements.
5. Apply the basic finite element formulation techniques to find natural frequency of single degree of vibration system.
6. Use commercial FEA software, to solve problems related to mechanical engineering.

| Module | Contents | Hours | CO's | RBT Level |
|---|---|---|---|---|
| **I** | **Introduction:**<br>1.1 Introductory Concepts: Introduction to FEM, Historical Background,General FEM procedure, Applications of FEM in various fields Advantages and disadvantages of FEM<br>1.2 Mathematical Modelling of field problems in engineering, Governing Differential equations, primary/secondary variables, boundary conditions-types-essential/natural etc. Approximate solution of differential equations, Weighted residual techniques (Galerkin , Subdomain method).<br>**Self-learning topics**: Exact solution of given differential equation | **06** | **CO1** | **3** |
| **II** | **FEA Procedure:(Pre-processing, Processing, Post-processing)**<br>2.1 Discrete and Continuous Models, Weighted Residual Methods - Ritz Technique- Basic Concepts of the Finite Element Method.<br>**2.2** Definitions of various terms used in FEM like element, | **09** | CO2 | 5 |

| | | | | |
|---|---|---|---|---|
| | order of the element, internal and external node/s, degree of freedom. Minimization of a functional, Principle of minimum total potential, Piecewise Rayleigh-Ritz method, Formulation of 'stiffness matrix', assembly concepts to develop system equation.<br>**Self-learning topics**: Result interpretation of post processing | | | |
| **III** | **One Dimensional Problems:**<br>3.1 One dimensional second order equations - discretization-element types - linear and higher order elements - derivation of shape functions andstiffness matrices and force vectors.<br>3.2 Assembly of Matrices- solution of problems in one dimensional structural analysis, heat transfer and fluid flow (stepped and taper bars,fluid network), Analysis of Plane trusses, Analysis of Beams<br>**Self-learning topics**: formation of element matrix for spring-Cart Systems | **11** | CO3 | 3 |
| **IV** | **Two Dimensional Finite Element Formulations:**<br>4.1 Introduction, three node triangular element, four node rectangularelement<br>4.2 Natural coordinates and coordinates transformations: serendipity andLagrange's methods for deriving shape functions for triangular element.<br>**Self-learning topics**: Convergence criterion, sources of errors | **06** | CO4 | 3 |
| **V** | **Two Dimensional Vector Variable Problems:**<br>5.1 Equations of elasticity - Plane stress, plane strain and axi-symmetric problems, Jacobian matrix, stress analysis of CST.<br>**Self-learning topics**: four nodded rectangular element | **07** | CO5 | 4 |
| **VI** | **Finite Element Formulation of Dynamics and Numerical Techniques:**<br>6.1 Applications to free vibration problems of rod and beam, Lumped and consistent mass matrices. Solutions techniques to Dynamic problems, longitudinal vibration frequencies and mode shapes, Fourth order beam equation, transversedeflections and natural frequencies of beams.<br>**Self-learning topics**: mode shape during transverse and longitudinal vibration of rod<br>**Advanced Topics:** Isogeometric analysis (IGA) and machine learning-based Finite Element Method (ML-FEM) for structural and thermal analysis. | **06** | CO6 | 3 |

**Reference Books:**

1. Programming the Finite Element Method, I M Smith,D V Griffiths and Margetts WILEY Publications.
2. The Finite Element Method: Theory, Implementation, and Applications, Larson, Mats G., Bengzon, Fredrik, Springer.

3. Introduction to Finite Element Analysis Using MATLAB and Abaqus By Amar Khennane, CRC Press publication.

**Text Books:**

1. Introduction to Finite Element Analysis and Design by N. H. Kim, B. V. Sankar, and A. V.Kumar by Wiley publication
2. Finite Element analysis using ANSYS by PaletiSrinivas,Krishna Chaitanya, Rajesh KumarDetti, PHI Publication.
3. Finite Element Analysis Theory and Application With ANSYS by Saeed Moaveni, Pearson Publication.

**Useful Links**

1. https://nptel.ac.in/courses/112/104/112104193/
2. https://nptel.ac.in/courses/105/106/105106051/
3. https://nptel.ac.in/courses/112/104/112104115/
4. https://nptel.ac.in/courses/112/103/112103295/

| Course Title: Industrial Robotics and Automation | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** V | | | **Term:** Odd | | | | **Course Code:** 24MEPEC5022C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |
| **Sustainable Development Goals Mapped:** 8, 9, 11, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To understand the principles of automation.
2. To understand importance of automated flow lines and its type.
3. To learn the concepts of Robotics, kinematics of robot.
4. To Understand principles of robot drives and controls, sensors used in robots and programming methods.

**Course Outcomes:** Learner will be able to…

1. Apply Automation in industrial applications.
2. Demonstrate the application of sensors and actuators in automated systems
3. Understand the types of flow lines and examine quantitative analysis of flow lines.
4. Apply the concept in the design of new robotic structure..
5. Analyze a robotic structure and method of developing different types of mechanisms and kinematics of the robot.
6. Apply robot programming languages which may adopt in different applications of robot.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Introduction to automation**: Need, Types, Basic elements of an automated system, Manufacturing Industries, Types of production, Functions in manufacturing, Organization and information processing in manufacturing, Automation strategies and levels of automation. Pneumatic and Hydraulic system<br>**Self-Learning**: - Hardware components for automation and process control. | 8 | CO1 | 3 |
| II | **Sensors & actuators for automation system:**:<br>**Sensors:** Selection of sensors (Displacement, temperature, force/pressure), velocity sensors, tactile sensors, proximity sensors,<br>**Actuators:** Principle and selection of mechanic-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC,<br>Microcontroller, Ladder logic and PLC Programming<br>**Self-Learning**: Static and dynamic characteristics of sensors, | 8 | CO2 | 2 |
| III | **Automated flow lines**: Part transfer methods and mechanisms, types of Flow lines, Quantitative analysis of flow lines.<br>**Assembly line balancing**: Assembly line, line balancing methods, ways of improving line balance,<br>**Self-Learning**: - Flexible assembly lines. | 6 | CO3 | 4 |

| | | | | |
|---|---|---|---|---|
| IV | **Introduction to industrial robotics**: Definition of robot, Laws of robots Components of robotic system, Classification of robot Robot Configurations, Robot degrees of freedom., Accuracy and repeatability Robot feedback controls, End effectors, Artificial Intelligence and Machine Learning in robotics<br>**Self-Learning**: - Evolution of robots, Selection of robots | 8 | CO4 | 3 |
| V | **Kinematics of robots & workspace analysis:**<br>**Direct:** Homogenous transformations as applicable to rotation and transition, Link coordinates D-H Representation, Direct kinematic analysis for Four axis SCARA robot and three axis articulated robots.<br>**Inverse:** The inverse kinematics problem, General properties of solutions, Tool configuration, Inverse kinematics of three axis articulated robot.<br>**Workspace Analysis and Trajectory Planning** Workspace Analysis, work envelope of a Four axis SCARA robot, the pick and place operations.<br>**Self-Learning**: - Straight line motion and Cartesian space technique in trajectory planning.. | 8 | CO5 | 4 |
| VI | **Robot programming**: Methods of programming - requirements and features of programming languages, software packages.<br>**Robotic vision systems:** Image representation, Object recognition and categorization, Depth measurement, Image data compression, Visual inspection,<br>**Robot application in manufacturing**: Material Transfer - Material handling, loading and unloading - Process - spot and continuous arc welding & spray painting - Assembly and Inspection.<br>**Self-Learning**: - Robots in Health care with Industry 4.0 perspective<br>**Advanced Topics:** Industry 4.0 enabled smart robotics with AI-based autonomous decision-making and collaborative robots (cobots) for flexible manufacturing systems. | 7 | CO6 | 3 |

**Text Books:**

1. Automation, Production systems and CIM, M.P. Groover /Pearson Edu. 2021
2. Industrial Robotics — Mikell P. Groover and Mitchell Weiss, Roger N. Nagel, McGraw Hill, 20217

**References Books:**

1. Robotics and control - R K Mittal and I I Nagrath, TataMcGraw Hill 2022.
2. An Introduction to Robot Technology, P. Coiffet and M. Chaironze, Kogam Page Ltd. 2012 London.
3. Robotic Engineering - integrated approach by Richard d Klafter-London: Prentice-Hall- 2021.
4. Robotics, Fundamental Concepts and analysis —Ashitave Ghosal, Oxford Press S. Introduction to Robotics - John J. Craig, Pearson Edu.

**Online resources:**

1. https://onlinecourses.nptel.ac.in/noc24_me117/preview
2. https://nptel.ac.in/courses/112101098

| Course Title: Additive Manufacturing Applications | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** V | | | **Term:** Even | | | **Course Code:** 24MDM501AMC | | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | 2 | 3 | - | 1 | 4 | 20 | 20 | 60 | 25 | - | 125 |

**Course Objectives:**

1. To provide an understanding of the practical applications of Additive Manufacturing (AM) across various industrial sectors such as automotive, aerospace, biomedical, and civil engineering.
2. To familiarize students with design considerations, process parameters, and post-processing techniques for AM-based product development. 3. To familiarize with basic process of additive manufacturing in different industries.
3. To enable students to analyze real-world case studies and identify suitable AM processes and materials for specific engineering applications.
4. To develop the capability to evaluate the performance, cost-effectiveness, and sustainability of AM technologies in industrial and research contexts.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. To understand the perspectives for 3D printing in Jewellery industries for selection of an appropriate material and tools to develop a given product using rapid prototyping techniques.
2. Develop 3D model using various types of available biomedical data.
3. To understand the perspectives for 3D printing in Aerospace industries for selection of an appropriate material and tools to develop a given product using rapid prototyping techniques.
4. Illustrate understanding of various cost-effective alternatives for manufacturing products.
5. Use rapid prototyping and tooling concepts in any real-life applications.
6. Contribute towards the Product Development at the respective domain in the industry.

| Module | Content | Hours | COs |
|---|---|---|---|
| 1 | Applications in Jewellery Industries<br>Introduction to 3D Printing Jewellery: Steps Involved in Jewellery 3D Printing, why 3D Printing for Jewellery Making, Techniques Involved in Jewellery 3D Printing, 3D Printing Processes for Jewellery Designing, Challenges with Jewellery 3D Printing, 3DPrinting vs Traditional Methods, Types of Jewellery can be 3D Printed,<br>3D Printers for Jewellery Making – How They Work & Which to Choose | 8 | 1 |
| 2 | Medical Applications in Additive manufacturing<br>Presurgical Planning Models, Mechanical Bone Replicas, Teaching Aids and Simulators, Customized Surgical Implants, Prosthetics and Orthotics', Anthropology, Forensics | 8 | 2 |
| 3 | Applications in Aerospace Industries | 8 | 3 |

| | | | |
|---|---|---|---|
| | Use of AM in Aerospace, Metal AM in Aerospace, Super alloys, Non-Destructive Evaluation, Space technology. | | |
| 4 | Applications in Tooling<br>Methods of Rapid tooling: Direct Soft Tooling, Indirect Soft Tooling, Direct Hard Tooling, Indirect Hard Tooling. | 7 | 4 |
| 5 | Applications in various industries<br>Automotive, Défense, Coin industries, Household appliance, Toy industry, Ship building, Un-manned Aerial Vehicles (UAV), Furniture, Construction and food | 7 | 5 |
| 6 | Applications in Design<br>Design for Additive Manufacturing (DFAM), Topology optimization for AM, Generative design<br>Applications in Engineering, Analysis and Planning | 7 | 6 |
| **Total** | | **45** | |

| Sr No. | List of Experiment | COs |
|---|---|---|
| **1** | Review of CAD Modeling Techniques and Introduction to RP | 1 |
| **2** | Forming Groups & Assigning Creative Idea | 1 |
| **3** | Generating STL files from the CAD Models & Working on STL files | 2 |
| **4** | Modeling Creative Designs in CAD Software | 2 |
| **5** | Assembling Creative Designs in CAD Software | 3 |
| **6** | Processing the CAD data in Catalyst software (Selection of Orientation, Supports generation, Slicing, Tool path generation) | 3 |
| **7** | Simulation in Catalyst Software | 4 |
| **8** | Sending the tool path data to FDM RP machine | 4 |
| **9** | Fabricating the physical part on FDM RP machine | 5 |
| **10** | Removing the supports & post processing (cleaning the surfaces) | 5 |
| **11** | Demonstrating Creative Working Models | 6 |
| **12** | Converting CT/MRI scan data into STL file using MIMICS software (Demo) | 6 |

**Reference Books:**

1. Medical Modelling the Application of Advanced Design and Rapid Prototyping Techniques in Medicine, Richard Bibb, Dominic Eggbeer and Abby Paterson, Woodhead Publishing Series in Biomaterials: Number 91, Elsevier Ltd. 2021
2. Additive Manufacturing for the Aerospace Industry, by Francis Froes, Rodney Boyer, 2016
3. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons, 2020.

**Text Books:**

1. Rapid Manufacturing an Industrial revolution for the digital age by N.Hopkinson, R.J. M. Hauge,P M, Dickens, Wiley, 2018
2. D Printing and Additive Manufacturing: Principles & Applications, Chua Chee Kai, Leong Kah Fai, World Scientific, 2015, 4th Edition.
3. Rapid Prototyping, Principles and Applications by Rafiq I. Noorani, Wiley & Sons, 2016

**Useful Links:**

1. https://onlinecourses.nptel.ac.in/noc20_me50/preview
2. https://onlinecourses.nptel.ac.in/noc21_me115/preview

| Course Title: Solar and Wind Energy Systems | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** V | | | **Term:** Even | | | **Course Code:** 24MDM501EEC | | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | 2 | 3 | - | 1 | 4 | 20 | 20 | 60 | 25 | - | 125 |

**Course Objectives:**

1. To provide fundamental knowledge of solar photovoltaic and solar thermal energy conversion systems.
2. To understand the principles, performance parameters, and design aspects of wind energy systems.
3. To analyze performance, efficiency, and economics of solar and wind energy technologies.
4. To develop practical skills in system design, performance estimation, and software-based simulation of solar and wind systems.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Describe the working principles, classifications, and components of solar and wind energy systems.
2. Estimate solar radiation, wind characteristics, and resource potential for a given location.
3. Analyze the performance of solar PV, thermal collectors, and wind turbines using standard equations.
4. Design and simulate basic solar PV and wind systems using tools such as PVsyst, PVGIS, and RETScreen.
5. Evaluate the techno-economic feasibility and environmental benefits of solar and wind energy projects.
6. Integrate solar and wind systems for hybrid operation and propose optimal energy solutions for practical applications.

| Module | Content | Hours | COs |
|---|---|---|---|
| 1 | Introduction to Solar and Wind Energy<br>Overview of solar and wind energy systems; global and Indian scenario; role in sustainable development; comparison with conventional energy. | 8 | 1 |
| 2 | Solar Radiation and Measurement<br>Solar geometry, declination, hour angle, solar time, radiation components, measurement instruments, and estimation using PVGIS data. | 8 | 2 |
| 3 | Solar Energy Conversion Systems<br>(a) **Photovoltaic Systems:** PV cell working, I–V and P–V characteristics, efficiency factors, series/parallel configurations, MPPT.<br>(b) **Solar Thermal Systems:** Flat plate collector, concentrating collectors, system efficiency. | 8 | 3 |

| | | | |
|---|---|---|---|
| 4 | Wind Resource and Turbine Fundamentals<br>Nature of wind, power in wind, Betz limit, tip speed ratio, characteristics of wind turbines (HAWT and VAWT), site selection, and performance parameters. | 7 | 4 |
| 5 | Design and Simulation Tools for Solar & Wind Systems<br>PV system design using PVsyst and PVGIS; wind system analysis using RETScreen; case study on hybrid solar-wind system simulation. | 7 | 5 |
| 6 | Performance Evaluation and Hybrid Integration<br>Techno-economic evaluation, capacity factor, payback period, LCOE; hybrid (solar-wind) integration; case studies and sustainability aspects. | 7 | 6 |
| **Total** | | **45** | |

| Sr No. | List of Experiment | COs |
|---|---|---|
| **1** | Study of solar and wind energy conversion principles and system components. | 1 |
| **2** | Measurement of solar radiation and determination of solar angles. | 1 |
| **3** | Study of I–V and P–V characteristics of a solar PV module. | 2 |
| **4** | Calculation of instantaneous efficiency of a solar flat plate collector. | 2 |
| **5** | Determination of wind speed distribution and plotting wind rose diagram using local data. | 3 |
| **6** | Simulation of solar PV system using PVsyst software for performance ratio and yield estimation. | 3 |
| **7** | Design and simulation of wind energy system using RETScreen. | 4 |
| **8** | Techno-economic analysis of standalone solar or wind system using Excel. | 4 |
| **9** | Case study of hybrid solar-wind system for remote/rural application. | 5 |
| **10** | Mini-project on solar–wind energy integration for specific load demand. | 6 |

**Reference Books:**

1. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University Press.
2. Tiwari and Ghosal, Renewable Energy Resources: Basic Principles and Applications, Narosa.
3. D. P. Kothari, K. C. Singal, and Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI Learning.

**Text Books:**

1. G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers.
2. B. H. Khan, Non-Conventional Energy Resources, McGraw Hill Education.
3. S. P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill.

**Useful Links:**

1. https://re.jrc.ec.europa.eu/pvg_tools/en/– PVGIS Solar Estimation Tool
2. https://www.nrel.gov/– NREL Renewable Resource Database
3. https://www.nptel.ac.in/– NPTEL Courses: Solar and Wind Energy Systems

| Course Title: Design Thinking | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Semester: V | | | Term: | | | | Course Code: 24OE5011C | | | | | |
| Teaching Scheme | | | | | | | Evaluation Scheme | | | | | |
| Contact Hrs. | | | Credit Allotted | | | Total Credit | IAE 1 | IAE 2 | ESE | CA | Or/Pr | Total |
| Th | Tu | Pr | Th | Tu | Pr | | | | | | | |
| 3 | - | - | 3 | - | - | 3 | 20 | 20 | 60 | - | - | 100 |
| **Sustainable Development Goals Mapped:** 4, 8, 9, 11, 12 | | | | | | | | | | | | |

**Course Objectives:**

1. To introduce a learner to the principles of Design Thinking
2. To familiarize a learner with the process (stages) of Design Thinking
3. To expose a learner to various case studies of Design Thinking

**Course Outcomes:**

At the end of the course students will be able to:

1. To compare traditional approach to problem solving with the Design Thinking approach and discuss the principles along with the process of Design Thinking
2. To define a user persona using Empathy Mapping
3. To frame a problem statement using various Design Thinking tools
4. To select best idea among the ideas generated through various Design Thinking tools
5. To create prototypes using engineering principles
6. To test the prototypes and gather feedback for refining the prototype

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Introduction to Design Thinking** | 6 | CO1 | 4 |
| | Definition, comparison of traditional approach with Design Thinking, process (stages) of Design Thinking, case studies | | | |
| II | **Creating User Persona** | 8 | CO2 | 3 |
| | Interview technique, user observation technique, creation of empathy map | | | |
| III | **Defining problem statement** | 8 | CO3 | 3 |
| | Cause and effect, mind mapping and journey maps technique | | | |
| IV | **Ideation** | 8 | CO4 | 5 |
| | Brain storming, Bench marking and prioritizing technique | | | |
| V | **Prototype generation** | 8 | CO5 | 6 |
| | Rules of prototype generation, Low and high-fidelity prototypes, Prototyping techniques - Paper, Digital and 3D prototyping | | | |
| VI | **Testing the prototype** | 7 | CO6 | 5 |
| | Evaluation techniques: Interviews, User observation, Wireframing, A/B Testing | | | |

| | | | | |
|---|---|---|---|---|
| | **Advanced Topics:** AI-assisted design thinking and rapid prototyping using digital twin and simulation-based validation tools. | | | |
| | **Total** | **45** | | |

| Sr. No. | Suggested Experiment List | COs |
|---|---|---|
| 1. | Conducting user interviews and observations for a specific product or system to identify user pain points. Prepare an empathy map. | CO1 |
| 2. | Developing detailed user personas based on their empathy research. | CO2 |
| 3. | Synthesizing the findings from user research to define a clear problem statement in engineering terms. | CO3 |
| 4. | Performing a brainstorming session withing the group using mind mapping techniques to generate creative solutions to the defined problem. | CO4 |
| 5. | Creating a prototype for selected idea using engineering principles. Prototype could be a physical model, electronic circuits, web or mobile app or a combination of these. | CO5 |
| 6. | Testing the prototype with the users and gathering feedback to created refined prototype. | CO6 |

**Reference Books:**

1. Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School, Idris Mootee, Wiley, 2013
2. Change by Design, Tim Brown, Harper Business, 2009

**Text Books:**

1. Design Thinking: Methodology Book, Emrah Yayichi, 2016
2. Handbook of Design Thinking: Christian Mueller-Roterberg, 2018

**Useful Links:**

1. Empathy map
   https://www.nngroup.com/articles/empathy-mapping/
2. Prototyping
   https://staragile.com/blog/prototype-in-design-thinking
3. Design Thinking case studies
   https://voltagecontrol.com/blog/8-great-design-thinking-examples/
   https://dyworks.in/design-thinking-case-studies/

| Course Title: Research Methodology | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** V | | | **Term:** Even | | | | **Course Code: 24OE5012C** | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | - | 3 | - | - | 3 | 20 | 20 | 100 | - | - | 100 |

**Sustainable Development Goals Mapped:** 4, 9, 12, 16, 17

**Course Objectives:**
CO1**:** Understand the fundamental concepts of research including constructs, hypotheses, propositions,
CO2**:** Differentiate among various types of research and apply appropriate research
CO3**:** Design effective
CO4**:** Apply the stages of the scientific research process from problem identification to report writing.
CO5: Formulate a relevant and feasible research problem considering key practical factors such as data availability and interpretation.
CO6**:** Evaluate research outcomes critically, test validity, and address ethical issues while presenting actionable recommendations.

**Course Outcomes:**
CO1:fundamental research concepts such as constructs, hypotheses, postulates, and distinguish
CO2: Identify and differentiate various types of research (e.g., basic, applied, analytical, empirical)
CO3: Develop an appropriate research and sample design, identifying stages and techniques, and recognize potential sampling errors.
CO4: Apply the scientific research process, from selecting a research problem to preparing the final report, including data collection, analysis, and hypothesis testing
CO5: Formulate a relevant and feasible research problem
CO6: Evaluate research outcomes by testing validity, addressing ethical issues, and proposing practical recommendations based on findings

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Module 1: Introduction and Basic Research Concepts**<br>Research – Definition; Concept of Construct, Postulate, Proposition,<br>Thesis, Hypothesis, Law, Principle. Research methods vs Methodology,<br>Need of Research in Business and Social Sciences, Objectives of Research, Issues and Problems in Research, Characteristics of Research:<br>Systematic, Valid, Verifiable, Empirical and Critical | 10 | 1 | 4 |
| II | **Module 2: Types of Research**<br>Basic Research, Applied Research, Descriptive Research, Analytical<br>Research, Empirical Research, Qualitative and Quantitative Approaches | 8 | 2 | 4 |

| | | | | |
|---|---|---|---|---|
| III | **Module 3: Research Design and Sample Design**<br>Research Design – Meaning, Types and Significance, Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors | 8 | 3 | 5 |
| IV | **Module 4: Research Methodology**<br>Meaning of Research Methodology ,Stages in Scientific Research Process: Identification and Selection of Research Problem, Formulation of Research Problem, Review of Literature,<br>Formulation of Hypothesis, Formulation of research Design, Sample Design , Data Collection, Data= Analysis, Hypothesis testing and Interpretation of Data, Preparation of Research Report | 6 | 4 | 3 |
| V | **Module 5: Formulating Research Problem**<br>Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis | 8 | 5 | 6 |
| VI | **Module 6: Outcome of Research**<br>Preparation of the report on conclusion reached, Validity Testing & Ethical Issues, Suggestions and Recommendation<br>**Advanced Topics:** AI-driven research analytics and bibliometric analysis tools for systematic literature review and research trend forecasting. | 5 | 6 | 5 |
| | **Total** | 45 | | |

**Reference Books:**

1. Uma Sekaran & Roger Bougie, Title: *Research Methods for Business: A Skill Building Approach,* Publisher: Wiley
2. Donald R. Cooper & Pamela S. Schindler, Title: *Business Research Methods,* Publisher: McGraw Hill
3. Zikmund, Babin, Carr & Griffin, Title: *Business Research Methods,* Publisher: Cengage Learning

**Text Books:**

1. C.R. Kothari & Gaurav Garg, Title: *Research Methodology: Methods and Techniques,* Publisher: New Age International Publishers
2. Ranjit Kumar, Title: *Research Methodology: A Step-by-Step Guide for Beginners,* Publisher: SAGE Publications

| Course Title: Foreign Language – I (German) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** V | | | **Term:** Odd | | | | **Course Code:** 24OE50132C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **Theory** | | | | **Practical** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | **IAE1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |

**Sustainable Development Goals Mapped: 4, 11**

**Course Objectives:**

1. To enable students to communicate basic information in German through greetings, introductions, and simple conversations.
2. To develop foundational grammar skills including verb conjugation, articles, pronouns, and sentence structure.
3. To build essential vocabulary for everyday situations, hobbies, places, family, and professions.
4. To introduce students to German culture and geography while enhancing their reading, writing, listening, and speaking abilities.

**Course Outcomes:** Learner will be able to…

1. To introduce themselves and others, use the German alphabet, and engage in basic conversations related to profession and origin.
2. Apply fundamental grammar rules, including verb conjugations and personal pronouns, to form meaningful sentences in present tense.
3. Use appropriate vocabulary and sentence structures to talk about hobbies, countries, languages, and leisure activities.
4. Describe places, housing types, and give directions using relevant vocabulary and composite words.
5. Express daily routines and events in present and past tenses using separable verbs, question forms, and time expressions.
6. Interact effectively in real-life situations using modal verbs, prepositions, negations, and vocabulary related to places, family, and professions

| Module | Contents | Hours | COs |
|---|---|---|---|
| I | **Introduction to German Language**<br>Sichbegrüßen (Greetings),Sichvorstellen (Self-introduction)<br>Das Alphabet & Deutsche Buchstabiertafel (German Alphabet & Spelling),Beruf und Herkunftangeben (Professions & Origin)<br>Wer bin ich? (Who am I?),Anderevorstellen (Introducing Others),Telefonieren (Telephoning),Rechnen (Basic Calculations) | 08 | 1 |
| II | **Grammar Basics and Daily Expressions**<br>KonjugationPräsens: trinken / kommen / sein,Wiespätist es? /Wie viel Uhr istes?,DiePersonalpronomen,Formelloderinformell – du oder Sie?,Begrüßung und Verabschiedung,Verben – arbeiten / machen / sein<br>Kurssprache: schreiben / lesen / hören / sprechen / sehenmarkieren / ergänzen / unterstreichen / kreuzen,Artikel: ein/eine/ein – kein/keine/kein – der/die/das | 08 | 2 |
| III | **Vocabulary Building and Communication**<br>Singular/Plural – Nomen schreiben, lernen,DasWörterbuchAdjektive,WasistIhrHobby?,Länder in EuropaWährungen,Sprachen:Muttersprache/Fremdsprache,UnregelmäßigeVerben – sprechen / lesen / essen / sehen<br>Was machen/tun Sie in der Freizeit? | 08 | 3 |
| IV | **Cultural Awareness and Descriptions**<br>Die Landkarte von Europa,Sehenswürdigkeiten in Indien und Europa,UnsereHeimat,Häuser und WohnungstypenDas Arbeitszimmer, Schlafzimmer, Küche, Balkonetc.Einfamilienhaus, Altbauwohnung, Studentenwohnheim etc.<br>Die Wohnung – Richtungen,Kompositabilden – Wörterkombinieren | 07 | 4 |
| V | **Grammar Deep Dive and Routine Activities**<br>Es gibt…,Subjekt/Objekt - Nominativ / AkkusativVerben: haben, schlafen, finden (Konjugation + Akkusativ),Personalpronomen&Possessivartikel,Wochentage / Wochenende,Präsens / Präteritum: sein / waren, haben / hattenDer Tagesablauf / Mein Alltag,TrennbareVerben,Fragen: Ja/Nein-Fragen, Wann...? Wie lange...?,Die Jahreszeiten / Der Feiertag | 07 | 5 |
| VI | **Practical Usage and Modal Verbs**<br>Präpositionen: auf / unter / vor / hinter / im / in / an / über / zwischen / neben,Negation: nicht / nein / nie,Zahlen: Kardinalzahlen / Ordinalzahlen,Wobekommt man was? (Places & Common Phrases),in der Schule, imSupermarkt, am Bahnhof, in der Bibliothek, etc.,DieFamilie: Beschreibung, Familienbaum, Berufe,Modalverben: können, müssen, möchten, wollen, sollen, dürfen | 07 | 6 |

| | | | |
|---|---|---|---|
| | **Total** | 45 | |

**Evaluation and Assessment Scheme:**

**A. Internal Assessment Examination (IAE):**

Assessment consists of two class tests, each 20 marks. The IAE 1 will cover any three Course Outcomes (COs) and IAE 2 will cover the remaining three Course Outcomes (COs). Each test will have a duration of one hour.

**B. End Semester Theory Examination (ESE):**

End Semester exam of 60 Marks will be conducted based on entire syllabus.

**Text Books:**

1. Netzwerk A1, Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, Klett Sprachen Verlag, 2024
2. Menschen A1 Kursbuch, Angela Pude and Franz Specht, Hueber Verlag, 2024
3. Berliner Platz Neu 1, Christiane Lemcke, Lutz Rohrmann, Theo Scherling, Langenscheidt Publishing Group, 2024

**Reference Books:**

1. Schritte international Neu A1.1, Daniela Niebisch, Sylvette Penning-Hiemstra, Franz Specht, Hueber Verlag, 2023
2. The Everything Learning German Book, Ed Swick, Adams Media, 2022 German Made Simple: Learn to Speak and Understand German Quickly and Easily, Arnold Leitner, Crown Publishing Group, 2021
3. Living Language German, Complete Edition, Living Language Staff, Penguin Random House, 2021

**Links for online NPTEL/SWAYAM courses:**

1. https://onlinecourses.nptel.ac.in/noc20_hs41/preview
2. https://onlinecourses.nptel.ac.in/noc21_hs30/preview

| Course Title: Foreign Language - I (Japanese) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Semester: V | | | Term: ODD | | | Course Code:24OE50131C | | | | | | |
| Teaching Scheme | | | | | | | Evaluation Scheme | | | | | |
| Contact Hrs. | | | Credit Allotted | | | Total Credit | IAE 1 | IAE 2 | ESE | CA | Or/Pr | Total |
| Th | Tu | Pr | Th | Tu | Pr | | | | | | | |
| 3 | - | - | 3 | - | - | 3 | 20 | 20 | 60 | - | - | 100 |
| Sustainable Development Goals Mapped: 4, 11 | | | | | | | | | | | | |

**Course Objectives:**

1. Develop basic Japanese communication skills through everyday conversations and classroom activities.
2. Learn Japanese scripts, vocabulary, particles, and sentence structures.
3. Apply grammar concepts such as verb tenses, counters, pronouns, and particles correctly.
4. Improve listening, speaking, reading, and writing skills through practice and revision.
5. Build confidence in using elementary Japanese in practical situations.

