

SYLLABUS
for
7th SEMESTER
B.TECH. DEGREE
in
MECHANICAL ENGINEERING

(Applicable from the academic session 2024-2025)



Approved by BOS(ME) dt 18.5.2025
& Academic Council, Agenda 02.04
dt 23.4.2025

Chatterjee



Dr. B. C. Roy Engineering College

An Autonomous Institution

Approved by: All India Council for Technical Education (AICTE)

*Affiliated to: Maulana Abul Kalam Azad University of Technology, West
Bengal (Formerly Known as -WBUT)*

Jemua Road, Durgapur, West Bengal, India,713206

Course Name: Finite Element Analysis

Course Code: ME-401

(Semester VII)

Course Broad Category: Professional Elective Courses

1. Course Prerequisite:

Engineering Mechanics, Strength of Materials,
Mathematics

2. Course Learning Objectives:

To apprise the students about the basics of the Finite Element analysis technique, a numerical tool for the solution of different classes of problems in solid mechanics, thermal engineering, and fluid mechanics.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Real World Problem Discussion.

Evaluation System –

A. CIA-1(40 Marks)

(Class Test (Objective + Subjective)) : 25 Marks, Assignment : 10 Marks,
Attendance : 5 Marks

B. CIA-2(40 Marks)

(Class Test (Objective + Subjective)) : 25 Marks, Assignment : 10 Marks,
Attendance : 5 Marks

C. End Semester Examination : 60 Marks.

4. Course Content:

Course Name: Finite Element Analysis

Course Code: ME-401

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module | Topics | 45L |
|---------------|---|------------|
| 1 | Historical Background: Relevance of FEA / FEM to design, Continuum & Discretization, Matrix Algebra, Gaussian Elimination, Rayleigh-Ritz Method, Galerkin's Method, Governing Equations for Continuum, Weighted Residual Methods. | 6L |

| | | |
|---|---|-----|
| 2 | <p>Shape Functions & Coordinate Systems: Element Shapes, Nodes, Nodal Unknowns, Shape Functions: Introduction, Polynomial Shape Functions, Convergence Requirements of Shape Functions, Derivation of Shape Functions using Polynomials, Finding Shape Functions using Lagrange Polynomials, Shape Functions for Serendipity Family Elements, Hermite Polynomials as Shape Functions, Coordinate Systems: Global Coordinates, Local Coordinates & Natural coordinates in 1D, Strain Displacement Matrix for a Bar Element, CST Element & Beam Element.</p> | 9L |
| 3 | <p>Variational Method & Discretization: Assembling Stiffness Equation by Direct Approach : Introduction, Element Stiffness Matrix for CST Element by Direct Approach, Nodal Loads by Direct Approach, Applied to Elasticity Problems, Variational Method : Introduction, General Variational Method in Elasticity Problems, Potential Energy in Elastic Bodies, Principles of Minimum Potential Energy, Variational Formulation in Finite Element Analysis, Discretization of Structure : Introduction, Nodes as Discontinuities, Refining Mesh, Use of Symmetry, Finite Representation of Infinite Bodies, Element Aspect Ratio, Higher Order Element vs Mesh Refinement, Numbering System to Reduce Band Width.</p> | 9L |
| 4 | <p>FEA of Bars & Trusses : Introduction, Tension Bars / Columns, Two Dimensional Trusses (Plane Trusses), FEA for Plain Stress & Plain Strain : Introduction, General Procedure when CST Elements are Used, Use of Higher Order Elements, Isoparametric Formulation : Introduction, Coordinate Transformation, Basic Theorems of Isoparametric Concept, Uniqueness of Mapping, Isoparametric, Superparametric and Subparametric Elements, Assembling Stiffness Matrix.</p> | 8L |
| 5 | <p>FEA Application in Heat Transfer & Fluid Flow: One-Dimensional Heat Conduction, One-Dimensional Heat Transfer in Thin Fins, Two-Dimensional Steady-State Heat Conduction, Two-Dimensional Fins, One-Dimensional Finite Element Formulation of Fluid Flow, Two-Dimensional Finite Element Formulation of Fluid Flow. Computer Implementation : Introduction, Commercially Available Standard Packages, Structure of a Finite Element Analysis Program, Pre and Post Processors, Desirable Features of FEA Packages.</p> | 13L |

5. References:

Text Book:

- S S Bhavikatti, Finite Element Analysis, 3rd Edition; Publisher. New Age International Publishers
- T R Chandrupatla, A D Belegundu, Introduction to Finite Elements in Engineering, 4th Edition, **Publisher.** Pearson.

Reference Books:

- P Seshu, Textbook of Finite Element Analysis; **Publisher.** PHI Learning Private Limited.
- U S Dixit, Finite Element Methods For Engineers; **Publisher.** Cengage Learning.
- David V Hutton, Fundamentals of Finite Element Analysis; **Publisher.** McGraw Hill Education
- R D Cook, D S Malkus, M E Plesha, R J Witt, Concepts and Applications of Finite Element Analysis, 4th Edition; **Publisher.** John Wiley & Sons, Inc.,
- Daryl L Logan, A First Course in the Finite Element Method, 6th Edition; **Publisher.** CENGAGE
- O C Zienkiewicz & R L Taylor, The Finite Element Method; **Publisher.** Butterworth Heinemann.

Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|--|-------------|-----------------|
| CO1 | Understand basic equations of FEA which would help to apply solutions in engineering problems. | Apply | Understand |
| CO2 | Develop the knowledge and skills needed to effectively evaluate FEA. | Develop | Analyze |
| CO3 | Understand the concept to explain different methods of FEA. | Explain | Understand |
| CO4 | Formulate Finite Element characteristic equations for two dimensional elements and Analyze plain stress & plain strain problems. | Formulate | Analyze |
| CO5 | Apply finite element method to solve problems in heat transfer & fluid mechanics. | Solve | Apply |
| CO6 | Analyze the ideas of mentioned FEA tools to solve complex real-life problems. | Solve | Analyze |

6. Mapping of course outcomes to module / course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | - | - | - | - | - |
| 2 | - | 3 | - | - | - | - |
| 3 | - | - | 3 | - | - | - |
| 4 | - | - | - | 3 | - | - |
| 5 | - | - | - | - | 3 | 3 |

7. Mapping of the Course outcomes to Program Outcomes

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-----|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1 | 2 | 1 | 1 | 1 | 3 | 1 | - | - | - | - | 1 |
| CO2 | 2 | 1 | 1 | 1 | 3 | 1 | - | - | - | - | 1 |
| CO3 | 2 | 1 | 1 | 1 | 3 | 1 | - | - | - | - | 1 |
| CO4 | 2 | 1 | 1 | 1 | 3 | 1 | - | - | - | - | 1 |
| CO5 | 2 | 1 | 1 | 1 | 3 | 1 | - | - | - | - | 1 |
| CO6 | 2 | 1 | 1 | 1 | 3 | 1 | - | - | - | - | 1 |

8. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|------------|-------------|-------------|
| CO1 | 3 | 1 |
| CO2 | 3 | 1 |
| CO3 | 3 | 1 |
| CO4 | 3 | 1 |
| CO5 | 3 | 1 |
| CO6 | 3 | 1 |

*****End of Syllabus*****

Course Name: Computer Aided Engineering (CAE)
Course Code: ME-402
(Semester VII)
Course Broad Category: Professional Elective

1. Course Prerequisite:

Engineering Mathematics, Design of Machine Elements, and concept of Manufacturing Technology.

2. Course Learning Objectives:

The objective of this course is to familiarize students with the fundamental principles and applications of Computer-Aided Engineering (CAE). It aims to equip students with essential concepts and tools in Computer-Aided Design (CAD), Finite Element Method (FEM), and Computational Fluid Dynamics (CFD) to solve engineering problems effectively. The course also introduces CNC programming and geometric modeling techniques, along with methodologies for Computer-Aided Process Planning (CAPP), enabling students to integrate modern computational tools into mechanical engineering design and manufacturing processes.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1: 40 Marks

(Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5Marks)

CIA-2: 40 Marks

(Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks)

End-Semester Examination: 60 Marks

4. Course Content:

Course Name: Computer Aided Engineering (CAE)

Course Code: ME-402

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module | Topics | 41L |
|--------|---|-----|
| 1. | Introduction to Computer Aided Engineering Fundamentals of Computer Aided Engineering (CAE), Application in industry: mass property, mechanical assembly, kinematic analysis & animation etc. | 2L |
| 2. | Theory of Finite Element Method Basics of FEM, steps in FEM, formation of stiffness matrix, Direct FEM formulation: axial rod problem, beam problem, heat transfer problem of a | 8L |

| | | |
|----|---|-----|
| | 2D rod using FEM, FEM software. | |
| 3. | Introduction to Computational Fluid Mechanics Fundamentals of CFD, Applications of CFD, Finite Difference Method, Classification of Partial Differential Equations, Boundary & Initial Conditions, Dirchlet, Neumann and mixed boundary conditions, Finite Difference by Taylor series expansion, truncation error, forward difference approximation, backward difference approximation, convergence, difference between FEM & FDM, CFD software. | 10L |
| 4. | CNC machining History of NC & CNC, Basics of CNC, coordinate system, structure of a part program, G-codes, M-codes, canned cycle, APT (Automatically Programmed Tool) language. | 6L |
| 5. | Theory of Geometric Modeling CAD & geometric modeling need of geometric modeling, types of geometric modeling, wire-frame model, surface model, solid model, analytical and synthetic curves, parametric & non-parametric curves, order of continuity, Hermite cubic curve, Bezier curve, B-spline curve. | 7L |
| 6. | Computer Aided Process Planning Process planning, methods of process planning, difference between conventional process planning & computer aided process planning, computer aided process planning system. | 8L |

**5.
Ref
ere**

nces:

Text Book:

1. CAD/CAM, Sareen-Grewal, S. Chand.
2. Computational Fluid Dynamics and Heat Transfer, P.S. Ghoshdastidar, Cenage.
3. Finite Element Methods for Engineers- U. S. Dixit, Cenage.

Reference Books:

1. Mastering CAD/CAM by Ibrahim Zeid, McGraw-Hill.
2. Computer Aided Engineering Design by Saxena & Sahay Springer.
3. A First Course in the Finite Element Method by Logan, Cenage.
4. Computational Fluid Dynamics by John D. Anderson Jr., McGraw Hill.

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|--|-------------------|-----------------|
| ME-402.1 | Visualize the principles and applications of computer aided design as a modern tool. | Visualize | Understand |
| ME-402.2 | Analyze different design problems using FEM. | Analyze | Analyze |
| ME-402.3 | Interpret basic principles of CFD as a problem solving tool. | Interpret | Understand |
| ME-402.4 | Write part programme using the knowledge of CNC machines, tools & work handling system. | Write | Create |
| ME-402.5 | Illustrate aspects of geometric modelling viz. wireframe, surface and solid | Illustrate | Apply |

| | | | |
|-----------------|---|------------------|------------|
| | modelling. | | |
| ME-402.6 | Elaborate the methodology Computer Aided Process Planning. | Elaborate | Understand |

7. Mapping of course outcomes to module / course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | - | - | - | - | - |
| 2 | - | 3 | - | - | - | - |
| 3 | - | - | 3 | - | - | - |
| 4 | - | - | - | 3 | - | - |
| 5 | - | - | - | - | 3 | - |
| 6 | - | - | - | - | - | 3 |

8. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| CO1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 1 |
| CO2 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | - | 1 | - | 1 |
| CO3 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | - | 1 | - | 1 |
| CO4 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | - | 1 | - | 1 |
| CO5 | 2 | 1 | 1 | 3 | 2 | 1 | 1 | - | 1 | - | 1 |
| CO6 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | - | 2 | - | 1 |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|------------|------|------|
| CO1 | 2 | 1 |
| CO2 | 2 | 1 |
| CO3 | 2 | 1 |
| CO4 | 2 | 1 |
| CO5 | 2 | 1 |
| CO6 | 2 | 1 |

*** End of Syllabus***

Course Name: Renewable Energy Engineering
Course Code: ME 403
(Semester VII)
Course Broad Category: Professional Elective Courses

1. Course Prerequisite:

Thermodynamics, Fluid Mechanics, Heat Transfer

2. Course Learning Objectives:

To have an idea about different sources of renewable energy that would be sustainable.

