SYLLABUS
for
5th SEMESTER

B.TECH. DEGREE

in

MECHANICAL ENGINEERING

(Applicable from the academic session 2024-2025)

Approved by BOS(ME) dt 5.11.2024 & Academic Council, Agenda-01.02, dt 21.11.2024

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: Machine Design
Course Code: ME-301
(Semester 5)
Course Broad Category: Professional Core

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1. Course Prerequisite: Design of Machine Elements

2. Course Learning Objectives:

The course aims to equip students with the knowledge and skills to design key machine elements, including power screws, springs, bearings, couplings, columns, and pressure vessels. Students will learn to perform design calculations, classify components, and determine failure loads and efficient design parameters

3. Teaching methodology and evaluation system for the course:

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

Evaluation System –

A. Mid-Term Exam (20 Marks)- Summative Assessment (CIA-1)
B. Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 2 (CIA-2)]
C. End-Semester Exam (60 Marks)- Summative Assessment.

4. Course Content:
Course Name: Machine Design
Course Code: ME-301
Hours per Week: 2L: 1T: 0P
Credits: 3

Syllabus:

Module No.	Description of Topic	Contact Hrs.
1	**Power screw:** forms of thread, multiple threaded screws, terminology of power screw, torque requirement- lifting load and lowering load, design of screw jack. **Springs:** Types of Springs, Terminology, Stress and deflection equation, series and parallel connection, Torsion Bar Springs, Coil Spring Stress and Deflection Equations, design of helical spring, Introduction of spiral and leaf spring.	14
2	**Bearing:** Types of Lubricants, Types of Sliding Bearings, Types of Lubrication, Basic Concepts of Hydrodynamic Lubrication, Viscosity, Temperature and Pressure Effects on Viscosity, Petroff's Equation for Bearing Friction, Hydrodynamic Lubrication Theory. Types of Rolling Contact Bearing, Principle of self-aligning bearing, selection of bearing types, static load carrying capacity, Steinbeck's equation, dynamic load carrying capacity.	10
3	**Coupling:** Types of coupling, Design procedure of muff coupling, clamp coupling, rigid flange coupling, design for lateral rigidity, Castiglione's theorem.	7
4	**Columns:** Types of column, Design of columns for buckling, slenderness ratio, Euler equation, Johnson's equation. **Pressure vessel:** Thick and Thin cylinder: Principal Stresses, Design	13

	of thickness based on failure criteria and end conditions, Pre stressing, design of thick cylinders.	

5. References

Text Book:

- Fundamentals of machine component design. Juvinall, R.C. and Marshek, K.M , John Wiley & Sons.
- Design of Machine Elements, V B Bhandari, McGraw Hill.
- Mechanical Engineering Design- Shigley, McGraw Hill.

Reference Books:

- Machine Design: An Integrated Approach, R L Norton, Pearson

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	**Understand** role of power screw as a machine elements.	**UNDERSTAND**	**U**
CO2	**Demonstrate** design calculations of springs .	**DEMONSTRATE**	**P**
CO3	**Classify** design aspects of bearings and their application.	**CLASSIFY**	**A**
CO4	**Determine** design procedure of different types of couplings.	**DETERMINE**	**E**
CO5	**Determine** failure load of different types of column.	**DETERMINE**	**P**
CO6	**Deduce design parameters for efficient** pressure vessel **design.**	**DEDUCE**	**P**

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	**3**	**3**				
2			**3**			
3				**3**		
4					**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	1	-	1
CO2	1	1	2	1	-	-	1	1	1	-	1
CO3	2	1	3	1	-	-	1	1	1	-	1
CO4	2	2	3	1	-	-	1	1	1	-	1
CO5	1	2	3	1	-	-	1	1	1	-	1
CO6	1	2	3	1	-	-	1	1	1	-	1
Average	1.33	1.50	2.67	1	-	-	1.0	1.0	1.0	-	1.0