**Course Outcomes:**

**After successful completion of the course students will be able to:**

1. Understand Japanese scripts, greetings, basic vocabulary, and self-introduction expressions.
2. Read and write Hiragana and Katakana and use common classroom phrases correctly.
3. Construct simple Japanese sentences using basic particles and vocabulary.
4. Use family vocabulary, counters, pronouns, and date expressions appropriately.
5. Apply time expressions, days, and particles in sentence formation.
6. Use basic verb tense forms and particles accurately in simple communication.

| Module | Contents | Hours | COs |
|---|---|---|---|
| I | **Introduction to Japanese Language** | 7 | CO1 |
| | Introduction to Japanese language, Japanese scripts, Hiragana, greetings and basic phrases, suffixes related to nationality, language, and country.<br><br>**Self-Learning:** Hiragana writing practice, greetings conversation, nationality vocabulary exercises, basic phrase reading | | |
| II | **Scripts and phrases** | 8 | CO2 |

| | | | |
|---|---|---|---|
| | Katakana, classroom phrases, vocabulary building, word formation using Hiragana and Katakana, numbers (1–10), quizzes, dictation, and phrase-based activities.<br><br>**Self-Learning:** Katakana writing practice, classroom phrase activities, number practice, dictation exercises | | |
| **III** | **Sentence structure & particle.**<br><br>Basic sentence structures, sentence formation, conversational reading, particles (ka, mo, wa, no), numbers (11–50), suffixes for age, month, and year, and revision.<br><br>**Self-Learning:** Sentence formation practice, particle usage exercises, conversational reading, number writing | 8 | CO3 |
| **IV** | **Family and Counters**<br><br>Vocabulary development, dates, family-related vocabulary, counters for people and objects, pronouns (kore, sore, are / kono, sono, ano), and sentence formation using pronouns.<br><br>**Self-Learning:** Family vocabulary practice, pronoun usage exercises, date writing, counters practice | 8 | CO4 |
| **V** | **Date and time & particle**<br><br>Revision, sentence formation, days of the week, suffixes for hours and minutes, particles indicating time for actions, verb-based vocabulary, and sentence construction using verbs.<br><br>**Self-Learning:** Days and time expression practice, verb sentence formation, particle usage activities, speaking exercises | 8 | CO5 |
| **VI** | **Verb tenses & particle III**<br><br>Verb tenses including present tense, past tense, non-past negative tense, and past negative tense; vocabulary enhancement; particles ((を)wo(で) de).<br><br>**Self-Learning:** Verb tense exercises, vocabulary building, sentence construction using particles を and で, paragraph writing | 6 | CO6 |
| | **Total** | **45hr** | |

| Course Title: Basics of Marketing Management | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Semester: V | | | Term: ODD | | | | Course Code: 24OE5014C | | | | | |
| Teaching Scheme | | | | | | | Evaluation Scheme | | | | | |
| Contact Hrs. | | | Credit Allotted | | | Total Credit | IAE 1 | IAE 2 | ESE | CA | Or/Pr | Total |
| Th | Tu | Pr | Th | Tu | Pr | | | | | | | |
| 3 | - | - | 3 | - | - | 3 | 20 | 20 | 60 | - | - | 100 |
| **Sustainable Development Goals Mapped:** 4, 8, 9, 10, 12, 16, 17 | | | | | | | | | | | | |

**Course Objectives:**

Students will be able to

1. Understand the fundamental concepts, scope, evolution, and significance of marketing in business and society.
2. Analyze the marketing environment and evaluate consumer behavior, segmentation, targeting, and positioning strategies.
3. Explain the key elements of product and pricing decisions, including branding, product lifecycle, and pricing strategies.
4. Examine distribution channels, promotional tools, and the role of integrated marketing communication in delivering customer value.
5. Understand the basics of digital marketing and identify the role of various online marketing channels.
6. Apply marketing principles in addressing ethical, environmental, and rural challenges, and to support innovations and startups.

**Course Outcomes:**

*Students will be able to*

1. Demonstrate knowledge of core marketing concepts and their relevance in modern business and societal contexts.
2. Assess consumer behavior, conduct market segmentation, and implement effective targeting and positioning strategies.
3. Develop appropriate product and pricing strategies, incorporating branding, packaging, and pricing methods.
4. Develop marketing plans using effective distribution systems and promotional mix strategies.
5. Distinguish between traditional and digital marketing and apply relevant digital tools for marketing decision-making.
6. Integrate concepts of green marketing, ethics, and rural marketing into real-world applications, including startups and engineering innovations.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Introduction to Marketing** | 06 | CO1 | 2 |
| | Definition, nature, scope, and importance of marketing<br>Core marketing concepts: Needs, Wants, Demand, Value, Exchange<br>Evolution of marketing: Production to Relationship orientation Role of marketing in business and society | | | |
| II | **Understanding the Market and Consumer Behavior** | 08 | CO2 | 5 |

| | | | | |
|---|---|---|---|---|
| | Marketing environment: Micro and Macro<br>Buyer decision process – stages and influencing factors<br>Market segmentation: Bases and strategies<br>Targeting and Positioning (STP) | | | |
| **III** | **Marketing Mix - Product and Price** | 10 | CO3 | 6 |
| | Product: Levels, types, lifecycle, new product development Branding, Packaging, and Labeling<br>Pricing: Objectives, strategies, and methods<br>Factors affecting pricing decisions | | | |
| **IV** | **Marketing Mix - Place and Promotion** | 10 | CO4 | 6 |
| | Distribution channels: Types and functions<br>Retailing, Wholesaling, and Logistics<br>Promotion mix: Advertising, Sales Promotion, Public Relations, Direct Marketing, Personal Selling<br>Integrated Marketing Communication (IMC) | | | |
| **V** | **Digital Marketing Basics** | 06 | CO5 | 4 |
| | Definition, nature, scope, and importance of digital marketing<br>Difference between traditional and digital marketing.<br>Overview of main online marketing channels:<br>Search Engine Optimization (SEO)<br>Search Engine Marketing (SEM)<br>Social Media Marketing (SMM)<br>Content Marketing<br>Email Marketing<br>Affiliate Marketing<br>Influencer Marketing | | | |
| **VI** | **Social Responsibility and Applications of Marketing** | 05 | CO6 | 5 |
| | Green marketing and sustainability<br>Ethical issues in marketing<br>Rural marketing in India<br>Applying marketing principles to engineering innovations/<br>Startups<br>**Advanced Topics:** AI-driven marketing analytics and predictive consumer behavior modeling using machine learning and big data. | | | |
| | **Total** | **45** | | |

**Evaluation Scheme and Assessment:**

**Internal Assessment Examination:**

The internal assessment consists of the following components:

| Sr. No. | Method | Marks | CO covered |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1 | Quiz- Google form | 10 | CO1 & CO2 |
| 2 | Individual Report Submission | 10 | CO3 & CO4 |
| 3 | Quiz- Google form | 10 | CO5 |
| 4 | Case Study | 10 | CO6 |

**End Semester Theory Examination:** End Semester exam of 60 Marks will be conducted based on entire syllabus.

**Reference Books:**

1. S.A. Sherlekar, Marketing Management, Himalaya Publishing.
2. Grewal & Levy, Marketing, McGraw-Hill Education.
3. Tracy L. Tuten, Principles of Marketing for a Digital Age, SAGE Publications.

**Text Books:**

1. Philip Kotler, Marketing Management, Pearson Education.
2. Ramaswamy & Namakumari, Marketing Management: Global Perspective Indian Context, Macmillan..\

| Course Title: Employability Enhancement Program – IV (Finite Element Analysis Lab) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** V | | | **Term:** Odd | | | | **Course Code:** 24MEVSE501C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| - | - | 2 | - | - | 1 | 1 | - | - | - | 25 | - | 25 |
| **Sustainable Development Goals Mapped: 4, 8, 9, 12, 13** | | | | | | | | | | | | |

**Course Objectives:**

1. To familiarize FEA concept for practical implementation
2. To acquaint with FEA application software

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Select appropriate element for given problem
2. Select suitable meshing and perform convergence test
3. Select appropriate solver for given problem
4. Interpret the result
5. Apply basic aspects of FEA to solve engineering problems
6. Validate FEA solution

| Sr No. | List of Experiment | COs |
|---|---|---|
| **1** | Analyze a stepped bar subjected to axial load. Determine nodal displacements, stresses, and compare with analytical solution. | 1 |
| **2** | Evaluate thermal expansion in a bar due to temperature rise and calculate induced stresses under constrained conditions. | 1 |
| **3** | Determine nodal displacements and member forces of a simple truss structure using FEM. | 2 |
| **4** | Analyze a cantilever truss subjected to point loads and study stress distribution in members. | 2 |
| **5** | Analyze a thin plate subjected to in-plane loading and determine stress components using CST elements. | 3 |
| **6** | Study effect of mesh refinement on displacement and stress accuracy using CST elements. | 3 |
| **7** | Analyze stress distribution in a thick-walled cylinder using axisymmetric elements. | 4 |
| **8** | Evaluate radial and hoop stresses in a pressure vessel subjected to internal pressure. | 4 |
| **9** | Determine natural frequency and mode shape of a bar using FEM and compare with theoretical values. | 5 |
| **10** | Analyze temperature distribution in a rod or plate under steady heat conduction conditions. | 5 |
| **11** | Determine deflection and bending stress in a simply supported beam under point load using FEM. | 6 |
| **12** | Analyze a simple frame structure combining beam and truss elements to evaluate real-world structural behavior. | 6 |

**Reference Books:**

1. . Programming the Finite Element Method, I M Smith, D V Griffiths and Margetts WILEY Publications.
2. The Finite Element Method: Theory, Implementation, and Applications, Larson, Mats G., Bengzon, Fredrik, Springer
3. Introduction to Finite Element Analysis and Design by N. H. Kim, B. V. Sankar, and A. V. Kumar by Wiley publication
4. Finite Element analysis using ANSYS by Paleti Srinivas, Krishna Chaitanya, Rajesh Kumar Detti, PHI Publication.
5. Finite Element Analysis Theory and Application With ANSYS by Saeed Moaveni, Pearson Publication.
6. Introduction to Finite Element Analysis Using MATLAB and Abaqus By Amar Khennane, CRC Press publication

**Useful Links:**

1. https://nptel.ac.in/courses/112104193?utm_source=chatgpt.com
2. https://onlinecourses.nptel.ac.in/noc22_me43/preview?utm_source=chatgpt.com

# Bachelor of Technology
# In
# Mechanical Engineering

## Third Year
## Semester – VI

## SJCEM : R–24C

## Effective from Academic Year

## 2026-27

**Scheme of Third Year Mechanical Engineering**
**(With Effect from 2026-27)**
**Semester VI**

| Course Code | Vertical | Course Name | Contact Hrs | | | Credit Allotted | | | Total Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Th | Tut | Pr | Th | Tut | Pr | |
| 24MEPCC601C | PCC | Turbomachinery and Space Propulsion System | 3 | - | 2 | 3 | - | 1 | 4 |
| 24MEPCC602C | PCC | Design of Mechanical Elements-II | 3 | - | - | 3 | - | - | 3 |
| 24MEPEC601XC | PEC | Professional Elective- III | 3 | - | 2 | 3 | - | 1 | 4 |
| 24MEPEC602XC | PEC | Professional Elective- IV | 3 | - | - | 3 | - | - | 3 |
| 24MDM601XC | MDM | Multidisciplinary Minor | - | - | 4 | - | - | 2 | 2 |
| 24MEVSE601C | VSEC | Employability Enhancement Program-V (Industry Certification) | - | - | 2 | - | - | 1 | 1 |
| 24MEVSE602C | VSEC | Electric Vehicles | 2 | - | - | 2 | - | - | 2 |
| 24MEPRJ601C | PRJ | Major Project Phase-I | - | - | 4 | - | - | 2 | 2 |
| 24MEOJT601C | OJT | Internship - II | - | - | 3 | - | - | 1 | 1 |
| | | **Total** | 14 | - | 17 | 14 | - | 8 | **22** |

| Course Code | Vertical | Course Name | Evaluation Scheme | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | | Theory | | | Practical | | |
| | | | IAE 1 | IAE 2 | ESE | CA | Or / Pr | |
| 24MEPCC601C | PCC | Turbomachinery and space Propulsion System | 20 | 20 | 60 | 25 | 25 | 150 |
| 24MEPCC602C | PCC | Design of Mechanical Elements-II | 20 | 20 | 60 | - | - | 100 |
| 24MEPEC601XC | PEC | Professional Elective- III | 20 | 20 | 60 | 25 | 25 | 150 |
| 24MEPEC602XC | PEC | Professional Elective- IV | 20 | 20 | 60 | - | - | 100 |
| 24MDM601XC | MDM | Multidisciplinary Minor | - | - | - | 50 | - | 50 |
| 24MEVSE601C | VSEC | Employability Enhancement Program-V (Industry Certification) | - | - | - | - | 25 | 25 |
| 24MEVSE602C | VSEC | Electric Vehicles | 20 | 20 | 60 | | | 100 |
| 24MEPRJ601C | PRJ | Major Project Phase-I | - | - | - | 50 | | 50 |
| 24MEOJT601C | OJT | Internship - II | - | - | - | - | 25 | 25 |
| | | **Total** | **100** | **100** | **300** | **150** | **100** | **750** |

**Professional Elective Courses**

| Semester | PEC | Professional Elective-I/III/V | | Professional Elective-II/IV/VI | |
|---|---|---|---|---|---|
| | | Track 1(T1) | Track 2 (T2) | Track 3 (T3) | Track 4 (T4) |
| | | Thermal and Fluid Science | Energy conservation and alternate energy | Mechanical Design | Manufacturing and Production |
| Sem V | Professional Elective - I/II | Internal Combustion Engine | Renewable Energy Sources | Finite Element Analysis | Industrial Robotics and Automation |
| Sem VI | Professional Elective - III/IV | HVAC and Cryogenics Systems | Energy System Modeling and Analysis | Advanced Vibration | Production Planning and Scheduling |
| Sem VII | Professional Elective - V/VI | Computational Fluid Dynamics | Energy Audit and Management | Mechanical System Design | Artificial Intelligence and Machine Learning in Mechanical Systems |
| | | Aerospace Engineering | Fuel cells and hydrogen technology | Design of Automobile Components | Biomedical Engineering |
| | | Power Plant Engineering | Solar Energy | Machinery Diagnostics | Operation Research |

**Professional Electives Courses**

| Semester | Professional Elective - III | | | |
|---|---|---|---|---|
| | Track 01 | | Track 02 | |
| | Thermal and Fluid Science | | Energy conservation and alternate energy | |
| Sem VI | 24MEPEC6011C | HVAC and Cryogenics Systems | 24MEPEC6012C | Energy System Modeling and Analysis |

| Semester | Professional Elective - IV | | | |
|---|---|---|---|---|
| | Track 03 | | Track 04 | |
| | Mechanical Design | | Manufacturing and Production | |
| Sem VI | 24MEPEC6021C | Advanced Vibration | 24MEPEC6022C | Production Planning and Scheduling |

**Multidisciplinary Minor**

| Semester | MDM | Course Code | Vertical | Course Name |
|---|---|---|---|---|
| VI | Additive Manufacturing | 24MDM601AMC | MDM | Additive Manufacturing Laboratory |
| VI | Energy Engineering | 24MDM601EEC | MDM | Energy Audit and Management |

# Syllabus

# for

# Third Year Mechanical Engineering

# Semester – VI

# SJCEM : R–24C

# (With Effect from 2026-27)

| Course Title: Turbomachinery and Space Propulsion System | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VI | | | **Term:** Even | | | | **Course Code:** 24MEPCC601C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or / Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | 2 | 3 | -- | 1 | 4 | 20 | 20 | 60 | 25 | 25 | 150 |
| **Sustainable Development Goals:** 7, 9, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. Understand the working principles of positive displacement and dynamic compressors and basic compressible flow concepts.
2. Analyze and calculate work, pressure rise, velocity triangles, and efficiency for compressors.
3. Comprehend gas turbines, steam generators, and steam turbines, their cycles, performance, and efficiency improvement methods.
4. Understand space propulsion systems, including jet and rocket engines, their types, principles, and applications.

**Course Outcomes:** Learner will be able to…

1. Analyze positive displacement compressors, including multistage designs, to optimize work input and volumetric efficiency.
2. Apply and analyze Euler's equation, velocity triangles, and compressible flow concepts to predict and optimize centrifugal and axial compressor performance.
3. Evaluate gas turbine cycles and propose modifications such as intercooling, reheat, and regeneration to enhance thermal efficiency and work output.
4. Compare and analyze different jet and rocket propulsion systems and design solutions for specific aerospace applications.
5. Analyze and evaluate boiler performance, efficiency, and equivalent evaporation for various types of steam generators.
6. Design and analyze impulse and reaction turbines, including compounding and degree of reaction, to maximize efficiency and work output.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Positive Displacement Compressor**<br>**Reciprocating compressors:** Parts, Operations, Work done during isothermal, polytropic and adiabatic compression process, P-v diagram, isothermal efficiency, Effect of clearance, volumetric efficiency, Mechanical efficiency, Multistage compressor, condition for minimum work input, Actual indicator diagram<br>**Self-learning:** Roots blower, Screw Compressor, Vane Compressor, Scroll Compressor | 8 | CO1 | 4 |
| II | **Dynamic Compressors & Compressible Flow**<br>**Compressible Flow**: Mach number, sonic velocity, stagnation properties, and the concept of choking in compressors and nozzles. | 8 | CO2 | 4 |

| | | | | |
|---|---|---|---|---|
| | **Centrifugal Compressors**: working principle, impeller and diffuser types, surge and choking phenomena, Euler's equation and work input and pressure rise.<br>**Axial Flow Compressors**: working principle with rotor-stator stages, velocity triangles, degree of reaction, stage efficiency, work per stage and pressure ratio<br>**Self-learning:** Compressor Performance Curves, Maintenance and Troubleshooting, Industrial Applications | | | |
| III | **Gas Turbines:** Applications of gas turbine, Actual Brayton cycle, open and closed cycle gas turbine, methods to improve efficiency and specific output, open cycle with intercooling, reheat, and regeneration, Effect of operating variable on thermal efficiency and work ratio<br>**Self-learning:** combined cycle plants and co-generation | 8 | CO3 | 5 |
| IV | **Space Propulsion**<br>**Jet Propulsion and rocket engines:** Introduction, Principle of jet propulsion, Classification of jet propulsion engines, Performance of jet propulsion engines, Turbojet engine, Turbofan engine, Turboprop engine, Turbojet engine with afterburner, Ramjet engine, Principle of rocket propulsion, Rocket engine, Solid propellant rocket engines, Liquid propellant rocket engines<br>**Self-learning:** Pulse jet engine | 7 | CO4 | 4 |
| V | **Steam Generators:** Layout of Thermal Power Plant, Classification of boiler, Difference between Fire tube and Water tube boiler with examples, Low pressure and high-pressure boilers, once through boiler, important features of HP boilers, Mountings and accessories, Equivalent evaporation of boilers, Boiler performance, Boiler efficiency<br>**Self-learning:** Boiler Troubleshooting | 7 | CO5 | 4 |
| VI | **Steam Turbine:** Basic of steam turbine, Classification,<br>**Impulse turbine:** velocity diagram, Condition for max efficiency, Numerical on Simple Impulse turbine (De-Laval turbine) of single stage only.<br>**Reaction turbine:** Degree of reaction, Parson's turbine, Condition for maximum efficiency, Numerical on Parson's turbine only.<br>**Self-learning:** Compounding of turbine<br>**Advanced topic**: Supercritical and ultra-supercritical boiler systems | 7 | CO6 | 6 |
| **Total** | | **45** | | |

**Lab Contents:**

| Sr. No. | List of Experiment | COs |
|---|---|---|
| 1. | Trial on reciprocating compressor | CO1 |
| 2. | Analysis of single stage reciprocating compressor | CO1 |
| 3. | Trial on rotary compressor | CO2 |
| 4. | Determine the performance characteristics of a centrifugal compressor, including pressure rise and work input. | CO2 |
| 5. | Analyze the velocity triangles and work per stage for an axial flow compressor through experimental data or simulation. | CO2 |
| 6. | Analytical study of gas turbine for the given data | CO3 |
| 7. | Case study of gas turbine power plant | CO3 |
| 8. | Study the thrust measurement of a small turbojet or ramjet model | CO4 |
| 9. | Analyze the performance of a solid or liquid propellant rocket motor model, measuring thrust and specific impulse. | CO4 |
| 10. | Demonstration / e-learning of Boiler, Boiler mountings and accessories | CO5 |
| 11. | Performance analysis of boiler for the given data | CO5 |
| 12. | Analytical study of steam turbine for the given data | CO6 |
| 13. | Case study of steam turbine power plant | CO6 |

**Reference Books:**

1. Thermal Engineering, R K. Rajput, Tenth Edition, Laxmi Publication, 2020 (All Modules)
2. *Power Plant Engineering,* P.K. Nag, 4th Edition (2014), McGraw-Hill Education India, ISBN**:** 978-9339204044 (Module 5 &6)
3. *Gas Turbines,* V. Ganesan, 3rd Edition (2017), McGraw-Hill Education India, **ISBN:** 978-0070681927 (Module 2,3 & 4)
4. *Jet Propulsion and Rocket Engines,* George P. Sutton and Oscar Biblarz, 7th Edition (2017), Wiley, ISBN**:** 978-1118975178 (Module 3 &4)
5. *Power Plant Engineering,* R.K. Rajput, 6th Edition (2024), Laxmi Publications, ISBN:978-8131802557 (Module 5 &6)

**Text Books:**

1. Turbines, Compressors and Fans by S.M. Yahya, Fourth Edition, McGraw-Hill, 2017 (Module 3 & 4)
2. Turbomachinery Design and Theory by Aijaz Khan and Rama Gorla, CRC Press Inc., First Edition, 2003 (Module 3 & 4)

3. Fluid Mechanics and Thermodynamics of Turbomachinery, Cesare Hall, Dixon, S.L., Amsterdam; Boston: Elsevier-Butterworth-Heinemann, 2013 (Module 3 & 4)
4. *Rocket Propulsion Elements,* George P. Sutton and Oscar Biblarz, 9th Edition (2023), Wiley, ISBN**:** 978-1118753651 (Module 3 & 4)
5. A Textbook of Thermal Engineering, R.S. Khurmi & J.K. Gupta, Latest Edition (2022), S. Chand Publishing, ISBN**:** 978-9355010544 (All Modules)
6. A Textbook of Power Plant Engineering, R.K. Sharma & S.K. Aggarwal, 2nd Edition (2018), S.K. Kataria & Sons, ISBN**:** 978-8174093202 (Module 5 &6)

**Links for online NPTEL/SWAYAM courses:**

https://nptel.ac.in/courses/112/106/112106303/ - Introduction to Turbomachines, IIT Madras

https://nptel.ac.in/courses/112/106/112106200/ - Fluid Dynamics and Turbomachines, IIT Madras

https://nptel.ac.in/courses/101104019?utm_source=chatgpt.com – Jet and rocket propulsion, IIT Kanpur

https://nptel.ac.in/courses/112103277?utm_source=chatgpt.com – Steam power engineering, IIT Guwahati

| Course Title: Design of Machine Element - II | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VI | | | **Term:** Even | | | | **Course Code:** 24MEPCC602C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |
| **Sustainable Development Goals:** 4, 8, 9, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To analyse and design gears (spur, helical, bevel, worm) based on strength, wear, and thermal considerations.
2. To study the classification, selection, and design of rolling and sliding contact bearings under different operating conditions.
3. To understand the design considerations of flexible drives like belts and chains used for power transmission.
4. To gain knowledge about internal combustion (IC) engine components such as pistons, connecting rods, and crankshafts with design considerations

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Design and analyse spur, helical, and bevel gears with strength and wear considerations.
2. Design gearboxes and worm gears considering load, speed, and thermal effects.
3. Identify, select, and design appropriate rolling contact bearings for various mechanical systems.
4. Design sliding contact bearings and understand lubrication mechanisms and mechanical seals.
5. Design and select suitable belt and chain drives for power transmission systems
6. Design essential IC engine components such as pistons, connecting rods, and crankshafts considering functional and structural requirements.

| Module | Content | Hours | COs |
|---|---|---|---|
| 1 | **Design of Gears:**<br>**1.1 Gears:** Design of spur, helical with strength, wear considerations.<br>**1.2 Gearbox:** Two stage Gear box with fixed ratio consisting of spur, helical and bevel gear pairs: gear box housing layout and housing design,<br>**Self-learning topics:** Law of gearing. | 8 | 1 |
| 2 | **Design of Gears:**<br>**2.1 Gears:** Design of bevel and worm gears with strength, wear and thermal considerations.<br>**Self-learning topics:** material for gear and their desired properties. | 7 | 2 |
| 3 | **3.1 Rolling Contact Bearings:** Types of bearing and designation, selection of rolling contact bearings based on constant / variable load & speed conditions (includes deep groove ball bearing, cylindrical roller, spherical roller, taper roller, self-aligning bearing and thrust bearing)<br>**Self-learning topics:** study of different bearings available in market. | 7 | 3 |
| 4 | **4.1 Sliding Contact Bearings:** Design of hydro dynamically lubricated bearings (self-contained), Introduction to hydrostatic bearings, Types and selection of Mechanical seals,<br>**Self-learning topics:** heat generation in bearing. | 7 | 4 |
| 5 | **5.1 Design and selection of Belts**: Flat and V-belts with pulley construction.<br>**5.2 Design and selection of standard roller chains**.<br>**Self-learning topics:** Chain maintenance. | 8 | 5 |

| | | | |
|---|---|---|---|
| 6 | **6.1 Engine Design (Petrol and Diesel):**<br>Design of Piston with pin and rings, cylinder head and liner, connecting rod, crankshaft.<br>**Self-learning topics:** Design of crankshaft with bearings<br>**Advanced Topics:** Optimization-based machine design using CAD/CAE tools (ANSYS/Creo) with topology optimization and fatigue-based design of mechanical power transmission components. | 8 | 6 |
| **Total** | | | 45 |

**Reference Books:**

1. Machine Design by Pandya & Shah, Charotar Publishing, 2019.
2. Mechanical Engineering Design by J.E.Shigley, McGraw Hill, 2023
3. Recommended Data Books - PSG, 2021
4. Machine Design by Reshetov, Mir Publication, 2019.
5. Machine Design by Black Adams, McGraw Hill, 2019.
6. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas & Co, 2019.
7. Recommended Data Books – Design Data: Data Book of Engineers by PSG College, Kalaikathir Achchagam, 2023

**Text Books:**

1. Design of Machine Elements by Spotts, 2022.
2. Design of Machine Elements - Sharma, Purohit. Prentice Hall India Publication, 2021
3. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education, 2021.
4. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication, 2022

**Useful Links:**

NPTEL Course:
https://nptel.ac.in/courses/112/105/112105124/
https://nptel.ac.in/courses/112/106/112106137/

| Course Title: HVAC and Cryogenics Systems | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VI | | | **Term:** Even | | | | **Course Code:** 24MEPEC6011C | | | | | |
| Teaching Scheme | | | | | | | Evaluation Scheme | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **Theory** | | | | **Practical** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | |
| **3** | **--** | **2** | **3** | **--** | **1** | **4** | 20 | 20 | 60 | 25 | 25 | 150 |
| **Sustainable Development Goals:** 3, 7, 9, 11, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To apply the thermodynamic principles to refrigeration and air-conditioning systems.
2. To analyse and compare the performance of different refrigeration and air-conditioning systems.
3. To study the controls and applications of refrigeration and air-conditioning systems.
4. To provide students with a comprehensive understanding of cryogenic systems, their properties, principles of gas liquefaction, and various storage methods used in cryogenic applications

**Course Outcomes:** Learner will be able to…

1. Apply the fundamentals of thermodynamics to refrigeration systems and calculate the coefficient of performance of reversed Carnot cycle, Bell-Coleman cycle and Aircraft refrigeration systems.
2. Analyse the vapour compression refrigeration systems, components and interpret the importance of refrigerant properties and its selection criteria.
3. Analyse Performance of Cooling Tower and Non-Conventional Refrigeration Systems.
4. Analyse the psychrometric properties, processes, charts and principles of air-conditioning.
5. Design air-conditioning systems using cooling load calculations and duct design principles and discuss controls of various refrigeration and air-conditioning systems and its application
6. Describe the properties of cryogenic systems and evaluate the elements of gas liquefaction and storage systems used in cryogenic applications.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Introduction to Refrigeration:** Methods of refrigeration, First and Second Law applied to refrigerating machines, Carnot refrigerator & Carnot heat pump. Unit of refrigeration, Co-efficient of Performance, Energy Efficiency Ratio (EER) and BEE star rating. Air refrigeration systems: Bell Coleman cycle, analysis and applications. Aircraft refrigeration systems: Simple, Bootstrap. aircraft cooling system. **Self-Learning:** Reduced ambient & Regenerative aircraft cooling system. | 08 | 1 | 3 |
| II | **Vapour Compression Refrigeration Systems:** Simple vapour compression cycle, Effect of liquid sub cooling & superheating, effect of evaporator and condenser pressures, methods of sub-cooling, Use of P-h charts, Actual VCR cycle, 2 stage VCR systems & applications. Types of Compressors, Condensers, Expansion devices and Evaporators. **Refrigerants:** Desirable properties of refrigerants, ASHRAE numbering system for refrigerants, Secondary refrigerants, ODP and GWP, Montreal & Kyoto protocol and India's commitment. | 08 | 2 | 4 |

| | | | | |
|---|---|---|---|---|
| | **Self-Learning:** Recent developments in refrigerants. | | | |
| III | **Heat Pump :** Performance, Primary energy ratio, Energy efficiency Introduction, Coefficient of performance, Heating season performance factor, Seasonal energy efficiency ,ratio, Classification of heat pump, Vapour compression heat pump systems Heat pump application in an industry<br>**Non-Conventional Refrigeration Systems:** Ammonia-water & Lithium Bromide–Water vapour absorption refrigeration system, Thermoelectric refrigeration, Thermo-acoustic refrigeration, Vortex tube refrigeration systems & Radiant heating and cooling systems.<br>**Cooling tower:** Types of cooling towers, tower approach, tower range, tower efficiency,<br>**Self-Learning:** Cooling tower losses & tower maintenance. | 07 | 3 | 4 |
| IV | **Psychrometry:**<br>Need for air conditioning, Principle of psychrometry, Psychrometric properties, chart and processes, Bypass factor, Sensible heat factor, Air washers, Requirements of comfort air conditioning, Summer and Winter Air conditioning.<br>**Self-Learning:** Adiabatic mixing of two air streams | 07 | 4 | 4 |
| V | **Design of Air Conditioning Systems:**<br>Different Heat sources, Cooling Load estimation, Ventilation and infiltration, Inside and Outside Design condition, RSHF, GSHF, ERSHF, Room apparatus dew point and coil apparatus dew point. Introduction to Unitary Products: Room/Split and Packaged Air Conditioners, Introduction to recent developments: VRF systems, VAV systems, Inverter Units. Human Comfort, Thermal exchange of body with environment, Effective temperature, Comfort chart, Comfort zone, Indoor Air Quality.<br>**Duct Design:**<br>Friction chart for circular ducts, Equivalent diameter of a circular duct for rectangular ducts, Methods of duct design, Factors considered in air distribution system, Air distribution systems for cooling and heating<br>**Controls and Applications:** Controls: LP/HP cut-off, Thermostats, Humidistats, Interlocking control, Electronic Controllers. **Applications:** Refrigeration & A/C Ice plant – food storage plants – dairy and food processing plants, Food preservation, Freeze Drying, A/C in textile industry, printing & Deep-Sea water air-conditioning.<br>**Self-Learning:** Application of HVAC in pharmaceutical industry and Hospitals | 08 | 5 | 6 |
| VI | **Introduction to Cryogenic Systems** – Mechanical Properties at low temperatures – Properties of cryogenic fluids.<br>**Gas Liquefaction:** Minimum work for liquefaction – Methods to produce low temperature – Liquefaction systems for gases other than Neon, Hydrogen and Helium.<br>**Cryogenic cycles and applications:** Carnot Liquefaction Cycle, Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle Dual Cycle, Critical Components in Liquefaction Systems. J. T. Cryocoolers, Stirling Cycle Refrigerators, G.M. Cryocoolers, Pulse Tube Refrigerators. | 07 | 6 | 5 |

| | | | | |
|---|---|---|---|---|
| | **Self-Learning:** Case study on any one practical example<br>**Advanced Topics:** Magnetic refrigeration (magnetocaloric cooling technology) and adsorption-based solid-state cooling systems for next-generation eco-friendly refrigeration applications. | | | |

| SR. NO. | List of Experiments | COs |
|---|---|---|
| **1** | Case study on performance evaluation of refrigeration system based on Bell- Coleman Cycle | CO1 |
| **2** | Study and performance on simple vapour compression test rig | CO2 |
| **3** | Trial on Window AC | CO2 |
| **4** | Simulation of VCR system with an open-source software | CO2 |
| **5** | Study and performance of heat pump test rig | CO3 |
| **6** | Trial on Vapour absorption refrigeration test rig. | CO3 |
| **7** | Study and performance of cooling tower based on the cooling load and approach to wet bulb temperature. | CO3 |
| **8** | Perform humidification and dehumidification air conditioning process on air. conditioning test rig | CO4 |
| **9** | Cooling load estimation exercise for an actual scenario. | CO5 |
| **10** | Study and performance of refrigeration cycle on Ice plant. | CO5 |
| **11** | Performance analysis on water cooler system. | CO5 |
| **12** | Case Study on Design and Operation of Cryogenic Storage and Liquefaction System. | CO6 |
| **13** | Industrial visit to demonstrate thermal devices (Compulsory) | All CO |

**Reference Books**

1. Principles of refrigeration – R J Dossat, Willey Eastern Publication., 5th edition 2001
2. Refrigeration and air-conditioning – W F Stoeker and J W Jones, 3rd edition 1982
3. Air Conditioning System Design – Roger Legg, Butterworth-Heinemann Publication,2017
4. Cryogenic Technology – Harold Weinstock, 1969, Boston Technical Publishers, Inc.
5. ASHRAE Handbook of Fundamentals,2021
6. ISHRAE Refrigeration Handbook,2019.