To have the concept of using solar energy for heating as well as Photovoltaic Generation.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

CIA-2-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Renewable Energy Engineering

Course Code: ME 403

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module | Topics | 45L |
|--------|---|-----|
| 1. | Principles of Renewable Energy: The history of energy scene, energy of the future: sustainable energy, development and role of renewable energy, Scientific Principles of renewable energy. Review of principles of thermodynamics, fluid dynamics and heat transfer. | 5L |
| 2. | Introduction to Solar Energy, Solar Radiation: i) Sun-Earth geometry, ii) Extraterrestrial Solar Radiation, iv) Measurement and estimation of solar radiation. Numerical Examples. Solar Thermal: Solar Water Heating: i) Flat Plate Collectors: Heat Transfer analysis, Testing ii) Evacuated Tube Collectors, Concentrated Solar Thermal Power. Other Solar Thermal Applications: i) Air heaters, ii) Water Desalination, iii) Space Cooling, iv) Solar Concentrators, v) Solar ponds. Worked out problems. Wind Power: Introduction to Wind Energy, i) Turbine types & terms, ii) Mechanical & Electrical Power from Wind Turbines, Wind Speed and Power | 21L |

| | | |
|----|--|-----|
| | Analysis, Design of Wind Turbine, Wind Turbine Parts and Performance, Wind farms, Offshore Wind Turbines. Numerical Examples | |
| | Hydro-power: Hydro Power, The Fundamentals of various Turbine working principle, Hydraulic turbine Selection, Pumped Hydro Storage, Worked Out Examples of Hydro-Power. | |
| | Solar Photo-voltaic: Generation: i) Photon absorption at Silicon p-n junction, ii) Solar Cell, iii) Application and Systems. | |
| 3. | Bioenergy, Biomass & Biofuels: i) Use of Biomass, ii) Classification & Use of Biofuels, Biofuel Feedstocks, Bioenergy Technology and Sustainability, Production Technologies for Bioethanol, Biodiesel and Biogas | 12L |
| | Wave Power & Tidal Power: Basic Concepts | |
| | Ocean Thermal Energy Conversion, Geothermal Energy. | |
| | Fuel Cells and Hydrogen Energy: Hydrogen production and storage technologies, Fuel cell technology, Fuel cell types, | |
| 4. | Energy Storage Systems: Introduction to energy storage systems, Basics of - Mechanical energy storage technologies, Energy storage system through Capacitor, Electrochemical Energy Storage Systems, Thermal Energy Storage Systems. | 7 |

5. References:

1. G. Boyle, Renewable Energy, 2nd Edition, Oxford University Press, 2010.
2. J. Twidell and T. Weir, Renewable Energy Resources, 2nd Edition, Taylor & Francis, 2006.
3. B. H. Khan, Non-Conventional Energy Resources, McGraw Hill, 2010.
4. G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers, New Delhi, 2017.
5. Ashish Chandra, Non-Conventional Energy Sources, Khanna Publishers, New Delhi, 2019.

5. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|---|-------------|-----------------|
| ME 403.1 | Apply Scientific Principles to Renewable Energy Technologies. | Apply | Apply |
| ME 403.2 | Evaluate Solar, Wind and Hydro-Power Energy Systems | Evaluate | Evaluate |
| ME 403.3 | Analyze and Implement Photovoltaic Systems | Analyze | Analyze |
| ME 403.4 | Explore Biomass Energy Technologies | Explore | Apply |
| ME 403.5 | Investigate Emerging Renewable Energy Sources (Ocean, Tidal, Wave, Geothermal, Fuel Cell technology etc.) | Investigate | Apply |
| ME 403.6 | Understand the working of energy storage systems. | Understand | Understand |

6. Mapping of course outcomes to module / course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | - | - | - | - | - |
| 2 | 1 | 3 | 2 | - | - | - |
| 3 | 1 | - | - | 3 | - | - |
| 4 | 1 | - | - | - | 3 | 2 |

7. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| ME 403.1 | 1 | 2 | 1 | 1 | - | 3 | 1 | 1 | 1 | - | 1 |
| ME 403.2 | 1 | 1 | 1 | 1 | - | 1 | 3 | 1 | 1 | - | 1 |
| ME 403.3 | 2 | 2 | 3 | 1 | - | 2 | 1 | 1 | 1 | - | 1 |
| ME 403.4 | 1 | 3 | 1 | 1 | - | 1 | 1 | 1 | 1 | - | 1 |
| ME 403.5 | 1 | 1 | 1 | 3 | - | 2 | 3 | 1 | 1 | - | 1 |
| ME 403.6 | 1 | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | - | 1 |

8. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|----------|------|------|
| ME 403.1 | 1 | 2 |
| ME 403.2 | 1 | 2 |
| ME 403.3 | 1 | 2 |
| ME 403.4 | 1 | 2 |
| ME 403.5 | 1 | 2 |
| ME 403.6 | 1 | 2 |

*** End of Syllabus***

Course Name: Computational Fluid Dynamics
Course Code: ME 404
(Semester VII)
Course Broad Category: Professional Elective

1. Course Prerequisite:

Basic knowledge of Fluid Mechanics, Engineering Mathematics, Heat Transfer, Numerical Methods and Programming using C++/MATLAB/Fortran/Python.

2. Course Learning Objectives:

The objective of this course is to provide an understanding of the fundamental concepts and numerical methods used in Computational Fluid Dynamics (CFD). The course will introduce students to governing equations of fluid dynamics, discretization methods, solution algorithms, and turbulence modeling, enabling them to apply CFD techniques to practical engineering problems.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

CIA-2-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Computational Fluid Dynamics

Course Code: ME 404

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module | Topics | 45L |
|--------|--|-----|
| 1. | <p>Introduction to CFD and Governing Equations:</p> <ul style="list-style-type: none"> • Overview of Computational Fluid Dynamics (CFD) and its applications. • Governing equations of fluid flow: Navier-Stokes equations, mass, momentum, and energy conservation laws. • Classification of Partial Differential Equations (PDEs): Elliptic, Parabolic, and Hyperbolic equations. • Initial and Boundary conditions, Well-posed problems. | 7L |
| 2. | <p>Discretization Techniques</p> <ul style="list-style-type: none"> • Finite Difference Method (FDM): Taylor Series Expansion, | 7L |

| | | |
|----|---|----|
| | Truncation Error. <ul style="list-style-type: none"> Basics of Finite Volume Method (FVM). | |
| 3. | Numerical Solution of Discretized Equations <ul style="list-style-type: none"> Direct and Iterative Methods: Gauss-Seidel, TDMA, Successive Over-Relaxation (SOR). Solution of Navier-Stokes equations: SIMPLE and SIMPLER algorithms. Pressure-velocity coupling. | 8L |
| 4. | Introduction to Turbulence Modeling <ul style="list-style-type: none"> Introduction to turbulence and its significance. Reynolds-Averaged Navier-Stokes (RANS) Equations. Turbulence models: $k - \omega$ Model. | 8L |
| 5. | Grid Generation and Convergence Criteria <ul style="list-style-type: none"> Structured and Unstructured Grids, Grid Independence Study. Mesh Quality Parameters: Skewness, Orthogonality, Aspect Ratio. Adaptive Mesh Refinement (AMR) and Grid Optimization. Convergence Criteria: Residuals and Iteration Control. | 7L |
| 6. | Applications of CFD and Case Studies <ul style="list-style-type: none"> CFD applications in aerospace, automotive, biomedical, and environmental engineering. Introduction to CFD software (ANSYS Fluent, COMSOL). 2-D Heat conduction problem, lid-driven cavity problem, and laminar pipe flow problem. | 8L |

5. References:

Text Book:

- Anderson, J.D., *Computational Fluid Dynamics: The Basics with Applications*, McGraw-Hill, 1995.
- Versteeg, H.K., and Malalasekera, W., *An Introduction to Computational Fluid Dynamics: The Finite Volume Method*, Pearson, 2007.
- Patankar, S.V., *Numerical Heat Transfer and Fluid Flow*, Hemisphere Publishing, 1980.

Reference Books:

- Chung, T.J., *Computational Fluid Dynamics*, Cambridge University Press, 2002.
- Ghoshdastidar, P.S., *Computer Simulation of Flow and Heat Transfer*, Tata McGraw-Hill, 1998.

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|---|-------------|-----------------|
| ME 404.1 | Interpret the fundamental equations governing fluid flow and heat transfer. | Interpret | Understand |
| ME 404.2 | Illustrate discretization methods to convert PDEs into algebraic equations. | Illustrate | Analyze |
| ME 404.3 | Analyze numerical solution techniques for discretized equations. | Analyze | Evaluate |
| ME 404.4 | Evaluate the performance of different turbulence models. | Evaluate | Evaluate |
| ME 404.5 | Demonstrate high-quality computational grids. | Demonstrate | Apply |
| ME 404.6 | Develop CFD models for real-world engineering applications. | Develop | Create |

7. Mapping of course outcomes to module / course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | - | - | - | - | - |
| 2 | - | 3 | - | - | - | - |
| 3 | - | - | 3 | - | - | - |
| 4 | - | - | - | 3 | - | - |
| 5 | - | - | - | - | 3 | - |
| 6 | - | - | - | - | - | 3 |

8. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| CO1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | - | 1 | - | 1 |
| CO2 | 2 | 1 | 3 | 2 | 2 | 1 | 1 | - | 1 | - | 1 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | - | 1 | - | 1 |
| CO4 | 1 | 2 | 3 | 3 | 3 | 1 | 1 | - | 1 | - | 1 |
| CO5 | 2 | 2 | 3 | 2 | 3 | 1 | 1 | - | 1 | - | 1 |
| CO6 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | - | 1 | - | 1 |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|-----|------|------|
| CO1 | 3 | 1 |
| CO2 | 3 | 1 |
| CO3 | 3 | 1 |
| CO4 | 3 | 1 |
| CO5 | 3 | 1 |
| CO6 | 3 | 1 |

*** End of Syllabus***

Course Name: Additive
 Manufacturing Course Code:
 ME-405
 (Semester VII)

Course Broad Category: Professional elective course

1. Course Prerequisite:

The prerequisite for the Additive Manufacturing course is a basic understanding of materials science, manufacturing processes, and computer-aided design (CAD) principles.

2. Course Learning Objectives:

The course on Additive Manufacturing aims to provide students with a comprehensive understanding of 3D printing technologies, design principles, material properties, process optimization, and their application in real-world manufacturing, while emphasizing economic, sustainability, and safety considerations.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Additive Manufacturing

Course Code: ME-405

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module No. | Description of Topic | Contact Hrs. | CO |
|------------|--|--------------|-----|
| 1 | Additive Manufacturing: Overview: Introduction, Processes, Classification, Advantages Comparison: Additive vs. Conventional Manufacturing Applications | 2 | CO1 |
| 2 | CAD for Additive Manufacturing: Data Formats, Translation, Loss STL Format | 3 | CO2 |
| 3 | Additive Manufacturing Techniques: Technologies: SLA, LOM, FDM, SLS, SLM, Binder Jetting Process Parameters and Selection Applications: Aerospace, Electronics, Healthcare, Defense, Automotive, Construction, Food Processing, Machine Tools | 10 | CO1 |

| | | | |
|---|--|---|-----|
| 4 | Materials: Types: Polymers, Metals, Non-Metals, Ceramics Forms: Liquid, Solid, Wire, Powder; Properties and Preparation Support Materials | 6 | CO3 |
| 5 | Additive Manufacturing Equipment: Equipment Design and Parameters Bonding Mechanisms Common Faults and Troubleshooting Process Design | 8 | CO4 |
| 6 | Post Processing: Techniques and Requirements | 3 | CO5 |
| 7 | Product Quality: Inspection and Testing Defects and Causes | 3 | CO6 |

5. Learning Resources:

1. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, by- Ian Gibson , D Savid W. Rosen , Brent Stucker, Springer.
2. Understanding Additive Manufacturing, by-Andreas Gebhardt, Hanser.
3. Additive Manufacturing, by-Amit Bandyopadhyay, Susmita Bose, CRCPress.

