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

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-701
(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-701
   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	**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.	9L
3	**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.	9L
4	**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.	8L
5	**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.	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-702
(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-702
   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. References:

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, Cengage.
4. Computational Fluid Dynamics by John D. Anderson Jr., McGraw Hill.

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ME-702.1	**Visualize** the principles and applications of computer aided design as a modern tool.	**Visualize**	Understand
ME-702.2	**Analyze** different design problems using FEM.	**Analyze**	Analyze
ME-702.3	**Interpret** basic principles of CFD as a problem solving tool.	**Interpret**	Understand
ME-702.4	**Write** part programme using the knowledge of CNC machines, tools & work handling system.	**Write**	Create
ME-702.5	**Illustrate** aspects of geometric modelling viz. wireframe, surface and solid	**Illustrate**	Apply

	modelling.		
ME-702.6	**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 703
(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 4703
   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.	21L
	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	

	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 703.1	Apply Scientific Principles to Renewable Energy Technologies.	Apply	Apply
ME 703.2	Evaluate Solar, Wind and Hydro-Power Energy Systems	Evaluate	Evaluate
ME 703.3	Analyze and Implement Photovoltaic Systems	Analyze	Analyze
ME 703.4	Explore Biomass Energy Technologies	Explore	Apply
ME 703.5	Investigate Emerging Renewable Energy Sources (Ocean, Tidal, Wave, Geothermal, Fuel Cell technology etc.)	Investigate	Apply
ME 703.6	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 703.1	1	2	1	1	-	3	1	1	1	-	1
ME 703.2	1	1	1	1	-	1	3	1	1	-	1
ME 703.3	2	2	3	1	-	2	1	1	1	-	1
ME 703.4	1	3	1	1	-	1	1	1	1	-	1
ME 703.5	1	1	1	3	-	2	3	1	1	-	1
ME 703.6	1	1	1	1	-	1	1	1	1	-	1

8. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
ME 703.1	1	2
ME 703.2	1	2
ME 703.3	1	2
ME 703.4	1	2
ME 703.5	1	2
ME 703.6	1	2

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

Course Name: Computational Fluid Dynamics
Course Code: ME 704
(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 704
   Hours per Week: 3L: 0T: 0P
   Credits: 3

Module	Topics	45L
1.	**Introduction to CFD and Governing Equations:** • 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.	**Discretization Techniques** • Finite Difference Method (FDM): Taylor Series Expansion,	7L

	Truncation Error. • Basics of Finite Volume Method (FVM).	
3.	**Numerical Solution of Discretized Equations** • 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** • Introduction to turbulence and its significance. • Reynolds-Averaged Navier-Stokes (RANS) Equations. • Turbulence models: $k-\omega$ Model.	8L
5.	**Grid Generation and Convergence Criteria** • 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** • 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 704.1	Interpret the fundamental equations governing fluid flow and heat transfer.	Interpret	Understand
ME 704.2	Illustrate discretization methods to convert PDEs into algebraic equations.	Illustrate	Analyze
ME 704.3	Analyze numerical solution techniques for discretized equations.	Analyze	Evaluate
ME 704.4	Evaluate the performance of different turbulence models.	Evaluate	Evaluate
ME 704.5	Demonstrate high-quality computational grids.	Demonstrate	Apply
ME 704.6	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-705
(Semester VII)

Course Broad Category: Professional Elective

……

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-705
   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-705.1	Understand the working principles and process parameters of additive manufacturing processes.	Understand	Understand
ME-705.2	Describe the CAD and data formatfor3Dprintingpurpose.	Describe	Understand
ME-705.3	Analyze materials suitable for 3Dprinting.	Analyze	Analyze
ME-705.4	Illustrate additive manufacturing equipments.	Illustrate	Understand
ME-705.5	Identify suitable post processing operation based on product repair requirement	Identify	Remember
ME-705.6	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-705.1	3	-	-	2	2	-	-	-	-	-	2
ME-705.2	3	-	-	2	3	-	-	-	-	-	2
ME-705.3	3	3	2	2	2	1	-	-	-	-	2
ME-705.4	3	-	2	2	2	-	-	-	-	-	1
ME-705.5	2	2	2	-	-	1	-	-	-	-	2
ME-705.6	3	2	-	2	-	2	-	-	-	-	2