**Text Books:**

1. Refrigeration and air-conditioning – C. P. Arora, 3rd Edition, 2017, McGraw Hill
2. Refrigeration and air-conditioning – Domkundwar, Arora, 2018, Dhanpat Rai
3. Basic Refrigeration and air-conditioning- P. Ananthanarayana, 2nd Edition, 2013
4. Refrigeration and air-conditioning – R K Rajput, 3rd Edition, 2013, S.K. Kataria & Sons
5. Refrigeration and air-conditioning – Manohar Prasad, 3rd Edition, 2015, New Age Publisher
6. Cryogenic Technology – Robert W. Vance, 1st Edition, John Wiley & Sons, Inc., New York and London.

**Useful Links:**

1) https://nptel.ac.in/courses/112/107/112107208/
2) https://nptel.ac.in/courses/112/105/112105128/

| Course Title: Energy System Modelling and Analysis | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VI | | | **Term:** Even | | | | **Course Code:** 24MEPEC6012C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | 2 | 3 | - | 1 | 4 | 20 | 20 | 60 | 25 | 25 | 150 |
| **Sustainable Development Goals:** 7, 9, 11, 12, 13, 17 | | | | | | | | | | | | |

**Course Objectives:**

1. To introduce the fundamentals and importance of renewable energy systems.
2. To learn basic modeling and analysis techniques for solar, wind, and hybrid systems.
3. To gain hands-on understanding of open-source and commercial energy simulation tools.
4. To perform techno-economic and environmental analysis of renewable projects.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Explain the basic working principles and classifications of renewable energy systems.
2. Develop simplified mathematical models for solar energy systems and estimate energy output.
3. Formulate basic models for wind and biomass systems and analyze their energy yield.
4. Simulate renewable energy systems using open-source tools such as eQuest and OpenStudio.
5. Analyze PV system performance using simulation tools like PVsyst, Helioscope, and PVGIS.
6. Perform techno-economic and environmental analysis of renewable and hybrid energy systems.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| 1 | **Introduction to Renewable Energy Systems:** Overview of solar, wind, biomass, small hydro, and hybrid systems. Need for system modeling and simulation. System boundaries and assumptions. ***Self-learning**:* Global and Indian renewable energy scenario. | 7 | 1 | 2 |
| 2 | **Modeling of Solar Energy Systems:** Solar radiation data, PV cell equivalent circuit, I–V characteristics, energy output estimation. Solar thermal collector performance modeling. ***Self-learning**:* Using PVGIS and Helioscope web tools for solar resource assessment. | 8 | 2 | 3 |
| 3 | **Modeling of Wind and Biomass Systems:** Wind power equation, turbine power curve, capacity factor, annual energy yield; biomass and biogas plant modeling using mass and energy balance. ***Self-learning**:* Case study of solar–wind–biomass hybrid system. | 7 | 3 | 4 |
| 4 | **Energy Simulation through Open-Source Software:** Introduction to eQuest and OpenStudio for energy system and building simulation. Creating input data, running simulations, interpreting results. ***Self-learning**:* Modeling solar-assisted buildings using OpenStudio interface. | 8 | 4 | 3 |
| 5 | **Solar PV System Simulation Tools:** Introduction to PVsyst, Helioscope, and PVGIS for PV system sizing, performance analysis, shading effect, and energy yield estimation. | 7 | 5 | 4 |

| | | | | |
|---|---|---|---|---|
| | ***Self-learning***: Preparing simple PV simulation report using PVsyst. | | | |
| 6 | **Techno-Economic and Environmental Analysis:** Cost estimation, life cycle cost, payback period, $CO_2$ reduction, energy payback time, sustainability indicators, and hybrid system optimization basics using spreadsheet tools. ***Self-learning***: Comparative study of renewable vs. fossil-based systems.<br><br>**Advanced Topics:** Energy storage systems integration with renewable energy (Battery Energy Storage Systems and Pumped Hydro Storage) and smart microgrid technology for real-time power management and grid stability. | 8 | 6 | 5 |
| **Total** | | **45** | | |

| Sr. No. | List of Experiments | COs |
|---|---|---|
| **1** | Draw and analyze energy flow and conversion stages of solar PV and wind systems using block diagrams. | CO1 |
| **2** | Use PVGIS web tool to estimate solar radiation and energy potential for a given location (e.g., Palghar). | CO1 |
| **3** | Plot solar PV I–V and P–V curves using given data in Excel; calculate fill factor and efficiency. | CO2 |
| **4** | Calculate instantaneous efficiency of a flat plate solar collector using simple experimental data. | CO2 |
| **5** | Use standard wind speed data to plot turbine power curve and calculate capacity factor. | CO3 |
| **6** | Perform simple mass and energy balance for a small fixed-dome biogas plant. | CO3 |
| **7** | Create a simple building or system model in eQuest and estimate monthly energy use. | CO4 |
| **8** | Model a solar-assisted building and analyze HVAC and solar contribution using OpenStudio. | CO4 |
| **9** | Simulate a small 1 kW solar PV system in PVsyst and generate performance ratio and yield report. | CO5 |
| **10** | Use Helioscope online to design a small rooftop PV layout and analyze shading losses. | CO5 |
| **11** | Calculate payback period and cost of energy for a small PV system using Excel or PVsyst data. | CO6 |
| **12** | Perform simple hybrid system (solar–wind) optimization for minimum cost using Excel model. | CO6 |

**Reference Books:**

1. **J Ranga, Modeling and Simulation of High Reliable Renewable Energy based Hybrid,** LAP Lambert Academic Publishing (7 April 2021)
2. **Dr. Sanjay Kumar, Renewable Energy Systems: Modeling, Optimization and Applications, Wiley**
3. Y. Maalawi, Modeling, Simulation and Optimization of Wind Farms and Hybrid Systems, Intech Open

**Text Books:**

1. "Non-conventional Energy Sources", G.D. Rai, 6th Edition, Khanna Publishers, ISBN: 978-81-7409- 073-7

2. **NREL, eQuest and OpenStudio User Manuals, U.S. DOE Publications.**
3. Thomas A. Adams, Modeling and Simulation of Energy Systems, MDPI

**Useful Software Tools**

- Open-Source Tools:
    - eQuest – Energy and building system simulation.
    - OpenStudio – Modeling of solar-assisted and hybrid energy systems.
    - PVGIS – Solar resource and PV energy potential estimation.
- Commercial (Educational License):
    - PVsyst – PV system design, sizing, and performance analysis.
    - Helioscope – Cloud-based PV layout and simulation tool.

**Useful Links:**

https://onlinecourses.nptel.ac.in/noc25_ch40/preview - Renewable Energy Engineering: Solar, Wind And Biomass Energy Systems, IIT Guwahati
https://onlinecourses.nptel.ac.in/noc25_ee132/preview – Modeling and TCAD Simulation of Solar PV Cell, IIT(ISM) Dhanbad
https://onlinecourses.nptel.ac.in/noc25_ee167/preview – Design and Simulation of Power Conversion using Open Source Tools, IISc Bangalore

| Course Title: Advanced Vibration | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VI | | | **Term:** Even | | | | **Course Code: 24MEPEC6021C** | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | - | 3 | - | - | 3 | 20 | 20 | 60 | - | - | 100 |
| **Sustainable Development Goals:** 4, 9, 11, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To study the multi-degree of freedom system.
2. To study different vibration measurement and control methods, and required instruments.
3. To study basic concepts of Random Vibrations.
4. To study the basic concepts of nonlinear vibrations.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Estimate natural frequency of mechanical element / system.
2. Understand the concepts of Vibration Isolation and Control.
3. Analyse vibratory response of mechanical element / system.
4. Analyse vibration of Continuous system.
5. Analyse Random Vibrations.
6. Analyse Non-Linear Vibrations

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| 1 | Multi Degree of Freedom System: Undamped free vibration: Free vibration equation of motion, Influence coefficients (stiffness and flexibility), Reciprocity theorem, Generalized Coordinates, and Coordinate Coupling, Lagrangian equations, Eigen Values and Eigen vectors: for translatory and torsional two D.O.F. systems, Matrix method<br><br>**Self-learning topics**: Rayleigh and Dunkerley method, two rotor and geared systems, Holzer's method (translatory and torsional unbranched systems) | 8 | 1 | 3 |
| 2 | Vibration Isolation and Control: Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, vibration isolation,<br><br>**Self-learning topics**: Dynamic vibration absorbers, and Vibration dampers, Passive, semi-active, and active vibration control | 8 | 2 | 2 |
| 3 | Vibration Measurement: Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis.<br><br>**Self-learning topics**: Modal analysis and Condition Monitoring: Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine condition monitoring and diagnosis. | 8 | 3 | 4 |

| | | | | |
|---|---|---|---|---|
| 4 | Vibration of Continuous Systems: Vibration of string, Longitudinal vibration of rods, Torsional vibration of rods,<br><br>**Self-learning topics**: Euler equation for beams. | 7 | 4 | 4 |
| 5 | Random Vibrations: Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density.<br><br>**Self-learning topics**: Fourier transforms and response. | 7 | 5 | 4 |
| 6 | Non-Linear Vibrations: Introduction, Sources of nonlinearity, Phase plane, Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method.<br><br>**Self-Learning Topics** Method of iteration, Self-excited oscillations, Runge-Kutta method.<br><br>**Advanced Topics:** Condition monitoring of rotating machinery using IoT-based vibration analysis systems and predictive maintenance techniques using vibration data analytics. | 7 | 6 | 4 |
| **Total** | | **45** | | |

**Reference Books:**

1. W.T. Thomson and M.D. Dahleh, "Theory of Vibration with Applications", 3rd Edition 2002, Pearson Education
2 G.K. Grover, "Mechanical Vibrations", 5th Edition 2009, Nem Chand and Bros, ISBN: 978-8185240565
3 W.W. Seto, "Mechanical Vibrations- Schaum's Outline Series", McGraw Hill, ISBN: 9780070563278
4 S.S. Rao, "Mechanical Vibrations", 5th Edition 2004, Pearson Publications
5 Leonard Meirovitch, "Fundamentals of Vibration", 1st Edition 2010, McGraw Hill, ISBN: 978-1577666912.

**Text Books:**

1. Advanced Vibrations: Theory and Application (2nd ed.) by Reza N. Jazar (2024)
2. Vibration of Continuous Systems (2nd ed.) by Singiresu S. Rao (2019).
3. Vibration with Control (2nd ed.) by Daniel J. Inman (2017).
4. Vibration of Discrete and Continuous Systems (3rd ed.) by Ahmed Shabana (2019).

**Useful Links:**

https://nptel.ac.in/courses/112107212 – Introduction to Mechanical Vibration, IIT Roorkee
https://nptel.ac.in/courses/112103111 – Mechanical Vibrations, IIT Guwahati
https://nptel.ac.in/courses/112103022 – Nonlinear Vibration, IIT Guwahati
https://nptel.ac.in/courses/112104211 – Principles of Vibration Control, IIT Kanpur

| Course Title: Production Planning and Scheduling | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VI | | | **Term:** Even | | | | **Course Code: 24MEPEC6022C** | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr/** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |
| **Sustainable Development Goals:** 4, 8, 9, 12, 17 | | | | | | | | | | | | |

**Course Objectives:**

1. To provide an exposure to Operations Planning & Control (PPC) and its significance in manufacturing and service organizations
2. To appraise about need and benefits of planning functions related to products and processes
3. To provide exposure to production scheduling, sequencing and project management so as to optimize resources
4. To demonstrate different techniques used for facility planning and assembly line balancing

**Course Outcomes**: At the end of the course students will be able to….

1. Illustrate production functions and manage production in a better way.
2. Apply various strategies to develop aggregate production plan based on the demand forecasting.
3. Apply various algorithms in scheduling and sequencing of manufacturing and service operations
4. Develop Material Requirements Plans (MRP) to estimate the planned order releases.
5. Apply various techniques for facility layout planning and importance of implementation of JIT, Lean in manufacturing and service organizations.
6. Demonstrate Production Planning & Scheduling in Smart Manufacturing Environments Agile and Synchronous manufacturing in manufacturing and service organizations.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| **01** | **1.1 Introduction:** Production and Operations Function, Production systems, Make to stock, Make to order, Assemble to order and Engineer to order, type of layouts. **1.2 Strategic Planning for Operations and Services:** Approaches like Forced Choice model and Operations Model, Quality and Productivity strategy, Technology strategy. Operations Strategies for Services, **Self-Learning Topic:** Types or Service Operations: Quasi manufacturing, Customer as participants, Customer as product, Classification of Services, Service capacity. | **08** | **CO1** | **2** |
| **02** | **2.1 Forecasting:** Forecasting and Prediction, Need for forecasting, role of forecasting in OPC, Methods of forecasting, Qualitative methods, Quantitative methods like time series analysis, least square method, moving average method, and exponential smoothing method. Forecasting Error; **2.2 Capacity Planning:** Measurement of capacity, Measures of operating capacity, Factors influencing effective capacity, factors favouring over capacity and under capacity, short range, medium range and long range capacity planning. Capacity requirement Planning (CRP) **2.3 Aggregate planning:** Concept of aggregate planning, Pure | **08** | **CO2** | **3** |

| | | | | |
|---|---|---|---|---|
| | Strategy; Mixed Strategy; Level Strategy, Rough cut capacity planning, Aggregate planning for Services;<br>**Self-Learning Topic:** Optimal Models for Aggregate Planning; Linear Programming; Linear Decision Rules Master Production Schedule | | | |
| **03** | **3.1 Job shop/Intermittent Manufacturing Scheduling:** Factors influencing scheduling, Inputs for scheduling, Forward Scheduling, Backward Scheduling, Stages in Scheduling: Product sequencing, Loading and Dispatching, progress report & expediting and control. Basic scheduling problems, Priority Sequencing, Gantt Charts, Johnson's Rule for optimal sequence of N jobs on 2 machine. Process N Jobs on 3 Machines (N/3 problem) and Jackson Algorithm. Processing of 2 Jobs on M Machine (2/M) problem<br><br>**3.2 Project scheduling:** Network analysis - PERT & CPM, cost analysis & crashing, resource leveling and smoothening.<br><br>**Self-Learning Topic:** Processing of 2 Jobs on M Machine (2/M) problem | **08** | **CO3** | **3** |
| **04** | **4.1 Material Requirement Planning:** Introduction, Limitations of conventional EOQ, Objectives of MRP, Inputs of MRP-I, Outputs of MRP, MRP lot sizing and Estimation of planned order releases, Manufacturing resource planning (MRP-II)<br>**4.2 Enterprise Resource Planning (ERP):** Evolution, features, purpose of modeling an enterprise, ERP model for OPC, Modules in ERP, ERP Implementation Life Cycle<br><br>**Self-Learning Topic:** ERP packages like SAP-R3/Baan/PeopleSoft | **08** | **CO4** | **6** |
| **05** | **5.1 Facility layout planning:** Factors influencing Plant Layout, Material Flow Patterns,<br><br>**5.2 Introduction to JIT system, Lean manufacturing :** Concept, Characteristics, Components and Implementation.<br><br>**Self-Learning Topic: Agile and Synchronous manufacturing** | **06** | **CO5** | **3** |
| **06** | **Production Planning & Scheduling in Smart Manufacturing Environments** : Integration with Shop Floor Technologies, APS (Advanced Planning & Scheduling) software; simulation tools; AI / ML in scheduling;<br><br>**Self-Learning Topic:** Basic Concepts of Agile manufacturing, feedback loops; use of digital twins.<br>**Advanced Topics:** Digital twin-based smart manufacturing systems integrated with Industry 4.0 technologies for real-time production planning and scheduling optimization. | **07** | **CO6** | **2** |

| | | | |
|---|---|---|---|
| **Total** | **45** | | |

**Reference Books:**

1. **Production Planning & Scheduling + Inventory Control: A Text and Cases —** V. S. P. Rao & V. Hari Krishna etc.
2. **Planning and Scheduling in Manufacturing and Services** — Michael L. Pinedo SpringerLink
3. "Elements Of Production Planning and Control", Samuel Eilon, Universal Publication, (2015) ISBN: 9788185027548
4. "Production and Operations Management", K. Aswathappa& K. Shridhara Rao, Himalaya
5. "Modern Production operations Management", Elwood S Buffa and Rakesh K Sarin, 8th
6. Edition, Wiley Eastern, New York (1999) ISBN: 978-0471819059

**Text Books:**

1. Dileep R. Sule, **Production Planning and Industrial Scheduling** (2nd Ed.)**,2021**
2. Oliver Wight, **Master Planning and Scheduling** (4th Ed.),2021
3. Georgios M. Kopanos & Luis Puigjaner, Solving Large-Scale Production Scheduling and Planning in the Process Industries,2018
4. Yuri Mauergauz, Advanced Planning and Scheduling in Manufacturing and Supply Chains, 2016

**Useful Links:**

1. https://onlinecourses.nptel.ac.in/noc25_mg126/preview
2. https://nptel.ac.in/courses/112107143
3. https://nptel.ac.in/courses/110105155
4. http://elearn.psgcas.ac.in/nptel/courses/video/110107141/110107141.html

| Course Title: Additive Manufacturing Laboratory | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VI | | | **Term:** Even | | | **Course Code:** 24MDM601AMC | | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| -- | -- | 4 | | -- | 2 | 2 | -- | -- | | 50 | -- | 50 |

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

**Course Objectives:**

1. To understand and apply the fundamentals of additive manufacturing processes, with a focus on 3D printing.
2. To design, model, and fabricate functional components or prototypes using 3D printing technology.
3. To explore the selection of suitable materials and printing parameters for different applications.
4. To evaluate the performance and accuracy of 3D-printed components.

**Course Outcomes:** Learner will be able to…

1. Understand and demonstrate the process of non-contact 3D scanning and generation of CAD models from physical objects.
2. Apply the principles of reverse engineering to legacy components using 3D scanning, CAD modeling, and physical verification via 3D printing.
3. Use 3D modeling software to create parametric and freeform designs and generate G-code for additive manufacturing using Fractal Software.
4. Perform segmentation of medical images using tools like 3D Slicer to create 3D printable models of anatomical parts.
5. Convert 2D medical imaging data (DICOM) into 3D models using image processing tools and fabricate the model using a 3D printer.
6. Develop functional mechanical components using different additive manufacturing processes and materials such as metal and plastic, and evaluate their structural integrity.

| Sr No. | List of Experiment | Hours | COs |
|---|---|---|---|
| 1 | Non - Contact Scanning – Generation of CAD model using 3D scanning equipment. | 8 | 1 |
| 2 | Reverse Engineering of a legacy component – Selection of components, 3D scanning, CAD model verification, 3D prints of CAD model. | 8 | 1 |
| 3 | Modeling of a component using 3D modelling software and development of G – Code output using Fractal Software. | 8 | 2 |
| 4 | Design an object with free form surface using Autodesk Fusion 360 and development of G – Code output using Fractal Software. | 8 | 2 |
| 5 | Segmentation in Slicer's Segment Editor module for the purpose of 3D printing. | 6 | 3 |

| | | | |
|---|---|---|---|
| 6 | Creation of 3D model from 2D images using any image processing software and printing it. (3D Slicer open source) (Application: Any body organ like Heart, Gallbladder etc. as per available Dicom files) | 6 | 4 |
| 7 | Development of physical 3D mechanical structure using any one of the Additive manufacturing processes – Material to be used Metal | 8 | 5 |
| 8 | Development of physical 3D mechanical structure using any one of the Additive manufacturing processes - Material to be used Plastic | 8 | 6 |

**Reference Books:**

**1.** Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, I. Gibson l D.W. Rosen l B. Stucker, Springer Publication.
2. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer 2001.
3. Biomaterials, artificial organs and tissue engineering, Edited by Larry L. Hench and Julian R. Jones, Woodhead Publishing and Maney Publishing, CRC Press 2005

**Text Books:**

1. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W Rosen, Brent Stucker, Springer, 2015, 2nd Edition.
2. 3D Printing and Additive Manufacturing: Principles & Applications, Chua Chee Kai, Leong Kah Fai, World Scientific, 2015, 4th Edition.

**Useful Links:**

1. https://www.autodesk.in/products/fusion-360/learn-support
2. https://knowledge.autodesk.com/support/inventor
3. https://www.slicer.org/wiki/Documentation/4.10/Training

| Course Title: Energy Audit and Management | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VI | | | **Term:** Even | | | **Course Code:** 24MDM601EEC | | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| -- | -- | 4 | | -- | 2 | 2 | -- | -- | | 50 | -- | 50 |

**Course Objectives:**

1. To understand the fundamental concepts and need for energy auditing and energy management in industrial and commercial sectors.
2. To develop the ability to conduct preliminary and detailed energy audits in various utilities.
3. To learn measurement techniques for assessing energy performance of equipment and systems.
4. To interpret audit data, identify energy conservation opportunities, and prepare professional energy audit reports.

**Course Outcomes:** Learner will be able to…

1. Understand the types, objectives, and methodologies of energy auditing in different sectors.
2. Measure electrical and thermal energy consumption using audit instruments and analyze data.
3. Conduct energy audit of utilities such as lighting, HVAC, compressors, and pumps.
4. Evaluate energy performance indices and calculate energy savings using standard methods.
5. Prepare and present detailed audit reports including cost–benefit and payback analysis.
6. Apply energy management principles and recommend sustainable energy conservation strategies.

| Sr No. | List of Experiment | Hours | COs |
|---|---|---|---|
| 1 | Study of energy audit process, objectives, and classification (preliminary and detailed). | 4 | 1 |
| 2 | Demonstration and use of energy audit instruments (lux meter, power analyzer, flow meter, temperature sensors). | 4 | 2 |
| 3 | Measurement of electrical parameters (voltage, current, power factor, and energy consumption) for selected equipment. | 6 | 2 |
| 4 | Energy audit of lighting system – measurement of illumination levels, identification of saving opportunities. | 6 | 3 |
| 5 | Energy audit of HVAC system – estimation of energy input and output, COP determination. | 6 | 3 |
| 6 | Audit of air compressor system – measurement of air leakage and calculation of energy loss. | 6 | 4 |
| 7 | Calculation of energy performance indices for motor-driven systems and pumps. | 4 | 4 |
| 8 | Determination of energy cost savings and payback period for energy-efficient measures. | 4 | 5 |
| 9 | Preparation of detailed audit report including recommendations and financial analysis. | 4 | 5,6 |

| | | | |
|---|---|---|---|
| 10 | Case study on implementation of energy conservation techniques in any industry/building. | 6 | 6 |

**Reference Books:**

1. W. R. Murphy and G. McKay, Energy Management, Butterworth-Heinemann.
2. S. L. Soni, R. S. Bansal, and S. P. Bansal, Handbook of Energy Audits, TERI Press.
3.Y. P. Abbi and Shashank Jain, Handbook on Energy Audit and Environment Management, TERI.

**Text Books:**

1. P. W. O'Callaghan, Energy Management, McGraw Hill Education.
2. C. B. Smith, Energy Management Principles: Applications, Benefits, Savings, Pergamon Press.
3. Bureau of Energy Efficiency (BEE), Energy Manager / Auditor Study Material, Govt. of India.

**Useful Links:**

1. https://beeindia.gov.in/– Bureau of Energy Efficiency Resources
2. https://nptel.ac.in/courses/112107296– NPTEL Course on Energy Conservation and Audit
3. https://energymanagertraining.com/– BEE Energy Manager Training Portal

| Course Title: Employability Enhancement Program-V (Industry Certification) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester: VI** | | | **Term: Even** | | | | **Course Code:** 24MEVSE601C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| - | - | 2 | - | - | 1 | 1 | - | - | - | - | 25 | 25 |
| **Sustainability Development Goals:** 4, 8, 9, 11, 12, 13, 16, 17 | | | | | | | | | | | | |

**Introduction**

As global competition intensifies, industries seek candidates who are not only skilled but also adaptable and ready to meet the demands of an evolving workforce. To bridge the gap between academic learning and industry expectations, SJCEM has introduced certification courses aimed at preparing students for impactful internships. These courses provide students with essential knowledge and skills, empowering them to excel in professional environments and increase their employability.

**Objectives:** The objectives of this course are to

1. Develop Professional Skills
2. Enhance Technical Competency
3. Cultivate Problem-Solving Abilities
4. Promote Ethical and Professional Conduct
5. Familiarize with Industry Standards and Expectations
6. Prepare for a Transition from Classroom to Workplace

**Outcomes:** After completion of this course, students will be able to

1. Communicate and Collaborate Effectively
2. Acquire Job-Ready Technical Skills
3. Enhanced Critical Thinking and Problem-Solving
4. Understand Ethical and Professional Standards
5. Use Industry Tools and Standards
6. Industry Integration effectively

**Certification Guidelines:**

The general procedure for organizing certification courses is as follows:

1. **Identification of Industry Partners**
   Industries have been identified to provide in-house certification courses in various domains. Students are regularly informed and encouraged to pursue these certification courses.
2. **Selection of Certification Domain**
   Students can choose two domains of their interest for the certification course and express their willingness to pursue the certification.
   Following combination of domains are offered in the even semesters:

| | | | | | | |
|---|---|---|---|---|---|---|
| SQL + Dotnet | AR-VR | Angular API Development | Metaverse | Software Testing | Data Analytics with Power BI & Advance MS Excel | Flutter |
| Mernstack | Applied Machine Learning with Python | Prompt Engineering & AI | Generative AI & LLM Application | IOT | Cyber Security | CCNP |
| Robotics and AI | SolidWorks | Creo | Digital Twin | Electrical Vehicles | BIM | Revit |

3. **Allocation of Tracks**
   Each track can accommodate a maximum of 60 students or as per the availability of maximum seats. Allocation will be based on a first-come, first-served basis. However, the institute reserves the right to reassign tracks as per the requirement.
4. **Course Duration**
   Students have to complete the certification course, which has a minimum duration of 30 hours.
5. **Oral & Practical Exam**
   Based on the entire syllabus, oral (20 marks) & practical/implementation (30 marks) examination will be conducted. Grades will be assigned as per the examination rules.

**Note:** A minimum of 90% attendance is required to award the certificate. If a student fails to meet this requirement, the student needs to re-register for the course internally or externally until successfully completed.

| Course Title: Electric Vehicles | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VI | | | **Term:** Even | | | **Course Code: 24MEVSE602C** | | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 2 | -- | -- | 2 | -- | -- | 2 | 20 | 20 | 60 | -- | -- | 100 |
| **Sustainable Development Goals Mapped:** 9, 11, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To understand the architecture and working principles of electric vehicles.
2. To analyse battery systems and energy storage technologies.
3. To study electric propulsion systems and power electronics.
4. To understand EV charging infrastructure and standards.
5. To evaluate environmental and economic aspects of EVs.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Understand the fundamentals, types, and architecture of electric vehicles.
2. Explain different energy storage systems and battery management in EVs.
3. Analyse electric propulsion systems, including motors and power electronics used in EVs.
4. Understand EV charging methods, infrastructure, and standards.
5. Apply basic vehicle dynamics and energy concepts in electric vehicles.
6. Evaluate the environmental impact, challenges, and future trends of electric vehicles.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| 1 | **Introduction to Electric Vehicles**<br>Overview of Electric Vehicles, Definition and classification (BEV, HEV, PHEV, FCEV), Comparison with conventional IC engine vehicles, History and Evolution of EVs, Early developments and modern advancements, Need for Electric Vehicles, Environmental concerns, Energy crisis and sustainability, EV Architecture, Basic components: battery, motor, controller, drivetrain<br>**Self-learning topics:** Comparison of actual EV available in Indian market. | 5 | 1 | L2 |
| 2 | **Energy Storage Systems**<br>Battery Basics, Types of batteries used in EVs, Characteristics: energy density, power density, Lithium-ion Batteries, Construction and working principle (basic), Advantages and limitations, Battery Management System (BMS), Functions and importance, State of Charge (SoC) and State of Health (SoH), Alternative Energy Storage, Supercapacitors (basic idea)<br>**Self-learning topics:** Fuel cell technology. | 5 | 2 | L3 |
| 3 | **Electric Propulsion System**<br>Electric Motors Used in EVs, DC motors (basic), Induction motors, Permanent Magnet Synchronous Motors (PMSM), Motor Characteristics, Torque-speed characteristics, Efficiency, Power Electronics, Inverters and converters (basic idea), EV | 5 | 3 | L3 |

| | | | | |
|---|---|---|---|---|
| | Drivetrain Configuration, Front-wheel, rear-wheel, all-wheel drive<br>**Self-learning topics:** Advanced propulsion systems**.** | | | |
| 4 | **Charging Infrastructure and Standards**<br>EV Charging Basics, AC and DC charging, Charging Levels, Level 1, Level 2, Level 3 charging, Charging Standards, CCS, CHAdeMO, Bharat standards (intro level), Charging Infrastructure, Public and private charging stations<br>**Self-learning topics:** Smart charging concept. | 5 | 4 | L3 |
| 5 | **Vehicle Dynamics and Control**<br>Basics of Vehicle Dynamics, Rolling resistance, Aerodynamic drag, Gradient resistance, Energy Consumption in EVs, Driving cycles (basic idea), Regenerative Braking, Principle and benefits, Control Strategies, Basic control of motor and power flow<br>**Self-Learning**: - Vehicle control with the help of AI. | 5 | 5 | L4 |
| 6 | **Environmental Impact and Future Trends**<br>Environmental Impact of EVs, Emissions comparison with IC engines, Lifecycle analysis (basic idea), EV Policies and Government Initiatives, Indian EV policies (intro level), Challenges in EV Adoption, Cost, infrastructure, battery disposal, Future Trends, Autonomous EVs, Wireless charging, Battery advancements<br>**Self-learning topics:** Effect of electromagnetic radiation generated through these electronics on environmental health.<br>**Advanced topic: -** Conversion of conventional automotive into an electric vehicle | 5 | 6 | L4 |
| | **Total** | **30** | | |

**Reference Books:**

1. Electric and Hybrid Vehicles – Tom Denton.
2. Modern Electric Vehicle Technology – C.C. Chan & K.T. Chau.
3. Electric Vehicle Design: Design, Simulation, and Applications – Arora et al.
4. Electric Vehicles: Modern Technologies and Trends – Patel et al.