6. Course outcomes of the paper Additive Manufacturing is as under:

| COs | Description | Action Verb | Knowledge Level |
|----------|---|--------------------|-------------------------|
| ME-405.1 | Understand the working principles and process parameters of additive manufacturing processes. | Understand | Understand |
| ME-405.2 | Describe the CAD and data format for 3D printing purpose. | Describe | Understand |
| ME-405.3 | Analyze materials suitable for 3D printing. | Analyze | Analyze |
| ME-405.4 | Illustrate additive manufacturing equipments. | Illustrate | Understand |
| ME-405.5 | Identify suitable post processing operation based on product repair requirement | Identify | Remember |
| ME-405.6 | Describe the quality of 3D printed products. | Describe, Identify | Understand/ Evaluate |

7. Mapping of course outcomes to module /course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | - | - | - | - | - |
| 2 | - | 3 | - | - | - | - |
| 3 | 3 | - | - | - | - | - |
| 4 | - | - | 3 | - | - | - |
| 5 | - | - | - | 3 | - | 3 |
| 6 | - | - | - | - | 3 | - |
| 7 | - | - | - | - | - | 3 |

8. Mapping of the Course outcomes to Program Outcomes

| COs | PO1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 |
|----------|-----|------|------|------|------|------|------|------|------|------|------|
| ME-405.1 | 3 | - | - | 2 | 2 | - | - | - | - | - | 2 |
| ME-405.2 | 3 | - | - | 2 | 3 | - | - | - | - | - | 2 |
| ME-405.3 | 3 | 3 | 2 | 2 | 2 | 1 | - | - | - | - | 2 |
| ME-405.4 | 3 | - | 2 | 2 | 2 | - | - | - | - | - | 1 |
| ME-405.5 | 2 | 2 | 2 | - | - | 1 | - | - | - | - | 2 |
| ME-405.6 | 3 | 2 | - | 2 | - | 2 | - | - | - | - | 2 |

9. Mapping to Program Specific Outcome (PSO)

| COs | PSO1 | PSO2 |
|----------|------|------|
| ME-405.1 | 3 | 2 |
| ME-405.2 | 3 | 2 |
| ME-405.3 | 3 | 3 |
| ME-405.4 | 3 | 2 |
| ME-405.5 | 2 | 3 |
| ME-405.6 | 2 | 3 |

End of Syllabus

Course Name: Automobile Engineering

Course Code: ME 406

(Semester VII)

Course Broad Category: Professional Elective Courses

1. Course Prerequisite:

Engineering Thermodynamics, IC Engine

2. Course Learning Objectives:

To acquire knowledge about the IC engine cycles, classification. Identify and describe the function and working principles of key automobile systems such as the engine, transmission, suspension, braking, and electrical systems.

Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

CIA-2-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

3. Course Content:

Course Name: Automobile Engineering

Course Code: ME 406

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module No. | | Description of Topic | CO's | Contact Hrs. |
|------------|------------------------------------|--|---------------|--------------|
| 1 | Introduction | History & Development of Automobiles. Various subsystems of Automobiles. | CO1, CO2 | 2 |
| | Prime Movers | Engine for Two-Wheeler & Three-Wheeler vehicles, Engine for passenger cars, commercial and other vehicle, Fuel system for carburetted engine, MPFI engine and Diesel engine, Lubrication and cooling system. | | 6 |
| 2 | Auto Electrical | Electric Motor as prime mover, Battery, generator, Ignition system, Starting system, lighting & signaling | CO2, CO6, | 6 |
| | Automotive air conditioning | Ventilation, heating, air condition, refrigerant, compressor and evaporator. | | 2 |
| | Electric Vehicle | Introduction to Electric Vehicle, difference of different systems between the conventional and electric vehicle | | 2 |
| 3 | Steering System | Devis steering & Ackerman steering mechanisms. Rack & pinion, cam & lever, worm & sector system, power assisted steering. | CO3, CO4, CO5 | 4 |

| | | | | |
|--------------|--------------------------------|---|-----|-----------|
| | Suspension System | Conventional and independent suspension system, application. | | 3 |
| | Power Requirement | Various resistances such as air resistance, gradient resistance, rolling resistance. Tractive effort. Torque- Speed curve. Horse power calculation. | | 4 |
| | Wheels and tyres | Wheel quality, assembly, types of wheels, wheel rims. Construction of tyres and tyre specifications. Automotive Restraint Systems: Seat belt, automatic seat belt tightener system, collapsible steering column and air bags. | | 3 |
| 4 | Transmission System | Flywheel & clutch. Gearbox sliding and constant mesh type, Automatic Transmission, Universal joint, Propeller shaft. | CO3 | 6 |
| | Differential & Axle | Construction & function of differential, Different types of front & rear axles. | | 3 |
| | Brake System | Disc & drum brake, Hydraulic brake, Parking brake. Stopping distance. Anti-lock braking system. | | 4 |
| Total | | | | 45 |

5. References:

1. K. Newton, W. Steed and T.K. Garrette, Motor Vehicle, 2nd Edition, Butterworth, 1989.
2. A.K. Babu, Automobile Mechanics, Khanna Publishing House, 2019.
3. A. De, Automobile Engineering, Revised Edition, Galgotia Publication Pvt. Ltd., 2010.
4. W.H. Crouse and D.L. Anglin, Automotive Mechanics, McGraw Hill, New Delhi, 2005.
5. J. Heitner, Automotive Mechanics, Affiliated South West Press, New Delhi, 2000.
6. G.B. Narang, Automobile Engineering, Khanna Publishers, New Delhi, 2001.
7. K. Ramakrishna, Automobile Engineering, PHI Learning Pvt. Ltd., New Delhi, 2012.
8. R. N. Bahl, Automobile Design, IK International Publishing House Pvt. Ltd. 2019.

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|---|-------------|-----------------|
| ME 406.1 | Understand the basic lay-out of an automobile and engines for two-wheelers, three wheelers, four wheelers, & other passenger and commercial vehicles. | Understand | Understand |
| ME 406.2 | Explain the operation of engine cooling, lubrication, ignition, electrical, electronics and air-conditioning systems. | Explain | Evaluate |
| ME 406.3 | Illustrate the principles of transmission, suspension, steering and braking systems and construction of wheels and tyres. | Illustrate | Apply |
| ME 406.4 | Determine the tractive effort and power requirements & learn the use of torque-speed curve. | Determine | Analyze |
| ME 406.5 | Learn automobile restraint system. | Learn | Apply |
| ME 406.6 | Know the latest developments in automobiles including EVs. | Know | Remember |

7. Mapping of course outcomes to module / course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | 2 | - | - | - | - |
| 2 | - | 3 | - | - | - | 2 |
| 3 | - | - | 2 | 3 | 2 | - |
| 4 | 1 | - | 3 | 2 | - | - |

8. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| ME 406.1 | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 | 1 | - | 1 |
| ME 406.2 | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 | 1 | - | 1 |
| ME 406.3 | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 | 1 | - | 1 |
| ME 406.4 | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 | 1 | - | 1 |
| ME 406.5 | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 | 1 | - | 1 |
| ME 406.6 | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 | 1 | - | 1 |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|----------|------|------|
| ME 406.1 | 3 | 2 |
| ME 406.2 | 3 | 2 |
| ME 406.3 | 3 | 2 |
| ME 406.4 | 3 | 2 |
| ME 406.5 | 3 | 2 |
| ME 406.6 | 3 | 2 |

*** End of Syllabus***



Course Name: Robotics
Course Code: ME-407
(Semester V)

Course Broad Category: Professional Electives

1. Course Prerequisite:

Knowledge of Engineering Mechanics, Mathematics (Matrices and Coordinate Geometry, Differential and Integral Calculus), Theory of Machines

2. Course Learning Objectives:

1. Understand advanced robotic concepts: Analyze and explain advanced robotic concepts, including robot kinematics, dynamics, and control.
2. Robot sensing and perception: Understand various robotic sensing and perception techniques, including computer vision, sensor fusion, and machine learning.
3. Students will learn to design, build, and program robots to perform various tasks, and will explore the applications of robotics in various fields.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System–

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks,

Attendance: 5 Marks

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks,

Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Robotics

Course Code: ME-407

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module | Topics | Contact hrs |
|--------|---|-------------|
| 1 | Introduction: History of robots, Definition of robot; Anatomy of robot, Classification; Robot geometry: Types of joints, workspace, number of degrees of freedom; Common configurations used in Robotic arms; Robot specifications: payload, accuracy, repeatability resolution, maximum tip speed, reach, stroke; Industrial applications | 8 |
| 2 | Kinematics of Manipulator – Forward & Inverse kinematics, Kinematic diagram, Spatial description & Frame transformation; Translational & Rotational operators; their Application; Link & Joint parameters, D-H | 8 |

| | | |
|---|--|----|
| | convention; Application of DH convention--3D OF planar manipulator- Forward & Inverse kinematics | |
| 3 | Robot End Effectors: Definition, gripper, tools; Gripper: main parts, source of power; Types of grippers: mechanical grippers, Vacuum cups, magnetic grippers, Peg-in-hole problem, Passive gripper, Remote center compliance. Robot Actuators - Electrical, Hydraulic, Pneumatic,Specialtype | 6 |
| 4 | Robot Sensors: Definition; Sensor vs. transducer; Functions, Characteristics; Calibration; Basic categories of measuring devices: analog, discrete; Placement of sensor; Main types of sensors: position sensors Encoders, Potentiometers, force & torque Sensors, LVDT, RVDT; Range sensor, velocity, acceleration, Proximity sensors, Robot Vision System | 10 |
| 5 | Robot programming - online method, Manual & Lead through teaching; Robot programming--off line method, Bottom-up programming, Language- VAL, MCL; Robot Programming (Contd.) -Other languages, Robot programing commands, Example-Pick and Place operation. Economics of Robots | 8 |

5. References:

TextBook:

1. Introduction on Robotics by J. J. Craig, Pearson Education

ReferenceBooks:

1. Robotic Engineering, Prentice-Klafter, Richard D. Chmielewski, Thomas A. and Negin, Michael - Prentice Hall of India Pvt. Limited.
2. Industrial Robotics: Technology Programming and Applications, Groover, Mikell P. Weiss, Mitchell., Nagel, Roger N., Odrey, Nicholas G. - McGraw-Hill International Edition
3. Introduction to Robotics Analysis, Systems, Applications, -Niku, Saeed B.-Prentice Hall of India Private Limited, New Delhi
4. Fundamentals of Robotics: Analysis & Control, -Shilling, Robert J.-Prentice Hall of India, New Delhi
5. Robotics for Engineers-Koren, Yoram, McGraw-Hill Book Company, Singapore
6. Robotics: A User-Friendly Introduction, Hall, Ernest L. Hall, Bettie C. -Holt, Rinehart and Winston, Holt-Saunders, Japan
7. Foundations of Robotics: Analysis and Control, Yoshikawa, Tsuneo Prentice Hall of India Private Limited, New Delhi
8. Mechanics of Robotic Manipulation, Mason, Matthew T., Prentice Hall of India Private Limited, New Delhi
9. Robotics Technology and Flexible Automation, S. R. Deb, Tata McGraw Hill
10. Industrial Robotics (Technology, Programming and applications), M. P. Groover, M. Weiss R.N. Nagel, N.G. Odrey McGraw, Hill
11. Robotics: Control, sensors, vision and intelligence-K.S.Fu, R.C.Gonzalez and C.S.G.Lee, - McGraw-Hill.
12. Robotics Engineering, Klafter, Richard D., et al PhI.
13. Robotics & Control, Nagrath, TMH
14. Theory and Application of Robots, Chandan Chatteraj, Lambert Publishers, 2019

6. CourseOutcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|---|-------------|-----------------|
| ME-407.1 | Demonstrate Robotic Anatomy and Illustrating industrial applications of Robots. | Demonstrate | Understand |
| ME-407.2 | Analyze Kinematics of Robotic manipulators Andactuators. | Analyze | Analyze |
| ME-407.3 | Demonstrate Robotics End-effectors and Actuators | Demonstrate | Understand |
| ME-407.4 | Demonstrate Robotic Sensors (tactile & non-tactile) | Demonstrate | Understand |
| ME-407.5 | Comprehend offline & online Robot Programming and write program blocks using VAL-II for pick-and-place movements. | Demonstrate | Understand |
| ME-407.6 | Analyze economics of robotics based on payback period & rate of return on investment. | Analyze | Analyze |

7. Mappingofcourseoutcomestomodule/course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 8 | - | - | - | - | - |
| 2 | - | 8 | - | - | - | - |
| 3 | - | - | 6 | - | - | - |
| 4 | - | - | - | 5 | 5 | - |
| 5 | - | - | - | - | - | 8 |

8. Mapping of the Course out comes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| CO1 | 2 | 1 | 3 | 1 | 1 | 1 | - | - | 1 | - | 1 |
| CO2 | 2 | 1 | 3 | 1 | 1 | 1 | - | - | 1 | - | 1 |
| CO3 | 2 | 1 | 3 | 1 | 1 | 1 | - | - | 1 | - | 1 |
| CO4 | 2 | 1 | 3 | 1 | 1 | 1 | - | - | 1 | - | 1 |
| CO5 | 2 | 1 | 3 | 1 | 1 | 1 | - | - | 1 | - | 1 |
| CO6 | 2 | 1 | 3 | 1 | 1 | 1 | - | - | 1 | - | 1 |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|------------|-------------|-------------|
| CO1 | 2 | 1 |
| CO2 | 2 | 1 |
| CO3 | 1 | 1 |
| CO4 | 1 | 1 |
| CO5 | 1 | 1 |
| CO6 | 1 | 1 |

*****End of Syllabus*****

Course Name: Advanced Welding Technology
Course Code: ME-408
(Semester VII)
Course Broad Category: Engineering Science Courses

1. Course Prerequisite:

Concept of Manufacturing Processes.