9. Mapping to Program Specific Outcome (PSO)

COs	PSO1	PSO2
ME-705.1	3	2
ME-705.2	3	2
ME-705.3	3	3
ME-705.4	3	2
ME-705.5	2	3
ME-705.6	2	3

End of Syllabus

Course Name: Automobile Engineering
Course Code: ME 706
(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 4706
   Hours per Week: 3L: 0T: 0P
   Credits: 3

Module No.		DescriptionofTopic	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 706.1	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 706.2	Explain the operation of engine cooling, lubrication, ignition, electrical, electronics and air-conditioning systems.	Explain	Evaluate
ME 706.3	Illustrate the principles of transmission, suspension, steering and braking systems and construction of wheels and tyres.	Illustrate	Apply
ME 706.4	Determine the tractive effort and power requirements & learn the use of torque-speed curve.	Determine	Analyze
ME 706.5	Learn automobile restraint system.	Learn	Apply
ME 706.6	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 706.1	2	2	3	1	1	1	-	1	1	-	1
ME 706.2	2	2	3	1	1	1	-	1	1	-	1
ME 706.3	2	2	3	1	1	1	-	1	1	-	1
ME 706.4	2	2	3	1	1	1	-	1	1	-	1
ME 706.5	2	2	3	1	1	1	-	1	1	-	1
ME 706.6	2	2	3	1	1	1	-	1	1	-	1

9. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
ME 706.1	3	2
ME 706.2	3	2
ME 706.3	3	2
ME 706.4	3	2
ME 706.5	3	2
ME 706.6	3	2

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

Course Name: Robotics
Course Code: ME-707
(Semester VII)
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, InteractiveDiscussions 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-707
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,RichardD.Chmielewaski,ThomasA.andNegin, Michael - Prentice Hall of India Pvt. Limited.
2. Industrial Robotics: Technology Programming and Applications,Groover,MikellP.Weiss, Mitchell., Nagel, Roger N., Odrey, Nicholas G. - McGraw-Hill International Edition
3. Introduction to Robotics Analysis, Systems, Applications,-Niku, Saeed B.-PrenticeHall of India Private Limited, New Delhi
4. Fundamentals of Robotics: Analysis & Control, -Shilling, RobertJ.-Prentice Hall of India, New Delhi
5. Robotics for Engineers-Koren,Yoram,McGrew-HillBookCompany,Sinagapore
6. Robotics: AUser-FriendlyIntroduction,Hall,ErnestL.HallBettieC. -Holt,Rinehartand 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, MatthewT., 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.GonzalezandC.S.G.Lee, -MCGraw-Hill.
12. Robotics Engineering, Klafter, RichardD.,et alPhI.
13. Robotics & Control, Nagrath, TMH
14. Theory and Application of Robots, Chandan Chattoraj, Lambert Publishers, 2019

6. CourseOutcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ME-707.1	Demonstrate Robotic Anatomy and Illustrating industrial applications of Robots.	Demonstrate	Understand
ME-707.2	Analyze Kinematics of Robotic manipulators Andactuators.	Analyze	Analyze
ME-707.3	Demonstrate Robotics End-effectors and Actuators	Demonstrate	Understand
ME-707.4	Demonstrate Robotic Sensors (tactile & non-tactile)	Demonstrate	Understand
ME-707.5	Comprehend offline & online Robot Programming and write program blocks using VAL-II for pick-and-place movements.	Demonstrate	Understand
ME-707.6	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

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

Course Name: Advanced Welding Technology
Course Code: ME-708
(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-708
   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 sand 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-708.1	Define welding terms, welded joints, positions, appropriate joint design for welding processes.	Define	Remember
ME-708.2	Explain the principles and characteristics of various welding processes and their parametric influences.	Explain	Understand

ME-7083	Apply the knowledge of power sources, polarity, and electrode characteristics for the selection of suitable arc welding technique.	Apply	Apply
ME-708.4	Explain critical and precision welding processes, such as USW, PAW, LBW, and EBW, in terms of their advantages and limitations.	Explain	Understand
ME-708.5	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-708.6	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	CO1	CO2	CO3	CO4	CO5	CO6
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
CO1	3	1
CO2	3	1
CO3	3	1
CO4	3	1
CO5	3	1
CO6	3	1

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

Course Name: Selection and Testing of Materials
Course Code: ME-709
(Semester VII)
Course Broad Category: Professional Elective Courses

.....