9. Mapping to Program Specific Outcome (PSO)

	PSO 1	PSO 2
CO1	3	1
CO2	3	1
CO3	3	1
CO4	3	1
CO5	3	1
CO6	3	1

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

Course Name: IC Engines and Gas Turbines
Course Code: ME 302
(Semester V)
Course Broad Category: Professional Core Courses

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1. **Course Prerequisite:**
   Engineering Thermodynamics,
2. **Course Learning Objectives:**
   To acquire knowledge about the IC engine cycles, classification, working Principles and to measure performance parameters along with heat balance sheet. To explain different alternate fuels, gas turbines and about jet propulsion

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: IC Engines and Gas Turbines
   Course Code: ME 302
   Hours per Week: 3L: 0T: 0P
   Credits: 3

Module	Topics	45L
1.	**Introduction**: Principle of working, Basic Engine Types, Components of I.C. Engine etc. Cycles: Analysis of air standard cycles (Otto, Diesel, Dual), fuel-air cycles and actual cycle.	15
	Fuel Introduction in SI engine: Carburetion: Air-fuel ratio requirement, Working principle, Analysis of a simple carburetor, Limitations of a simple carburetor and its remedy. **Gasoline injection**: mechanical & electronic fuel injection systems and their control. **Fuel Introduction in CI engine**: Classification of diesel fuel injection systems, Working principle, Engine requirements, Injection pumps and nozzles	
	Ignition: Battery, magneto and electronic ignition systems, Ignition timing and spark advance.	
2.	**Combustion**: Theories of normal and abnormal combustion in SI &CI engine, parameters influencing combustion, prevention of abnormal combustion in SI & CI engine. Types of combustion chamber.	14
	Super charging and Scavenging: Engine requirements, supercharging limits, turbo-charging. Scavenging of two stroke SI & CI engine,	

	scavenging parameters, ideal & actual scavenging processes, scavenging pumps.	
	Lubrication: Principle of lubrication, properties of lubricating oil, lubrication systems. Cooling: Principle of cooling, air & water cooling systems Pollutant Emission: Formation and control of pollutants.	
3.	Performance and Testing: Performance parameters and their measurement, different types of dynamometers, heat balance, performance characteristics, governing methods.	8
4.	**Gas Turbine:** Introduction to Gas Turbines, Development, Classification and Application of Gas Turbines, Ideal and Actual Cycles; Effect of Inter cooling, Reheating, Regeneration, Combined cycle and Cogeneration.	8

5.

References:

1. V. Ganesan, I.C. Engines, McGraw Hill,2017.
2. V.Ganesan,GasTurbines,McGrawHill,2004.
3. C.R. Ferguson and A. T. Kirkpatrick, Internal Combustion Engines, Wiley, 2015.
4. H. N. Gupta, Fundamentals of Internal Combustion Engines,PHI,2012.

   H.Cohen, H.I.H. Saravanamuttoo, G. F. C. Rogers, P. Straznicky and A. C. Nix, Gas Turbine Theory, Pearson,2019.
5. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Co., 1988.
6. W.W. Pulkrabek, Engineering Fundamentals of IC Engine, PHI Pvt. Ltd., 2002

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ME 302.1	**UNDERSTAND** the basic concepts, components and operations of IC Engines.	Understand	Understand
ME 302.2	**ILLUSTRATE** the process of carburetion, ignition of SI Engines and injections of CI Engines.	Illustrate	Apply
ME 302.3	**DESCRIBE** the conventional and alternative fuels and combustion phenomena in SI and CI engines.	Describe	Understand
ME 302.4	Explain the operation of engine cooling, lubrication, supercharging and scavenging systems.	Explain	Evaluate
ME 302.5	**EVALUATE** the performance parameters of IC engines.	Evaluate	Analyze
ME 302.6	**ILLUSTRATE** the essential components of gas turbines along with its performance improving methods (inter-cooling, reheating and regenerating).	Illustrate	Apply