2. Course Learning Objectives:

- a. To impart knowledge about different welding processes and their applicability.
- b. To make the students understand the mechanism behind weld joints.
- c. To impart ideas of different testing techniques of the welded joint.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks

CIA-2-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Advanced Welding Technology

Course Code: ME-408

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module No. | Syllabus/Lecture Schedule | Contact Hrs. | CO |
|------------|--|--------------|-----|
| 1. | Unit-1 Introduction to welding and joining processes: Classification of welding processes, welding terms and definitions, types of fusion weld and types of joints, Design considerations, welding positions, elements of and construction of welding symbols. | 7 | CO1 |
| | Unit-2 Descriptions and Parametric influences on Welding processes: Arc Welding- SMAW, Stud Arc welding, SAW, GMAW, FCAW, and GTAW. Resistance Welding processes- Spot, Butt, Seam, and Projection. Solid State Welding processes-Forge welding, Friction Welding, Friction Stir welding, Diffusion welding, Roll welding. | 8 | CO2 |

| | | | |
|----|---|----|-----|
| 2. | Unit-1 Welding Power Sources: Basic characteristics of power sources for various arc welding processes, Transformer, rectifier and generators. | 7 | CO3 |
| 3. | Unit-1 Critical and Precision Welding processes- USW, PAW, LBW, EBW. Underwater Welding- Wet Welding and Dry, Welding of Plastics- Hot Gas Welding, Hot Tool Welding, Hot Press Welding, Joining of Ceramics and Composites. | 8 | CO4 |
| | Unit-2 Welding Metallurgy, HAZ Effect of different process parameters on the characteristics of weldment. Weldability of Plain Carbon Steel, Stainless Steel, Cast Iron, Aluminium and its Alloys. | 7 | CO5 |
| 4. | Unit-1 Welding Defects- Types, Causes, Inspection and Remedial Measures. Testing of Welded Joints- Visual Inspection, Dye-Penetration (DP) Test, Ultrasonic Test and Radiography Test. Welding Fixtures, Welding Automation and Robotic Welding. Safe Practices in Welding. | 8 | CO6 |
| | TOTAL | 45 | |

5. References:

Text Book:

- O.P. Khanna, A Text Book of Welding Technology, DhanpatRai& Sons, 2015.
- R. S. Parmar, Welding Engineering and Technology, Khanna Publishers, 2013.
- J. L. Morris, Welding Process and Procedures, 2nd Edition, Prentice Hall, 1955.
- J. F. Lancaster, The Metallurgy of Welding, 6thEdition, William Andrew Publishing, 1999.

Reference Books:

- M. Bhattacharyya, Weldment Design, The Association of Engineers, India Publication, Kolkata, 1991.
- J. C. Lippold and D. J. Kotecki, Welding Metallurgy and Weldability of Stainless Steels, Wiley India (P)Ltd., New Delhi, 2011.
- B. Raj, V. Shankar, A.K. Bhaduri (Editors), Welding Technology for Engineers, Narosa Publishing House, 2006.

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|--|-------------|-----------------|
| ME-408.1 | Define welding terms, welded joints, positions, appropriate joint design for welding processes. | Define | Remember |
| ME-408.2 | Explain the principles and characteristics of various welding processes and their parametric influences. | Explain | Understand |

| | | | |
|-----------------|---|----------|------------|
| ME-4083 | Apply the knowledge of power sources, polarity, and electrode characteristics for the selection of suitable arc welding technique. | Apply | Apply |
| ME-408.4 | Explain critical and precision welding processes, such as USW, PAW, LBW, and EBW, in terms of their advantages and limitations. | Explain | Understand |
| ME-408.5 | Assess the weldability of different materials, including plain carbon steel,Stainless steel, cast iron, and aluminium alloys, based on their metallurgical properties and behaviour during welding. | Assess | Understand |
| ME-408.6 | Identify common welding defects, understand their causes and remedies, and Select appropriate inspection and testing methods for welded joints. | Identify | Apply |

7. Mapping of course outcomes to module / course content

| Module | C01 | C02 | C03 | C04 | C05 | C06 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | 3 | - | - | - | - |
| 2 | - | - | 3 | - | - | - |
| 3 | - | - | - | 3 | 3 | - |
| 4 | - | - | - | - | - | - |
| 5 | - | - | - | - | - | 3 |

8. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| CO 1 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | - | - | - | 1 |
| CO 2 | 3 | 2 | 2 | 1 | - | 1 | - | - | - | - | 1 |
| CO 3 | 3 | 2 | 2 | - | - | 1 | - | - | - | - | 1 |
| CO 4 | 3 | 2 | 2 | - | 1 | 1 | 1 | 1 | - | - | 1 |
| CO 5 | 3 | 2 | - | - | - | 1 | - | 1 | - | - | 1 |
| CO 6 | 3 | - | - | - | 2 | 1 | - | - | - | - | 1 |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|------------|------|------|
| C01 | 3 | 1 |
| C02 | 3 | 1 |
| C03 | 3 | 1 |
| C04 | 3 | 1 |
| C05 | 3 | 1 |
| C06 | 3 | 1 |

*** End of Syllabus***

Course Name: Selection and Testing of Materials
Course Code: ME-409
(Semester VII)
Course Broad Category: Professional Elective Courses

1. Course Prerequisite:

Materials Engineering

2. Course Learning Objectives:

The subject exposes students to the basic parameter for selection of materials and different classes of materials, and various destructive and non-destructive testing methods of materials and its industrial applications.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Real World Problem Discussion.

Evaluation System –

A CIA-1(40 Marks)

(Class Test (Objective + Subjective)) : 25 Marks, Assignment : 10 Marks, Attendance : 5 Marks

B CIA-2(40 Marks)

(Class Test (Objective + Subjective)) : 25 Marks, Assignment : 10 Marks, Attendance : 5 Marks

C End Semester Examination : 60 Marks.

4. Course Content:

Course Name: Selection and Testing of Materials

Course Code: ME-409

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module | Topics | 45L |
|--------|---|-----|
| 1 | <p>Composite Materials & Material Properties: Composites: Introduction, Particle Reinforced Composites: Large-Particle Composites, Dispersion-Strengthened Composites. Fiber Reinforced Composites: Polymer-Matrix Composites, Metal-Matrix Composites, Ceramic-Matrix Composites, Carbon-Carbon Composites, Hybrid Composites. Material Properties : Thermal Properties, Magnetic Properties, Fabrication Properties, Electrical, Optical properties, Environmental Properties, Corrosion Properties.</p> | 10L |

| | | |
|---|--|-----|
| 2 | Static Failure Theories : Ductile & Brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb. Fracture Mechanics : Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure : High cycle fatigue, stress life approach, S-N Curve, Endurance & fatigue limits, effects of mean stress using the Modified Goodman diagram, Fracture with fatigue. Creep : Creep behavior, stress and temperature effects. | 10L |
| 3 | Material Selection Procedure & Testing Introduction, Selection Strategy, Attribute limits & Material Indices, Selection Procedure, Computer aided selection, Structural Index. Material characterization testing, optical & electron Microscopy (SEM & TEM), Phased array ultrasonic testing (PAUT). Bend Test, Shear Test, Creep & Fatigue Test-Principles, Techniques, Methods, Advantages & Limitations, Applications. | 10L |
| 4 | Selection of Materials: Material selection for wear resistance-mechanism of wear, effects of environment, surface treatment to reduce wear, wear resistant polymers, erosive wear, Materials for automobile structure-use of steel, plastics, aluminium and its alloys, corrosion damage to automobiles, surface treatment of steel for car bodies, future trends in body construction & materials, exhaust system, Bearings-rolling & plain bearings, Springs- steel, non ferrous & non metallic. | 8L |
| 5 | Environmental & Societal Issues : Introduction, Environmental and societal considerations, recycling issues, Materials of importance-Biodegradable & Bio-renewable Polymers / plastics. | 4L |
| 6 | Other Material Testing: Thermal Testing : differential Scanning calorimetry, Differential Thermal Analysis, Chemical testing : X-ray fluorescence, Different elemental analysis. | 3L |

5. References:

Text Book:

- Gladius, Selection of Engineering Materials; **Publisher.** Prentice Hall Inc. New Jersey, USA,1995

Reference Books:

- J.A. Charles and F.A.A. Crane, Selection and Use of Engineering Materials, 3rd Edition; **Publisher.** Butterworths, London, UK, 1996.
- William D. Callister, Jr. & David G. Rethwisch, Materials Science & Engineering, 10th Edition; **Publisher.** Wiley

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|--|-------------|-----------------|
| CO1 | To Understand Composite Materials & Material Properties | Understand | Understand |
| CO2 | To understand different theories of failure of materials. | Understand | Apply |
| CO3 | To understand Material Selection Procedure & Testing. | Understand | Apply |
| CO4 | Acquire knowledge about Selection of Materials. | Explain | Analyze |
| CO5 | To select Biodegradable and Bio-renewable materials & understand environmental issues. | Select | Understand |
| CO6 | To understand Other Material Testing | Understand | Apply |

7. Mapping of course outcomes to module / course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | - | - | - | - | - |
| 2 | - | 3 | - | - | - | - |
| 3 | - | - | 3 | - | - | - |
| 4 | - | - | - | 3 | - | - |
| 5 | - | - | - | - | 3 | - |
| 6 | - | - | - | - | - | 3 |

8. Mapping of the Course outcomes to Program Outcomes

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1 | - | - | 3 | - | 2 | 1 | - | - | - | - | 1 |
| CO2 | 2 | - | 3 | 1 | 1 | - | - | - | - | - | 1 |
| CO3 | - | - | 3 | - | 2 | 1 | - | 1 | - | - | 1 |
| CO4 | - | - | 3 | - | 2 | 1 | - | - | - | - | 1 |
| CO5 | - | - | 2 | - | 1 | 3 | - | - | - | - | 1 |
| CO6 | - | - | 2 | 3 | - | - | - | - | - | - | 1 |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|------------|------|------|
| CO1 | 3 | 1 |
| CO2 | 3 | 1 |
| CO3 | 3 | 1 |
| CO4 | 3 | 1 |
| CO5 | 3 | 1 |
| CO6 | 3 | 1 |

*****End of Syllabus*****

Course Name: Total Quality Management
Course Code: ME-410
(Semester VII)
Course Broad Category: Engineering Science Courses

1. Course Prerequisite:

Concept of Basic Engineering Knowledge.

2. Course Learning Objectives:

- a. To express knowledge about various aspects of quality and total quality management.
- b. To understand different tools of TQM and related standards.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks)

CIA-2-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks)

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Total Quality Management

Course Code: ME-410

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module | Description | Contact hrs. |
|--------|--|--------------|
| 1 | <p>Unit-I: INTRODUCTION</p> <p>Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs – Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation</p> <p>Unit-II: TQM PRINCIPLES</p> <p>Customer satisfaction- Customer Perception of Quality, Customer Complaints, Service Quality. Customer Retention; Employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCA cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.</p> | 18 |

| | | |
|---|---|----|
| 2 | Unit- III: TQM TOOLS Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA. | 10 |
| 3 | Unit- IV: STATISTICAL PROCESS CONTROL (SPC) The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools. | 8 |
| 4 | Unit- V: QUALITY SYSTEMS Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, TS16949, ISO 14000 – Concept, Requirements and Benefits | 8 |

5. References:

Text Book:

- Mitra, Fundamentals of Quality Control and Improvement, Wiley Student Edition, 2008. V.K.
- S. Ramasamy, Total Quality Management, McGraw Hill Publishing Co., New Delhi, 2011.
- D.H. Besterfield, C. Besterfield, G.H. Besterfield, M. Besterfield, H. Urdhwareshe and R. Urdhwareshe, Total Quality Management, Pearson Education, 2018.
- J.R. Evans and W.M. Lindsay, The Management and Control of Quality, Cengage Learning, 1999.