1. **Course Prerequisite:**
   Materials Engineering
2. **Course Learning Objectives:**
   The subject exposes students to the basics 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-709
   Hours per Week: 3L: 0T: 0P
   Credits: 3

Module	Topics	45L
1	**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.	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-710
(Semester VII)
Course Broad Category: Engineering Science Courses Open Elective

……

1. **Course Prerequisite:**
   Concept ofBasic 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-710
   Hours per Week: 3L: 0T: 0P
   Credits: 3

Module	Description	Contact hrs.
1	**Unit-I: INTRODUCTION** Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs – AnalysisTechniques for Quality Costs, Basic concepts of Total Quality Management, HistoricalReview, Principles of TQM, Leadership – Concepts, Role of Senior Management,Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers toTQM Implementation **Unit-II: TQM PRINCIPLES** 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.	**18**

2	**Unit- III: TQM TOOLS** Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality FunctionDeployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality LossFunction, 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 Tendencyand Dispersion, Population and Sample, Normal Curve, Control Charts for variables andattributes, 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-710.1	**Understand** the basic concepts of quality and quality management philosophies	Understand	Understand
ME-710.2	**Understand** customer needs and perceptions to design feedback systems.	Understand	Understand

ME-710.3	**Understand** reasons for benchmarking, and proficiently execute the benchmarking process to enhance organizational performance	Understand	Understand
ME-710.4	**Apply** tools of TQM in manufacturing and service sectors.	Apply	Apply
ME-710.5	**Apply** the technique for effective implementation of TQM.	Apply	Apply
ME-710.6	**Understand** the different quality standards and their applications.	Understand	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	3	-
5	-	-	-	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

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

9. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
CO1	PSO 1	PSO2
CO2	1	-
CO3		-
CO4	1	-
CO5		-
CO6		-

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

Course Name: Industrial Pollution and Control
Course Code: ME 711
(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 711
   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 711.1	**Describe** types of pollution caused by the industries and their effects on the environment	Describe	Remember
ME 711.2	**Explain** the physical effects, sampling method of air pollution	Explain	Analyze
ME 711.3	**Discuss** the processes and control techniques of air pollution	Discuss	Remember
ME 711.4	**Demonstrate** the causes, processes and control techniques of water pollution	Demonstrate	Understand
ME 711.5	**Learn** the physics of sound generation, transmission and physical characteristics of noise	Learn	Remember
ME 711.6	**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	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1
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 712
(Semester VII)
Course Broad Category: Open Elective

……

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 712
   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.	9 + 7=16
	HVAC systems- Lighting systems- Performing financial analysis- Applications of Non-conventional and Renewable energy sources- Waste minimization and resource conservation.	
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 712.1	**Understand** the energy conversion and conservation of units as well as systems	Identify	U
ME 712.2	**Analyse** the financial aspect of energy systems	Explain	A
ME 712.3	**Analyse** the efficiencies of the thermal utility systems	Implement	A

ME 712.4	**Evaluate** the performance parameters for industrial electrical and mechanical systems.	Organize	E
ME 712.5	**Assess** the performance of the renewable energy sources	Assess	E
ME 712.6	**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 712.1	1	2	1	1	-	3	1	1	1	-	1
ME 712.2	3	1	1	1	-	1	1	1	1	-	1
ME 712.3	2	2	3	1	-	2	1	1	1	-	1
ME 712.4	1	3	1	1	-	1	1	1	1	-	1
ME 712.5	1	1	1	3	-	2	2	1	1	-	1
ME 712.6	3	1	1	1	-	1	1	1	1	-	1

9. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
ME 712.1	1	2
ME 712.2	1	2
ME 712.3	1	2
ME 712.4	1	2
ME 712.5	1	2
ME 712.6	1	2

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

Course Name: Waste to Energy – An Overview
Course Code: ME 713
(Semester VII)
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 713
   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
ME713.1	Differentiate and characterize different waste	Differentiate	Analyze
ME713.2	Recognize the various wastes to energy conversion processes.	Recognize	Understand
ME713.3	Explain the various biochemical conversion processes.	Explain	Apply
ME713.4	Explain the various thermochemical conversion processes.	Explain	Analyze
ME713.5	Explain the various biomass processes to energy conversion.	Explain	Analyze
ME713.6	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-714
(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-714
   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

	diagram representation of control systems. Block diagram algebra. Signal flow graph. Mason's gain formula. **Control system components:** Potentiometer, Synchros, Resolvers, Position encoders.	
3.	**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. **Error Analysis:** Steady state errors in control systems due to step, ramp and parabolic inputs. Concepts of system types and error constants. **Control System performance measure:** Improvement of system performance through compensation. Lead, Lag and Lead- lag compensation, PI, PD and PID control.	14L
4.	**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.	8L
5.	**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. **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	10L

5. References:

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-714.1	Students will be able to define and classify control systems, *recall* the foundational mathematics, and *remember* masons gain formula and stability criteria.	Define, Recall	Remember
ME-714.2	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-714.3	Students will be able tom *apply* their knowledge for solving problems related to control engineering.	Apply	Apply
ME-714.4	Students will be able to *analyze* control system in time-domain and frequency domain and also analyze performance of control systems.	Analyze	Analyze
ME-714.5	Students will be able to *evaluate* the performance and parameters of control systems, steady sate error etc.	Evaluate	Evaluate
ME-714.6	Students will be able to *design* and *create* 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 715
(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 715
   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 Arithmatic, 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 715.1	**Understand** the basic concept of fluid dynamics in water resource engineering	Identify	Remember
ME 715.2	**Understand** and analyze conservation laws in fluid mechanics and the dimensional analysis	Explain	Understand
ME 715.3	**Analyze** the different conservation laws in fluid flow system also in open channel and pipe networking system	Implement	Apply
ME 715.4	**Solve** the dimensional and non-dimensional system in fluid machines	Organize	Analyze
ME 715.5	Learn and **solve** the surface water hydrology problems	Solve	Evaluate
ME 715.6	**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 715.1	3	2	2	1	1	1	-	1	-	1	1
ME 715.2	1	3	2	1	1	1	-	1	-	1	1
ME 715.3	1	3	2	2	1	1	-	1	-	1	1
ME 715.4	1	2	3	1	1	2	-	1	-	1	1
ME 715.5	1	2	3	1	1	2	-	1	-	1	1
ME 715.6	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-716
(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-716
   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-716.1	Students will gain *knowledge* in graphical models, Classification of Machine learning and different machine learning algorithms and they have to *recall* foundational mathematics.	Recall	Remember
ME-716.2	Students will be able to *understand* concept learning, machine learning model, linear models, different algorithms, neural networks and associated algorithms, concept of over fitting and under fitting.	Understand	Understand
ME-716.3	Students will be able to *apply* different machine learning algorithms and find out applications with different case studies.	Apply	Apply
ME-716.4	Students will be able to *analyze* and *interpret* the efficiency, accuracy of different algorithms.	Analyze, Interpret	Analyze
ME-716.5	Students will be able to *evaluate* the performance of different algorithms.	Evaluate	Evaluate
ME-716.6	Students will be able to *create* various neural networks, decision trees, support vector models, Baysian 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
CourseCode: ME-717
(SemesterVII)
CourseBroad Category: Open Elective

……

1. **Course Prerequisite:**
   Introduction to Mechanical Engineering, Physics

2. **CourseLearningObjectives:**
   - 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, InteractiveDiscussions 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-717
   Hours per Week: 3L: 0T: 0P
   Credits: 3