**Text Books:**

1. Electric Vehicle Powertrains: Design Fundamentals – Ashok & Indragandhi.
2. Electric Vehicle Technology – Gandhi et al.

**Useful Links:**

https://e-amrit.niti.gov.in/resources
https://www.mathworks.com/academia/student-competitions/resources/electric-vehicles.html
https://powermin.gov.in/en/content/electric-vehicle
https://www.meaenergy.org/services/electric-vehicles/

| Course Title: Major Project Phase-I | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VI | | | **Term:** Even | | | **Course Code:** 24MEPRJ601C | | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| - | - | 4 | - | - | 2 | 2 | - | - | - | 50 | - | 50 |

**Sustainable Development Goals:** "SDG mapping will be carried out based on the project topic and its relevance to sustainable development goals."

**Course Objectives:**

The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification, analyzing the problem and designing solutions.

**Course Outcomes:**

At the end of the course students will be able to:

1. Students will be able to develop the understanding of the problem domain through extensive review of literature.
2. Students will be able to identify and analyze the problem in detail to define its scope with problem specific data.
3. Students will be able to identify various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
4. Students will be able to design solutions for real-time problems that will positively impact society and environment.
5. Students will be able to develop clarity of presentation based on communication, teamwork and leadership skills.
6. Students will be able to inculcate professional and ethical behavior..

**Guidelines:**

**Project Topic Selection and Allocation:**

- Project topic selection Process to be defined and followed:
- Project orientation can be given at the end of sixth semester.
- Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects.
- Student should be encouraged to refer papers from reputed conferences/ journals like
- IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
- Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements. Students can be informed to refer Digital India portal, SIH portal or any other hackathon portal for problem selection.
- Topics can be finalized with respect to following criterion:
- **Topic Selection**: The topics selected should be novel in nature (Product based, Application based or Research based) or should work towards removing the lacuna in currently existing systems.
- **Technology Used:** Use of latest technology or modern tools can be encouraged**.**
- Students should not repeat work done previously (work done in the last three years).
- Project work must be carried out by the group of at least 2 students and maximum 4.
- The project work can be undertaken in a research institute or organization/Industry/any business establishment. (out-house projects)
- The project proposal presentations can be scheduled according to the domains

and should be judged by faculty who are expert in the domain.

- Head of department and senior staff along with project coordinators will take decision regarding final selection of projects.
- Guide allocation should be done and students have to submit weekly progress report to the internal guide.
- Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding continuous assessment marks.
- In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels

**Project Report Format:**

At the end of semester, each group need to prepare a project report as per the guidelines issued by the institute.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey
- Survey of Existing systems
- Limitations of Existing systems or research gaps
- Motivation (Challenges that are encouraging to choose the problem)
- Problem Statement and Proposed Solution
- Scope of the system
- Proposed System
- General Workflow/Block diagram
- Analysis and Modeling (only applicable diagrams)
- Design
- Architectural View
- Algorithms/ Methodology
- Experimental Set up
- Details of Database or details about input to systems or selected data
- Performance Evaluation Parameters (for Validation)
- Software and Hardware Set up
- Implementation Plan for Next Semester
- Timeline Chart for Term1 and Term-II (Project Management tools can be used.)
- Summary
- References

**Desirable**

- Students can be asked to undergo some Certification course (for the technical skill set that will be useful and applicable for projects.)

**1. Continuous Assessment:**

Distribution of marks for continuous assessment shall be done based on following:

**a.** Weekly Log Report
**b.** Project Work Contribution
**c.** Project Report (Spiral Bound) (both side print)
**d.** Term End Presentation (Internal)

The final certification and acceptance of CA ensures the satisfactory performance on the above aspects.

**Suggested quality evaluation parameters are as follows:**

1. Quality of problem selected
2. Clarity of problem definition and feasibility of problem solution
3. Relevance to the specialization / industrial trends
4. Originality
5. Clarity of objective and scope
6. Quality of analysis and design
7. Quality of written and oral presentation
8. Individual as well as team work

| Course Title: Internship-II | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VI | | | **Term:** Even | | | **Course Code:** 24MEOJT601C | | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| - | - | 3 | - | - | 1 | 1 | - | - | - | - | 25 | 25 |

**Sustainable Development Goals:** "SDG mapping for internship will be based on the organization, work domain, and activities carried out by the student."

**Introduction**

The rise in global competition has prompted organizations to devise strategies to have a talented and innovative workforce to gain a competitive edge. Developing an internship policy is an impactful strategy for creating a future talent pool for the industry. The internship (a form of experiential learning) program helps fresh pass–outs in gaining professional know-how and benefits corporate sectors. The internship also enhances the student's employability skills passing out from Technical Institutions.

**Objectives:**

1. Integration of workshop with workplace in physical and/or hybrid model.
2. Developing research aptitude in emerging technologies
3. Enhance entrepreneurial capabilities and professional competency
4. Development of decision-making and teamwork skills
5. Cultivate a sense of Social Imagery and Citizenship Responsibility

**Outcomes:** After completion of this course, students will be able to

1. Apply practical skills effectively in physical and hybrid workplace settings.
2. Conduct and communicate research on emerging technologies.
3. Demonstrate creative problem-solving and an entrepreneurial mindset.
4. Meet industry standards with strong communication and technical skills.
5. Collaborate effectively and make informed decisions within teams.

**Internship Guidelines:**

- The students should apply for internships of their choice with the permission of the Institute.
- The internship duration ranges from 4 to 6 weeks and is scheduled during the summer vacation period for students
- Industry will confirm the training slots and the number of seats allocated for internships via confirmation letter/ email.
- Students on joining Training at the concerned Industry / Organization, submit the Joining Report/Letters / Email.
- Students undergo industrial training at the concerned Industry / Organization.
- Training and placement team will visit the industry and evaluate(s) the performance of students regularly and evaluation Report of the students is submitted in department office/TPO with the consent of Industry persons/ Trainers.
- Students will submit training report after completion of internship.

- Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.
- It will be evaluated on the basis of the following criteria:
  - Regularity in maintenance of the diary.
  - Project/Case study/Completion of assigned task by industry undertaken during the internship
  - Employer feedback
- Training Certificate to be obtained from industry followed by the presentation in the department.

# Bachelor of Engineering
# In
# Mechanical Engineering

## Final Year
## Semester – VII

## SJCEM : R–24C

## Effective from Academic Year

## 2026-27

**Program Structure for Final Year Mechanical Engineering**
**(With Effect from 2026-27)**

| Course Code | Vertical | Course Name | Contact Hours | | | Credits Allotted | | | Total Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | Th | Tu | Pr | Th | Tu | Pr | Total |
| 24MEPCC701C | PCC | Design of Experiments | 3 | - | 2 | 3 | - | 1 | 4 |
| 24MEPCC702C | PCC | Logistics and Supply Chain Management | 3 | - | - | 3 | - | - | 3 |
| 24MEPEC701XC | PEC | Professional Elective- V | 3 | - | 2 | 3 | - | 1 | 4 |
| 24MEPEC702XC | PEC | Professional Elective- VI | 3 | - | - | 3 | - | - | 3 |
| 24OE701XC | OE | Open Elective-III | 3 | - | - | 3 | - | - | 3 |
| 24MEAEC701C | AEC | Employability Enhancement Program-VI (Communication) | - | - | 2 | - | - | 1 | 1 |
| 24MEPRJC701C | PRJ | Capstone Project | - | - | 4 | - | - | 2 | 2 |
| **Total** | | | **15** | **-** | **10** | **15** | **-** | **5** | **20** |

| Course Code | Vertical | Course Name | Evaluation Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | IAE 1 | IAE 2 | ESE | CA | Or / Pr | Total |
| 24MEPCC701C | PCC | Design of Experiments | 20 | 20 | 60 | 25 | 25 | 150 |
| 24MEPCC702C | PCC | Logistics and Supply Chain Management | 20 | 20 | 60 | - | - | 100 |
| 24MEPEC701XC | PEC | Professional Elective- V | 20 | 20 | 60 | 25 | - | 125 |
| 24MEPEC702XC | PEC | Professional Elective- VI | 20 | 20 | 60 | - | - | 100 |
| 24OE701XC | OE | Open Elective-III | 20 | 20 | 60 | - | - | 100 |
| 24MEAEC701C | AEC | Employability Enhancement Program-VI (Communication) | - | - | - | 25 | - | 25 |
| 24MEPRJC701C | PRJ | Capstone Project | - | - | - | 50 | 50 | 100 |
| **Total** | | | **100** | **100** | **300** | **125** | **75** | **700** |

**Professional Elective Courses**

| Elective | PEC | Professional Elective - V | | Professional Elective - VI | |
|---|---|---|---|---|---|
| | | Track 1 | | Track 2 | |
| Semester \ Track | Professional Elective - V / VI | Thermal and Fluid Science | Energy conservation and alternate energy | Mechanical Design | Manufacturing and Production |

| | | | | | |
|---|---|---|---|---|---|
| **Sem VII** | | Computational Fluid Dynamics | Energy Audit and Management | Mechanical System Design | Artificial Intelligence and Machine Learning for Mechanical Systems |
| | | Aerospace Engineering | Fuel Cells and Hydrogen Technology | Design of Automobile Components | Biomedical Engineering |
| | | Power Plant Engineering | Solar Energy | Machinery Diagnostics | Operation Research |

| **Professional Elective: V** | | | |
|---|---|---|---|
| **Track 1** | | **Track 2** | |
| **Subject Code** | **Thermal and Fluid Science** | **Subject Code** | **Energy conservation and alternate energy** |
| 24MEPEC70111C | Computational Fluid Dynamics | 24MEPEC70121C | Energy Audit and Management |
| 24MEPEC70112C | Aerospace Engineering | 24MEPEC70122C | Fuel Cells and Hydrogen Technology |
| 24MEPEC70113C | Power Plant Engineering | 24MEPEC70123C | Solar Energy |

| **Professional Elective: VI** | | | |
|---|---|---|---|
| **Track 3** | | **Track 4** | |
| **Subject Code** | **Mechanical Design** | **Subject Code** | **Manufacturing and Production** |
| 24MEPEC70211C | Mechanical System Design | 24MEPEC70221C | Artificial Intelligence and Machine Learning for Mechanical Systems |

| | | | |
|---|---|---|---|
| 24MEPEC70212C | Design of Automobile Components | 24MEPEC70222C | Biomedical Engineering |
| 24MEPEC70213C | Machinery Diagnostics | 24MEPEC70223C | Operation Research |

**Open Elective - III**

| **Semester \ Track** | **Track 1 : Entrepreneurship** | **Track 2: Research Methodology** | **Track 3: Foreign Language** | **Track 4 : Business Management** |
|---|---|---|---|---|
| **Sem VII** | 24OE7011C<br>Finance and Accounting | 24OE7012C<br>Intellectual Property Rights | 24OE70131C<br>Foreign Language-III (Japanese 2)<br>24OE70132C<br>Foreign Language-III (German 2) | 24OE7014C<br>Basics of HR Management |

# Syllabus

# for

# Final Year Mechanical Engineering

# Semester – VII

# SJCEM : R–24C

# (With Effect from 2026-27)

| Course Title: Design of Experiments | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** ODD | | | | **Course Code:** 24MEPCC701C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | 2 | 3 | -- | 1 | 4 | 20 | 20 | 60 | 20 | 20 | 150 |
| **Sustainable Development Goals:** 4, 9, 12 | | | | | | | | | | | | |

**Course Objectives:**

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

**Course Outcomes:**

At the end of the course students will be able to:

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyse, and interpret the results of experiments
4. Gain knowledge of two level fractional factorial design
5. Understand response surface method design.
6. To illustrate Taguchi approach to understand robustness of variation & cost reduction.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Introduction**<br>1.1 Strategy of Experimentation<br>1.2 Typical Applications of Experimental Design<br>1.3 Guidelines for Designing Experiments<br>**Self-learning topics:** Response Surface Methodology | 07 | **CO1** | **6** |
| **II** | **Fitting Regression Models**<br>2.1 Linear Regression Models<br>2.2 Estimation of the Parameters in Linear Regression Models<br>2.3 Hypothesis Testing in Multiple Regression<br>2.4 Confidence Intervals in Multiple Regression<br>2.5 Prediction of new response observation<br>2.6 Regression model diagnostics<br>**Self-learning topics:** Testing for lack of fit | 08 | **CO2** | **3** |
| **III** | **Two-Level Factorial Designs**<br>3.1 The $2^2$ Design<br>3.2 The $2^3$ Design<br>3.3 The General $2^k$ Design<br>3.4 A Single Replicate of the $2^k$ Design | 08 | **CO3** | **4** |

| | | | | |
|---|---|---|---|---|
| | 3.5 The Addition of Center Points to the $2^k$ Design,<br>3.6 Blocking in the $2^k$ Factorial Design<br>**Self-learning topics:** Split-Plot Designs | | | |
| **IV** | **Two-Level Fractional Factorial Designs**<br>4.1 The One-Half Fraction of the $2^k$ Design<br>4.2 The One-Quarter Fraction of the $2^k$ Design<br>4.3 The General $2^{k-p}$ Fractional Factorial Design<br>4.4 Resolution III Designs<br>4.5 Resolution IV and V Designs<br>**Self-learning topics:** Fractional Factorial Split-Plot Designs | 08 | **CO4** | **2** |
| **V** | **Response Surface Methods and Designs**<br>5.1 Introduction to Response Surface Methodology<br>5.2 The Method of Steepest Ascent<br>5.3 Analysis of a Second-Order Response Surface<br>**Self-learning topics:** Experimental Designs for Fitting Response Surfaces | 07 | **CO5** | **2** |
| **VI** | **Taguchi Approach**<br>6.1 Crossed Array Designs and Signal-to-Noise Ratios<br>6.2 Analysis Methods<br>**Self-learning topics:** Robust design examples<br>**Advanced Topics:** Sequential Design of Experiments for Process Optimization | 07 | **CO6** | **3** |

**Lab contents:**

| Sr. No. | Name of Experiments | COs |
|---|---|---|
| **1.** | Study of different strategies of experimentation (OFAT vs factorial approach) | 1 |
| **2.** | Identification of process variables and development of cause–effect diagram | 1 |
| **3.** | Development of simple linear regression model | 2 |
| **4.** | Development of multiple regression model and prediction of response | 2 |
| **5.** | Analysis of $2^2$ factorial design | 3 |
| **6.** | Analysis of $2^3$ factorial design | 3 |
| **7.** | Design and analysis of half-fraction (2^(k−1)) factorial experiment | 4 |
| **8.** | Study of resolution and aliasing in fractional factorial designs | 4 |
| **9.** | Application of steepest ascent method for optimization | 5 |
| **10.** | Development of second-order model using response surface methodology | 5 |
| **11.** | Design and analysis using Taguchi L9 orthogonal array | 6 |
| **12.** | Optimization using Signal-to-Noise ratio analysis | 6 |

**Reference Books:-**

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001

3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley

**Text Books:**

1. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
2. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

**Useful Link:**

https://onlinecourses.nptel.ac.in/noc21_mg48/preview

| Course Title: Logistics and Supply Chain Management | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** ODD | | | | **Course Code:** 24MEPCC702C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | - | 3 | 20 | 20 | 60 | - | - | 100 |
| **Sustainable Development Goals:** 8, 9, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To understand the fundamentals of supply chain management and Logistics
2. To develop an understanding related to Supply Chain Performance and related aspects
3. To understand Inventory management in supply chain
4. To learn tools and techniques used in logistics, transportation, warehousing and outsourcing decisions.
5. To develop critical understanding towards digitization in supply chain management and sustainability
6. To develop analytical and critical understanding for planning and designing supply chain network.

**Course Outcomes:**

At the end of the course students will be able to:

1. Demonstrate a sound understanding of Logistics and Supply Chain Management concepts and their role in today's business environment.
2. Identify the drivers of supply chain performance and risks in supply chain management.
3. Apply various techniques of inventory management and rank the items using inventory management technique
4. Apply various strategies and techniques to minimize overall logistics cost
5. Understand the role of digitization in supply chain management leading to sustainability
6. Apply various mathematical models/tools to design the supply chain network

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Introduction:** Objectives of a Supply Chain Management, Stages of Supply chain, Value Chain Process, Cycle view of Supply Chain Process, Key issues in SCM, logistics & SCM, Supply Chain Drivers /decisions and obstacles, Supply chain strategies, strategic fit, Best practices in SCM, Obstacles of streamlined SCM. Decisions in the Supply Chain World Supplier Selection, Supplier quality audits, Contract management, Non- Disclosure Agreement (NDA). **Self-learning topics:** Make & Buy Decision while in-out sourcing | **7** | **CO1** | **2** |
| **II** | **Supply Chain Performance:** Bullwhip effect and reduction, Performance measurement: Dimension, Tools of performance measurement, SCOR Model. Demand chain management, Global Supply chain- Challenges in establishing Global Supply Chain, Factors that influences designing Global Supply Chain Network. Supply Chain Risk Management (Risks involved in supply chain which includes – Supplier Financial Risk, | **8** | **CO2** | **2** |

| | | | | |
|---|---|---|---|---|
| | Performance Risk, Compliance Risk, Country specific Risk, Cyber Security.<br>**Self-learning topics:** Supplier performance measurement – (Delivery & Quality performance, schedule adherence, Goods receipt compliance etc), Supplier Capacity Analysis, Supplier Score card. | | | |
| **III** | **Inventory management:** Definition of Inventory, Inventory types & functions; EOQ Model and Buffer Stock, Assumptions, Instantaneous Replenishment case, Demand and production rate are different, when backorders are allowed, Buffer Stock and ROL. Replenishment systems (Q and P system) Inventory Control-ABC Analysis, Numerical problems on ABC analysis, Inventory Optimization<br>**Self-learning topics:** Numerical problems on VED Analysis | **7** | **CO3** | **3** |
| **IV** | **Logistics Management and outsourcing:** Evolution, Objectives, Components and Functions of Logistics Management, Distribution related Issues and Challenges; Gaining competitive advantage through Logistics Management, Transportation- Functions, Costs, and Mode; Network and Decision, Containerization, Cross docking. Warehousing: Concept and types, Warehousing strategy, Warehouse facility location & network design Part Packaging, Use of Returnable pallets, ASN – Advance Shipment Notification.<br>**Self learning topics:** Reverse logistics: Outsourcing - Nature and concept, Strategic decision to Outsourcing, Third party logistics(3PL), Fourth party logistics(4PL), Cold chain operations in Supply chain. | **8** | **CO4** | **3** |
| **V** | **Digitization in supply chain Management and Sustainability:** IT in supply chain - Role of IT in a supply chain, The supply chain IT framework, Application of Bar coding, Significance of SAP/RFID, The future of IT in the supply chain, Supply chain IT in practice, TMS (Transport Management System), WMS (Warehouse Management System), E-Logistics, E-markets, Electronic business process optimization, Business objects in SCM<br>**Self-learning topics:** Green supply chain management, Supply Chain sustainability, Supply Chain sustainability index measurement with case studies.<br>Social aspects of supply chain (CSR), Environment aspects of supply chain (CO2 emission), resource utilization, recycling. | **8** | **CO5** | **2** |
| **VI** | **Supply Chain Network Design:**<br>Factors influencing distribution network design, Supply chain resilience, Design options for distribution network, Introduction to mathematical modelling, considerations in modelling SCM systems, Dynamic Routing and Scheduling<br>Overview of the models, Models on transportation, Transportation problem, Vehicle routing problem, Travelling salesman problem, Capacitated transshipment problem, shortest path problem. Supply Chain Facilities Layout, Capacity Planning,<br>**Self-learning topics:** Value Stream Mapping (VSM), Order | **7** | **CO6** | **3** |

| | | | | |
|---|---|---|---|---|
| | Fulfillment Process Flow, understanding the terms related to Supply chain-Lead Time, Takt Time, Minimum Order Quantity(MOQ), Manufacturing Critical Path Time(MCT)<br>**Advanced Topics:** Supply Chain Resilience and Disruption Management Strategies | | | |

**Reference Books:**

1. R.P. Mohanty, S.G. Deshmukh, "Essentials of Supply Chain management", 1st Edition 2004, Jaico Publishing House.
2. S.K. Bhattacharya, "Logistics Management", 3rd Edition, Pearson Publication ISBN: 9788131768624
3. Sunil Chopra, P. Meindl, "Supply Chain Management", 6th Edition 2016, Pearson Education Asia.
4. Martin Christopher, "Logistics and Supply Chain Management",4th Edition 2010, Pitman Publishing.
5. Bowon Kim, "Supply Chain Management in Mastering Business in Asia", Edition 2005, John Wiley & sons (Asia) Pvt Ltd, ISBN: 978-0470821404
6. Michael Hugos, "Essentials of Supply Chain Management", 4th Edition 2018, John Wiley and Sons, ISBN: 9781119461104
7. Rahul V Altekar, "Supply Chain Management: Concepts and cases", Edition 2009, PHI, ISBN:
8. 9788120328594.
9. D. Simchi-Levi, P. Kaminsky, E. Simchi-Levi, and Ravi Shankar, "Designing and Managing the Supply Chain concepts, Strategies and Case studies", 3rd Edition, Tata McGraw Hill, New Delhi, 2008.

**Useful Links**

1. https://onlinecourses.nptel.ac.in/noc22_mg74/preview
2. https://onlinecourses.swayam2.ac.in/cec22_mg22/preview

| Course Title: Computational Fluid Dynamics | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Odd | | | | **Course Code:** 24MEPEC70111C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | 2 | 3 | -- | 1 | 4 | 20 | 20 | 60 | 25 | -- | 125 |
| **Sustainable Development Goals Mapped: 9, 11, 13** | | | | | | | | | | | | |

**Course Objectives:**

1. To understand the fundamentals of fluid flow equations and CFD concepts
2. To apply basic numerical methods for solving fluid flow problems
3. To introduce students to CFD software and practical simulations
4. To analyse engineering problems using CFD tools.

.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Understand the governing equations of fluid flow and classify different types of fluid flow problems.
2. Apply basic discretization techniques such as finite difference and finite volume methods for simple problems.
3. Analyze numerical solution techniques, stability, and convergence for CFD problems.
4. Explain the basics of turbulence and apply simple turbulence models conceptually.
5. Perform CFD simulations using standard software including pre-processing, solving, and post-processing.
6. Apply CFD concepts to solve simple real-life engineering problems and interpret results.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Introduction to CFD and Governing Equations**<br>Introduction to CFD, What is CFD and its importance Applications in engineering (automobile, aerospace, HVAC, etc.) Advantages and limitations of CFD, Review of Fluid Mechanics, Types of flow (laminar, turbulent, steady, unsteady), Fluid properties and basic concepts, Governing Equations of Fluid Flow, Continuity equation (mass conservation), Momentum equation (Navier–Stokes concept – basic idea only), Energy equation (basic understanding)<br>**Self-learning topics:** Types of Partial Differential Equations, Elliptic, Parabolic, Hyperbolic equations (conceptual understanding) | 8 | 1 | L2 |
| II | **Discretization Methods**<br>Need for Discretization, Converting differential equations into algebraic equations, Finite Difference Method (FDM), Forward, backward, and central difference, Simple 1D problems, Finite Volume Method (FVM) – Basic Idea<br>Control volume approach, Conservation principle, Grid Generation (Meshing)<br>Structured and unstructured grids, Grid quality and its importance | 8 | 2 | L3 |

| | | | | |
|---|---|---|---|---|
| | **Self-learning topics:** Types of mesh (triangular, quadrilateral, etc.)**.** | | | |
| **III** | **Solution Techniques**<br>Algebraic Equation Solvers, Direct methods (basic idea), Iterative methods (Gauss-Seidel concept), Stability and Convergence, Concept of stability, Convergence criteria, Residuals, Time Integration Methods, Explicit and implicit methods (basic difference), Boundary Conditions, Types: inlet, outlet, wall, symmetry, Importance in CFD simulations<br>**Self-learning topics:** Boundary Conditions for two-phase flows**.** | 7 | 3 | L3 |
| **IV** | **Turbulence Modeling (Basic Level)**<br>Introduction to Turbulence, Laminar vs turbulent flow, Reynolds number significance, Need for Turbulence Models, Why direct simulation is difficult, Common Turbulence Models (Conceptual), k–ε model (basic idea), k–ω model (basic idea), Near Wall Treatment, Boundary layer concept, Wall functions (basic idea)<br>**Self-learning topics:** Effect of introducing bubbles into the flow. | 8 | 4 | L3 |
| **V** | **CFD Software and Pre/Post Processing**<br>Introduction to CFD Software, Overview of popular tools (ANSYS Fluent, OpenFOAM – only introduction), Pre-Processing, Geometry creation, Meshing basics, Setting boundary conditions, Solver Settings, Selecting models, Initialization, Post-Processing, Contours, vectors, streamlines, Interpretation of results<br>**Self-Learning**: - Hands-on sessions on post-processing using Ansys Fluent. | 7 | 5 | L4 |
| **VI** | **Applications and Case Studies**<br>Internal Flow Problems, Flow in pipes and ducts, External Flow Problems, Flow over flat plate, Flow over cylinder, Heat Transfer Problems, Conduction and convection (basic CFD application), Industrial Applications, Automotive aerodynamics, Heat exchangers, HVAC systems<br>**Self-learning topics:** Simple CFD simulation (e.g., pipe flow or airfoil analysis).<br>**Advanced topic: -** Heat transfer analysis in heat sinks used in Electronics cooling | 7 | 6 | L5 |
| **Total** | | | | |

| Sr No. | List of Experiment | COs |
|---|---|---|
| **1** | Introduction to CFD Software - Familiarisation with interface ANSYS Fluent | CO1 |
| **2** | Mesh Generation of Simple Geometry - 2D plate or pipe geometry | CO2 |
| **3** | 1D Heat Conduction (Numerical) Solve using the finite difference method (manual + software comparison) | CO3 |
| **4** | Laminar Flow in a Pipe: Velocity profile validation | CO3 |

| | | |
|---|---|---|
| **5** | Flow Over a Flat Plate, Boundary Layer Development Visualisation | CO4 |
| **6** | Flow Over a Circular Cylinder, Pressure distribution and wake formation | CO4 |
| **7** | Grid Independence Study - Effect of mesh size on results | CO5 |
| **8** | Turbulent Flow Simulation Using k–ε model (basic setup and comparison) | CO4 |
| **9** | Heat Transfer in a Pipe - Convection heat transfer simulation | CO6 |
| **10** | Mini Project on Heat transfer in real life | CO6 |

**Note – Perform any 8 of the listed experiments**

**Reference Books:**

1. Computational Methods for Fluid Dynamics – Ferziger & Perić.
2. Fluid Dynamics: Theory, Computation, and Numerical Simulation – C. Pozrikidis
3. Computational Fluid Dynamics: An Introduction for Mechanical Engineering Students – S. Sazhin.

**Text Books:**

1. Computational Fluid Dynamics: A Practical Approach – Jiyuan Tu.
2. Introduction to Computational Fluid Dynamics – Atul Sharma
3. Computational Fluid Dynamics for Engineers and Scientists – S. Jayanti.

**Useful Links:**

https://onlinecourses.nptel.ac.in/noc21_me126/preview
https://www.asme.org/learning-development/find-course/introduction-computational-fluid-dynamics
https://www.coursera.org/learn/applied-computational-fluid-dynamics
https://cce.iisc.ac.in/cce-proficience/computational-fluid-dynamics-jm-2026/

| Course Title: Aerospace Engineering | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Odd | | | **Course Code:** 24MEPEC70112C | | | | | | |
| **Teaching Scheme** | | | | | | **Evaluation Scheme** | | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | 2 | 3 | - | 1 | 4 | 20 | 20 | 60 | 25 | - | 125 |
| **Sustainable Development Goals Mapped: 7,9,11,12,13** | | | | | | | | | | | | |

**Course Objectives:**

1. To understand basic concepts of aerospace engineering.
2. To apply aerodynamics and propulsion principles.
3. To analyze aircraft performance and stability.
4. To learn fundamentals of aircraft design and modern technologies.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Explain basic aerospace engineering concepts and aircraft components.
2. Apply aerodynamics principles to analyze lift and drag.
3. Analyze aircraft propulsion systems and their performance.
4. Evaluate aircraft performance and stability.
5. Analyze aircraft structures and materials.
6. Evaluate aircraft design and emerging technologies.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Introduction to Aerospace Engineering**<br>• History and evolution of aviation and space technology<br>• Atmosphere: Structure, properties, ISA model<br>• Classification of aircraft and spacecraft<br>• Basic components of aircraft (wing, fuselage, empennage, landing gear)<br>• Types of aircraft (civil, military, UAVs)<br>• Introduction to flight: Forces acting on aircraft<br>• Aerospace materials overview<br>**Self-learning:** Study of standard atmosphere and its effect on aircraft performance | 7 | 1 | 2 |
| **II** | **Basics of Aerodynamics:**<br>• Incompressible flow and Bernoulli's equation<br>• Reynolds number and Mach number<br>• Coanda effect (concept only)<br>• Boundary layer and flow separation<br>• Airfoils and lift generation theories<br>• Types of drag<br>• Critical Mach number (intro only)<br>• Pressure measurement basics<br>**Self-learning:** Analysis of different airfoil shapes and their applications | 8 | 2 | 3 |
| **III** | **Aircraft Propulsion** | 8 | 3 | 4 |

| | | | | |
|---|---|---|---|---|
| | • Types of aircraft engines (piston, turbojet, turbofan, turboprop)<br>• Working principle of jet engines<br>• Brayton cycle (concept only, no heavy derivation)<br>• Introduction to rocket propulsion<br>• Performance parameters (thrust, SFC)<br>**Self-learning:** Comparison of turbojet and turbofan engines | | | |
| **IV** | **Flight Mechanics & Performance**<br>• Steady level flight<br>• Lift-to-drag ratio<br>• Aircraft performance parameters:<br>  ○ Climb, glide, ceiling (combined)<br>  ○ Turning and pull-up (conceptual)<br>• Take-off and landing basics<br>• Range and endurance<br>• Range–payload diagram<br>• Basic longitudinal stability<br>• V–n diagram (flight envelope)<br>**Self-learning:** Role of control surfaces in aircraft stability | 7 | 4 | 5 |
| **V** | **Aircraft Structures & Materials**<br>• Types of loads on aircraft<br>• Structural components: wing, fuselage<br>• Thin-walled structures<br>• Stress and deformation in aircraft structures<br>• Introduction to composite materials<br>• Fatigue and failure in aerospace structures<br>• Weight optimization concepts<br>**Self-learning:** Use of composite materials in modern aircraft structures | 7 | 5 | 4 |
| **VI** | **Aircraft Design & Emerging Technologies**<br>• Introduction to aircraft design process<br>• Basic sizing and weight estimation<br>• Wing design basics (aspect ratio, wing loading)<br>• Powerplant selection<br>• Introduction to UAVs and drones<br>• Basics of space vehicles and satellites<br>• Green aviation and sustainable fuels<br>• Future trends: electric aircraft, supersonic travel<br>**Self-learning:** Conceptual design of a small UAV (drone)<br>**Advanced topic:** Electric and Hybrid Aircraft Propulsion Systems | 8 | 6 | 5 |

| Sr No. | List of Experiment | COs |
|---|---|---|
| 1 | Study of standard atmosphere and variation of properties with altitude (analytical/Excel-based) | 1 |
| 2 | Case study of aircraft components and configurations (study-based) | 1 |
| 3 | Study of airflow over an airfoil using simulation (XFOIL/online tools) | 2 |
| 4 | Determination of lift and drag coefficients (analytical/virtual) | 2 |
| 5 | Boundary layer thickness estimation over a flat plate (analytical) | 2 |
| 6 | Study of Brayton cycle using P-V and T-S diagrams (analytical) | 3 |
| 7 | Performance analysis of jet engine cycle (numerical) | 3 |
| 8 | Estimation of thrust and specific fuel consumption (calculation-based) | 3 |
| 9 | Calculation of lift-to-drag ratio for aircraft (case study) | 4 |
| 10 | Range and endurance estimation using Breguet equations | 4 |
| 11 | Basic aircraft stability analysis using simple models (Excel/simulation) | 4 |
| 12 | Study of stress distribution in thin-walled structures (SOM lab analogy) | 5 |
| 13 | Case study on composite materials used in aircraft | 5 |
| 14 | Conceptual design of a basic UAV using CAD tools | 6 |
| 15 | Case study on electric/hybrid aircraft systems | 6 |

**Reference Books:**

1. Fundamentals of Electric Aircraft, Pascal Thalin et al., Academic Press / Wiley, 2nd Edition, 2023.
2. Internet of Drone Things: Architectures, Approaches and Applications, Amartya Mukherjee et al., Elsevier, 1st Edition, 2024.
3. Orbital Mechanics for Engineering Students, Howard D. Curtis, Elsevier, 5th Edition, 2026.