Reference Books:

- D.C. Montgomery, Introduction to Statistical Quality Control, John Wiley, 2019.
- M. Zairi, Total Quality Management for Engineers Wood head Publishing ISBN:1855730243
- H. Lal, Organizational Excellence through TQM New age Publications 2008
- A Ravindran, K, M. Ragsdell, Engineering Optimization Methods and Applications, Willey India Private Limited 2nd Edition, 2006
- F.S. Hillier. G.J. Lieberman, Introduction to Operations Research- Concepts and Cases Tata McGraw Hill 9 th Edition, 2010

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|---|-------------|-----------------|
| ME-410.1 | Understand the basic concepts of quality and quality management philosophies | Understand | Understand |
| ME-410.2 | Understand customer needs and perceptions to design feedback systems. | Understand | Understand |

| | | | |
|----------|---|------------|------------|
| ME-410.3 | Understand reasons for benchmarking, and proficiently execute the benchmarking process to enhance organizational performance | Understand | Understand |
| ME-410.4 | Apply tools of TQM in manufacturing and service sectors. | Apply | Apply |
| ME-410.5 | Apply the technique for effective implementation of TQM. | Apply | Apply |
| ME-410.6 | Understand the different quality standards and their applications. | Understand | Understand |

7. Mapping of course outcomes to module / course content

| Module | C01 | C02 | C03 | C04 | C05 | C06 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | - | - | - | - | - |
| 2 | - | 3 | - | - | - | - |
| 3 | - | - | 3 | - | - | - |
| 4 | - | - | - | 3 | 3 | - |
| 5 | - | - | - | - | - | 3 |

8. Mapping of the Course outcomes to Program Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| C01 | 2 | 3 | - | - | - | - | - | - | - | - | 1 |
| C02 | 3 | 2 | - | - | - | - | - | - | - | - | 1 |
| C03 | 2 | 3 | - | - | - | - | - | - | - | - | 1 |
| C04 | 2 | 3 | 1 | - | - | - | - | - | - | - | 1 |
| C05 | 1 | 2 | 3 | - | - | - | - | - | - | - | 1 |
| C06 | 3 | 2 | | - | - | - | - | - | - | - | 1 |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|-----|-------|------|
| C01 | PSO 1 | PSO2 |
| C02 | 1 | - |
| C03 | | - |
| C04 | 1 | - |
| C05 | | - |
| C06 | | - |

*** End of Syllabus***

Course Name: Industrial Pollution and Control
Course Code: ME 411
(Semester VII)
Course Broad Category: Open Elective

1. Course Prerequisite:

A fundamental understanding of environmental engineering, environmental sciences, biological sciences, or related disciplines.

2. Course Learning Objectives:

The objective of these courses to prepare students to analyze, controls, and mitigate industrial pollution effectively.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks

CIA-2-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Industrial Pollution and Control

Course Code: ME 411

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module | Topics | 45L |
|---------------|--|------------|
| 1. | Introduction; classification of pollution; effects of pollution on Human beings, plants and animals. | 5L |
| 2. | Air pollution: physical effects; atmospheric dispersion and diffusion; method of sampling and analysis; modeling technique; practical control of air pollution and abatement | 10L |
| 3. | Water pollution: water quality parameters; dispersion and diffusion of pollutants in water; control and abatement of water pollution. | 10L |
| 4. | Noise pollution: physics of sound generation and transmission; physical characters of noise; physiological effects of noise; measuring instruments and technique; assessment of noise; noise control principle, practice and laws. | 10L |
| 5. | Introduction to Control of Waste & Control for Electronic, Medical & Solid Waste | 10L |

5. References:

Text Book:

- 1.Rao. C.S., “Environmental Pollution and Control Engineering”, 2nd Edition, Revised, New AgeInternational, 2007.
2. Swamy, A.V.N., “Industrial Pollution Control and Engineering”, Galgotia Publications,Hyderabad, 2005

Reference Books:

1. Mahajan. S.P., “Pollution Control in Process Industries”, Tata-McGraw Hill, New Delhi, 1985.
2. Narayana Rao, M. and Datta, A.K., “WasteWater Treatment”, 2nd Edition, Oxford and IBHPublications, New Delhi, 2005.

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|---|-------------|-----------------|
| ME 411.1 | Describe types of pollution caused by the industries and their effects on the environment | Describe | Remember |
| ME 411.2 | Explain the physical effects, sampling method of air pollution | Explain | Analyze |
| ME 411.3 | Discuss the processes and control techniques of air pollution | Discuss | Remember |
| ME 411.4 | Demonstrate the causes, processes and control techniques of water pollution | Demonstrate | Understand |
| ME 411.5 | Learn the physics of sound generation, transmission and physical characteristics of noise | Learn | Remember |
| ME 411.6 | Illustrate sustainable waste management in various sectors | Illustrate | Analyze |

7. Mapping of course outcomes to module / course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2 | 3 | 3 | - | - | - |
| 3 | 2 | - | - | 3 | - | - |
| 4 | 2 | - | - | - | 3 | 3 |
| 5 | 1 | 2 | 2 | 2 | 2 | 3 |

8. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| CO1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| CO2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| CO3 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| CO5 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| CO6 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|------------|------|------|
| CO1 | 3 | 2 |
| CO2 | 3 | 2 |
| CO3 | 3 | 2 |
| CO4 | 3 | 2 |
| CO5 | 3 | 2 |
| CO6 | 3 | 2 |

***** End of Syllabus*****

Course Name: Energy Conservation and Management
Course Code: ME 412
(Semester VII)
Course Broad Category: Basic Science

1. Course Prerequisite:

Thermodynamics, Basic Electrical Engineering.

2. Course Learning Objectives:

To understand the energy data from industries and carry out energy audit for energy savings.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

CIA-2-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Energy Conservation and Management

Course Code: ME 412

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module No. | Description of Topic | Contact Hrs |
|------------|---|-------------|
| 1. | Energy scenario-Basics of energy and its various forms- Energy Management and audit, Basic Steps; Graphical representation -Material and Energy Balance-Energy Action Planning-Financial Management-Project Management-Energy Monitoring and targeting-Global Environmental concerns. | 9 |
| 2. | Energy efficiency in thermal utilities- Fuels and combustion-Furnaces-Insulation and refractory-Boilers-Steam systems-FBC Boilers-Cogeneration-Waste heat recovery, Waste Heat Exchangers; Commercial Waste Heat Recovery Devices- Recuperators, Regenerative Heat Exchangers, Heat Pipes | 10 |
| 3. | Energy efficiency in electrical utilities-Electrical systems-Electrical motors-Industrial Energy Conservation- Industrial Insulations, Air Compressor, Compressed air systems, Mechanical Handling & Other Systems - HVAC | 10 |

| | | |
|--------------|---|-----------|
| | and case studies, and refrigeration systems-Fans and blowers- Pumps and pumping systems, Cooling towers - Lighting systems-Diesel generating system- Energy efficient technologies in electrical systems. | |
| 4. | Energy performance assessment for equipment and utility systems- Boilers, Furnaces, Cogeneration, Gas and Steam Turbines – Heat Exchangers- Electric motors and Variable speed drives- Fans and blowers- Water Pumps-Compressors. HVAC systems- Lighting systems- Performing financial analysis- Applications of Non-conventional and Renewable energy sources- Waste minimization and resource conservation. | 9 + 7=16 |
| Total | | 45 |

5. References:

Text Book:

- Energy Management- Murphy WR, G Mckay- Butterworth Heinmann, 2007
- Energy Mangement, Audit & Conservation-De Barun, Vrinda Publications, Delhi, 2007
- Eastop& Croft- Energy Efficiency, Longman, 1990

Reference Books:

- Turner- Energy management Handbook, 2nd Ed., Fairmont Press, 1993
- Energy Efficiency and Management for Engineers, Mehmet &Cengel, McGraw Hill, 2020.
- Energy Engineering and Management, AmlanChakraborty, PHI, 2019.
- Industrial Energy Management and Utilisation, Wright, Larry C., Hemisphere Publisher, Washington, 1988.
- Energy Auditing and Conservation, Methods Measurements Managements and Case Study, Hemisphere Publisher, Washington, 1980.
- Guide Book for Energy National Certification for Energy Managers andEnergy Auditors, Bureau of Energy Efficiencies, 2005

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|--|-------------|-----------------|
| ME 412.1 | Understand the energy conversion and conservation of units as well as systems | Identify | U |
| ME 412.2 | Analyse the financial aspect of energy systems | Explain | A |
| ME 412.3 | Analyse the efficiencies of the thermal utility systems | Implement | A |

| | | | |
|-----------------|--|-----------|---|
| ME 412.4 | Evaluate the performance parameters for industrial electrical and mechanical systems. | Organize | E |
| ME 412.5 | Assess the performance of the renewable energy sources | Assess | E |
| ME 412.6 | Enumerate the useful energy potential of waste heat sources | Construct | E |

7. Mapping of course outcomes to module / course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | 1 | - | - | - | - |
| 2 | 1 | 3 | - | - | - | 2 |
| 3 | 1 | 2 | 2 | 1 | - | - |
| 4 | 1 | 2 | 2 | 1 | 3 | 1 |

8. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| ME 412.1 | 1 | 2 | 1 | 1 | - | 3 | 1 | 1 | 1 | - | 1 |
| ME 412.2 | 3 | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | - | 1 |
| ME 412.3 | 2 | 2 | 3 | 1 | - | 2 | 1 | 1 | 1 | - | 1 |
| ME 412.4 | 1 | 3 | 1 | 1 | - | 1 | 1 | 1 | 1 | - | 1 |
| ME 412.5 | 1 | 1 | 1 | 3 | - | 2 | 2 | 1 | 1 | - | 1 |
| ME 412.6 | 3 | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | - | 1 |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|-----------------|------|------|
| ME 412.1 | 1 | 2 |
| ME 412.2 | 1 | 2 |
| ME 412.3 | 1 | 2 |
| ME 412.4 | 1 | 2 |
| ME 412.5 | 1 | 2 |
| ME 412.6 | 1 | 2 |

***** End of Syllabus*****

Course Name: Waste to Energy – An Overview

Course Code: ME 413 (Semester VIII)

Course Broad Category: Open Elective

1. Course Prerequisite:

Basic Chemistry, Thermodynamics, Fluid Mechanics

2. Course Learning Objectives:

To know about various types of bio-wastes.

To learn about biomass pyrolysis, biomass gasification and gasifiers.

To know about biomass combustion and combustors, biogas plants and production.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System–

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks)

CIA-2-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks)

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Waste to Energy – An Overview

Course Code: ME 413

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module | Topics | 45L |
|--------|---|-----|
| 1. | Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste- MSW– conversion devices– Incinerators, gasifiers, digesters. Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gases, yields and applications. | 11L |
| 2. | Biomass Gasification: Gasifiers– Fixed bed system– Downdraft and updraft gasifiers– Fluidized bed gasifiers– Design, construction and operation. | 5L |
| 3. | Biomass Combustion: Biomass stoves– Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors. | 4L |
| 4. | Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status– Bio energy system- Design and constructional features- Biomass resources and their classification–Biomass conversion processes- Thermo chemical conversion-Direct combustion- biomass gasification- pyrolysis and liquefaction- biochemical conversion- anaerobic digestion– Types of biogas Plants. | 10L |

5. References:

Text Book:

- I. V. Desai, Non-Conventional Energy, Wiley Eastern Ltd., 1990.
- II. K.C. Khandelwal and S.S. Mahdi, Biogas Technology - A Practical Hand Book, Vol. I & II, McGraw Hill Publishing Co. Ltd., 1983.
- III. S. Challal, Food, Feed and Fuel from Biomass, IBH Publishing Co. Pvt. Ltd., 1991.