Module	Topics	Contacthrs
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	6L
	- Application of biological concepts to mechanical engineering problems - Design of medical devices and biomimetic systems	
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-R astogi
4. N. A. Campbell, J. B. Reece,L.Urry,M.L.CainandS.A.Wasserman,"Biology:Aglobal 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,2 014
2. De Robertis EDP & EMFDeRobertis.2001.CellandMolecularbiology.LippincottWilliams & Wilkins. Bombay.
3. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, "Outlines of Biochemistry", John Wiley and Sons,2009.4.JohnEnderleandJosephBronzinoIntroductiontoBiomedicalEngineering,3/e,2012 Principles of Biochemistry. 2nd ed. 1993. A.L. Lehninger, D.L.Nelson.M.Cox. Paniama Publications. PP. 1090.
5. Harper'sbiochemistry.1988.R.K.Murray.D.K.Granner,P.A.Mayes.PrinticeHallInternational.
6. IntroductoryMicrobiology.1995,byTrevorGross.
7. MolecularBiologybyG.Padmanabhan,K.SivaramSastry,C.Subramanyam,1995,MacMillan.
8. BiochemistryofNucleicAcids.1992.11thed.R.L.P.Adams.J.T.Knowler.D.PLeader.ChapmanandHall.
9. GeneticEngineering–SandhyaMitra.
10. MolecularBiologyandBiotechnologybyMeyers,RA,AcomprehensiveDeskreference(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 718
(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 718
   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 718.1	Illustrate Industrial Safety Measures and Compliance with Regulations	Illustrate	Understand
ME 718.2	Differentiate Maintenance Engineering Strategies for Optimal Equipment Performance	Differentiate	Analyze
ME 718.3	Utilize Wear and Corrosion Prevention Techniques to Enhance Equipment Life	Utilize	Apply
ME 718.4	Develop Systematic Approaches for Identifying and Resolving Industrial Faults	Develop	Apply
ME 718.5	Formulate Preventive and Periodic Maintenance Plans for Industrial Equipment	Formulate	Apply
ME 718.6	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-719
(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-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: Corrosion Engineering Course
   Code: ME-719
   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.,CorrosionEngineering,TataMcGraw-Hill(2008).3rded.(seventhreprint)
2. Jones,D.A.,PrinciplesandPreventionofCorrosion,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).2nded.
3. Sastri, V.S., Ghali, E. and Elboujdaini, 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-719.1	Understand the fundamental principles of corrosion engineering	Understand	Understand
ME-719.2	Apply corrosion prevention and control methods	Apply	Apply
ME-719.3	Analyze and evaluate corrosion data and Case studies	Analyze	Analyze
ME-719.4	Design and implement corrosion protection techniques	Design	Apply
ME-719.5	Understand corrosion in different environments	Understand	Understand
ME-719.6	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-719.1	3	2	-	-	-	2	-	-	-	-	2
ME-719.2	3	2	2	-	2	2	-	-	-	-	2
ME-719.3	3	3	2	3	2	2	-	-	-	-	2
ME-719.4	3	2	3	2	2	3	1	-	-	-	2
ME-719.5	3	2	-	2	-	3	-	-	-	-	2
ME-719.6	2	-	-	-	-	-	-	2	3	2	2

9. Mapping to Program Specific Outcome(PSO)

Course Outcomes	PSO1	PSO2
ME-719.1	3	2
ME-719.2	3	3
ME-719.3	3	3
ME-719.4	3	3
ME-719.5	2	3
ME-719.6	2	2

End of Syllabus

Course Name: Advanced Manufacturing Lab
Course Code: ME-791
(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-791
   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-781
(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-781
   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	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1
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

Course Code: ME-782

Semester: VII

Course Broad Category: Major

---

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-782

Hours per Week: 0L:0T:6P

Credits: 3

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-782.1	Apply knowledge of research methodology to identify a research problem and develop a research proposal	Apply	Apply
ME-782.2	Conduct independent research and collect data	Conduct	Analyze
ME-782.3	Communicate research findings effectively through a thesis	Communicate	Understand
ME-782.4	Apply critical thinking and problem-solving skills to analyze complex data	Apply	Analyze
ME-782.5	Demonstrate expertise in a specialized area of research	Demonstrate	Evaluate
ME-782.6	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