**Text Books:**

1. Aircraft Design: A Systems Engineering Approach, Mohammad H. Sadraey, John Wiley & Sons, 2nd Edition, 2024.
2. Introduction to Aerospace Flight Vehicles, J. Gordon Leishman, Cambridge University Press, Latest Edition, 2025.
3. Fundamentals of Aerospace Propulsion, Ahmed F. El-Sayed, Springer, 3rd Edition, 2023.
4. General Aviation Aircraft Design: Applied Methods and Procedures, Snorri Gudmundsson, Butterworth-Heinemann (Elsevier), 2nd Edition, 2022.

**Useful Links:**

1. https://onlinecourses.nptel.ac.in/noc21_ae11/preview
2. https://www.coursera.org/courses?query=aerospace&index
3. https://nptel.ac.in/courses

| Course Title: Power Plant Engineering | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Odd | | | | **Course Code:** 24MEPEC70113C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | 2 | 3 | -- | 1 | 4 | 20 | 20 | 60 | 25 | -- | 125 |
| **Sustainable Development Goals Mapped:** 7, 9, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To understand the fundamentals of power generation systems.
2. To study different types of power plants and their working principles.
3. To analyze performance and efficiency of power plants.
4. To evaluate environmental and economic aspects of power generation.
5. To introduce modern and sustainable power generation technologies.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Understand different energy sources, load characteristics, and basic economics of power plants.
2. Explain the components and working of thermal power plants and analyse basic steam cycle performance.
3. Describe hydroelectric power plant systems and select appropriate turbines based on applications.
4. Understand the working principles and safety aspects of nuclear power plants.
5. Explain renewable energy technologies and evaluate their role in sustainable power generation.
6. Analyze environmental and economic aspects of power plants and suggest sustainable solutions.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Introduction to Power Plants**<br>Energy resources and classification, Conventional vs non-conventional energy sources, Load curves (load duration, demand factor, diversity factor), Power plant economics (basic concepts), Site selection of power plants<br>**Self-learning topics:** Energy scenario in India (current status and future demand) | 7 | 1 | L2 |
| **II** | **Thermal Power Plant (Steam Power Plant)**<br>Layout and working of thermal power plant, Rankine cycle (basic concept), Boilers: types and classification, Steam turbines (overview), Condensers and cooling systems<br>**Self-learning topics:** Supercritical and ultra-supercritical power plants. | 8 | 2 | L3 |
| **III** | **Hydroelectric Power Plant**<br>Hydropower potential and classification, Layout of hydroelectric power plant, Types of turbines (Pelton, Francis, Kaplan – basic), Pumped storage plants, Advantages and limitations<br>**Self-learning topics:** Small and micro hydropower systems. | 8 | 3 | L4 |

| | | | | |
|---|---|---|---|---|
| **IV** | **Nuclear Power Plant**<br>Basics of nuclear energy, Nuclear fission and chain reaction, Nuclear reactors (types – PWR, BWR – basic), Components of nuclear power plant, Safety and waste disposal<br>**Self-learning topics:** Nuclear power development in India. | 8 | 4 | L4 |
| **V** | **Renewable Energy Power Plants**<br>Solar power plant (PV and thermal basics), Wind power plant (working and components), Biomass and biogas plants, Geothermal and tidal energy (overview), Hybrid power systems<br>**Self-Learning**: - Solar rooftop systems and net metering. | 7 | 5 | L4 |
| **VI** | **Environmental Impact and Power Plant Economics**<br>Environmental impact of power plants, Pollution control methods (ESP, scrubbers – basic idea), Carbon emissions and climate change, Economic analysis (cost of power generation – basic), Energy conservation and efficiency<br>**Self-learning topics:** Carbon capture and storage (CCS) technology.<br>**Advanced topic: -** Smart Grid and Integrated Energy Systems | 7 | 6 | L4 |
| | **Total** | **45** | | |

| Sr No. | List of Experiment | COs |
|---|---|---|
| **1** | To analyze load curves and calculate demand factor, load factor, and diversity factor. | CO1 |
| **2** | To estimate cost of power generation using simple economic parameters. | CO1 |
| **3** | To analyze performance of a steam power plant using Rankine cycle. | CO2 |
| **4** | To study boiler, turbine, and condenser performance using virtual data. | CO2 |
| **5** | To select an appropriate turbine based on head and discharge. | CO3 |
| **6** | To understand working and layout of hydroelectric plant using virtual tools. | CO3 |
| **7** | To understand basic operation of nuclear reactor systems. | CO4 |
| **8** | To estimate power output of a solar PV system. | CO5 |
| **9** | To calculate power generated from wind energy. | CO5 |
| **10** | To compare emissions from different power plants. | CO6 |

**Reference Books:**

1. Arora, S. C., & Domkundwar, S. (2016). *A Course in Power Plant Engineering* (8th ed.). New Delhi: Dhanpat Rai & Co. Pvt. Ltd
2. Black & Veatch. (1996). *Power Plant Engineering*. New York: Springer.

**Text Books:**

1. Nag, P. K. (2014). *Power Plant Engineering* (4th ed.). New Delhi: Tata McGraw-Hill Education
2. Rajput, R. K. (2008). *A Textbook of Power Plant Engineering* (4th ed.). New Delhi: Laxmi Publications.

**Useful Links:**

https://onlinecourses.nptel.ac.in/noc20_me10/preview
https://digitalskills.iitmpravartak.org.in/course_details.php?courseID=63&cart=
https://www.everyeng.com/learn/power-plant-engineering
https://onlinecourses.nptel.ac.in/noc25_me62/preview

| Course Title: Energy Audit and Management | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** ODD | | | | **Course Code:** 24MEPEC70121C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme:** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total** | **Theory** | | | | **Practical** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | **Credit** | **IAE1** | **IAE2** | **ESE** | **CA** | **Or/Pr** | |
| **3** | **--** | **2** | **3** | **--** | **1** | **4** | 20 | 20 | 60 | 25 | - | 125 |
| **Sustainable Development Goals:** 7, 9, 11, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

**Course Outcomes:** Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of a utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures
6. To gain knowledge of energy conservation in buildings to understand its impact on society.

**Course Contents:**

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act, 2001 and its Features. Basics of Energy and its various forms. **Self-learning topics:** Material and Energy balance. | 06 | **CO1** | **2** |
| **II** | **Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements. Elements of monitoring & targeting; Energy audit Instruments; Data and information-analysis. **Financial analysis techniques:** Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR) **Self-learning topics:** Fuel and energy substitution | 09 | **CO2** | **2** |
| **III** | **Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load | 08 | **CO3** | **2** |

| | | | | |
|---|---|---|---|---|
| | management and maximum demand Control; Power factor improvement, Energy efficient equipment and appliances. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives. **Self-learning topics:** Star ratings. | | | |
| **IV** | **Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities. **Self-learning topics:** Use of insulation- types and application | 09 | **CO4** | **2** |
| **V** | **Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis. **Self-learning topics:** Case studies based on variable speed drive. | 06 | **CO5** | **4** |
| **VI** | **Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources. **Self-learning topics:** GRIHA- Green Rating for Integrated Habitat Assessment. **Advanced Topics:** Energy Audit and Optimization of Industrial Utilities | 07 | **CO6** | **2** |

**Lab Contents:**

| SR. NO. | List of Experiments | CO |
|---|---|---|
| **1** | Preliminary energy audit of mechanical workshop facility (machine shop). | CO1 |
| **2** | Detailed energy audit of computer laboratory. | CO2 |
| **3** | Determination of specific energy consumption (SEC) of air compressor system. | CO2 |
| **4** | Financial analysis of energy conservation measures using Payback Period, NPV, IRR. | CO2 |
| **5** | Measurement and improvement of power factor in electrical systems. | CO3 |
| **6** | Determination of illumination (lux) levels in classroom, lab, workshop, corridor, etc. and suggest improvements. | CO3 |
| **7** | Energy audit of lighting system with LED retrofit analysis. | CO3 |
| **8** | Assessment of heat loss in thermal systems (steam line / hot surface – simulated or actual). | CO4 |
| **9** | Performance evaluation of air conditioning system (COP calculation). | CO4 |

| | | |
|---|---|---|
| **10** | Performance evaluation of induction motor under varying load conditions. | CO5 |
| **11** | Energy audit of pumping system and analysis using variable speed drive (VSD). | CO5 |
| **12** | Energy audit of academic building (mini project / case study). | CO6 |
| **13** | Study of energy conservation measures in buildings (ECBC/GRIHA concepts). | CO6 |

**Reference Books:-**

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).

**Text Books:**

1. Energy Management Principles, C.B.Smith, Pergamon Press
2. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
3. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
4. www.energymanagertraining.com
5. www.bee-india.nic.in

**Useful Links:**

**https://onlinecourses.swayam2.ac.in/nou23_es05/preview**

| Course Title: Fuel Cells and Hydrogen Technology | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Odd | | | | **Course Code:** 24MEPEC70122C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | 2 | 3 | - | 1 | 4 | 20 | 20 | 60 | 25 | - | 125 |
| **Sustainable Development Goals Mapped:** 9,11,12 | | | | | | | | | | | | |

**Course Objectives:**

1. To understand the fundamentals of hydrogen as a clean energy carrier.
2. To study different hydrogen production, storage, and transportation methods.
3. To learn the working principles and types of fuel cells.
4. To analyze performance characteristics and efficiency of fuel cell systems.
5. To develop practical knowledge through experiments and simulation tools.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Explain hydrogen energy systems and their role in sustainable energy.
2. Analyze hydrogen production and storage technologies.
3. Describe construction and working of different fuel cells.
4. Evaluate performance parameters of fuel cells.
5. Perform experiments and basic simulations of hydrogen systems.
6. Propose hydrogen-based energy solutions for real-world applications.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Introduction to Hydrogen Energy**<br>Global energy scenario; need for hydrogen economy; properties of hydrogen; advantages and challenges; applications.<br>**Self-learning:** Hydrogen Economy Roadmap (India & Global) | 7 | 1 | L1, L2 |
| **II** | **Hydrogen Production Methods**<br>Electrolysis (alkaline, PEM); steam methane reforming; coal gasification; biological and thermochemical methods; efficiency comparison.<br>**Self-learning:** Green, Blue, and Grey Hydrogen classification | 8 | 2 | L2, L3 |
| **III** | **Hydrogen Storage and Transportation**<br>Compressed gas, liquid hydrogen, metal hydrides, chemical storage; safety aspects; transportation and infrastructure.<br>**Self-learning:** Design and working of Hydrogen Refueling Stations | 7 | 3 | L2, L3 |
| **IV** | **Fuel Cell Fundamentals**<br>Working principle, electrochemical reactions, thermodynamics; polarization curve; efficiency and losses.<br>**Self-learning:** Types of losses in fuel cells (activation, ohmic, concentration) | 8 | 4 | L2, L3, L4 |
| **V** | **Types of Fuel Cells**<br>PEMFC, SOFC, AFC, MCFC, PAFC; construction, working, applications and comparison. | 8 | 5 | L2, L4 |

| | | | | |
|---|---|---|---|---|
| | **Self-learning:** Fuel Cell Electric Vehicles (FCEVs) vs Battery Electric Vehicles (BEVs) | | | |
| **VI** | **Applications and Future Trends**<br>Hydrogen vehicles, stationary power systems, microgrids; integration with renewable energy; techno-economic and environmental aspects.<br>**Self-learning:** National Hydrogen Mission of India<br>**Advanced topic:** Hydrogen blending with natural gas ($H_2$–NG blends) for existing pipeline infrastructure | 7 | 6 | L3, L4, L5 |
| **Total** | | **45** | | |

| Sr No. | List of Experiment | COs |
|---|---|---|
| **1** | Study of hydrogen properties and safety measures | 1 |
| **2** | Demonstration of water electrolysis for hydrogen production | 2 |
| **3** | Measurement of hydrogen generation rate in electrolyzer | 2 |
| **4** | Study of different hydrogen storage methods (model/demo) | 2 |
| **5** | Assembly and working of a simple PEM fuel cell kit | 3 |
| **6** | V–I characteristics of fuel cell under varying load | 4 |
| **7** | Efficiency calculation of fuel cell system | 4 |
| **8** | Performance comparison of battery vs fuel cell | 5 |
| **9** | Simulation of hydrogen production using software/Excel | 5 |
| **10** | Mini project | 6 |

**Reference Books:**

1. Yinshi Li (2025), Fuel Cell Fundamentals and Applications, Springer Nature Singapore, 1st Edition, ISBN: 978-981-96-9845-5,
2. Shengjie Peng (2024), Hydrogen Fuel Cells, Springer Nature Singapore, ISBN: 978-981-96-0157-8,
3. Timothy E. Lipman & Adam Z. Weber (2019) Fuel Cells and Hydrogen Production (Encyclopedia of Sustainability Science and Technology) Springer, 2nd Edition.
4. Yang et al. (2025), Hydrogen and Fuel Cells: Innovations and Challenge, MDPI Books, ISBN: 978-3-7258-3190-6
5. Detlef Stolten (2010), Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications, Wiley-VCH, ISBN: 978-3-527-32711-9

**Text Books:**

1. O'Hayre, R., Cha, S.-W., Colella, W. G., & Prinz, F. B. (2016), Fuel Cell Fundamentals (3rd ed.). Hoboken, NJ: John Wiley & Sons. ISBN: 978-1-119-11380-5
2. Sørensen, B. (2011)., Hydrogen and Fuel Cells: Emerging Technologies and Applications (2nd ed.)., Oxford: Elsevier Academic Press.
3. Dincer, I., & Acar, C. (2018)., Hydrogen Energy Systems: Production and Applications. Cham: Springer International Publishing.

4. Larminie, J., & Dicks, A. (2013).Fuel Cell Systems Explained (3rd ed.).Chichester, UK: John Wiley & Sons.
5. Santhanam, K. S. V., Press, R. J., Miri, M. J., Bailey, A. V., & Takacs, G. A. (2017). Introduction to Hydrogen Technologies. Hoboken, NJ: John Wiley & Sons.

**Useful Links:**

4. Hydrogen Energy: Production, Storage, Transportation and Safety, (IIT Bombay) https://onlinecourses.nptel.ac.in/noc25_ch93/preview
5. Electrochemical and Economic Aspects of Hydrogen Energy, (IIT Roorkee) https://onlinecourses.nptel.ac.in/noc25_ge46/preview

| Course Title: Solar Energy | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** ODD | | | | **Course Code:** 24MEPEC70123C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | 1 | 3 | - | 1 | 4 | 20 | 20 | 60 | 25 | | 125 |
| **Sustainable Development Goals Mapped: 7,11,13** | | | | | | | | | | | | |

**Course Objectives:**

1. To understand solar radiation, measurement techniques, and fundamentals of solar energy systems
2. To analyze solar thermal collectors and solar thermal power generation systems
3. To understand and design solar photovoltaic systems for real-world applications
4. To evaluate techno-economic feasibility and sustainability of solar energy systems

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Understand solar radiation geometry and estimation methods
2. Analyze solar thermal collectors and solar thermal power systems
3. Apply solar energy in thermal and industrial applications
4. Understand solar PV principles and system components
5. Design solar PV systems for practical applications
6. Evaluate economic, environmental, and policy aspects of solar systems

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Solar Radiation & Measurement**<br>Solar radiation basics, solar constant, Solar geometry: declination, hour angle, zenith angle, Radiation on tilted surfaces, Air mass and solar spectrum, Measurement instruments: Pyranometer, Pyrheliometer, Radiation estimation models (Liu & Jordan)<br>**Self-learning:** Solar radiation data analysis (NASA/MNRE datasets) | 7 | 1 | 2 |
| **II** | **Solar Thermal Collectors & Power Generation**<br>Flat Plate Collectors (FPC): construction, efficiency Evacuated Tube Collectors (ETC), Solar Air Heaters, Concentrating collectors: CPC, Parabolic trough, Solar Thermal Power Generation: Parabolic trough systems, Solar tower (central receiver), Linear Fresnel systems, Thermal energy storage (molten salts), Performance analysis and efficiency<br>**Self-learning:** Case study of CSP plant (India/Global) | 8 | 2 | 4 |
| **III** | **Solar Thermal Applications**<br>Solar water heating systems, Space heating (Trombe wall, greenhouse), Solar drying systems, Solar cooking, Solar distillation (solar still), Solar refrigeration (VAM, adsorption), Industrial applications: Process heat, Solar steam generation, Desalination systems | 7 | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| | **Self-learning:** Industrial solar applications in India | | | |
| **IV** | **Solar Photovoltaic Fundamentals**<br>Photovoltaic effect, Solar cell materials and technologies, I-V characteristics, Efficiency and losses, PV modules and arrays, Effects of temperature, shading, dust<br>**Self-learning:** Comparison of PV technologies | 7 | 4 | 2 |
| **V** | **Solar PV System Design & Applications**<br>Components: inverter, MPPT, charge controller, Battery systems: Lead-acid, Li-ion, Load estimation, Panel sizing and battery sizing, Standalone and grid-connected systems, Applications: Solar Street lighting, Water pumping, Rooftop systems, Hybrid systems<br>**Self-learning:** Design PV system for a house | 8 | 5 | 6 |
| **VI** | **Cost Analysis, Policy & Sustainability**<br>Economic analysis: Simple Payback Period, Return on Investment (ROI), Net Present Value (NPV), Internal Rate of Return (IRR), Life Cycle Costing (LCC), Government policies (MNRE, Net Metering), Environmental impact, Future trends: Floating solar, BIPV, Smart grids<br>**Self-learning:** Feasibility study of solar plant<br>**Advanced topic:** Simulation of Solar Thermal collectors\PV\Concentrating Collectors Using TRNSYS | 8 | 6 | 5 |
| **Total** | | | | 45 |

| Sr No. | List of Experiment | COs |
|---|---|---|
| **1** | Measurement of Solar Radiation Using Pyranometer | 1 |
| **2** | Determination of Solar Radiation on Tilted Surface | 1 |
| **3** | Experimental and analytical analysis of liquid heating flat plate collector, concentrated collector and solar air heater | 2 |
| **4** | Performance Analysis of Evacuated Tube Collector (ETC) | 2 |
| **5** | Experimental and analytical analysis of Solar Cooker | 3 |
| **6** | Sizing of solar water heating system for domestic and industrial process heat. Case study of industrial process heat applications. | 3 |
| **7** | Experimental analysis on PV module for comparison of I-V characteristics for series and parallel connection. | 4 |
| **8** | Effect of module cleaning and maintenance on performance of PV system. | 4 |
| **9** | Design of solar PV systems using TRNSYS17 software and comparison of result with experimental result. | 5 |
| **10** | Experimental and analytical analysis of solar PV systems (Solar lamps, solar PV water pump, DC Cooker etc.) | 5 |
| **11** | Economics of solar thermal power generation a case studies on existing solar thermal power plants such as milk pasteurization, textile and dying industries | 6 |
| **12** | Economic and Environmental analysis of power plant. | 6 |

**Reference Books:**

[1] S. P. Sukhatme and J.K. Nayak, Solar Energy - Principles of thermal collection and storage; Tata McGraw-Hill, US, Third Edition, 2008.
[2] Chetan Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, Prentice Hall of India, 2015
[3] J. A. Duffie and W.A. Beckman, Solar Engineering of Thermal Processes, John Wiley and Sons, New York,2006.
[4] Angèle Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Photovoltaic Solar Energy: From Fundamentals to Applications, Wiley, USA, 2016
[5] J. Twidell and T. Weir, Renewable Energy Resources, Taylor and Francis (special Indian edition) UK, Second Edition, 2006

**Text Books:**

[1] H.P. Garg and Prakash, Solar Energy, Fundamentals and Applications, Tata McGraw Hill, US, First Edition, 2000.
[2] S. A. Kalogirous, Solar Energy Engineering, Academic Press, Cambridge, 2009.
[3] G. D. Rai, Non-Conventional Energy Sources, 6th ed. New Delhi, India: Khanna Publishers, 2017
[4] G. Boyle, Ed., Renewable Energy: Power for a Sustainable Future, 3rd ed. Oxford, U.K.: Oxford Univ. Press, 2012
[5] B. H. Khan, *Non-Conventional Energy Resources*, 3rd ed. New Delhi, India: McGraw Hill Education (India) Pvt. Ltd., 2017

**Useful Links:**

1. Design of photovoltaic systems - https://onlinecourses.nptel.ac.in/noc22_ee71/preview
2. Solar Energy Engineering and Technology: https://onlinecourses.nptel.ac.in/noc20_ph14/preview
3. Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems:- https://onlinecourses.nptel.ac.in/noc21_ch11/preview

| Course Title: Mechanical System Design | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Odd | | | **Course Code:** 24MEPEC70211C | | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |
| **Sustainable Development Goals:** 9, 12, 8 | | | | | | | | | | | | |

**Course Objectives:**

1. To introduce the integration of engineering systems and the morphology of design.
2. To develop proficiency in systematic product development and industrial design approaches.
3. To enable students to apply optimization techniques for industrial-scale mechanical systems.
4. To provide expertise in design for excellence (DFX) and reliability-based engineering.

**Course Outcomes:**

- **CO1:** Understand the systematic design process and the product life cycle in an industrial context.
- **CO2:** Apply material handling system design principles to industrial workflows.
- **CO3:** Implement Design for Manufacturing, Assembly, and Environment (DFx) methodologies.
- **CO4:** Execute optimization strategies to balance performance, cost, and weight constraints.
- **CO5:** Develop robust systems using statistical tools and reliability engineering.
- **CO6:** Synthesize concurrent engineering principles for rapid product development.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Industrial Design Process:** Morphology of design, Product life cycle (PLC), identification of needs, and preparation of design specifications (PDS).<br>**Self-learning topics:** The role of "Digital Twins" in initial design validation. | 7 | 1 | 2 |
| **II** | **Design of Material Handling Systems:** Design of belt conveyors, unit load handling, and selection of equipment for automated warehouses.<br>**Self-learning topics:** Integration of AGVs (Automated Guided Vehicles) in material flow. | 7 | 2 | 3 |
| **III** | **Design for Excellence (DFX):** Concepts of Design for Manufacturing (DFM), Design for Assembly (DFA), and Design for Environment (DFE/Sustainability).<br>**Self-learning topics:** Design for Serviceability and Maintenance (DFM/DFS). | 7 | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| **IV** | **System Optimization:** Formulating objective functions, constraint analysis, and using Johnson's Method of Optimum Design for mechanical elements.<br>**Self-learning topics:** Use of Genetic Algorithms (GA) for multi-objective optimization. | 7 | 4 | 3 |
| **V** | **Reliability & Robust Design:** Statistical considerations, Failure Mode and Effects Analysis (FMEA), and designing for target reliability and safety factors.<br>**Self-learning topics:** Six Sigma tools for quality-driven design. | 8 | 5 | 6 |
| **VI** | **Modern Design Approaches:** Concurrent Engineering, Reverse Engineering, and introduction to Agile design methodologies for mechanical systems.<br>**Self-learning topics:** Generative Design and Topology Optimization in CAD.<br>**Advanced Topics:** Topology Optimization for Lightweight Mechanical Design | 8 | 6 | 6 |
| **Total** | | | 45 | |

**Reference Books:**

1. **"Engineering Design: A Systematic Approach"** by G. Pahl and W. Beitz (Springer, 2007).
2. **"Product Design and Development"** by Karl Ulrich and Steven Eppinger (McGraw Hill, 2020).
3. **"Mechanical System Design"** by Simant, S.R. and K.U. Siddiqui (UMESH Publications, 2018).
4. **"Design for Manufacturing and Assembly"** by Geoffrey Boothroyd (CRC Press, 2010).

**Useful Links:**

**NPTEL Course - Design for Quality, Manufacturing and Assembly :**
**https://onlinecourses.nptel.ac.in/noc19_me48/preview**
**NPTEL Course - Design Practice :** https://onlinecourses.nptel.ac.in/noc22_me29/preview
**NPTEL Course - Product Design and Development :**
**https://onlinecourses.nptel.ac.in/noc20_me12/preview**

| Course Title: Design of Automobile Components | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Odd | | | | **Course Code:** 24MEPEC70212C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |
| **Sustainable Development Goals:** 9, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To understand the fundamental principles of design and selection of materials for automotive components.
2. To develop the ability to design engine components subjected to various loading conditions.
3. To provide expertise in the design of transmission systems, including clutches and gearboxes.
4. To enable students to design suspension and braking systems for vehicle safety and stability.
5. To introduce the design of steering systems and axles.
6. To explore modern trends in lightweighting and the use of CAD/CAE in automotive design.

**Course Outcomes:**

**CO1:** Identify appropriate materials and manufacturing processes for specific automotive parts.
**CO2:** Design internal combustion engine components like pistons, connecting rods, and crankshafts.
**CO3:** Analyze and design automotive clutches and gearbox assemblies.
**CO4:** Evaluate and design suspension springs and braking system components.
**CO5:** Formulate designs for steering linkages and front/rear axles.
**CO6:** Apply optimization techniques and simulation tools for advanced vehicle component design.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Introduction to Automotive Design:**<br>1.1 Design requirements, Factor of Safety, and Material Selection (Alloys, Composites).<br>1.2 Review of stress analysis: Static and Fatigue loading in vehicle frames.<br>**Self-learning topics:** Evolution of vehicle chassis designs. | 7 | 1 | 2 |
| **II** | **Design of Engine Components:**<br>2.1 Design of Piston and Piston Rings based on thermal and mechanical loads.<br>2.2 Design of Connecting Rod (Buckling considerations) and Crankshaft.<br>**Self-learning topics:** Design of valves and cooling systems. | 7 | 2 | 6 |
| **III** | **Transmission System Design:**<br>3.1 Design of clutches: Single plate, Multi-plate, and Centrifugal clutches.<br>3.2 Design of Gearbox: Sliding mesh and Constant mesh gear ratios and tooth loads.<br>**Self-learning topics:** Automatic Transmission fluid coupling. | 7 | 3 | 4 |
| **IV** | **Suspension and Braking Systems:**<br>4.1 Design of Leaf springs and Helical coil springs for suspension.<br>4.2 Braking system design: Disc and Drum brake mechanics, heat dissipation. | 7 | 4 | 5 |

| | | | | |
|---|---|---|---|---|
| | **Self-learning topics:** Anti-lock Braking System (ABS) components. | | | |
| **V** | **Steering and Axle Design:**<br>5.1 Steering geometry: Ackermann and Davis mechanisms, design of tie-rods.<br>5.2 Design of Front Axle (Stub axle) and Rear Axle (Full-floating vs Semi-floating).<br>**Self-learning topics:** Power steering pump assemblies. | 8 | 5 | 6 |
| **VI** | **Optimization & Computer-Aided Design:**<br>6.1 Lightweighting: Topology optimization for automotive brackets and housings.<br>6.2 Integration of FEA/Simulation in the design cycle.<br>**Self-learning topics:** Design for Electric Vehicle (EV) battery enclosures.<br>**Advanced Topics:** Lightweight Automotive Design using Advanced Materials (Aluminum Alloys & Composites) | 8 | 6 | 3 |
| **Total** | | | 45 | |

**Reference Books:**

1. "Design Data Book for Mechanical Engineers" by **K. G. Kala and B. D. Khandare** (Townsend Publication).
2. "Design of Automobile Components" by **G. K. Grover** and **A. K. Pandey** (Nem Chand & Bros).
3. "Design of Machine Elements" by **V. B. Bhandari** (McGraw Hill Education).
4. "Automobile Engineering" by **R. B. Gupta** (Satya Prakashan).
5. "Mechanical Engineering Design" by **Joseph E. Shigley**, **Charles R. Mischke**, and **Richard G. Budynas** (McGraw Hill).
6. "The Design of the Modern Automobile" by **J. Reimpell** and **H. Stoll** (Butterworth-Heinemann).

**Useful Links:**

https://onlinecourses.nptel.ac.in/noc26_de12/preview
https://onlinecourses.nptel.ac.in/noc26_me16/preview

| Course Title: Machinery Diagnostics | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Odd | | | | **Course Code:** 24MEPEC70213C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |
| **Sustainable Development Goals**: 9, 12 | | | | | | | | | | | | |

**Course Objectives:**

1. To introduce the fundamental concepts of machinery maintenance and failure modes.
2. To develop proficiency in vibration-based condition monitoring and transducer selection.
3. To enable students to perform signal processing in time and frequency domains for fault detection.
4. To provide expertise in diagnosing malfunctions in rotating machinery (unbalance, misalignment).
5. To explore advanced diagnostic techniques for bearings, gears, and reciprocating machines.
6. To introduce modern AI/ML applications in predictive maintenance and machinery health management.