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|--|---------------|-----------------|
| ME413.1 | Differentiate and characterize different waste | Differentiate | Analyze |
| ME413.2 | Recognize the various wastes to energy conversion processes. | Recognize | Understand |
| ME413.3 | Explain the various biochemical conversion processes. | Explain | Apply |
| ME413.4 | Explain the various thermochemical conversion processes. | Explain | Analyze |
| ME413.5 | Explain the various biomass processes to energy conversion. | Explain | Analyze |
| ME413.6 | Differentiate among different Bio-gas plants. | Differentiate | Knowledge |

7. Mapping of course out comes to module/course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | - | - | 2 | - | 1 |
| 2 | 2 | 3 | - | 1 | - | 1 |
| 3 | 2 | 3 | 3 | 2 | - | 1 |
| 4 | 2 | - | - | 2 | 3 | 1 |

8. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| CO1 | 2 | 2 | 1 | 1 | 2 | - | - | - | - | - | - |
| CO2 | 1 | 2 | 3 | 1 | - | - | - | - | - | - | - |
| CO3 | 1 | 2 | 2 | 1 | 1 | - | - | - | - | - | - |
| CO4 | 1 | 2 | 1 | 1 | 2 | - | - | - | - | - | - |
| CO5 | 2 | 2 | 2 | 2 | 3 | - | - | - | - | - | - |
| CO6 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|-----|------|------|
| CO1 | 2 | 1 |
| CO2 | 2 | 1 |
| CO3 | 2 | 1 |
| CO4 | 2 | 1 |
| CO5 | 2 | 1 |
| CO6 | 2 | 1 |

Endof Syllabus

Course Name: Automation and Control
Course Code: ME-414
(Semester VII)
Course Broad Category: Open Elective

1. Course Prerequisite:

Basic Electronics Engineering, Mathematics

2. Course Learning Objectives:

To know about various types of control systems used in different industries.
 To learn about mathematical representation and analysis of control systems.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks,

Attendance: 5 Marks

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks,

Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Automation and Control

Course Code: ME-414

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module | Topics | 45L |
|--------|---|-----|
| 1. | Introduction to control system: Concept of feedback and Automatic control, Effects of feedback, Objectives of control system, Definition of linear and nonlinear systems, Elementary concepts of sensitivity and robustness. Types of control systems, Servo mechanisms and regulators, examples of feedback control systems. Transfer function concept. Pole and Zeroes of a transfer function. Properties of Transfer function. | 5L |
| 2. | Mathematical modeling of dynamic systems: Translational systems, Rotational systems, Mechanical coupling, Liquid level systems, Electrical analogy of Spring–Mass–Dashpot system. Block | 8L |

| | | |
|----|---|-----|
| | <p>diagram representation of control systems. Block diagram algebra. Signal flow graph. Mason's gain formula.</p> <p>Control system components: Potentiometer, Synchros, Resolvers, Position encoders.</p> | |
| 3. | <p>Time domain analysis: Time domain analysis of a standard second order closed loop system. Concept of undamped natural frequency, damping, overshoot, rise time and settling time. Dependence of time domain performance parameters on natural frequency and damping ratio. Step and Impulse response of first and second order systems. Effects of Pole and Zeros on transient response. Stability by pole location. Routh-Hurwitz criteria and applications.</p> <p>Error Analysis: Steady state errors in control systems due to step, ramp and parabolic inputs. Concepts of system types and error constants.</p> <p>Control System performance measure: Improvement of system performance through compensation. Lead, Lag and Lead-lag compensation, PI, PD and PID control.</p> | 14L |
| 4. | <p>State variable Analysis: State variable model of Linear Time invariant system, properties of the State transition matrix, State transition equation, Definition of transfer function & Characteristic equation, definition of controllability and observability.</p> | 8L |
| 5. | <p>Stability Analysis using root locus: Importance of Root locus techniques, construction of Root Loci for simple systems. Effects of gain on the movement of Pole and Zeros.</p> <p>Frequency domain analysis of linear system: Bode plots, Polar plots, Nichols chart, Concept of resonance frequency of peak magnification. Nyquist criteria, measure of relative stability, phase and gain margin. Determination of margins in Bode plot. Nichols chart. M circle and M-Contours in Nichols chart</p> | 10L |

5.
Ref

ferences:

Text Book:

- I.J. Nagrath and M. Gopal, Control System Engineering, New Age International, 2009.
- K. Ogata, Modern Control Engineering, 4th Edition, Pearson Education, 2010.

Reference Books:

- Khurmi R. S., Gupta J. K., Theory of Machines, S Chand.
- D. Roy Choudhury, Control System Engineering, PHI, 2005.
- B.C. Kuo and F. Golnaraghi, Automatic Control Systems, 8th Edition, PHI, 2014.
- M.N. Bandyopadhyay, Control Engineering Theory & Practice, PHI, 2002.

- K.R. Varmah, Control Systems, Mc Graw Hill, 2010.
- Norman Nise, Control System Engineering, 5th Edition, John Wiley & Sons, 2010.
- R.C. Dorf and R.H. Bishop, Modern Control System, 11th Edition, Pearson Education, 2011.
- C.G. Graham, F. Graebe, F. Stefan, S.E. Mario, Control System Design, PHI, 2009.
- 10. N.F. Macia and G.J. Thaler, Modeling & Control of Dynamic System, Thompson, 2004.
- C.T. Kilian, Modern Control Technology Components & Systems, 3rd Edition, Cengage

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|---|----------------|-----------------|
| ME-414.1 | Students will be able to define and classify control systems, <i>recall</i> the foundational mathematics, and <i>remember</i> masons gain formula and stability criteria. | Define, Recall | Remember |
| ME-414.2 | The students will be able to understand the theory of control systems, mathematical modeling and behavior of the system in time domain and frequency domain. | Understand | Understand |
| ME-414.3 | Students will be able tom <i>apply</i> their knowledge for solving problems related to control engineering. | Apply | Apply |
| ME-414.4 | Students will be able to <i>analyze</i> control system in time-domain and frequency domain and also analyze performance of control systems. | Analyze | Analyze |
| ME-414.5 | Students will be able to <i>evaluate</i> the performance and parameters of control systems, steady sate error etc. | Evaluate | Evaluate |
| ME-414.6 | Students will be able to <i>design</i> and <i>create</i> control system using the acquired knowledge of time-domain, frequency domain, Bode plot, Nyquist plot etc. | Design | Create |

7. Mapping of course outcomes to module / course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | 2 | - | - | - | - |
| 2 | 2 | 3 | - | - | - | - |
| 3 | 1 | 1 | 2 | 3 | 2 | 2 |
| 4 | 1 | 1 | 3 | 2 | 1 | 2 |
| 5 | 1 | 2 | 2 | 2 | 2 | 3 |

8. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| CO1 | 2 | 1 | 3 | 1 | 1 | 1 | - | - | 1 | - | 1 |
| CO2 | 2 | 1 | 3 | 1 | 1 | 1 | - | - | 1 | - | 1 |
| CO3 | 2 | 1 | 3 | 1 | 1 | 1 | - | - | 1 | - | 1 |
| CO4 | 2 | 1 | 3 | 1 | 1 | 1 | - | - | 1 | - | 1 |
| CO5 | 2 | 1 | 3 | 1 | 1 | 1 | - | - | 1 | - | 1 |
| CO6 | 2 | 1 | 3 | 1 | 1 | 1 | - | - | 1 | - | 1 |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|-----|------|------|
| CO1 | 2 | 3 |
| CO2 | 2 | 3 |
| CO3 | 2 | 3 |
| CO4 | 2 | 3 |
| CO5 | 2 | 3 |
| CO6 | 2 | 3 |

*** End of Syllabus***

Course Name: Water Resource Engineering
Course Code: ME 415
(Semester VII)
Course Broad Category: Open Elective Courses

1. Course Prerequisite:

Fluid Mechanics.

2. Course Learning Objectives:

The objective of this course is to provide an understanding of the concepts of closed conduit flow, open channel flow, surface water hydrology and rainfall, and also groundwater hydrology and its characteristics.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

CIA-2-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Water Resource Engineering

Course Code: ME 415

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module | Topics | 45L |
|--------|---|-----|
| 1. | Fluid Mechanics: Review of fluid statics, Review of fluid dynamics; dimensional analysis. | 8L |
| 2. | Closed Conduit Flow: Closed conduit flow, Design of water distribution systems, pipe network analysis: Hardy Cross Method, Design of Network Reservoir pipeline. Open Channel Flow: Continuity, momentum equations, Chezy, Mannings and energy equations, Water surface profiles | 24L |
| 3. | Surface Water Hydrology: Rainfall depth, duration, distribution, determination of average rainfall depth by Arithmetic, Mean Method, Thiessen Polygon Method and Isohyetal Method, | 8L |

| | | |
|----|--|----|
| | Rainfall/runoff equations, Rainfall/ runoff models, unit hydrograph, hydrologic routing models. | |
| 4. | Groundwater Hydrology: Porosity and water content, Equations of ground water flow (unconfined aquifers/ confined, aquifers/unsaturated flow), Estimation of aquifer parameters using graphical and analytical approach. | 5L |

5. References:

Text Book:

- S. K. Garg, hydrology and Water Resources Engineering, Khanna Pub., 1973.
- R.A. Wurbs and W.P. James, Water Resources Engineering, Pearson, 2001.

Reference Books:

- K. Subramanya, Engineering Hydrology, 4th Edition, McGraw-Hill, New Delhi, 2013.
- C.S.P. Ojha, R. Berndtsson and P. Bhunya, Engineering Hydrology, Oxford University Press, 2008.
- M.J. Deodhar, Elementary Engineering Hydrology, Pearson Education, 2008.
- K. Subramanya, Flow in Open Channels, 5th Edition, McGraw-Hill, 2019.
- R. Srivastava, Flow through Open Channels, Oxford University Press, 2008.
- V.T. Chow, Open-Channel Hydraulics, The Blackburn Press, 2009.

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|---|-------------|-----------------|
| ME 415.1 | Understand the basic concept of fluid dynamics in water resource engineering | Identify | Remember |
| ME 415.2 | Understand and analyze conservation laws in fluid mechanics and the dimensional analysis | Explain | Understand |
| ME 415.3 | Analyze the different conservation laws in fluid flow system also in open channel and pipe networking system | Implement | Apply |
| ME 415.4 | Solve the dimensional and non-dimensional system in fluid machines | Organize | Analyze |
| ME 415.5 | Learn and solve the surface water hydrology problems | Solve | Evaluate |
| ME 415.6 | Investigate the different parameters related to ground water hydrology | Construct | Create |

7. Mapping of course outcomes to module / course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | - | - | 2 | - | 1 |
| 2 | 2 | 1 | - | 1 | - | 1 |
| 3 | 2 | 3 | 3 | 2 | 1 | 1 |
| 4 | - | - | - | 2 | 2 | 3 |

8. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| ME 415.1 | 3 | 2 | 2 | 1 | 1 | 1 | - | 1 | - | 1 | 1 |
| ME 415.2 | 1 | 3 | 2 | 1 | 1 | 1 | - | 1 | - | 1 | 1 |
| ME 415.3 | 1 | 3 | 2 | 2 | 1 | 1 | - | 1 | - | 1 | 1 |
| ME 415.4 | 1 | 2 | 3 | 1 | 1 | 2 | - | 1 | - | 1 | 1 |
| ME 415.5 | 1 | 2 | 3 | 1 | 1 | 2 | - | 1 | - | 1 | 1 |
| ME 415.6 | 1 | 2 | 3 | 1 | 1 | 1 | - | 1 | - | 1 | 1 |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|------------|------|------|
| CO1 | 2 | 3 |
| CO2 | 2 | 3 |
| CO3 | 2 | 3 |
| CO4 | 2 | 3 |
| CO5 | 2 | 3 |
| CO6 | 2 | 3 |

***** End of Syllabus*****

Course Name: Machine Learning
Course Code: ME-416
(Semester VII)
Course Broad Category: Open Elective

1. Course Prerequisite:

Basic Electronics Engineering, Mathematics

2. Course Learning Objectives:

The course aims to provide basic knowledge on various machine learning algorithms, their performance evaluation and deployment for use in various domains of mechanical engineering.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks,

Attendance: 5 Marks

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks,

Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Machine Learning

Course Code: ME-416

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module | Topics | 45L |
|--------|---|-----|
| 1. | Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation and Performance Measures, cross-validation, Bias-Variance Trade off | 6L |
| 2. | Regression, Decision Tree, SVM: Linear regression, Decision trees, Overfitting, Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM | 9L |
| 3. | Instance Based Learning: Instance based learning, Feature reduction, Collaborative filtering based recommendation, Dimensionality Problem, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA) | 6L |
| 4. | Bayesian Learning: | 6L |

| | | |
|----|--|----|
| | Probability and Bayes learning, normal Density and Discriminant Function, Bayes Decision Theory – Binary Features | |
| 5. | Neural network: Perceptron, multilayer network, back propagation, RBF Neural Network introduction to deep neural network | 6L |
| 6. | Ensemble Learning: Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning | 6L |
| 7. | Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture model | 6L |

5. References:

Text Book:

- Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer
- T.M. Mitchell, Machine Learning, First Edition, McGraw Hill Education, 2013.