7. Mapping of course outcomes to module / course content

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

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ME 302.1	2	3	2	1	1	1	-	1	-	1	1
ME 302.2	2	3	2	1	1	1	-	1	-	1	1
ME 302.3	2	3	2	1	1	1	-	1	-	1	1
ME 302.4	2	3	2	1	1	1	-	1	-	1	1
ME 302.5	2	3	2	1	1	1	-	1	-	1	1
ME 302.6	2	3	2	1	1	1	-	1	-	1	1

9. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
ME 302.1	2	3
ME 302.2	2	3
ME 302.3	2	3
ME 302.4	2	3
ME 302.5	2	3
ME 302.6	2	3

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

Course Name: Dynamics of Machines
Course Code: ME-303 (Semester V)
Course Broad Category: Professional Core

1. **Course Prerequisite:**
   Engineering Mechanics, Mechanisms, Strength of Materials

2. **Course Learning Objectives:**
   - Define and explain the concepts of kinematics, kinetics, and energy methods
   - Analyze the motion of machines using graphical and analytical methods
   - Design and optimize machine systems using computer-aided engineering tools
   - Apply dynamics principles to solve problems related to machine design
   - Understand the principles of vibration and balancing of machines
   - Develop and apply mathematical models to analyze and design machine systems
   - Use simulation software to analyze and design machine systems
   - Evaluate the safety and reliability of machine systems and develop safety protocols

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: 5Marks)

   End-Semester Examination: 60 Marks

4. **Course Content:**
   Course Name: Dynamics of Machines
   Course Code: ME-303
   Hours per Week: 2L: 1T: 0P **Credits:** 3

Module	Topics	41L
1	**Introduction to Vibration** - Definition, Motivation, Classification; Causes, Terminology & Basic Elements of Vibration Lumping of Parameters; Equation of Motion-Equilibrium Method; Energy method & Rayleigh's maximum energy principle; Equivalent stiffness & Equivalent inertia of a Vibratory system; Solution of Equation of Motion (SDOF system); Representation - Rotating vector approach, Phase-Plane diagram; Natural frequency of free transverse vibration of a beam due to one or multiple point loads. whirling of shaft; types of whirl definition of critical speed;	13L

	Calculate deflection of rotating shaft and critical speed. Free Damped SDOF vibratory model; Over-, Critical- & Under- damping; Logarithmic decrement. Forced Damped SDOF model with Harmonic excitation; Dynamic Magnifier, Vibration Isolation & Transmissibility. Vibration measuring devices.	
2	**Balancing-** Significance of balancing (dynamic loads) in engineering applications, Classification, Balancing of rotating mass by balanced mass in the same plane/different planes(Analytical & Graphical methods); Balancing of rotating bodies subjected to several unbalanced forces on different planes - Analytical & Graphical methods; Balancing of reciprocating bodies - primary and secondary forces & couples; Hammer blow, Variation of tractive force and Swaying couple. Engine balancing.	10L
3	**Governors**- Classifications, Application; terminologies of governors, viz. sensitiveness, stability, isochronism, hunting, effort, power, controlling force diag., insensitiveness. Porter, Proell & Wilson-Hartnell Governor; Industrial applications.	5L
4	**Flywheel -** Causes of speed fluctuation, Application of Flywheel, Maximum fluctuation of energy, Flywheel Analysis; mean peripheral velocity of flywheel in terms of material density and tensile stress; flywheel in presses	5L
5	**Gyroscope -** Introduction: Motivation; spin velocity, precessional motion and gyroscopic couple (active and reactive); Effect of Gyro-couple on bearings of rotor; stabilization of sea vessels and aeroplanes considering effect Gyro-couple; stabilization of Two-& Four-wheelers while taking turn using the concept of gyro-couple.	8L

5. References:

Text Book:

1. Theory of Machines by S.S. Rattan, TMH.

Reference Books:

1. T. Bevan, Theory of Machines, 3rd Edition, CBS Publishers & Distributors, 2005.
2. A. Shariff, Theory of Machines, Dhanpat Rai Publication, New Delhi, 2000.
3. W.L. Cleghorn, Mechanisms of Machines, Oxford University Press, 2005.
4. R.L. Norton, Kinematics and Dynamics of Machinery, 1st Edition, McGraw Hill India, 2010.
5. A. Ghosh and A.K. Mallick, Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd., New Delhi, 1988.
6. Theory of Machines and Mechanisms by Uicker, Pennock & Shigley, 3rd Ed., Oxford University Press.
7. Mechanism and Machine Theory by Rao &Dukkipati, 2nd Ed., New Age Int. Pub.
8. The Theory of Machines through solved problems by J.S. Rao, New Age Int.

Pub.
9. Theory of Machines & Mechanisms by P.L. Ballaney, Khanna Publishers.
10. Theory of Machines by B B Low, Longmans.
11. Machines and Mechanisms - Applied Kinematic Analysis by David H. Myszka, Prentice Hall.
12. Theory of vibration with Applications by W.T. Thomson, Mc.Graw Hill.

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO 1	Understand basic concepts of vibration and **DETERMINE** vibration parameters related to problems of SDOF vibratory systems (Free, Forced with or without damping).	Determine	Apply
CO 2	**DEMONSTRATE** vibration isolation. Determine critical speed of undamped single DOF vibrating system.	Demonstrate	Understand
CO3	**ANALYSE** flywheels for speed fluctuations in IC Engines and Presses.	Analyse	Analyse
CO4	**DETERMINE** unbalanced force & moment of rotary as well as reciprocating bodies using analytical and graphical methods and demonstrate static & dynamic balancing of multi-cylinder engines.	Determine	Apply
CO5	**DEMONSTRATE** specified parameters (viz. sensitiveness, stability, isochronism, hunting, effort, power, controlling force diag., insensitiveness) of Porter, Proell and Wilson-Hartnell governors and analyse their stability.	Demonstrate	Understand
CO6	Conceive stabilization of sea vessels, aeroplanes, two- & four-wheeled vehicles taking turn, considering gyroscopic effect on them and **DETERMINE** their operational parameters.	Determine	Apply

7. Mapping of course outcomes to module / course content

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

9. Mapping to Program Specific Outcome (PSO)

	PSO 1	PSO 2
CO1	3	1
CO2	3	1
CO3	3	1
CO4	3	1
CO5	3	1
CO6	3	1

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

Course Name: Fluid Mechanics & Fluid Machines
Course Code: ME 304
(Semester V)
Course Broad Category: Professional Core

1. **Course Prerequisite:**

   Concept of Engineering Mathematics.

2. **Course Learning Objectives:**

   To learn about the application of mass and momentum conservation laws for fluid flows
   To understand the importance of dimensional analysis.
   To obtain the velocity and pressure variations in various types of simple flows
   To analyze the flow in water pumps and turbines.

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: Fluid Mechanics & Fluid Machines
   Course Code: ME 304
   Hours per Week: 3L: 0T: 0P
   Credits: 3

Module	Topics	45L
1.	**Properties of Fluids:** Definition of fluid, continuum hypothesis, Newton's law of viscosity. Properties of fluids **Fluid Statics:** Pascal's law, variation of pressure within a static fluid; Measurement of pressure; hydrostatic thrust on plane and curved surfaces; buoyancy, stability of submerged and floating bodies.	7L
2.	**Fluid Kinematics:** Preliminaries of Eulerian and Lagrangian description of fluid flow; velocity and acceleration of fluid; continuity equation. **Fluid Dynamics:** Principle of conservation of linear momentum, Euler's equation of motion along a stream line; Applications of Bernoulli's equation; Pitot tube, venture-	13L