**Course Outcomes:**

- **CO1:** Understand maintenance strategies and the role of condition monitoring in industrial reliability.
- **CO2:** Select and deploy appropriate sensors (accelerometers, proximity probes) for data acquisition.
- **CO3:** Analyze vibration signatures using FFT, envelope analysis, and cepstrum techniques.
- **CO4:** Diagnose common rotor-dynamic faults like unbalance, misalignment, and mechanical looseness.
- **CO5:** Evaluate the health of critical components such as rolling element bearings and gearboxes.
- **CO6:** Apply diagnostic methodologies to real-world industrial case studies and automated monitoring systems.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Principles of Maintenance & Diagnostics:**<br>1.1 Maintenance strategies: Breakdown, Preventive, and Predictive Maintenance (CBM).<br>1.2 Failure Analysis: FMECA (Failure Modes, Effects, and Criticality Analysis).<br>**Self-learning topics:** Root Cause Analysis (RCA) procedures. | 7 | 1 | 2 |

| | | | | |
|---|---|---|---|---|
| **II** | **Instrumentation and Data Acquisition:**<br>2.1 Transducers: Selection and mounting of accelerometers, velocity pickups, and LVDTs.<br>2.2 Signal Conditioning: Amplifiers, filters, and A/D conversion; Aliasing and Windowing.<br>**Self-learning topics:** Wireless sensor networks for remote monitoring. | 7 | 2 | 3 |
| **III** | **Signal Processing & Vibration Analysis:**<br>3.1 Fundamentals of Vibration: Time-domain vs. Frequency-domain; FFT (Fast Fourier Transform).<br>3.2 Specialized Analysis: Envelope analysis, Cepstrum, and Order tracking for variable speed machines.<br>**Self-learning topics:** Wavelet transform applications in transient analysis. | 7 | 3 | 4 |
| **IV** | **Fault Diagnosis in Rotating Machinery:**<br>4.1 Diagnosis of Unbalance, Misalignment, Bent Shaft, and Resonance.<br>4.2 Rotor Dynamics: Critical speeds, Campbell diagrams, and Orbit analysis.<br>**Self-learning topics:** Field balancing techniques for industrial rotors. | 7 | 4 | 4 |
| **V** | **Component-Specific Diagnostics:**<br>5.1 Bearings: Signal characteristics of inner/outer race defects in rolling element bearings.<br>5.2 Gearboxes: Detection of gear tooth wear, pitting, and eccentricity.<br>**Self-learning topics:** Lubricant analysis and Thermography as secondary diagnostic tools. | 8 | 5 | 5 |
| **VI** | **Automated Diagnostics & Case Studies:**<br>6.1 Integration of AI/ML: Feature extraction for automated fault classification.<br>6.2 Case Studies: Pump cavitation, compressor surges, and motor current signature analysis (MCSA).<br>**Self-learning topics:** Digital Twins for machinery health prognosis<br>**Advanced Topics:** Integrated Machinery Health Monitoring using Multisensor Data Fusion Techniques | 8 | 6 | 3 |
| **Total** | | | 45 | |

**Reference Books:**

1. "Design Data Book for Mechanical Engineers" by **K. G. Kala and B. D. Khandare** (Townsend Publication).
2. "Machinery Malfunction Diagnosis and Correction: Vibration Analysis and Troubleshooting" by

**Robert C. Eisenmann Sr.** and **Robert C. Eisenmann Jr.** (Prentice Hall / Hewlett-Packard Professional Books).

3. "Mechanical Fault Diagnosis and Condition Monitoring" by **R. A. Collacott** (Chapman & Hall).
4. "Vibration-based Condition Monitoring" by **Robert Bond Randall** (Wiley).
5. "Condition Monitoring of Rotating Electrical Machines" by **Peter Tavner**, **Li Ran**, **Jim Penman**, and **Howard Sedding** (The Institution of Engineering and Technology).
6. "AI and Machine Learning for Mechanical and Electrical Engineering" by **T. Rajasanthosh Kumar**, **Surendra Reddy Vinta**, **Sagar Dhanraj Pande**, and **Aditya Khamparia** (CRC Press, 2025).

**Useful Links:**

**NPTEL Course - Machinery Fault Diagnosis and Signal Processing:**
https://nptel.ac.in/courses/112105232

**NPTEL Course - Introduction to Mechanical Vibration:**
https://nptel.ac.in/courses/112107212

**ISO 18436 Standards for Condition Monitoring:**

https://www.iso.org/standard/63038.html

| Course Title: Artificial Intelligence and Machine Learning for Mechanical Systems | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Odd | | | | **Course Code:** 24MEPEC70221C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |
| **Sustainable Development Goals:** 9, 8, 12 | | | | | | | | | | | | |

**Course Objectives:**

1 To introduce the integration of Artificial Intelligence and Machine Learning
2 To develop proficiency in data acquisition and preprocessing techniques
3 To enable students to apply supervised learning algorithms
4 To provide expertise in unsupervised learning and dimensionality reduction
5 To explore deep learning architectures
6 To introduce the concepts of Physics-Informed Machine Learning and Generative Design

**Course Outcomes:**

1 Understand the integration of AI/ML within the mechanical engineering domain.
2 Apply regression and classification algorithms for predictive maintenance of mechanical assets.
3 Execute unsupervised learning techniques to simplify and group complex sensor data.
4 Implement deep learning architectures for visual inspection and non-linear modeling.
5 Develop sequential models and reinforcement learning strategies for autonomous systems.
6 Synthesize physics-based knowledge with generative algorithms for advanced design and optimization.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Foundations of AI in Mechanical Engineering:**<br>**1.1 Introduction:** Role of AI/ML in Industry 4.0, Digital Twins, and Cyber-Physical Systems.<br>**1.2 Data Acquisition:** Sensor data types (vibration, thermal, acoustic), data cleaning, normalization, and handling missing values in mechanical time-series data.<br>**Self-learning topics:** History of AI in manufacturing. | 8 | 1 | 2 |
| II | **Statistical Learning & Predictive Maintenance:**<br>**2.1 Regression:** Linear and Polynomial regression for predicting Remaining Useful Life (RUL) of machine components.<br>**2.2 Classification:** Support Vector Machines (SVM) and K-Nearest Neighbors (KNN) for fault detection in gearboxes and bearings.<br>**Self-learning topics:** Evaluation metrics (Precision, Recall, F1-Score). | 7 | 2 | 3 |

| | | | | |
|---|---|---|---|---|
| **III** | **Unsupervised Learning & Feature Engineering:**<br>**3.1 Dimensionality Reduction:** Principal Component Analysis (PCA) for reducing high-dimensional sensor arrays.<br>**3.2 Clustering:** K-Means and Hierarchical clustering for identifying different operating regimes and machine states.<br>**Self-learning topics:** Signal processing techniques like FFT for feature extraction. | 7 | 3 | 3 |
| **IV** | **Neural Networks and Deep Learning:**<br>**4.1 Artificial Neural Networks (ANN):** Multi-layer perceptrons for modeling complex non-linear mechanical behaviors.<br>**4.2 Convolutional Neural Networks (CNN):** Image-based inspection for surface defects, crack detection, and weld quality analysis.<br>**Self-learning topics:** Activation functions and backpropagation. | 7 | 4 | 3 |
| **V** | **Sequence Modeling & Reinforcement Learning:**<br>**5.1 Recurrent Neural Networks (RNN/LSTM):** Analyzing sequential sensor data for early warning systems in turbines and engines.<br>**5.2 Reinforcement Learning:** Basic concepts of agents, states, and rewards applied to robotic path planning and autonomous navigation.<br>**Self-learning topics:** Q-Learning algorithms. | 8 | 5 | 6 |
| **VI** | **Physics-Informed ML & Generative Design:**<br>**6.1 Physics-Informed Neural Networks (PINNs):** Integrating physical laws (Thermodynamics, Fluid Mechanics) into ML models.<br>**6.2 Generative Design:** Using GANs and VAEs for topology optimization and automated CAD generation based on weight/stress constraints.<br>**Self-learning topics:** Deployment of ML models on Edge devices.<br>**Advanced Topics:** Physics-Informed Machine Learning for Engineering System Modeling | 8 | 6 | 6 |
| **Total** | | | 45 | |

**Reference Books:**

1. "AI and Machine Learning for Mechanical and Electrical Engineering" by T. Rajasanthosh Kumar, Surendra Reddy Vinta, Sagar Dhanraj Pande, and Aditya Khamparia (CRC Press, 2025).
2. "Artificial Intelligence and Machine Learning Applications in Civil, Mechanical, and Industrial Engineering" by Gebrail Bekdaş, Sinan Melih Nigdeli, and Melda Yücel (IGI Global, 2020).
3. "Artificial Intelligence in Mechanical and Industrial Engineering" by Kaushik Kumar, Divya Zindani, and J. Paulo Davim (CRC Press, 2021/2024).

4. "Machine Learning for Mechanical Engineering: A Beginners Guide" by Dr. Jobin M. V. and Dr. L. C. Manikandan.
5. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron (O'Reilly Media).
6. "Mathematics for Machine Learning" by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong (Cambridge University Press).
7. "The Hundred-Page Machine Learning Book" by Andriy Burkov.
8. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville (MIT Press).

**Useful Links:**

https://onlinecourses.nptel.ac.in/noc26_cs76/preview

| Course Title: Biomedical Engineering | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Odd | | | | **Course Code:** 24MEPEC70222C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |
| **Sustainable Development Goals Mapped:** 3, 4, 9, 12 | | | | | | | | | | | | |

**Course Objectives:**

1. To introduce fundamental concepts of biomedical engineering and the structure and function of human body systems relevant to mechanical engineering.
2. To apply principles of mechanics to analyze biological systems, including bones, joints, and human motion.
3. To understand the selection and application of biomaterials and the working of biomedical instruments and devices.
4. To familiarize students with modern medical technologies such as imaging systems, prosthetics, and emerging trends like 3D printing in healthcare.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Explain fundamental concepts of biomedical engineering and human body systems.
2. Analyze mechanical behavior of biological tissues using principles of biomechanics.
3. Select suitable biomaterials for biomedical applications based on required properties.
4. Understand and interpret biomedical signals and instrumentation systems.
5. Evaluate design and working of prosthetic devices and artificial organs.
6. Explain modern medical imaging techniques and emerging biomedical technologies.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Introduction to Biomedical Engineering:** Definition and scope of Biomedical Engineering, Role of mechanical engineers in healthcare, Overview of human body systems (skeletal, muscular, cardiovascular) Basic anatomical terminology Engineering ethics in biomedical applications. **Self-learning topics:** Role of Artificial Intelligence in Healthcare | 8 | 1 | L2 |
| **II** | **Biomechanics:** Fundamentals of biomechanics Mechanical properties of biological tissues (bone, cartilage, muscles) Stress-strain behaviour of biological materials Analysis of human motion (kinematics & kinetics) Joint mechanics (hip, knee, shoulder) **Self-learning topics:** Gait Analysis and Its Engineering Applications | 8 | 2 | L3 |

| | | | | |
|---|---|---|---|---|
| **III** | **Biomaterials:**<br>Introduction to biomaterials, Types: Metals, polymers, ceramics, composites, Properties: biocompatibility, corrosion resistance, strength, Selection of materials for implants, Applications: orthopaedic implants, dental materials.<br>**Self-learning topics:** Smart Biomaterials (Shape Memory Alloys in Implants). | 8 | 3 | L4 |
| **IV** | **Biomedical Instrumentation:**<br>Basic physiological signals (ECG, EEG, EMG), Sensors and transducers in biomedical applications, Measurement of blood pressure, temperature, and flow, Working principles of common diagnostic devices, Signal acquisition and basic processing<br>**Self-learning topics:** Wearable Health Monitoring Devices | 7 | 4 | L4 |
| **V** | **Medical Devices and Prosthetics:**<br>Classification of medical devices, Design principles of prosthetic limbs, Orthotic devices, Artificial organs (heart valves, pacemakers), Rehabilitation engineering<br>**Self-Learning**: - Design and Working of Bionic Prosthetic Limbs | 7 | 5 | L3 |
| **VI** | **Medical Imaging and Advanced Applications:**<br>Principles of imaging techniques: X-ray, CT, MRI, Ultrasound, Image processing basics, CAD/CAM in biomedical applications, 3D printing in biomedical field, Tissue engineering and future trends.<br>**Self-learning topics:** 3D Printing in Biomedical Applications.<br>**Advance Topic: -** AI and Data Analytics in Biomedical Signal Processing | 7 | 6 | L2 |
| **Total** | | **45** | | |

**Reference Books:**

1. Marek Gzik, Zbigniew Paszenda, Ewa Piętka, et al., "Innovations in Biomedical Engineering 2023", Springer, 2024.
2. Marek Gzik, Zbigniew Paszenda, Ewa Piętka, Krzysztof Milewski, et al., "Innovations in Biomedical Engineering 2024", Springer, 2025.
3. Andreas Öchsner, "Progress in Biomaterials and Biomedical Engineering", Springer, 2026.

**Text Books:**

1. Nabisab Mujawar Mubarak, Mahmood Anwar, Sujan Debnath, et al., "Fundamentals of Biomaterials: A Supplementary Textbook", Springer, 2023.
2. Oguzhan Gunduz, Christophe Egles, Román A. Pérez, Denisa Ficai, Cem Bulent Ustundag, "Biomaterials and Tissue Engineering", Springer, 2023.
3. Luis Jesús Villarreal-Gómez, "Biotechnology: Biosensors, Biomaterials and Tissue Engineering", IntechOpen, 2023.

**Useful Links:**

**https://onlinecourses.nptel.ac.in/noc22_bt20/preview**
**https://onlinecourses.nptel.ac.in/noc21_me75/preview**
**https://onlinecourses.nptel.ac.in/noc20_ee84/preview**
**https://onlinecourses.nptel.ac.in/noc21_ee47/preview**
**https://onlinecourses.nptel.ac.in/noc21_bt19/preview**

| Course Title: Operation Research | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** ODD | | | | **Course Code:** 24MEPEC70223C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | - | 3 | 20 | 20 | 60 | - | - | 100 |
| **Sustainable Development Goals:** 8, 9, 12 | | | | | | | | | | | | |

**Course Objectives:**

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

**Course Outcomes:**

At the end of the course students will be able to:

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Understand the applications of integer programming and a queuing model and compute important performance measures
3. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
4. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
5. Gain knowledge of Game theory to understand strategic decision making.
6. Illustrate various inventory models to determine various models.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | **Introduction to Operations Research**: Introduction, Structure of the Mathematical Model, Limitations of Operations Research<br>**Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.<br>**Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n | 14 | **CO1** | **2** |

| | | | | |
|---|---|---|---|---|
| | Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem<br>**Self-learning topics:**<br>**Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms. | | | |
| **II** | **Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service.<br>**Self-learning topics:** Finite and infinite population | 07 | **CO2** | **2** |
| **III** | **Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation.<br>**Self-learning topics:** Limitations of Simulation | 06 | **CO3** | **3** |
| **IV** | **Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path.<br>**Self-learning topics:** Cargo loading and Reliability problems. | 06 | **CO4** | **3** |
| **V** | **Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle.<br>**Self-learning topics:** Rectangular games without saddle point – mixed strategy for 2 X 2 games. | 06 | **CO5** | **2** |
| **VI** | **Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage.<br>**Self-learning topics:** Probabilistic EOQ Model<br>**Advanced Topics:** Stochastic Optimization Models for Uncertain Demand and Supply Systems | 06 | **CO6** | **3** |

**Reference Books:-**

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.

**Text Books:**

1. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
2. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

**Useful Links:**

https://onlinecourses.nptel.ac.in/noc22_ma48/preview

| Course Title: Finance and Accounting | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Even | | | **Course Code:** 24IOE7011C | | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | - | 3 | - | - | 3 | 20 | 20 | 60 | - | - | 100 |
| **Sustainable Development Goals Mapped:** 1, 4, 8, 10, 16 | | | | | | | | | | | | |

Course Objectives:

1 Understand the basic concepts of managerial economics, demand analysis, and elasticity of demand.
2 Apply break-even analysis and pricing strategies in business decision-making.
3 Analyze business organizations, economic policies, and cost accounting methods.
4 Evaluate accounting procedures and preparation of financial statements.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Explain the concepts and scope of managerial economics and demand analysis.
2. Analyze elasticity of demand and apply demand forecasting methods.
3. Apply break-even analysis and pricing strategies for business decisions.
4. Evaluate business organizations and the impact of economic policies.
5. Prepare cost sheets using cost accounting techniques.
6. Prepare financial statements using accounting principles and procedures.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| 1 | **Introduction to managerial economics** Definition, nature and scope of managerial economics, demand analysis, demand determinants, law of demand and its exceptions | 7 | 1 | 2 |
| 2 | **Elasticity of Demand** Definition types measurement and significance of elasticity of demand. Factors governing demand forecasting, methods of demand forecasting (survey methods, statistical methods, expert opinion method, test marketing, controlled experiment, and judgmental approach to demand forecasting) | 8 | 2 | 4 |
| 3 | **Break even analysis and pricing strategies** Break even analysis-determination of breakeven point (simple problems) - managerial significance and limitations of BEA. Objectives and policies of pricing-methods of pricing: cost plus pricing, sealed bid pricing, going rate pricing, market skimming pricing, penetration | 8 | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| | pricing, two part pricing, block pricing, bundling pricing, peak load pricing, cross subsidization.) | | | |
| 4 | **Business and New economic policy** Characteristics of business , features and evaluation of forms of business organization based on ownership, nature of the economy, structure of the economy, economic policies, new economic policy 1991, economic conditions | 7 | 4 | 5 |
| 5 | **Cost accounting Introduction-** Classification of costs –methods of costing – techniques of costing – preparation of cost sheet. | 7 | 5 | 4 |
| 6 | **Accountancy** Accounting principles, procedure-double entry system-journal-ledger, trail balance –cash book- preparation of trading, profit and loss account-balance sheet. | 8 | 6 | 5 |

**TEXT BOOKS:**

1. Management Economics and Financial Analysis, Aryasri, 4/e, TMH, 2009.
2. Managerial Economics, Varshney & Maheswari, Sultan Chand, 2009.

**REFERENCE BOOKS:**

1. Agarwal AN," Indian Economy "Wiley Eastern Ltd,New Delhi
2. Jain and Narang "Accounting part-1"Kalyani publishers
3. Arora,M.N."Cost Accounting", Vikas publications
4. Ashwatappa. K "Business Environment"

**e-Resources and Digital Material:**

1. http://nptel.ac.in/courses/110105067/
2. http://nptel.ac.in/courses/110107073/

| Course Title: Intellectual Property Rights | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Even | | | | **Course Code:** 24IOE7012C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | - | 3 | - | - | 3 | 20 | 20 | 60 | - | - | 100 |
| **Sustainable Development Goals Mapped:** 4, 8, 9, 16 | | | | | | | | | | | | |

**Course Objectives:**

1. To understand the fundamentals and importance of Intellectual Property Rights (IPR).
2. To learn various types of IPR such as patents, copyrights, trademarks, and designs.
3. To understand procedures related to registration, protection, and infringement of IPR.
4. To gain knowledge of IT Act 2000, cyber laws, and digital security concepts.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Explain the basics of IPR, TRIPS, and WTO.
2. Describe patent and copyright registration, rights, and infringement.
3. Analyze copyright protection and software piracy issues.
4. Examine trademarks, domain names, and legal remedies
5. Apply concepts of industrial design and layout protection.
6. Evaluate provisions of IT Act 2000 and cybercrimes

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| 1 | INTRODUCTION TO IPR: Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights<br><br>Introduction to TRIPS and WTO.<br>Kinds of Intellectual property rights—Copy Right, Patent, Trade Mark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge. | 8 | 1 | 2 |
| 2 | PATENT RIGHTS AND COPY RIGHTS— Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties. – 6 hours | 8 | 2 | 3 |

| | | | | |
|---|---|---|---|---|
| 3 | COPY RIGHT—Origin, Definition &Types of Copy Right, Registration procedure, Assignment & licence, Terms of Copy Right, Piracy, Infringement, Remedies, Copy rights with special reference to software. | 8 | 3 | 4 |
| 4 | TRADE MARKS— Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing Off, Penalties.<br><br>Domain Names on cyber space. | 7 | 4 | 4 |
| 5 | DESIGN- Meaning, Definition, Object, Registration of Design, Cancellation of Registration, International convention on design, functions of Design.<br>Semiconductor Integrated circuits and layout design Act-2000. | 7 | 5 | 3 |
| 6 | BASIC TENENTS OF INFORMATION TECHNOLOGY ACT-2000 –<br>IT Act - Introduction<br>E- Commerce and legal provisions<br>E- Governance and legal provisions<br>Digital signature and Electronic Signature.<br>Cybercrimes, | 7 | 6 | 5 |

**TEXT BOOKS:**

1 N.K. Acharya, *Textbook on Intellectual Property Rights*, Asia Law House, 2017.
2 Deborah E. Bouchoux, *Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets*, Cengage Learning, 2013.
3 P. Narayanan, *Intellectual Property Law*, Eastern Law House, 2017.

**REFERENCE BOOKS:**

1 W.R. Cornish, *Intellectual Property Rights*, Universal Book Traders, 2010.
2 V.K. Ahuja, *Law Relating to Intellectual Property Rights*, LexisNexis, 2017.
3 S.K. Roy Chaudhary & H.K. Saharay, *The Law of Trademark, Copyright, Patents and Designs*, Eastern Law House, 2011.
4 Farooq Ahmad, *Cyber Law in India*, Pioneer Books, 2015.
5 Vakul Sharma, *Information Technology Law and Practice*, Universal Law Publishing, 2011.

**e-Resources and Digital Material:**

https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr25_ed87

https://nptel.ac.in/courses/109106137

| Course Title: Foreign Language - III (Japanese-2) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Semester: VII | | | Term: Even | | | Course Code: 24OE70131C | | | | | | |
| Teaching Scheme | | | | | | | Evaluation Scheme | | | | | |
| Contact Hrs. | | | Credit Allotted | | | Total Credit | IAE 1 | IAE 2 | ESE | CA | Or/Pr | Total |
| Th | Tu | Pr | Th | Tu | Pr | | | | | | | |
| 3 | | | 3 | | | 3 | 20 | 20 | 60 | | | 100 |

**Sustainable Development Goals Mapped: 4 , 11**

**Course Objectives:**

1. Develop basic Japanese communication skills for daily conversations.
2. Understand and use fundamental grammar, vocabulary, particles, and sentence structures.
3. Apply verb forms, adjectives, and expressions in practical situations.
4. Improve listening, speaking, reading, and writing skills through practice and revision.
5. Build confidence in using elementary Japanese in real-life contexts.

**Course Outcomes:**

**After successful completion of the course students will be able to:**

1. Use self-introduction, basic verb tenses, particles, suffixes, and counters correctly.
2. Apply vocabulary and grammar related to time, dates, and activities.
3. Use transitive verbs, particles, and invitation sentence patterns accurately.
4. Identify and apply i-adjectives and na-adjectives correctly.
5. Construct sentences using different tense forms of i-adjectives.
6. Describe existence, positions, and locations using suitable particles and expressions.

| Module | Contents | Hours | COs |
|---|---|---|---|
| I | **Introduction and revision family** | 6 | CO1 |
| | Self-introduction, verb tenses, particles, suffixes, family chart, counters for people and objects, and revision activities.<br><br>**Self-Learning:** Self-introduction practice, family tree preparation, counters practice, paragraph writing | | |
| II | **Time & Activities** | 8 | CO2 |
| | Suffixes related to time and dates, vocabulary development, particles (no, de, to), expressions for likes and dislikes, introduction to Kanji, five basic Kanji characters, and expressions indicating wants/desires.<br><br>**Self-Learning:** Daily routine writing, Kanji practice, likes/dislikes conversations, time expressions | | |

| | | | |
|---|---|---|---|
| **III** | **Transitive Verbs and Usage** | 8 | CO3 |
| | Introduction to transitive verbs, usage of particle *wo*, grammar patterns for inviting someone, vocabulary enrichment, hobbies, introduction to five Kanji characters, and revision.<br><br>**Self-Learning:** Sentence formation with transitive verbs, invitation dialogues, hobbies vocabulary, Kanji practice | | |
| **IV** | **Adjectives and usage.** | 8 | CO4 |
| | *i*-ending adjectives, *na*-ending adjectives, appropriate usage of adjectives, tense forms of *na*-adjectives and nouns, daily-use vocabulary, and introduction to five Kanji characters.<br><br>**Self-Learning:** Describing people and objects, adjective usage practice, picture description, Kanji writing | | |
| **V** | **Tenses of *i*-Ending Adjectives** | 8 | CO5 |
| | Vocabulary enhancement, present negative, past negative, and past positive forms of *i*-ending adjectives, sentence structures using all tense forms, asking questions, adverbs, and sentence formation using adverbs.<br><br>**Self-Learning:** Adjective tense exercises, descriptive paragraph writing, adverb usage, question-answer practice | | |
| **VI** | **Existence, Positions and Location** | 7 | CO6 |
| | New adjectives, positions of living and non-living objects, particles (*ni*, *ga*), directions, introduction to five Kanji characters, and IAE–2 revision.<br><br>**Self-Learning:** Location-based conversations, direction practice, object position description, Kanji revision | | |
| | **Total** | **45hr** | |

| Course Title: Foreign Language – III (German-2) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Odd | | | | **Course Code:** 24OE70132C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **Theory** | | | | **Practical** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | **IAE1** | **IAE2** | **ESE** | **CA** | **Or/Pr** | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

**Course Objectives:**

1. To strengthen students't ability to communicate confidently in German through day to day conversations, role plays & practical ituations..
2. To develop intermediate grammar skills including cases (Nominativ-Akkusativ-Dativ) seprable verbs, conjunctions, past tense forms,sentence connectors & question formation.
3. Students can describe their daily schedules. Students can talk about routines using correct time expressions.
4. To improve reading comprehension through short passages, dialouges, advertisements,E-Mails& simple articles in German.

**Course Outcomes:** Learner will be able to…

1. Demonstrate basic Japanese greetings, self-introduction, and Japanese scripts.
2. Apply basic vocabulary and expressions for daily communication.
3. Construct simple Japanese sentences using particles and sentence structures.
4. Use family-related vocabulary, counters, and pronouns appropriately.
5. Apply date, time, and verb-based expressions in communication.
6. Demonstrate correct usage of verb tenses and particles in Japanese.

| Module | Contents | Hours | COs |
|---|---|---|---|
| I | **Intermediate Grammar and Sentence Structure**<br>Numbers,Time ,Opposites, Akkusativ&Dativ Case(*Nominativ / Akkusativ / Dativ*),Dativ Verbs: *helfen, danken, gefallen*,Wechselpräpositionen (*in, an, auf, unter,vor, hinter, zwischen*),wer-wen-wem-was Frage | 08 | 1 |
| II | **Communication in Daily Life**<br>Dativmit Präpositionen, Ja-Nein-Doch, Wegbeschreibung und Orientierung, In der Stadt / Verkehrsmittel, Am Bahnhof / Am Flughafen, Dialogeim All tag, E-Mails und kurzeNachrichtenschreiben | 07 | 2 |
| III | **Vocabulary Building and Communication**<br>**Tagesablauf & Uhrzeit:** Daily routine Vocabulary, Sequencing activities, Time expressions, Akkusativ Prespositions<br><br>**Kleidung &Einkaufen:** Colors, sizes, prices, clothes vocabulary, | 08 | 3 |

| | | | |
|---|---|---|---|
| | Dialogue in shopsgefallen + dative, möchten , mögen verbs, Food & drinks Vocabulary, Ordering food, Preferences and quantities. | | |
| IV | **Communication**<br>**Gesundheit & Beim Arzt:** Body parts, Symptoms and advice, Imperative basics<br>**Wohnung & Möbel:** Rooms and furniture vocabulary, Articles and plural forms<br>**MeineHeimat:** Short paragraphs and descriptions, Conjuctions ( ADUSO), Sentence connectors: und, aber, denn | 07 | 4 |
| V | **Grammar Deep Dive and Routine Activities**<br>Perfekt -haben / sein + PartizipII, Regular and irregular verbs<br>**Zeitangaben & Reihenfolge:** zuerst, dann, danach, später, am Morgen, am Abend<br>**Wetter und Jahreszeiten:** Weather expressions, Seasonal activities | 07 | 5 |
| VI | **Practical Usage of Grammar**<br>**Einkaufen und Dienstleistungen**<br>Shops, offices, stations, pharmacies, Requests and polite questions, Wo-WohinFrage ,House Vocabulary & Conversation, asking & giving directions, Fruits& Vegetables & Market Conversation, Demonstrative Articles, Possesive Articles ( Akkusativ-Dativ ) | 08 | 6 |

**Text Books:**

1. Netzwerk A1, Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, Klett Sprachen Verlag, 2024
2. Menschen A1 Kursbuch, Angela Pude and Franz Specht, Hueber Verlag, 2024
3. Berliner Platz Neu 1, Christiane Lemcke, Lutz Rohrmann, Theo Scherling, Langenscheidt Publishing Group, 2024

**Reference Books:**

1. Schritte international Neu A1.1, Daniela Niebisch, Sylvette Penning-Hiemstra, Franz Specht, Hueber Verlag, 2023
2. The Everything Learning German Book, Ed Swick, Adams Media, 2022 German Made Simple: Learn to Speak and Understand German Quickly and Easily, Arnold Leitner, Crown Publishing Group, 2021
3. Living Language German, Complete Edition, Living Language Staff, Penguin Random House, 2021

**Links for online NPTEL/SWAYAM courses:**

1. https://onlinecourses.nptel.ac.in/noc20_hs41/preview
2. https://onlinecourses.nptel.ac.in/noc21_hs30/preview

| Course Title: Basics of HR Management | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Even | | | | **Course Code:** 24IOE7014C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | - | 3 | - | - | 3 | 20 | 20 | 60 | - | - | 100 |
| **Sustainable Development Goals Mapped:** 1, 4, 8, 10, 16 | | | | | | | | | | | | |

Course Objectives:

1. Understand the basic concepts and functions of Human Resource Management.
2. Analyze job analysis, HR planning, recruitment, and selection processes.
3. Apply training and performance appraisal methods for employee development.
4. Evaluate labour welfare, social security, and employee discipline practices.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1 Understand the concepts, functions, and importance of Human Resource Management.
2 Analyze job analysis and human resource planning processes.
3 Apply recruitment, selection, and employee placement procedures.
4 Evaluate training and development methods for employee growth.
5 Analyze the process and methods of performance appraisal.
6 Evaluate labour welfare, social security, and employee discipline practices.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| 1 | Human Resource Management:<br>Introduction, meaning, nature, scope of HRM - Importance and Evolution of the concept of HRM - Major functions of HRM - Principles of HRM | 7 | 1 | 2 |
| 2 | Job Analysis: Meaning, process of Job Analysis, methods of collecting job analysis data, Job Description and Job Specification, Role Analysis. Human Resource Planning: Objectives, Importance and process of Human Resource Planning,<br>Effective HRP. | 8 | 2 | 4 |
| 3 | Recruitment: Definition, Constraints and Challenges, Sources and Methods of Recruitment, New Approaches to recruitment.<br>Selection: Definition and Process of Selection. Placement: Meaning, Induction/Orientation, Internal Mobility, Transfer, Promotion, Demotion and Employee Separation. | 8 | 3 | 3 |
| 4 | Training and development: Training v/s development, Training v/s Education, Systematic Approach to Training, Training Methods. | 7 | 4 | 5 |
| 5 | Performance Appraisal: Concept of Performance | 7 | 5 | 4 |

| | | | | |
|---|---|---|---|---|
| | Appraisal, the Performance Appraisal Process, Methods of Performance Appraisal. | | | |
| 6 | Social Security & Labour Welfare:<br>Workers' Participation in Management: Levels of Management participation, Methods/ Schemes of Workers' participation in Management. Social security in India, Scope, Types of Social security and welfare programmes, non-monetary welfare measure. Employee Discipline: Characteristics of a sound disciplinary system, Common causes of indiscipline in an organisation, Disciplinary procedure, Ways of handling grievances. | 8 | 6 | 5 |

**Text & Reference Books:**

1 Human Resource Management, Pathania, Batra, Pathak, Kalyani Publishers
2 Human Resource Management, Durai, Pearson
3 Human Resource Management, VSP Rao, Excel Books
4 Human Resource Management, Khanka, S. Chand
5 Human Resource Management Text & Cases, Ashwathappa
a. Personnel & Human Resource Management, P. Subba Rao, HPH

**Useful Links:**

https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_mg21
http://www.digimat.in/nptel/courses/video/110105069/L01.html

| Course Title: Employability Enhancement Program-VI (Communication) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** Odd | | | | **Course Code:** 24MEAEC701C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| -- | -- | 02 | -- | -- | 01 | 01 | -- | -- | -- | 25 | -- | 25 |
| **Sustainable Development goals:** 4, 8 | | | | | | | | | | | | |

**Course Objectives:**

1. To apply required interpersonal skills so as to face challenges at the global level.
2. To equip students with relevant employment skills for their career advancement.