Reference Books:

- Jeeva Jose, Introduction of Machine Learning, Khanna Publishing House, 2019.
- S. Marsland-, Machine Learning– An Algorithmic Perspective, 2nd Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
- P. Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, First Edition, Cambridge University Press, 2012.
- J. Bell, Machine learning– Hands on for Developers and Technical Professionals, First Edition, Wiley, 2014.
- E. Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning Series), 3rd Edition, MIT Press, 2014.
- Machine Learning by Dr. Himanshu Sharma, S K Karia and Sons

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|---|--------------------|-----------------|
| ME-416.1 | Students will gain <i>knowledge</i> in graphical models, Classification of Machine learning and different machine learning algorithms and they have to <i>recall</i> foundational mathematics. | Recall | Remember |
| ME-416.2 | Students will be able to <i>understand</i> concept learning, machine learning model, linear models, different algorithms, neural networks and associated algorithms, concept of over fitting and under fitting. | Understand | Understand |
| ME-416.3 | Students will be able to <i>apply</i> different machine learning algorithms and find out applications with different case studies. | Apply | Apply |
| ME-416.4 | Students will be able to <i>analyze</i> and <i>interpret</i> the efficiency, accuracy of different algorithms. | Analyze, Interpret | Analyze |
| ME-416.5 | Students will be able to <i>evaluate</i> the performance of different algorithms. | Evaluate | Evaluate |
| ME-416.6 | Students will be able to <i>create</i> various neural networks, decision trees, support vector models, Bayesian models, Logistic regression and others for solution to various problems. | Create | Create |

7. Mapping of course outcomes to module / course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | 2 | - | - | - | - |
| 2 | 1 | 2 | 2 | 1 | 1 | 1 |
| 3 | 1 | 3 | 2 | 2 | 1 | 1 |
| 4 | 1 | 1 | 2 | 3 | 1 | 1 |
| 5 | 1 | 1 | 2 | 1 | 1 | 3 |
| 6 | 1 | 1 | 2 | 3 | 1 | 1 |
| 7 | 1 | 1 | 2 | 2 | 1 | 3 |

8. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|
| CO1 | 2 | 1 | 3 | - | 1 | 1 | - | - | 1 | - | 1 |
| CO2 | 2 | 1 | 3 | - | 1 | 1 | - | - | 1 | - | 1 |
| CO3 | 2 | 1 | 3 | - | 1 | 1 | - | - | 1 | - | 1 |
| CO4 | 2 | 1 | 3 | - | 1 | 1 | - | - | 1 | - | 1 |
| CO5 | 2 | 1 | 3 | - | 1 | 1 | - | - | 1 | - | 1 |
| CO6 | 2 | 1 | 3 | - | 1 | 1 | - | - | 1 | - | 1 |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|------------|-------------|-------------|
| CO1 | 2 | 3 |
| CO2 | 2 | 3 |
| CO3 | 2 | 3 |
| CO4 | 2 | 3 |
| CO5 | 2 | 3 |
| CO6 | 2 | 3 |

***** End of Syllabus*****



Course Name: Biology for Engineers
Course Code: ME-417
(Semester VII)
Course Broad Category: Open Elective

1. Course Prerequisite:

Introduction to Mechanical Engineering, Physics

2. Course Learning Objectives:

- Understand the fundamental principles of biology, including the structure and function of cells, tissues, and organs
- Apply biological concepts to mechanical engineering problems, including the design of medical devices and biomimetic systems
- Analyze the interactions between living organisms and mechanical systems
- Develop innovative solutions to engineering challenges using biological inspiration
- Communicate complex biological concepts to non-experts

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System–

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks,

Attendance: 5 Marks

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks,

Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Biology for Engineers
Course Code: ME-417
Hours per Week: 3L: 0T: 0P
Credits: 3

| Module | Topics | Contact hrs |
|--------|---|-------------|
| 1 | Introduction to Biology - Overview of biology and its relevance to mechanical engineering - Structure and function of cells | 6L |

| | | |
|----------|---|----|
| 2 | Bio-molecules and Cells - Bio-molecules: carbohydrates, proteins, nucleic acids, and lipids - Cell membrane structure and function | 6L |
| 3 | Tissues and Organs - Types of tissues: epithelial, connective, muscle, and nervous tissue - Organ systems: skeletal, muscular, circulatory, and nervous systems | 6L |
| 4 | Biological Systems and Mechanical Engineering - Application of biological concepts to mechanical engineering problems - Design of medical devices and biomimetic systems | 6L |
| 5 | Interactions between Living Organisms and Mechanical Systems - Biomechanics: movement, forces, and energy in living organisms - Bio-fluid mechanics: fluid flow in living organisms | 6L |
| 6 | Biological Inspiration and Innovation - Bio-mimicry: using nature to inspire innovative solutions - Case studies of biological inspiration in mechanical engineering | 6L |

5. References:

TextBook:

1. Cell and Molecular Biology-P.K.Gupta
2. Cell Biology-Verma and Agarwal
3. Cell Biology-Rastogi
4. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A global approach", Pearson Education Ltd, 2018.
5. T Johnson, Biology for Engineers, CRC press, 2011 Molecular Biology and Biotechnology 2nd ed. J. M. Walker and E. B. Gingold. Panima Publications. PP434.

ReferenceBooks:

1. Alberts et al. The molecular biology of the cell, 6/e, Garland Science, 2014
2. De Robertis EDP & EMF De Robertis. 2001. Cell and Molecular biology. Lippincott Williams & Wilkins. Bombay.
3. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, "Outlines of Biochemistry", John Wiley and Sons, 2009.
4. John Enderle and Joseph Bronzino Introduction to Biomedical Engineering, 3/e, 2012
- Principles of Biochemistry. 2nd ed. 1993. A. L. Lehninger, D. L. Nelson. M. Cox. Panima Publications. PP. 1090.
5. Harper's biochemistry. 1988. R. K. Murray. D. K. Granner, P. A. Mayes. Printice Hall International.
6. Introductory Microbiology. 1995, by Trevor Gross.
7. Molecular Biology by G. Padmanabhan, K. Sivaram Sastry, C. Subramanyam, 1995, MacMillan.
8. Biochemistry of Nucleic Acids. 1992. 11th ed. R. L. P. Adams. J. T. Knowler. D. P. Leader. Chapman and Hall.
9. Genetic Engineering - Sandhya Mitra.
10. Molecular Biology and Biotechnology by Meyers, R. A. A comprehensive desk reference (VCH Publishers).

6. CourseOutcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|--|-------------|-----------------|
| CO1 | Understand the fundamental principles of biology | Understand | Understand |
| CO2 | Apply biological concepts to mechanical engineering problems | Apply | Apply |
| CO3 | Analyze the interactions between living Organisms and mechanical systems | Analyze | Analyze |
| CO4 | Develop innovative solutions using Biological inspiration | Develop | Understand |
| CO5 | Communicate complex biological concepts to non-experts | Communicate | Understand |
| CO6 | Evaluate the ethical implications of Biological systems and mechanical devices | Evaluate | Evaluate |

7. Mapping of course out comes to module/course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 6 | - | - | - | - | - |
| 2 | - | 6 | - | 10 | - | - |
| 3 | - | - | 6 | - | 5 | - |
| 4 | - | - | - | 6 | - | - |
| 5 | - | - | - | - | 6 | - |
| 6 | - | - | - | - | - | 6 |

8. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| CO1 | 2 | 1 | 1 | 1 | 1 | 2 | - | - | 1 | - | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 2 | - | - | 1 | - | 1 |
| CO3 | 2 | 1 | | 1 | 1 | 2 | - | - | 1 | - | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 2 | - | - | 1 | - | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 2 | - | - | 1 | - | 1 |
| CO6 | 2 | 1 | 1 | 1 | 1 | 2 | - | - | 1 | - | 1 |

9. Mapping to Program Specific Outcome(PSO)

| | PSO1 | PSO2 |
|-----|------|------|
| CO1 | 1 | 1 |
| CO2 | 1 | 1 |

| | | |
|------------|---|---|
| CO3 | 1 | 1 |
| CO4 | 1 | 1 |
| CO5 | 1 | 1 |
| CO6 | 1 | 1 |

*****Endof Syllabus*****

Course Name: Industrial Safety
Course Code: ME 418
(Semester VII)
Course Broad Category: Open Elective

1. Course Prerequisite:

Basic knowledge of engineering (mechanical, electrical, chemical, or civil).
Understanding of occupational health and safety concepts.

2. Course Learning Objectives:

The objective to equip students with the knowledge and skills to improve safety in industrial environments.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks)

CIA-2-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks)

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Industrial Safety

Course Code: ME 418

Hours per Week: 3L: 0T: 0P

Credits: 3

| Module | Topics | 45L |
|--------|---|-----|
| 1. | Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety colour codes. Fire prevention and fire fighting, equipment and methods.. | 10L |
| 2. | Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment. | 8L |
| 3. | Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, | 10L |

| | | |
|----|---|----|
| | Definition principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods. | |
| 4. | Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes. | 8L |
| 5. | Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance | 9L |

5.

References:

Text Book:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company

Reference Books:

1. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
2. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|--|---------------|-----------------|
| ME 418.1 | Illustrate Industrial Safety Measures and Compliance with Regulations | Illustrate | Understand |
| ME 418.2 | Differentiate Maintenance Engineering Strategies for Optimal Equipment Performance | Differentiate | Analyze |
| ME 418.3 | Utilize Wear and Corrosion Prevention Techniques to Enhance Equipment Life | Utilize | Apply |
| ME 418.4 | Develop Systematic Approaches for Identifying and Resolving Industrial Faults | Develop | Apply |
| ME 418.5 | Formulate Preventive and Periodic Maintenance Plans for Industrial Equipment | Formulate | Apply |
| ME 418.6 | Assess Workplace Safety and Fire Prevention Practices to Minimize Risks | Assess | Analyze |

7. Mapping of course outcomes to module / course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 3 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2 | 3 | 3 | - | - | - |
| 3 | 2 | - | - | 3 | - | - |
| 4 | 2 | - | - | - | 3 | 3 |
| 5 | 2 | - | 3 | 3 | - | - |

8. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| CO1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| CO2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| CO3 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| CO5 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| CO6 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |

9. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|-----|------|------|
| CO1 | 3 | 2 |
| CO2 | 3 | 2 |
| CO3 | 3 | 2 |
| CO4 | 3 | 2 |
| CO5 | 3 | 2 |
| CO6 | 3 | 2 |

***** End of Syllabus*****

Course Name: Corrosion Engineering
Course Code: ME-419
(Semester VII)
Course Broad Category: Open Elective

1. Course Prerequisite: Chemistry

2. Course Learning Objectives:

- Understand the fundamental principles of corrosion engineering
- Identify the causes and mechanisms of corrosion
- Apply corrosion prevention and control methods
- Design and implement corrosion protection techniques
- Analyze and evaluate corrosion data and case studies

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks

CIA-2-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:

Course Name: Corrosion Engineering Course

Code: ME-419

Hours per Week: 3L:0T:0P

Credits: 3

| Module | Topics | Contacthrs |
|--------|--|------------|
| 1 | Introduction to Corrosion Engineering - Overview of corrosion engineering - Importance of corrosion prevention and control - Types of corrosion | 6L |
| 2 | Corrosion Mechanisms and Kinetics - Thermodynamics of corrosion - Electrochemistry of corrosion - Corrosion kinetics and rate laws | 6L |
| 3 | Corrosion Prevention and Control Methods - Materials selection and design - Coatings and linings - Cathodic protection | 6L |
| | -Anodic protection | |

| | | |
|---|---|----|
| 4 | Corrosion Protection Techniques - Surface treatment and finishing - Corrosion inhibitors - Corrosion monitoring and inspection - Corrosion repair and maintenance | 6L |
| 5 | Corrosion in Different Environments - Atmospheric corrosion - Aqueous corrosion - Soil corrosion - Microbiologically influenced corrosion | 6L |
| 6 | Case Studies and Group Project - Analysis and evaluation of corrosion case studies - Group project on corrosion prevention and control | 6L |

5. References:

Text Book:

1. Fontana, M.G., Corrosion Engineering, Tata McGraw-Hill (2008). 3rd ed. (seventh reprint)
2. Jones, D.A., Principles and Prevention of Corrosion, Prentice-Hall (1996)

Reference Books:

1. Pierre R. Roberge, Corrosion engineering: principles and practice, McGraw- Hill (2008).
2. Pierre R. Roberge, Handbook of corrosion engineering, McGraw- Hill (2012). 2nd ed.
3. Sastri, V.S., Ghali, E. and Elboudjaini, M., Corrosion prevention and protection: Practical solutions, John Wiley and Sons (2007).

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|--|-------------|-----------------|
| ME-419.1 | Understand the fundamental principles of corrosion engineering | Understand | Understand |
| ME-419.2 | Apply corrosion prevention and control methods | Apply | Apply |
| ME-419.3 | Analyze and evaluate corrosion data and Case studies | Analyze | Analyze |
| ME-419.4 | Design and implement corrosion protection techniques | Design | Apply |
| ME-419.5 | Understand corrosion in different environments | Understand | Understand |
| ME-419.6 | Communicate corrosion engineering Concepts and solutions effectively | Communicate | Understand |

7. Mapping of course outcomes to module/ course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|--------|-----|-----|-----|-----|-----|-----|
| 1 | 6 | - | - | - | - | - |
| 2 | - | 6 | - | 10 | - | - |
| 3 | - | - | 6 | - | 5 | - |
| 4 | - | - | - | 6 | - | - |
| 5 | - | - | - | - | 6 | - |
| 6 | - | - | - | - | - | 6 |

8. Mapping of the Course outcomes to Program Outcomes

| Course Outcomes | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 |
|-----------------|------|------|------|------|------|------|------|------|------|------|------|
| ME-419.1 | 3 | 2 | - | - | - | 2 | - | - | - | - | 2 |
| ME-419.2 | 3 | 2 | 2 | - | 2 | 2 | - | - | - | - | 2 |
| ME-419.3 | 3 | 3 | 2 | 3 | 2 | 2 | - | - | - | - | 2 |
| ME-419.4 | 3 | 2 | 3 | 2 | 2 | 3 | 1 | - | - | - | 2 |
| ME-419.5 | 3 | 2 | - | 2 | - | 3 | - | - | - | - | 2 |
| ME-419.6 | 2 | - | - | - | - | - | - | 2 | 3 | 2 | 2 |

9. Mapping to Program Specific Outcome(PSO)

| Course Outcomes | PSO1 | PSO2 |
|-----------------|------|------|
| ME-419.1 | 3 | 2 |
| ME-419.2 | 3 | 3 |
| ME-419.3 | 3 | 3 |
| ME-419.4 | 3 | 3 |
| ME-419.5 | 2 | 3 |
| ME-419.6 | 2 | 2 |

End of Syllabus

Course Name: Advanced Manufacturing Lab
Course Code: ME-420
(Semester VII)
Course Broad Category: Professional Core Courses

1. Course Prerequisite:

Manufacturing Processes, Manufacturing Technology

2. Course Learning Objectives:

Students will gain a practical knowledge of various manufacturing processes in a hands-on environment through experiments and simulations.

3. Teaching methodology and evaluation system for the course:

Teaching methodology –

Conduction laboratory experiments, Correlate with Theory by Interactive Discussions and Case Studies.

Evaluation System –

A Internal Assessment (60 Marks)- Formative Continuous Assessment [Continuous Assessment]

B End Semester Exam (40 Marks)- Summative Assessment.

4. Course Content:

Course Name: Advanced Manufacturing Lab

Course Code: ME-420

Hours per Week: 0L: 0T: 2P

Credits: 1

5. List of Experiments

- 1.Measurement of Cutting Force in Turning
- 2.Study of the effect of parametric variation in arc welding
- 3.Testing of moulding sand
- 4.Testing for Weld Quality
- 5.Programming on CNC Lathe using G and M Codes
- 6.Programming on CNC Lathe using APT
- 7.Programming on CNC Milling Machine using G and M Codes
- 8.Programming on CNC Milling Machine using APT
- 9.Programming on CNC machine Simulator and to observe virtual machining
- 10.Study of and Solving problems on geometry of robot manipulator, actuators and grippers
- 11.Robot Programming
- 12.Experiments on AJM/ USM/ WEDM/ EDM/ ECM/ LBM
- 13.Design and manufacture of products using Additive Manufacturing

6. Text Book:

- M. P .Groover, Principles of Modern Manufacturing, 5th Edition; **Publisher.** Wiley, 2014

Reference Books:

- S. Kalpakjian & Schmid, Manufacturing Processes for Engineering Materials, 5th Edition; **Publisher.** Pearson Education, 2010
- E. P. DeGarmo, J. T. Black & R. A. Kohser, DeGarmo's Materials and Processes in Manufacturing, 11th Edition; **Publisher.** John Wiley & Sons, 2011.

7. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|---|-------------|-----------------|
| CO1 | Applying Part Programming on CNC Lathe for Multi Stepped Shaft & Single Stepped Shaft With Round End. | Apply | Apply |
| CO2 | Applying Part Programming on CNC Milling for Single Slot, Curve Slot and Square Loop. | Apply | Apply |
| CO3 | Understanding the working of a robot and its programming. | Understand | Understand |
| CO4 | Understanding measurement of cutting forces in turning by using Dynamometer. Develop a practical understanding of advanced manufacturing processes. | Develop | Understand |
| CO5 | Understanding effect of parametric variation in MMA welding and Applying dye penetration test for determination of welding joint defect. | Understand | Understand |
| CO6 | Applying various tests to determine fineness number, AFS clay content and permeability number of moulding sand. | Apply | Apply |

8. Mapping of course outcomes to module / course content

| Module | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|---------------|------------|------------|------------|------------|------------|------------|
| 1 | - | - | - | 3 | - | - |
| 2 | - | - | - | - | 3 | - |
| 3 | - | - | - | - | - | 3 |
| 4 | - | - | - | - | 3 | - |
| 5 | 3 | - | - | - | - | - |
| 6 | 3 | - | - | - | - | - |
| 7 | - | 3 | - | - | - | - |
| 8 | - | 3 | - | - | - | - |
| 9 | 3 | 3 | - | - | - | - |
| 10 | - | - | 3 | - | - | - |
| 11 | - | - | 3 | - | - | - |
| 12 | - | - | - | 3 | - | - |
| 13 | - | - | - | 3 | - | - |

9. Mapping of the Course outcomes to Program Outcomes

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1 | - | - | 2 | - | 3 | - | - | 1 | - | - | 1 |
| CO2 | - | - | 2 | - | 3 | - | - | 1 | - | - | 1 |
| CO3 | - | - | 2 | - | 3 | - | - | 1 | - | - | 1 |
| CO4 | - | - | 2 | - | 2 | - | - | 1 | - | - | 1 |
| CO5 | - | - | 2 | - | 2 | - | - | 1 | - | - | 1 |
| CO6 | - | - | 2 | - | 2 | - | - | 1 | - | - | 1 |

10. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|------------|------|------|
| CO1 | 3 | 1 |
| CO2 | 3 | 1 |
| CO3 | 3 | 1 |
| CO4 | 3 | 1 |
| CO5 | 3 | 1 |
| CO6 | 3 | 1 |

*****End of Syllabus*****



Course Name: Industrial Training & Seminar
Course Code: ME-421
(Semester VII)
Course Broad Category: Major

1. Course Prerequisite:

Concept of all subjects related to Mechanical Engineering

2. Course Learning Objectives:

- Apply theoretical knowledge in a practical setting
- Develop practical skills and competencies in the field of study
- Understand industry practices and standards
- Develop communication and teamwork skills
- Prepare for the workforce and professional practice

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Training at Industry, Interactive Discussions.

Evaluation System –

End-Semester Viva-voce (100 Marks) – The examination will be conducted by a panel of examiners, and will consist of a presentation on industrial training followed by questions and discussions on a wide range of topics related to the training. The examination will be designed to assess the student's comprehensive knowledge and understanding of the subject matter, as well as their ability to think critically and communicate effectively.

4. Course Content:

Course Name: Industrial Training & Seminar

Course Code: ME-421

Hours per Week: 0L: 0T: 4P

Credits: 2

This course provides students with hands-on industrial experience and training in a real-world setting. Students will work on projects and tasks assigned by the industry partner, and will be supervised by industry professionals. The course aims to provide students with practical skills and knowledge in their field of study, and to prepare them for the workforce.

6. Course Outcomes (CO):

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|--|-------------|-----------------|
| CO1 | Apply theoretical knowledge in a practical setting | Apply | Apply |
| CO2 | Develop practical skills and competencies | Develop | Understand |
| CO3 | Understand industry practices and standards | Understand | Understand |
| CO4 | Develop communication and teamwork skills | Develop | Understand |
| CO5 | Prepare for the workforce and professional practice | Prepare | Understand |
| CO6 | Demonstrate reflective practice and self-directed learning | Demonstrate | Understand |

7. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| CO1 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO2 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO3 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO6 | 2 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

8. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|-----|------|------|
| CO1 | 2 | 3 |
| CO2 | 2 | 3 |
| CO3 | 2 | 3 |
| CO4 | 2 | 3 |
| CO5 | 2 | 3 |
| CO6 | 2 | 3 |

*** End of Syllabus***

Course Name: PROJECT-IV

Minor Course Code: ME-422

(Semester VII) Category: Minor

1. Course Prerequisite:

Skills up to the previous semester level in Mechanical Engineering, Programming skill

2. Course Learning Objectives:

It is a research-based project that requires students to apply the knowledge and skills they have acquired during their course-work to a real-world problem or research question. The project and thesis are designed to help students develop their research skills, critical thinking, and problem- solving abilities.

- To apply the knowledge and skills acquired during the coursework to a real-world problem or research question
- To develop research skills, including literature review, research design, data collection, data analysis, and interpretation
- To develop critical thinking and problem-solving abilities
- To produce a high-quality thesis that demonstrates the student's ability to conduct independent research
- To develop communication skills, including written and oral presentation

3. Teaching methodology and evaluation system for the course:

- **Regular Meetings:** Regular meetings between the student and supervisor to discuss progress, provide feedback, and set goals.
- **Progress Reports:** The student submits regular progress reports, outlining their progress, challenges, and plans for the next stage of the project.
- **Peer Review:** The student's work is reviewed by peers, providing feedback and suggestions for improvement.
- **Workshops and Seminars:** The student participates in workshops and seminars, learning about research methods, academic writing, and presentation skills.
- **Online Resources:** The student has access to online resources, such as research articles, tutorials, and videos, to support their learning.
- **Guest Lectures:** Guest lectures from industry experts or researchers, providing insights into real-world applications and current research trends.
- **Research Conferences:** The student attends research conferences, presenting their research and learning from others in the field.
- **Academic Writing Support:** The student receives support and guidance on academic writing, including structure, style, and grammar.
- **Time Management:** The student receives guidance on time management, including setting goals, prioritizing tasks, and managing deadlines.
- **Feedback and Evaluation:** The student receives regular feedback and evaluation, including constructive criticism and suggestions for improvement.

Total Marks: 100

Passing criteria: 50% and above

- Literature review (10%)
- Research proposal (10%)
- Data collection and data analysis (15%)
- Results and discussion (15%)
- Conclusion and recommendations (10%)
- Thesis writing (20%)
- Thesis defense (20%)

4. Course Content: Course Name: Project-IV Minor

Course Code: ME-422

Hours per Week: 0L:0T:10P

Credits: 5

| Description | Tentative Timeline (overlapped) |
|--|---------------------------------|
| 1. Literature Review - Conduct a comprehensive literature review on the research topic - Identify the research gap and formulate a research question - Develop a research proposal | 4weeks |
| 2. Research Design - Develop a research design, including data collection and data analysis methods - Identify the sampling strategy and sample size - Develop a data collection plan | 4weeks |
| 3. Data Collection - Collect data using the methods identified in the research design - Ensure that the data is accurate, reliable, and valid | 8 weeks |
| 4. Data Analysis - Analyze the data using the methods identified in the research design - Identify the trends, patterns, and relationships in the data | 8 weeks |
| 5. Results and Discussion - Present the results of the data analysis - Discuss the implications of the findings - Identify the limitations of the study | 4 weeks |
| 6. Conclusion and Recommendations - Summarize the main findings of the study - Provide recommendations for future research | 2 weeks |

| | |
|---|-----------|
| -Identify the contributions of the study to the field | |
| 7. Report Writing - Write a high-quality thesis that demonstrates the student's ability to conduct independent research - Ensure that the thesis is well-organized, well- written, and free of errors | 12 weeks) |
| 8. Presentation - Defend the thesis in front of a panel of examiners - Answer questions and provide clarification on the research | 2 weeks |

5. Course Outcomes

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|-----------------|---|-------------|-----------------|
| ME-422.1 | Apply knowledge of research methodology to identify a research problem and develop a research proposal | Apply | Apply |
| ME-422.2 | Conduct independent research and collect data | Conduct | Analyze |
| ME-422.3 | Communicate research findings effectively through a thesis | Communicate | Understand |
| ME-422.4 | Apply critical thinking and problem-solving skills to analyze complex data | Apply | Analyze |
| ME-422.5 | Demonstrate expertise in a specialized area of research | Demonstrate | Evaluate |
| ME-422.6 | Integrate knowledge and skills to produce a high-quality thesis that contributes to the body of knowledge | Integrate | Create |

6. Mapping of the Course outcomes to Program Outcomes

| | PO1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 |
|-----|-----|------|------|------|------|------|------|------|------|-------|-------|
| CO1 | 1 | 1 | 1 | 1 | 1 | - | 1 | 3 | 2 | - | 1 |
| CO2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 3 | 1 | 1 | 2 |
| CO3 | 2 | 1 | 1 | 2 | - | 1 | 1 | 3 | 1 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | - | 1 | 3 | 1 | - | 2 |
| CO5 | 1 | 1 | 2 | 1 | - | 1 | 1 | 3 | 1 | - | 2 |
| CO6 | 1 | 1 | 1 | 1 | - | - | 1 | 3 | 1 | - | 2 |

7. Mapping to Program Specific Outcome (PSO)

| | PSO1 | PSO2 |
|-----|------|------|
| CO1 | 3 | 2 |
| CO2 | 3 | 2 |
| CO3 | 3 | 1 |
| CO4 | 3 | 1 |
| CO5 | 3 | 1 |
| CO6 | 3 | 1 |

End of Syllabus