**Course Outcomes:**

At the end of the course, learner will be able to:

1. Exhibit emotional intelligence by recognizing and responding appropriately to the emotions and perspectives of individuals from various cultural backgrounds.
2. Develop a comprehensive set of employability skills, including critical thinking, problem-solving, and adaptability, to navigate the evolving job market.

| Tut No. | List of Tutorials | Hours | CO |
|---|---|---|---|
| | **Listening Skills** | | |
| 1 | IELTS Listening | **1** | **1** |
| 2 | Grooming, Dress and Appearance | **1** | **1** |
| | **Speaking Skills** | | |
| 3 | Self-Introduction | **1** | **1** |
| 4 | Technical Presentation (External Evaluator) | **1** | **1** |
| 5 | Impromptu Speech | **1** | **1** |
| 6 | Group Discussion | **1** | **2** |
| 7 | Mock Interview (Panel/Online) | **2** | **2** |
| | **Reading Skills** | | |
| 8 | Book Review | **2** | **2** |
| 9 | Crossword & News/Editorial Reading | **1** | **2** |
| | **Writing Skills** | | |
| 10 | Proficiency Test | **1** | **2** |
| 11 | Resume Writing | **1** | **2** |
| 12 | Official Correspondence: Inquiry & Reply, Complaint & Adjustment | **1** | **2** |

**Reference Books:**

1. M Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill, 2008
2. Gadyalji Vaishali K, Communication Skills, Nandu Publications, 2010
3. Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2007
4. Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2008
5. Raman Meenakshi & Sharma Sangeeta, Technical Communication Principles and Practice, Oxford University Press, 2015
6. Raman Meenakshi & Singh Prakash, Business Communication, Oxford University Press, 2008
7. Locker O Kitty & Kaczmarek Kyo Stephen, Business Communication Building Critical Skills, McGraw Hill Education Private Limited, 2007
8. Chaturvedi P D & Chaturvedi Mukesh, Business Communication Concepts, Cases and Applications, Pearson Education, 2008

**Text Books:**

1. Luthans Fred, Organizational Behavior An Evidence-Based Approach, McGraw Hill Education Private Limited, 2013

**Useful Links:**

- https://youtu.be/k9NMWDqun5A?si=HKOdK5PtKy6HvkBk
- https://youtu.be/waOIjlaTSo8?si=iHiCOT-KQRoJvFE3
- https://youtu.be/FfhZFRvmaVY?si=7NcRYuRBb0F6sfKf
- https://youtu.be/FVqSiFUVX78?si=-ZMO0_yT-Hl-5UW0
- https://youtu.be/6OdCoMgpx7o?si=iq2oK3auNRI1Z7D0

| Course Title: Capstone Project | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VII | | | **Term:** ODD | | | | **Course Code:** 24MEPRJC701C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| - | - | 4 | - | - | 2 | 2 | - | - | - | 50 | 50 | 100 |

**Sustainable Development Goals**: "SDG mapping will be carried out based on the project topic and its relevance to sustainable development goals."

**Introduction:**
The Capstone Project is a final academic exercise that integrates knowledge and skills acquired during the program. It enables students to solve real-world problems through design, analysis, and implementation. The project enhances critical thinking, research ability, teamwork, and communication skills, preparing students for professional practice and industry requirements.

**Important Note:** The Capstone Project is introduced in Semester VII as a foundational project-based learning experience. In Semester VIII, students may opt for either a Major Project or an Internship. Students choosing an internship must complete the Capstone Project in Semester VII. Those opting for a Major Project may either continue the same project or undertake a new project in Semester VIII.

**Course Objectives:**

The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification, analyzing the problem and designing solutions.

**Course Outcomes:**

At the end of the course students will be able to:

1. Students will be able to develop the understanding of the problem domain through extensive review of literature.
2. Students will be able to identify and analyze the problem in detail to define its scope with problem specific data.
3. Students will be able to identify various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
4. Students will be able to design solutions for real-time problems that will positively impact society and environment.
5. Students will be able to develop clarity of presentation based on communication, teamwork and leadership skills.
6. Students will be able to inculcate professional and ethical behavior..

**Guidelines:**

**Project Topic Selection and Allocation:**

- Project topic selection Process to be defined and followed:
- Project orientation can be given at the end of sixth semester.
- Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects.
- Student's should be recommended to refer papers from reputed conferences/ journals like
- IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
- Students can certainly take ideas from anywhere, but be sure that they should evolve them in the

unique way to suit their project requirements. Students can be informed to refer Digital India portal, SIH portal or any other hackathon portal for problem selection.

- Topics can be finalized with respect to following criterion:
- **Topic Selection**: The topics selected should be novel in nature (Product based, Application based or Research based) or should work towards removing the lacuna in currently existing systems.
- **Technology Used:** Use of latest technology or modern tools can be encouraged**.**
- Students should not repeat work done previously (work done in the last three years).
- Project work must be carried out by the group of at least 2 students and maximum 4.
- The project work can be undertaken in a research institute or organization/Industry/any business establishment. (out-house projects)
- The project proposal presentations can be scheduled according to the domains and should be judged by faculty who are expert in the domain.
- Head of department and senior staff along with project coordinators will take decision regarding final selection of projects.
- Guide allocation should be done and students have to submit weekly progress report to the internal guide.
- Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding continuous assessment marks.
- In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels

**Project Report Format:**

At the end of semester, each group need to prepare a project report as per the guidelines issued by the institute.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey
- Survey of Existing systems
- Limitations of Existing systems or research gaps
- Motivation (Challenges that are encouraging to choose the problem)
- Problem Statement and Proposed Solution
- Scope of the system
- Proposed System
- General Workflow/Block diagram
- Analysis and Modeling (only applicable diagrams)
- Design
- Architectural View
- Algorithms/ Methodology
- Experimental Set up
- Details of Database or details about input to systemsor selected data
- Performance Evaluation Parameters (for Validation)
- Software and Hardware Set up
- Implementation Plan for Next Semester

- Timeline Chart for Term1 and Term-II (Project Management tools can be used.)
- Summary
- References

**Desirable**

- Students can be asked to undergo some Certification course (for the technical skill set that will be useful and applicable for projects.)

**1. Continuous Assessment:**

Distribution of marks for continues assessment shall be done based on following:

**a.** Weekly Log Report
**b.** Project Work Contribution
**c.** Project Report (Spiral Bound) (both side print)
**d.** Term End Presentation (Internal)

The final certification and acceptance of CA ensures the satisfactory performance on the above aspects.

**2. Oral & Practical:**

Oral &Practical examination (Final Project Evaluation) of Project 1 should be conducted by Internal and External examiners approved by institute at the end of the semester.

**Suggested quality evaluation parameters are as follows:**

1. Quality of problem selected
2. Clarity of problem definition and feasibility of problem solution
3. Relevance to the specialization / industrial trends
4. Originality
5. Clarity of objective and scope
6. Quality of analysis and design
7. Quality of written and oral presentation
8. Individual as well as team work

# Bachelor of Engineering
# In
# Mechanical Engineering

## Fourth Year

## Semester – VIII

## SJCEM : R–24C

## Effective from Academic Year 2026-27

Scheme for Final Year (Eighth Semester) Mechanical Engineering
(With Effect from 2026-2027)

**Semester: VIII (A)**

| Course Code | Vertical | Course Name | Contact Hours | | | Credits Allotted | | | Total Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | Th | Tu | Pr | Th | Tu | Pr | Total |
| 24MEPCC801C | PCC | Smart and Sustainable Energy Systems | 3 | - | - | 3 | - | - | 3 |
| 24MEPCC802C | PCC | Design and Analysis of Mechanical Systems | 3 | - | 2 | 3 | - | 1 | 4 |
| 24MEPEC801XC | PEC | Professional Elective-VII (MOOCs) | 3 | - | - | 3 | - | - | 3 |
| 24MEPEC802XC | PEC | Professional Elective-VIII (MOOCs) | 3 | - | - | 3 | - | - | 3 |
| 24MEVEC801C | VEC | Constitution of India (Self Study) | 1 | - | - | 1 | - | - | 1 |
| 24MEPRJ801C | PRJ | Major Project | - | - | 12 | - | - | 6 | 6 |
| **Total** | | | **13** | **-** | **14** | **13** | **-** | **7** | **20** |

| Course Code | Vertical | Course Name | Evaluation Scheme | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | | Theory | | | Practical | | |
| | | | IAE 1 | IAE 2 | ESE | CA | Or/Pr | |
| 24MEPCC801C | PCC | Smart and Sustainable Energy Systems | 20 | 20 | 60 | -- | -- | 100 |
| 24MEPCC802C | PCC | Design and Analysis of Mechanical Systems | 20 | 20 | 60 | 25 | 25 | 150 |
| 24MEPEC801XC | PEC | Professional Elective-VII (MOOCs) | 20 | 20 | 60 | -- | -- | 100 |
| 24MEPEC802XC | PEC | Professional Elective-VIII (MOOCs) | 20 | 20 | 60 | -- | -- | 100 |
| 24MEVEC801C | VEC | Constitution of India (Self Study) | 10 | 10 | 30 | -- | -- | 50 |
| 24MEPRJ801C | PRJ | Major Project | - | - | - | 100 | 100 | 200 |
| **Total** | | | **90** | **90** | **270** | **125** | **125** | **700** |

**Semester: VIII (B)**

| Course Code | Vertical | Course Name | Contact Hours | | | Credits Allotted | | | Total Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | Th | Tu | Pr | Th | Tu | Pr | Total |
| 24MEPECP801XC | PEC | Professional Elective-VII (MOOCs) | 3 | - | - | 3 | - | - | 3 |
| 24MEPECP802XC | PEC | Professional Elective-VIII (MOOCs) | 3 | - | - | 3 | - | - | 3 |
| 24MEVEC801C | VEC | Constitution of India (Self Study) | 1 | - | - | 1 | - | - | 1 |
| 24MEOJT801C | OJT | Internship | - | - | 39 | - | - | 13 | 13 |
| **Total** | | | **7** | **-** | **39** | **7** | **-** | **13** | **20** |

| Course Code | Vertical | Course Name | Evaluation Scheme | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | | Theory | | | Practical | | |
| | | | IAE 1 | IAE 2 | ESE | CA | Or/Pr | |
| 24MEPECP801XC | PEC | Professional Elective-VII (MOOCs) | 20 | 20 | 60 | -- | -- | 100 |
| 24MEPECP802XC | PEC | Professional Elective-VIII (MOOCs) | 20 | 20 | 60 | -- | -- | 100 |
| 24MEVEC801C | VEC | Constitution of India (Self Study) | 10 | 10 | 30 | -- | -- | 50 |
| 24MEOJT801C | OJT | Internship | - | - | - | 300 | 150 | 450 |
| **Total** | | | **50** | **50** | **150** | **300** | **150** | **700** |

| Professional Elective- VII (MOOCs) | | Professional Elective- VIII (MOOCs) | |
|---|---|---|---|
| 24MEPECP8011C | Product Design and Development | 24MEPECP8021C | Automobile Engineering |
| 24MEPECP8012C | Optimization Techniques | 24MEPECP8022C | Composite Materials |
| 24MEPECP8013C | Total Quality Management | 24MEPECP8023C | Vibration Controls |

# Syllabus for

# Final Year Mechanical Engineering

## Semester – VIII

## SJCEM : R–24C

## (With Effect from 2026-27)

| Course Title: Smart and Sustainable Energy Systems | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VIII | | | **Term:** Even | | | | **Course Code: 24MEPCC801C** | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | - | 3 | - | - | 3 | 20 | 20 | 60 | - | - | 100 |
| **Sustainable Development Goals: 7,9,11,13** | | | | | | | | | | | | |

**Course Objectives:**

1. To understand integrated renewable and smart energy systems.
2. To study energy efficiency and energy audit principles.
3. To explore hydrogen and fuel cell technologies in modern energy systems.
4. To analyze smart grid and energy management strategies.
5. To develop practical and simulation-based skills for sustainable energy solutions.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Explain concepts of smart and sustainable energy systems.
2. Analyze renewable energy resources and hybrid systems.
3. Apply energy audit techniques for efficiency improvement.
4. Evaluate hydrogen and fuel cell technologies.
5. Analyze smart grid and energy management systems.
6. Propose integrated sustainable energy solutions.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| 1 | **Introduction to Smart & Sustainable Energy Systems** Energy scenario; sustainability concept; smart energy systems; need for integration; overview of RES, energy storage, hydrogen systems. **Self-learning:** Smart cities and energy systems in India | 7 | 1 | L1, L2 |
| 2 | **Renewable Energy Systems & Hybrid Integration** Solar PV, wind, biomass basics; hybrid systems (solar–wind–biomass); resource assessment; microgrid concept. **Self-learning:** Design of hybrid renewable system for rural electrification | 8 | 2 | L2, L3 |
| 3 | **Energy Audit and Energy Management** Energy audit types; instruments; energy efficiency in electrical and thermal systems; energy conservation techniques; economic analysis. **Self-learning:** Case study of energy audit in commercial building | 7 | 3 | L2, L3 |
| 4 | **Hydrogen and Fuel Cell Systems** Hydrogen production, storage; fuel cell working and types; integration with renewable energy; applications. **Self-learning:** Green hydrogen production technologies | 8 | 4 | L2, L3, L4 |
| 5 | **Smart Grid and Energy Management Systems** Smart grid concept; IoT in energy systems; demand response; smart meters; energy monitoring and control systems. **Self-learning:** Role of IoT in smart energy systems | 8 | 5 | L2, L4 |

| | | | | |
|---|---|---|---|---|
| 6 | **Sustainable Energy Applications and Future Trends** Electric vehicles, hydrogen economy, net-zero energy buildings, microgrids; techno-economic and environmental analysis.<br>**Self-learning:** Net-zero energy building concept<br>**Advanced topic:** AI-based energy management systems | 7 | 6 | L3, L4, L5 |
| **Total** | | **45** | | |

**Reference Books:**

1. Stolten, D. (Ed.). (2010). Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications. Weinheim, Germany: Wiley-VCH Verlag GmbH & Co. KGaA. ISBN: 978-3-527-32711-9
2. Sørensen, B. (2011). Hydrogen and Fuel Cells: Emerging Technologies and Applications (2nd ed.). Oxford, UK: Elsevier Academic Press.
3. Twidell, J., & Weir, T. (2015). Renewable Energy Resources (3rd ed.). London, UK: Routledge (Taylor & Francis Group).
4. Murphy, W. R., & McKay, G. (2012).Energy Management. Oxford, UK: Butterworth-Heinemann (Elsevier).
5. Lund, H. (2014). Renewable Energy Systems: A Smart Energy Systems Approach to the Choice and Modeling of 100% Renewable Solutions. London, UK: Academic Press (Elsevier).

**Text Books:**

1. O'Hayre, R., Cha, S.-W., Colella, W. G., & Prinz, F. B. (2016), Fuel Cell Fundamentals (3rd ed.). Hoboken, NJ: John Wiley & Sons. ISBN: 978-1-119-11380-5
2. Dincer, I., & Acar, C. (2018). Hydrogen Energy Systems: Production and Applications Cham, Switzerland: Springer International Publishing. DOI: 10.1007/978-3-319-91890-1
3. Boyle, G. (Ed.). (2012). Renewable Energy: Power for a Sustainable Future (3rd ed.). Oxford, UK: Oxford University Press. ISBN: 978-0-19-954533-9
4. Kothari, D. P., Singal, K. C., & Ranjan, R. (2011). Renewable Energy Sources and Emerging Technologies (2nd ed.). New Delhi, India: PHI Learning Pvt. Ltd. ISBN: 978-8120344789
5. Smith, C. B. (2015). Energy Management Principles: Applications, Benefits, Savings (2nd ed.). Oxford, UK: Elsevier (Butterworth-Heinemann). ISBN: 978-0-08-098226-7

**Useful Links:**

1. Hydrogen: Key Concepts and Use in Green Technologies, Coursera, https://www.coursera.org/learn/hydrogen-key-concepts-and-use-in-green-technologies.
2. Hydrogen Energy: Production, Storage, Transportation and Safety, (IIT Bombay) https://onlinecourses.nptel.ac.in/noc25_ch93/preview

| Course Title: Design and Analysis of Mechanical Systems | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VIII | | | **Term:** Even | | | | **Course Code:** 24MEPCC802C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | 2 | 3 | -- | 1 | 4 | 20 | 20 | 60 | 25 | 25 | 150 |
| **Sustainable Development Goals:** 4, 9, 11, 12 | | | | | | | | | | | | |

**Course Objectives:**

1. To provide an advanced understanding of 3D stress-strain states and energy methods.
2. To analyze the behavior of plates, shells, and contact mechanics in engineering applications.
3. To model and solve multi-degree-of-freedom and continuous vibration systems.
4. To master the formulation and application of Finite Element Analysis for complex geometries.

**Course Outcomes:**

- **CO1:** Analyze three-dimensional stress states and apply advanced failure theories to brittle and ductile materials.
- **CO2:** Evaluate stresses in non-circular members and solve problems involving contact mechanics.
- **CO3:** Derive equations of motion for multi-degree-of-freedom (MDOF) systems using Lagrangian dynamics.
- **CO4:** Predict the vibration behavior of continuous systems like strings, bars, and beams.
- **CO5:** Formulate element stiffness matrices and apply FEA to 1D and 2D structural problems.
- **CO6:** Conduct dynamic and thermal analysis using finite element procedures.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| 1 | **Advanced Stress Analysis - I:** Analysis of stress and strain in 3D, Airy's stress functions, Energy methods (Castigliano's theorems), and advanced theories of elastic failure. **Self-learning:** Impact of residual stresses on fatigue life. | 7 | 1 | 4 |
| 2 | **Advanced Stress Analysis - II:** Torsion of non-circular sections, Bending of curved beams, and Hertzian contact stresses in bearings and gears. **Self-learning:** Introduction to the Theory of Plasticity. | 7 | 2 | 5 |
| 3 | **Advanced Vibrations - I:** Multi-degree-of-freedom (MDOF) systems, Influence coefficients, Lagrange's equations, and Eigenvalue problems (Natural frequencies and Mode shapes). **Self-learning:** Vibration isolation in high-precision industrial equipment. | 7 | 3 | 6 |

| | | | | |
|---|---|---|---|---|
| 4 | **Advanced Vibrations - II:** Vibration of continuous systems: Exact solutions for strings, bars in axial vibration, and Euler-Bernoulli beam theory.<br>**Self-learning:** Random vibrations and Power Spectral Density (PSD). | 7 | 4 | 4 |
| 5 | **Advanced FEA - I:** Variational calculus and Rayleigh-Ritz method. Formulation of 1D (bar/beam) and 2D (CST, LST) elements. Isoparametric formulation.<br>**Self-learning:** Convergence criteria and mesh refinement techniques. | 8 | 5 | 6 |
| 6 | **Advanced FEA - II:** Fluid-structure interaction basics, Heat transfer analysis using FEA, and Non-linear FEA (Geometric vs. Material non-linearity).<br>**Self-learning:** Commercial FEA software (Ansys/Abaqus) workflow.<br>**Advanced Topics:** Nonlinear Dynamic Analysis of Smart Materials and Adaptive Structures | 8 | 6 | 3 |
| **Total** | | 45 | | |

**Reference Books:**

1. **"Design Data Book for Mechanical Engineers"** by K. G. Kala and B. D. Khandare (Townsend Publication, 2014).
2. **"Advanced Mechanics of Materials"** by Arthur P. Boresi and Richard J. Schmidt (John Wiley & Sons, 2003).
3. **"Mechanical Vibrations"** by S. S. Rao (Pearson Education, 2017).
4. **"The Finite Element Method: Its Basis and Fundamentals"** by O.C. Zienkiewicz and R.L. Taylor (Elsevier, 2013).
5. **"Textbook of Finite Element Analysis"** by P. Seshu (PHI Learning, 2003).

**List of Experiments :**

| Sr. No. | List of Experiment | RBT Level | COs |
|---|---|---|---|
| 1 | 3D Stress State Analysis: Computational modeling of a complex mechanical component to determine principal stresses and von Mises stresses under triaxial loading | L4 (Analyze) | CO1 |
| 2 | Contact Stress Analysis: Simulation of Hertzian contact stresses between two rotating cylinders or a ball and a flat plate to validate theoretical depth of maximum shear stress. | L4 (Analyze) | CO2 |
| 3 | Stress Concentration in Non-Circular Sections: Analysis of torsion and | L4 | CO2 |

| | | | |
|---|---|---|---|
| | shear stress distribution in non-circular members (e.g., elliptical or rectangular shafts) using FEA. | (Analyze) | |
| 4 | Extraction of Natural Frequencies: Determination of the first five natural frequencies and mode shapes of a multi-degree-of-freedom (MDOF) system using FEA. | L3 (Apply) | CO3 |
| 5 | Modal Analysis of Continuous Systems: Determination of natural frequencies for a cantilever beam, comparing FEA results with Euler-Bernoulli analytical solutions. | L4 (Analyze) | CO4 |
| 6 | Harmonic Response Analysis: Analysis of a mechanical system subjected to cyclic loading to identify resonance zones and steady-state displacement response. | L4 (Analyze) | CO3 |
| 7 | Steady-State Thermal Analysis: Modeling temperature distribution and heat flux in a composite wall or fin assembly with convection boundary conditions. | L3 (Apply) | CO6 |
| 8 | Transient Thermal Analysis: Simulation of the cooling rate of a forged component or a brake disc to determine time-dependent temperature gradients. | L4 (Analyze) | CO6 |
| 9 | Coupled Thermo-Structural Analysis: Analyzing the thermal stresses induced in a piping system or engine component due to non-uniform temperature distribution. | L5 (Evaluate) | CO6 |
| 10 | 1D and 2D Structural Modeling: Comparative study of displacement and stress results using Bar, Beam, and Plane Stress (CST) elements for a given truss or plate. | L3 (Apply) | CO5 |

**Reference Books:**

1. **"Design Data Book for Mechanical Engineers"** by K. G. Kala and B. D. Khandare (Townsend Publication, 2014).
2. **"Advanced Mechanics of Materials"** by Arthur P. Boresi and Richard J. Schmidt (John Wiley & Sons, 2003).
3. **"Mechanical Vibrations"** by S. S. Rao (Pearson Education, 2017).
4. **"The Finite Element Method: Its Basis and Fundamentals"** by O.C. Zienkiewicz and R.L. Taylor (Elsevier, 2013).
5. **"Textbook of Finite Element Analysis"** by P. Seshu (PHI Learning, 2003).

**Useful Links:**

**NPTEL Course - Advanced Mechanics of Solids https://nptel.ac.in/courses/105106049**

**NPTEL Course - Mechanical Vibrations : https://nptel.ac.in/courses/112103111**

**NPTEL Course - Finite Element Method : https://nptel.ac.in/courses/112104115**

| Course Title: Product Design and Development | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VIII | | | **Term:** Even | | | | **Course Code:** 24MEPECP8011C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or / Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |
| **Sustainable Development Goals:** 4, 8, 9, 11, 12 | | | | | | | | | | | | |

**Course Objectives:**

1. To understand the basic concepts of engineering design and product design & development, focusing on the front-end processes.
2. To demonstrate an understanding of the overview of all the product design & development processes.
3. To demonstrate knowledge of concept generation and the selection of tools.
4. To study the applicability of product design & development in industrial applications.

**Course Outcomes:** Learner will be able to…

1. Describe the process of product design & development.
2. Deploy engineering, scientific, and mathematical principles to develop and execute a design, project from a concept to a finished product.
3. Develop product design with specifications using QFD by identifying customers needs.
4. Demonstrate creativity and problem-solving approach for product design by using CAD software.
5. Develop team work for user-friendly design, design for serviceability, design for environment.
6. Demonstrate CAD modeling and Project Management skills on Design for Manufacturing Assembly (DFMA) and RP model.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Introduction to Product, Product Design & Product Development:** Need for developing products, the importance of Engineering and Industrial design, the design process, Relevance of product lifecycle issues in design, Societal considerations in Engineering and Industrial Design, Generic product development process, Various phases of product development, Establishing markets - market segments - relevance of market research. **Self-learning topic**: Planning for products | 8 | CO1 | 2 |
| II | **Design processes:** The design processes, Descriptive and prescriptive design models, Concept development & evaluation, Pugh's total design activity model, Concept generation and selection method, Product architecture, and Steps in developing product architecture. **Case Study:** Developing a Sustainable Product Design Framework for the Automotive Industry. **Self-learning topic**: Embodiment design | 8 | CO2 | 3 |
| III | **Customer Needs and Quality of Product Design:** Identifying customer needs, Voice of Customer (VoC):, Customer populations, Hierarchy of human needs, Need gathering methods, Establishing engineering characteristics, Competitive benchmarking, Quality Function Deployment (QFD), House of Quality (HoQ), Product design specification, | 7 | CO3 | 6 |

| | | | | |
|---|---|---|---|---|
| | Development of product design with specifications using QFD,<br>**Case Study:**. Apple's Approach to Balancing Innovation and Customer-Centric Design<br>**Self-learning topic**: Quality Function Deployment (QFD) case studies. | | | |
| IV | **Creative Thinking and Problem Solving Approach:**<br>Creative thinking, Creativity and problem-solving methods, Creative thinking methods, Brainstorming technique, Gorden technique, Check listing technique, Synectic technique, Morphological Analysis, and Attribute Listing technique. Generating design concepts, Systematic methods of designing.<br>**Self-learning topic**: Systematic methods of designing | 7 | CO4 | 3 |
| V | **Design Aspects of Industrial product:**<br>Industrial design, Basic forms & elements, Integrating basic forms & elements such as balance, rhythm, proportion, The golden rule of proportions, human factors, and design, User-friendly design, Design for serviceability, Design for environment.<br>**Case Study:** Industrial Design of Wind Turbines for Renewable Energy Applications.<br>**Self-learning topic**: User-friendly design | 7 | CO5 | 3 |
| VI | **Design for Manufacturing and Assembly (DFMA) and Introduction to Rapid Prototyping:**<br>Concept of Design for Manufacturing and Assembly (DFMA). Role of computers in product design and manufacturing process, Prototyping techniques such as Stereolithography (SLA), Selective laser sintering (SLS), Fused desposition Modelling (FDM), Laminated object manufacturing (LOM), 3-D printing, and Ballistic Particle Manufacturing (BPM).<br>**Case Study:** The Role of DFMA in the Development of the Tesla Model<br>**Self-learning topic**: Ballistic Particle Manufacturing (BPM).<br>**Advanced Topics:** Sustainable Product Lifecycle Engineering and Circular Design Strategies | 8 | CO6 | 3 |

**Text Books:**

1. Karl T. Ulrich, Steven D. Eppinger, and Maria C. Yang, "Product Design and Development", (7th Edition, 2020)
2. Steven E. LeBlanc, "Product Development: Principles and Tools for Creating Desirable and Transferable Products", (2020)
3. "The PDMA Handbook of New Product Development", (4th Edition, 2021)
4. Kevin Otto, Kristin Wood, "Product Design," Indian Reprint 2004, Pearson Education, ISBN 9788177588217.

**References Books:**

1. Clive L. Dym, Patrick Little, Elizabeth Orwin, and Richard Spjut, "Engineering Design: A Project-Based Introduction", (5th Edition, 2020).
2. Robert Curedale, "Design Thinking: Process and Methods Manual", (2021).
3. George E. Dieter, Linda C.Schmidt, "Engineering Design," 4th Edition, McGraw-Hill International Edition, 2009, ISBN 978-007-127189-9.
4. Yousef Haik, T. M. M. Shahin, "Engineering Design Process," 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141.

**Links for online NPTEL/SWAYAM courses:**

https://nptel.ac.in/courses/112107217

| Course Title: Optimization Techniques | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VIII | | | **Term:** Even | | | | **Course Code:** 24MEPECP8012C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| **3** | **-** | **-** | **3** | **-** | **-** | **3** | **20** | **20** | **60** | **-** | **-** | **100** |
| **Sustainable Development Goals:** 4, 8, 9, 12 | | | | | | | | | | | | |

**Course Objectives:**

1. To Understand the need and origin of the optimization methods.
2. To understand various linear, nonlinear and other optimization techniques.
3. To understand various multi criterion and multi-objective decision making methods.
4. To understand recent optimization tools

**Course Outcomes:**

1. Identify the types of optimization problems and apply the calculus method to single variable problems.
2. Formulate the problem as Linear Programming problem and analyse the sensitivity of a decision variable.
3. Apply various linear and non-linear techniques for problem solving in various domain.
4. Apply multi-objective decision making methods for problem in manufacturing environment and other domain.
5. Apply multi criterion decision making methods for problem in manufacturing environment and other domain.
6. Apply Design of Experiments method for Optimization.

| Module | Contents | Hours | CO'S | RBT Level |
|---|---|---|---|---|
| **I** | Basic Concepts: Statement of the Optimization Problem, Basic Definitions, Optimality Criteria for Unconstrained Optimization, Optimality Criteria for Constrained Optimization, Engineering Application of Optimization, Classification of Optimization Problems.<br>**Self-learning topics**: Classical Optimization Techniques: Single variable optimization | **06** | **CO1** | **3** |
| **II** | Linear Programming Problem: Formulation, Simplex method, Big M Method, Two Phase, Primal to Dual, Dual Simplex method, Sensitivity Analysis and applications of LP Transportation and Assignment Models. | **08** | **CO2** | **4** |
| **III** | Integer Programming Model: Gomory's cutting plane method, Branch &Bound Technique.<br>Non L.P. Model: Lagrangian method & Kuhn tucker Method, Newton'smethod.<br>**Self-learning topics**: Discrete Event Simulation: Generation of Random Variable, Simulation Processes, Monte-Carlo Technique. | **08** | **CO3** | **3** |
| **IV** | Multi Objective Decision making (MODM) Methods: Introduction to Multi objective optimization, Traditional Techniques such as, quadratic programming, geometric programming, Numerical on goal programming and dynamic programming.<br>**Self-learning topics**: Introduction to Non-traditional | **8** | **CO4** | **3** |

| | | | | |
|---|---|---|---|---|
| | optimization Techniques such as Genetic Algorithm, particle swarm, genetic algorithms, simulated annealing and Techniques based on Neural network & Fuzziness **(Only concepts)** | | | |
| **V** | Multi Criterion Decision-making (MCDM) Methods: Introduction to multi criterion optimization<br>Simple Additive Weighting (SAW) MethodWeighted Product Method (WPM) Analytic Network Process (ANP)<br>**Self-learning topics**: Analytic Hierarchy Process (AHP) MethodTOPSIS Method PROMETHEE | **7** | **CO5** | **3** |
| **VI** | Robust Design Methods: DOE and Taguchi techniques Full Factorial Design:<br>The basics of "full factorials", ANOVA, Factorial effects and plots, and Model evaluation<br>Fractional Factorial Design:<br>The one-half fraction and one-quarter of the 2k design, The general 2k-p fractional factorial design<br>**Self-learning topics**: Application of related software (Minitab, Design Expert or MATLAB)<br>**Advanced Topics:** Robust Multi-Objective Optimization under Uncertainty (Stochastic & Reliability-Based Design Optimization) | **8** | **CO6** | **3** |

**Reference Books:**

1. Pierre D.A., "Optimization, Theory with Application", John Wiley & sons.
2. Pablo Pedregal, "Introduction to Optimization", Springer.
3. Ritter, H., Martinetz, T., &Schulten, K., Addison, "Neural Computation and Self-Organizing Maps"-Wesley Publishing Company.
4. Douglas C. Montgomery, "Design and analysis of experiments" (John Wiley & Sons Inc.)

**Text Books:**

1. L.C. Jhamb, "Quantitative Techniques Vol. 1 and 2", Everest Pub. House.
2. Pierre D.A., "Optimization, Theory with Application", John Wiley & sons.
3. S.S. Rao, "Engineering Optimization - Theory and Practice", John Wiley and Sons Inc.
4. Ranjan Ganguli, "Engineering Optimization - A Modern Approach" Universities Press.

**Useful Links**

https://nptel.ac.in/courses/112/101/112101298/ - Optimization from Fundamentals, IIT Bombay

| Course Title: Total Quality Management | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VIII | | | **Term:** Even | | | | **Course Code:** 24MEPECP8013C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or / Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |
| **Sustainable Development Goals:** 9, 12, 8, 13, 16, 17 | | | | | | | | | | | | |

**Course Objectives:**

1. To understand the importance of Quality Management and principles of TQM.
2. To understand seven basic QC tools and advanced QM tools.
3. To understand the concept of Statistical Quality Control.
4. To understand the concept of Continuous Improvement and TQM implementation.
5. To understand different Quality Systems and Quality Standards.
6. To understand the future trends in TQM and TQM strategies.

**Course Outcomes:** Learner will be able to…

1. Apply QM and principles of TQM in organizational development process.
2. Apply the QC & QM tools in process improvement.
3. Apply SQC techniques to improve process quality.
4. Apply Six Sigma project in TQM Implementation.
5. Apply QMS and Certification for Quality Accreditation
6. Apply the advanced tools for Quality Sustainability.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Introduction to Quality Management:**<br>A) Definitions of Quality, product quality and service quality; the evolution of quality; need for Quality Management, Quality statements and Policy, Customer orientation & satisfaction, Customer complaints, customer retention; Supplier partnership, Supplier rating & selection, CSI, Costs of Quality, Prevention, appraisal and failure aspects, Use of COQ for improving quality and performance.<br>B) Basic concepts of TQM, TQM framework, Contributions of Deming, Juran and Crosby, Juran Trilogy, PDCA Cycle, Barriers to TQM; TQM principles; Strategic Quality Planning.<br>**Self-Learning: -** Designing for quality, Quality of design, Quality of conformance, Quality councils; employee involvement, motivation; Empowerment; Team and Teamwork; recognition and reward, performance appraisal | 8 | CO1 | 3 |
| II | **QC Tools:**<br>A) **Seven QC Tools:** Check Sheet, Histogram, Pareto Chart, Fishbone Diagram, Run Charts, Scatter Diagram,<br>B) **Seven QM Tools:** Program Decision Process Chart, Tree Diagram, Affinity Diagram, Prioritization Matrix, etc. Bench Marking Types – Process, Product<br>**Self-Learning: -** Process Flow Chart. Quality Improvement Tools: Why-Why Analysis, Root Cause Analysis, Poka Yoke (Mistake Proofing) | 8 | CO2 | 3 |
| III | **Statistical Quality Control:**<br>100% Inspection versus Sampling Inspection, Reasons for | 8 | CO3 | 3 |

| | | | | |
|---|---|---|---|---|
| | SQC.<br>**A) Acceptance Sampling**: Concept of Producer Risk and Consumers Risk. Operating Characteristics Curve. Sampling Plan – Single Sampling Plan versus Double Sampling Plan.<br>**B) Statistical Process Control**: Variations – Concept, Causes – Random & Assignable, Difference – Process in Control versus Process is Capable, Control Charts, X-Bar, R, P and C Charts, Process Capability (Cp) & Process Capability Index (Cpk), Sigma Limits. Applications of Control Charts in Mass Production, Process Production.<br>**Self-Learning: -** Design Sampling Plan on the basis of MIL, ASQ Standards. Sigma Limits. Applications of Control Charts in Mass Production, Process Production. | | | |
| IV | **A) Continuous Improvement**: Quality Circles, Quality Function Development (QFD), Taguchi quality loss function, Parameter Design, Robust Design; TPM- concepts, 5S, Kaizen,<br>**B) TQM Implementation**: Manufacturing and Service sectors, Introduction to Six Sigma: Definition, Concept, Methodology. Six Sigma Approaches – Design for Six Sigma (DFSS) Approach & DMAIC Approach,<br>**Self-Learning: -** FMEA- stages, Zero Defect. Six Sigma Tools: Applications to manufacturing and service sector including IT, ITeS, and E Com. | 7 | CO4 | 3 |
| V | **Quality Management System & Certification:**<br>**A) QMS**: Elements and documentation, Quality auditing, Necessity for Certification & Certification Process, Benefits of Certification. Certifying Bodies & Accreditation Agencies, ISO 9000-2015 (5 th Edition), Introduction to TS16949: Technical Specifications, QS9000, ISO14000- concepts, requirements and benefits. Case studies of TQM implementation in manufacturing and service sectors including IT and<br>**B) Quality Awards**: Malcom Baldrige National Quality Award and Rajiv Gandhi National Quality award.<br>**Self-Learning: -** Environmental management systems- ISO 14000 Series Standards, Integration of ISO 14000 with ISO 9000. | 7 | CO5 | 3 |
| VI | **Future Trends in TQM:**<br>Strategic approach to leadership, Customer centric endeavors, Involvement & empowerment of all employees / stake holders, Decision making based on real time facts, Win-Win policy with suppliers, new paradigms of Green & sustainability,<br>**Self-Learning: -** TQM beyond Manufacturing i.e. Healthcare, Education, Finance. Accountability through new tools and technologies, Quality Analytics<br>**Advanced Topics:** Blockchain-based Quality Management Systems | 7 | CO6 | 3 |

**Reference Books:**

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 6th Edition, South-Western (Thomson Learning), 2020.

2. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2023.

**Text Books:**

1. Besterfield D.H. et al.: Total quality Management, 3rd Edition, Pearson Education Asia, 2020.
2. Janakiraman B. and Gopal R.K.: Total Quality Management, Prentice Hall India, 2018.
3. Poornima M. Charantimath: Total Quality Management, 2nd Edition, Pearson Education Asia, 2015.

**Links for online NPTEL/SWAYAM courses:**

https://onlinecourses.nptel.ac.in/noc23_mg06/

| Course Title: Automobile Engineering | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VIII | | | **Term:** Even | | | **Course Code:** 24MEPECP8021C | | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | - | - | 3 | - | - | 3 | 20 | 20 | 60 | 0 | - | 100 |
| **Sustainable Development Goals:** 3,7,9,11,12,13 | | | | | | | | | | | | |

Course Objectives:

1. To understand construction and working of automobile systems
2. To analyze performance of engine and transmission systems
3. To study modern automotive technologies and trends
4. To develop problem-solving skills in vehicle design and operation

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Explain automobile components and vehicle layouts using engineering principles.
2. Analyze engine systems and explain their performance characteristics.
3. Analyze transmission and drivetrain systems for effective power transmission.
4. Evaluate braking, suspension, and steering systems based on performance criteria.
5. Analyze automotive electrical and electronic systems for proper functioning.
6. Evaluate emerging automotive technologies for efficiency and sustainability.

| Module | Content | Hours | COs | RBT Level |
|---|---|---|---|---|
| 1 | **Introduction to Automobiles**<br>• Classification of automobiles<br>• Vehicle construction and layouts (FR, FF, MR, 4WD)<br>• Major components of an automobile<br>• Chassis and frame types<br>• Introduction to vehicle specifications<br>**Self-learning:** Basics of vehicle aerodynamics | 7 | 1 | 2 |
| 2 | **Engine Systems**<br>• SI and CI engines – construction and working<br>• Engine components (piston, crankshaft, valves, etc.)<br>• Fuel supply systems (carburetor, fuel injection systems)<br>• Air intake and exhaust systems<br>• Cooling and lubrication systems<br>**Self-learning:** Turbocharging and supercharging | 8 | 2 | 4 |
| 3 | **Transmission Systems**<br>• Clutch: Types and working<br>• Gearboxes: Manual and automatic<br>• Propeller shaft, universal joints, differential<br>• Final drive and rear axle<br>**Self-learning:** Continuously Variable Transmission (CVT) | 8 | 3 | 4 |
| 4 | **Suspension, Steering, and Braking Systems**<br>• Suspension systems: Types and components<br>• Steering geometry and steering mechanisms<br>• Braking systems: Mechanical, hydraulic, air brakes, ABS<br>• Wheel alignment and balancing | 7 | 4 | 5 |

| | | | | |
|---|---|---|---|---|
| | **Self-learning:** Active and semi-active suspension systems | | | |
| 5 | **Electrical and Electronic Systems**<br>• Automotive electrical systems<br>• Battery, starting and charging systems<br>• Ignition systems<br>• Sensors and actuators<br>• Introduction to ECU and automotive electronics<br>**Self-learning:** Automotive embedded systems | 7 | 5 | 4 |
| 6 | **Modern Trends in Automobiles**<br>• Electric Vehicles (EVs) and Hybrid Vehicles<br>• Alternative fuels (CNG, LNG, Hydrogen)<br>• Autonomous and connected vehicles<br>• Emission norms and pollution control<br>• Introduction to ADAS (Advanced Driver Assistance Systems)<br>**Self-learning:**<br>**Advanced topic:** Battery Management Systems (BMS) in electric vehicles | 8 | 6 | 5 |

**Text Books**

1. *A Textbook of Automobile Engineering*, S.K. Gupta, S. Chand Publishing, Latest Edition, 2020. (S Chand Publishing)
2. *A Textbook of Automobile Engineering*, R.K. Rajput, Laxmi Publications, 2nd Edition, 2022. (Kopykitab)
3. *Automobile Engineering*, Dr. D.S. Kumar, S.K. Kataria & Sons, 2nd Edition (Reprint 2025). (S.K. Kataria and Sons)
4. *Automobile Engineering*, Dr. K.M. Moeed, S.K. Kataria & Sons, 2nd Edition (Reprint 2024). (S.K. Kataria and Sons)

**Reference Books**

1. *Automotive Handbook*, Robert Bosch GmbH, Wiley, 11th Edition, 2022. (Wiley)
2. *Braking of Road Vehicles*, Andrew J. Day, Elsevier, 2nd Edition, 2022. (Elsevier Shop)
3. *Smart Electric and Hybrid Vehicles: Advancements in Materials, Design, Technologies, and Modeling*, Ajay Kumar et al., Wiley, 1st Edition, 2024. (Wiley)
4. *Automobile Engineering Vol. I & II*, Kirpal Singh, Standard Publishers, Latest Edition. (Engineering Books)

**Useful Links:**
**https://onlinecourses.nptel.ac.in/noc21_de02/preview**
**https://www.coursera.org/courses?query=automobile%20engineering**

| Course Title: Composite Materials | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VIII | | | **Term:** Even | | | | **Course Code:** 24MEPECP8022C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE1** | **IAE2** | **ESE** | **CA** | **Or / Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | -- | 3 | 20 | 20 | 60 | -- | -- | 100 |
| **Sustainable Development Goals:** 9, 12, 13 | | | | | | | | | | | | |

**Course Objectives:**

1. To study the manufacturing methods of composite material.
2. To study the behaviour of composite materials, both at micro and macro levels.
3. To study the procedure of designing a composite laminate and structure as a whole for the given application.
4. To study the applicability of composite materials for various industrial/loading applications
5. To study the damage detection and damage repair methods for composite materials

**Course Outcomes:** Learner will be able to…

1. Select the type of material for the fibres and matrix in a composite material for the given application.
2. Relate stresses and strains through the elastic constants for a given lamina.
3. Evaluate elastic properties of a lamina based on the properties of its constituents.
4. Predict failure of a lamina under the given loading condition.
5. Select the number of laminae and their stacking sequence in a composite material for the given loading condition.
6. Identify the type of damage occurring in a composite structure and select an appropriate method to repair it.

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| I | **Introduction of Composite Materials:** Classifications based on fibres and matrix, Advantages, Applications, Terminology, Manufacturing Methods: Hand layup, Spray layup, Vacuum bagging, Prepregs, Industrial autoclave, Filament winding, Pultrusion, Resin transfer moulding, Vacuum Infusion Processing, **Self-learning topic**: Powder metallurgy route for ceramic and metal matrix composites | 10 | CO1 | 5 |
| II | **Analysis of Lamina**: Hooke's law for different types of materials, Plane stress assumption, Hooke's law for a two-dimensional unidirectional lamina, Relationship of compliance and stiffness matrix to engineering elastic constants of a lamina, Engineering constants of an angle lamina **Self-learning topic**: Hooke's law for a two-dimensional angle lamina | 8 | CO2 | 2 |
| III | **Lamina Failure Theories:** Introduction, Maximum stress failure theory, Maximum strain failure theory, Tsai-Hill failure theory, Strength ratio, Failure envelopes **Self-learning topic**: Tsai-Wu failure theory, | 5 | CO3 | 5 |
| IV | **Introduction to Micromechanics of Lamina and Laminate Design:** Prediction of mechanical properties of lamina based on properties | 7 | CO4 | 4 |

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|---|---|---|---|---|
| | of its constituents (fibre and matrix), Laminate types and their codes.<br>**Self-learning topic**: Overview of laminate design (no problems on this topic) | | | |
| V | **Inspection of Composites**:<br>Different types of damages in composites, Non-destructive testing of composites: Ultrasonics inspection, Acoustography, Low frequency Methods, Radiographic inspection, Shearography, Acoustic emission.<br>**Self-learning topic**: Thermography | 8 | CO5 | 5 |
| VI | **Repair of Composites:**<br>Restitution and repair of composites: Selection of Repair method, Repair criteria, Generic repair designs, Matrix cracks, Delamination, Holes and Fiber fracture,<br>**Self-learning topic**: Damage removal and surface preparation<br>**Advanced Topics:** Self-healing and Nano-engineered Composites for High-Performance Applications | 7 | CO6 | 4 |

**Text Books:**

1. Krishan K. Chawla, "Composite Materials: Science and Engineering", (4th Edition, 2021) (SpringerLink).
2. Bryan Harris,"Engineering Composite Materials", (2nd Edition, 2020) (Cambridge University Press & Assessment).
3. T. W. Clyne, and D. Hull, "An Introduction to Composite Materials", (3rd Edition, 2019) (Cambridge University Press & Assessment).
4. M.Balasubramanian, "Composites materials processing" ,1st edition, CRC press 2013.
5. A.K. Kaw, "Mechanics of Composite Materials", Taylor and Francis Group, ISBN: 9780815351481
6. Ajay Kapadia, "Non Destructive Testing of Composite Materials", National Composites Network
7. R.B. Heslehurst, "Defects and Damage in Composite Materials and Structures", CRC Press 2014.

**Reference Books**

1. **"Mechanics of Composite Materials" by Autar K. Kaw (2nd Edition, 2021) (Cambridge University Press & Assessment).**
2. **"Composite Materials: Applications in Engineering, Biomedicine and Food Science" (2019) (SpringerLink).**
3. R.M. Jones, "Mechanics of Composite Materials", 2nd Edition,Taylor and Francis, Inc,ISBN: 9781138571075
4. I.M. Daniel and O. Isai, "Engineering Mechanics of Composite Materials", 2nd Edition 2005,Oxford University Press, ISBN: 9780195150971
5. D. Gay, S.V. Hoe, and S.W. Tsai, "Composite Materials: Design and Applications", 3rd Edition 2014, CRC Press, ISBN: 978-1466584877
6. R.B. Heslehurst, "Defects and Damage in Composite Materials and Structures", CRC Press 2014.
7. M.M. Schwartz, "Composite Materials: Properties, Nondestructive Testing, and Repair", Prentice Hall PTR (1997), ISBN: 9780133000474

**Links for online NPTEL/SWAYAM courses:**

1. https://nptel.ac.in/courses/112104168
2. https://archive.nptel.ac.in/courses/112/103/112103298/

| Course Title: Vibration Controls | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VIII | | | **Term:** Even | | | | **Course Code:** 24MEPECP8023C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 3 | -- | -- | 3 | -- | - | 3 | 20 | 20 | 60 | - | - | 100 |
| **Sustainable Development Goals:** 9, 11, 13 | | | | | | | | | | | | |

**Course Objectives:**
1. To study Vibration Absorbers.
2. To study Vibration Isolators.
3. To study Vibration Control.

**Course Outcomes**: Learner will be able to…
1. Apply basic concepts of Vibration Isolation and Damping.
2. Identify suitable Vibration Absorber
3. Identify suitable Vibration Isolator
4. Apply suitable method to Control the vibrations to the acceptable level.
5. Analyze suitable Vibration Absorber
6. Analysis of Active and semi-active vibration isolation

| Module | Contents | Hours | COs | RBT Level |
|---|---|---|---|---|
| **I** | 1.1 **Introduction**: Vibration reduction at source, factors affecting vibration level, isolation of the source, methods of vibration control, **Self-Learning Topic**: dynamic properties and selection of materials | **08** | **CO1** | **3** |
| **II** | 2.1 Dynamic vibration absorbers: Dynamic vibration neutralizers, self-tuned pendulum neutralizer, optimum design of damped absorbers, absorber with ideal spring and viscous dashpot, gyroscopic vibration absorbers, **Self-Learning Topic** impact absorbers, absorbers attached to continuous systems | **08** | **CO2** | **2** |
| **III** | 3.1 Vibration isolation of single degree of freedom systems: Isolators with complex stiffness, Isolators with Coulomb damping, Three element isolators, **Self Learning Topic :**Two-stage isolators, Pneumatic suspension, Concept of negative stiffness in vibration isolation. | **08** | **CO3** | **2** |
| **IV** | 4.1 Active vibration control: Classification and modelling, actuators and sensors for active vibration control, Active vibration absorption and damping, classical control, optimal control, Piezoelectric transducers for active vibration control **Self Learning Topic:** Semi-active vibration control: Introduction, Magneto-rheological fluids, MR models and devices, semi-active suspension, narrowband disturbance | **07** | **CO4** | **3** |
| **V** | 5.1 Active, semi-active, and adaptive dynamic vibration absorbers: Active tuned vibration absorber, active mass damper, **Self Learning Topic** adaptive vibration absorber, semi-active tuned vibration absorber | **07** | **CO5** | **4** |

| | | | | |
|---|---|---|---|---|
| **VI** | 6.1 Active and semi-active vibration isolation: Active single-axis base isolation, active force isolation system, isolator based on piezoelectric stack actuator, semi-active isolation,<br>**Self Learning Topic** Adaptive-passive vibration isolation, active control of vehicle suspensions<br>**Advanced Topic:** Design and Optimization of Tuned Mass Dampers for High-Rise Buildings and Machinery | **07** | **CO6** | **4** |

**Reference Books:**

1. A.K. Mallik and A. Chatterjee, "Principles of Active and Passive Vibration Control", East-WestPress 2014, ISBN: 9788176710985

2. A. Preumont, "Vibration Control of Active Structures", Springer 2018, ISBN: 9783319722962

**Text Book:**

1. S.S. Rao, "Mechanical Vibrations", 5th Edition 2004, Pearson Publications

2. Clarence de Silva, "Vibration: Fundamentals and Practice",1st Edition 2000, CRC Press, ISBN:

0849318084

**Useful Links**

https://nptel.ac.in/courses/112104211– Principles of Vibration Control, IIT Kanpur

https://nptel.ac.in/courses/112107088– Vibration control, IIT Roorkee

| Course Title: Constitution of India | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VIII | | | **Term:** Even | | | | **Course Code:** 24MEVEC801C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| 1 | -- | -- | 1 | -- | - | 1 | 10 | 10 | 30 | - | - | 50 |
| **Sustainable Development Goals:** 4, 10, 16 | | | | | | | | | | | | |

**Course Objectives:**

1. To introduce students to the fundamental principles and key elements of the Indian Constitution.
2. To familiarize students with the historical evolution of India as a Republic.
3. To develop an understanding of the structure and functioning of major political institutions in India.
4. To enable students to analyze the role of the Constitution in shaping governance and democratic

**Course Outcomes**: Learner will be able to…

1. Explain the making and key features of the Indian Constitution.
2. Describe Fundamental Rights, Duties, and Directive Principles.
3. Explain the structure and functions of the Union Government.
4. Describe the structure and functions of the State Government.
5. Explain the composition and role of the Judiciary and judicial review.
6. Describe the electoral process and role of the Election Commission.

| Module | Contents | Hours | COs |
|---|---|---|---|
| **I** | **Making of Indian Constitution**: Constituent Assembly-Composition, Objectives, Preamble and Salient features of the Indian Constitution. | **3** | **CO1** |
| **II** | Fundamental Rights, Fundamental Duties, Directive Principles. | **3** | **CO2** |
| **III** | **Union Government:** President, Prime Minister and Council of Ministers | **3** | **CO3** |
| **IV** | **State Government:** Governor, Chief Minister and Council of Ministers | **2** | **CO4** |
| **V** | **Judiciary:** Supreme Court and High Court: Composition, Powers and Functions and Judicial Review | **2** | **CO5** |
| **VI** | **Electoral Process:** Election Commission-Composition, Powers and Functions, Electoral Reforms. | **2** | **CO6** |

***Note:*** *The Constitution of India is designated as a self-study course. Students are expected to undertake independent learning of the prescribed syllabus and appear for the examination accordingly.*

**Reference Books:**

**1.** Durga Das Basu, Introduction to the Constitution of India, Gurgaon; Lexis Nexis, (23rdedn.) 2018.

**2.** M. V. Pylee, India‟s Constitution, New Delhi; S. Chand Pub., (16thedn.) 2017.

**3.** J. N. Pandey, The Constitutional Law of India, Allahabad; Central Law Agency, (55thedn.)

2018.

4. Constitution of India (Full Text), India.gov.in., National Portal of India, https://www.india.gov.in/sites/upload_files/npi/files/coi_part_full.pdf 5.

5. K. Sharma, Introduction to the Constitution of India, Prentice Hall of India, New Delhi,2002.

6. P. M Bakshi, Constitution of India, Universal Law Publishing House, NewDelhi,1999.

7. D. C. Gupta, Indian Government and Politics, Vikas publishing House, New Delhi, 1975.

8. S. N. Jha, Indian Political System: Historical Developments, Ganga Kaveri Publishing House, Varanasi,2005.

9. Arora & Mukherji, Federalism in India, Origin and Developments, Vikas Publishing House, New Delhi,1992.

**Useful Links**

https://onlinecourses.swayam2.ac.in/e-learning/preview/imb26_mg151

https://onlinecourses.nptel.ac.in/noc24_lw05/preview

https://onlinecourses.nptel.ac.in/noc24_lw09/preview

| Course Title: Major Project | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VIII | | | **Term:** Even | | | | **Course Code:** 24MEPRJ801C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or / Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| -- | -- | 12 | -- | -- | 6 | 6 | -- | -- | -- | 100 | 100 | 200 |

**Sustainable Development Goals:** "SDG mapping will be carried out based on the project topic and its relevance to sustainable development goals."

**Course Objectives:**
The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification to successful completion of the project by implementing the solution.

**Course Outcomes:**
1. Students will be able to implement solutions for the selected problem by applying technical and professional skills.
2. Students will be able to Analyse impact of solutions in societal and environmental context for sustainable development.
3. Students will be able to collaborate best practices along with effective use of modern tools.
4. Students will be able to develop proficiency in oral and written communication with effective leadership and teamwork.
5. Students will be able to nurture professional and ethical behavior.
6. Students will be able to gain expertise that helps in building lifelong learning experience.

**1. Guidelines:**
Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.

**2. Project Report Format:**
At the end of semester, each group needs to prepare a project report as per the guidelines issued by the University of Mumbai. Report should be submitted in hardcopy. Also, each group should submit softcopy of the report along with project documentation, implementation code, required utilities, software and user Manuals.
A project report should preferably contain at least following details:
- Abstract
- Introduction
- Literature Survey/ Existing system
- Limitation Existing system or research gap
- Problem Statement and Objective
- Proposed System
- Analysis/Framework/ Algorithm
- Design details
- Methodology (your approach to solve the problem) Proposed System

**o Experimental Set up**
- Details of Database or details about input to systems or selected data
- Performance Evaluation Parameters (for Validation)
- Software and Hardware Set up

**o Results and Discussion**
- Conclusion and Future Work
- References
- Appendix – List of Publications or certificates

**3. Desirable**

- Students should be encouraged
  - To participate in various project competitions.
  - To write minimum one technical paper & publish in good journal.
  - To participate in national / international conference.

**4. Continuous Assessment:**

Distribution of marks for term work shall be done based on following:

a. Weekly Log Report
b. Completeness of the project and Project Work Contribution
c. Project Report (Black Book) (both side print)
d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

**5. Oral & Practical:**

Oral & Practical examination (Final Project Evaluation) of Major Project-II should be conducted by Internal and External examiners at the end of the semester.

**6. Suggested quality evaluation parameters are as following:**

1. Relevance to the specialization / industrial trends
2. Modern tools used
3. Innovation
4. Quality of work and completeness of the project
5. Validation of results
6. Impact and business value
7. Quality of written and oral presentation
8. Individual as well as team work

| Course Title: Internship | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester:** VIII | | | **Term:** Even | | | | **Course Code:** 24MEOJT801C | | | | | |
| **Teaching Scheme** | | | | | | | **Evaluation Scheme** | | | | | |
| **Contact Hrs.** | | | **Credit Allotted** | | | **Total Credit** | **IAE 1** | **IAE 2** | **ESE** | **CA** | **Or/Pr** | **Total** |
| **Th** | **Tu** | **Pr** | **Th** | **Tu** | **Pr** | | | | | | | |
| - | - | 39 | - | - | 13 | 13 | - | - | - | 300 | 150 | 450 |

**Introduction**

A Full Semester Internship is an experiential learning component designed to bridge the gap between academic learning and professional practice. It provides students with an opportunity to work in industries, research organizations, startups, government organizations, MSMEs, or other approved organizations related to their discipline. During the internship, students apply engineering concepts to real-world problems, gain exposure to industrial practices, develop technical and professional competencies, and enhance their employability.

The internship encourages innovation, teamwork, communication, ethical practices, and lifelong learning while preparing students for successful careers or higher education.

**Course Objectives:**

1. Apply engineering knowledge to solve real-world industrial problems.
2. Develop technical competency through hands-on industrial experience.
3. Enhance professional ethics, communication, teamwork, and leadership skills.
4. Strengthen research aptitude, innovation, and entrepreneurial thinking.
5. Understand industrial practices, project management, and organizational culture.

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

1. Apply engineering knowledge, modern tools, and domain-specific skills to solve real-world industrial problems.
2. Analyze industrial processes and develop effective technical solutions by integrating theoretical concepts with practical applications.
3. Demonstrate technical competency, innovation, and research aptitude while executing assigned industrial projects.
4. Exhibit professionalism through ethical practices, effective communication, teamwork, leadership, and project management skills.
5. Prepare comprehensive technical documentation, maintain project records, and communicate outcomes through professional reports and presentations.
6. Evaluate industrial practices, reflect on professional learning experiences, and demonstrate readiness for employment, entrepreneurship, or higher studies.

**Internship Guidelines:**

- Students shall obtain prior approval from the Department and Training & Placement Cell before joining the internship.
- The internship shall be carried out during the entire VIII Semester with a minimum duration of 16 weeks.
- The internship shall be undertaken in industries, research organizations, startups, MSMEs, government organizations, academic research laboratories, or other organizations approved by the Institute.
- Students shall submit the approval letter Offer Letter, and Company Profile before commencement of the internship.
- Every student shall provide Industry Mentor's contact details and an assigned Faculty Mentor for continuous guidance and evaluation.
- Students shall maintain minimum 90% attendance or as prescribed by the host organization.
- A Weekly Internship Diary/Logbook shall be maintained and verified periodically by the Industry Mentor.
- Faculty Mentors shall conduct regular reviews (online/offline) throughout the internship period.
- Students shall strictly follow the rules, regulations, confidentiality policies, safety practices, and code of conduct of the host organization.
- Any change in internship organization shall require prior approval from the Institute.
- At the end of the internship, students shall submit all required documents and appear for the final presentation and viva-voce.

**Evaluation and Assessment Scheme:**

**A. Documents to be Submitted**

The following documents shall be submitted after completion of the internship:

- Internship Offer Letter
- Approval letter of college
- Attendance Certificate
- Weekly Internship Diary / Logbook
- Employer Evaluation Form
- Internship Completion Certificate
- Final Internship Report (consisting of all Proofs like geotag photos, copy of attendance record & salary slips of all months).
- Presentation Slides
- Project Demonstration (where applicable)

**B. Evaluation Scheme (450 Marks)**

| Sr. No. | Assessment Component | Assessment By | Marks |
|---|---|---|---|
| 1 | Attendance, Punctuality & Professional Conduct | Industry Mentor | 40 |
| 2 | Weekly Internship Diary / Logbook | Faculty Mentor | 40 |
| 3 | Progress Review–I | Institute Evaluation Committee | 30 |
| 4 | Progress Review–II | Institute Evaluation Committee | 30 |
| 5 | Technical Performance & Project Execution | Industry Mentor | 60 |
| 6 | Industry Mentor Evaluation | Industry Mentor | 50 |
| 7 | Final Internship Report | Institute Evaluation Committee | 50 |
| | **Continuous Assessment (CA)** | | **300** |
| 8 | Final Presentation, Demonstration & Viva-Voce (OR/PR) | Institute Evaluation Committee | 150 |
| | **Total** | | **450** |

➢ **Assessment Criteria**

- The assessment shall be based on:
- Regularity and discipline during the internship.
- Quality of technical work carried out.
- Problem-solving ability and innovation.
- Technical knowledge and practical competency.
- Communication skills and teamwork.
- Employer's feedback and professional conduct.
- Quality of the internship report and documentation.
- Technical presentation and viva-voce performance.

Students must obtain satisfactory performance in both the industrial assessment and institute evaluation to successfully complete the course. Submission of false documents, plagiarism, or violation of organizational policies shall invite disciplinary action as per Institute regulations.

## VISION

**Excellence in Engineering Education & Creating Next-Gen Leaders / Managers in the Service of Society"**

## MISSION

- **To impart transformative and multidisciplinary engineering education for holistic development.**
- **To provide a conducive and inclusive environment for joyful experiential learning, innovation, and research.**
- **To promote student-centric and technology-enabled teaching and learning processes.**
- **To nurture socially responsible and ethical engineers, entrepreneurs, and leaders.**
- **To enhance employability, entrepreneurship, and higher study opportunities through strong industry–institute collaboration.**