	meter, orifice meter	
3.	**Dimensional analysis:** Methods of dimension analysis – Similitude – types of similitude Dimensionless parameters – application of dimensionless parameters – Model analysis. **Flow Through Closed Conduits:** Darcy-Weisbach equation, friction factor of closed conduits, Major and minor losses – at sudden expansion, at sudden contraction, Couette and Poisuielle flow, laminar flow through circular conduits **Boundary Layer Theory:** Concept of boundary layer – measures of boundary layer thickness – Darcy-Weisbach equation, friction factor. concept of boundary layer, boundary layer thickness, displacement thickness, momentum thickness, growth of boundary layer; Prandtl's boundary layer equations, Von Karman's momentum integral equation	15L
4.	**Turbo machines:** Euler's equation – theory of Rotodynamic machines –Classification of water turbines, heads and efficiencies, velocity triangles Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles **Pumps:** Centrifugal pump and Reciprocating pump	10L

5. References:

Text Book:

- Introduction to Fluid Mechanics & Fluid Machines, Som and Biswas, TMH.
- Fluid Mechanics & Hydraulic Machines, S.S. Rattan, Khanna Book Publishing Co., 2018

Reference Books:

- Fluid Mechanics and Machinery, R.K.Bansal, Laxmi Publication.
- A Textbook on Fluid Mechanics and Machines, S.Pati, McGrawHill.
- Fluid Mechanics and Machinery, C.S.P.Ojha, R. Berndtsson and P. N. Chadramouli, Oxford University Press, 2010.
- Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard Book House.

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ME 304.1	**Define** the fluid properties and conservation laws in fluid mechanics	Define	Understand
ME 304.2	**Solve** the conservation laws in fluid flow system	Solve	Apply
ME 304.3	**Evaluate** pressure drop in pipe flow using Hagen-Poiseuli's equation for laminar flow in pipe	**Evaluate**	Evaluate
ME 304.4	**Demonstrate** boundary layer concept	Organize	Understanding
ME 304.5	Dimensional analysis in fluid machines and in fluid flow systems	Evaluate	Evaluating
ME 304.6	**Investigate** the performance parameters related to hydraulic machines	Construct	Analyzing

7. Mapping of course outcomes to module / course content

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

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ME 304.1	3	2	2	1	1	-	1	1	-	1	1
ME 304.2	2	3	2	1	1	-	1	1	-	1	1
ME 304.3	2	2	3	1	1	-	1	1	-	1	1
ME 304.4	1	1	1	1	3	-	1	1	-	1	1
ME 304.5	1	2	2	1	1	-	1	1	-	1	1
ME 304.6	1	2	3	2	1	-	1	1	-	1	1

9. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
ME 304.1	2	3
ME 304.2	2	3
ME 304.3	2	3
ME 304.4	2	3
ME 304.5	2	3
ME 304.6	2	3

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

DR. B.C. ROY SOCIETY ENGINEERING
(An Autonomous Institute)

Course Name: Operations Research
Course Code: ME 305
(Semester V)
Course Broad Category: Humanities and Social Sciences including Management Courses

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1. **Course Prerequisite:**

   Basic Mathematics, Calculus, Linear Algebra and Probability Theory.

2. **Course Learning Objectives:**
   - Operations Research is a tools to formulate the problem, solve and analyze the problems on the given situation and apply it to an appropriate model of similar kind.
   - The objective of Operations Research is to improve their decision-making processes, reduce costs, and improve efficiency.
   - Operations Research involves analyzing complex systems, identifying problems, and developing solutions to optimize performance and increase efficiency.
   - The course is aimed to build a robust base of knowledge and skills in Operations Research, enabling based on collected and analyzed data systematically from engineering to into real-life applications.

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Classroom 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 : Operations Research
   Semester : Fifth
   Course Code : ME 305
   Hours per Week : 3L: 0T: 0P
   Credits : 3

5. **Syllabus for Bachelor of Technology in Mechanical Engineering :**

Sl. No	Module	Description of the Topics	Number of Lectures
01	01	**Introduction** to Operations Research**;** Background, Purpose, Scope and Features of Operations Research; Phases of Operations Research, Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools, Structure of the Mathematical Model, Limitations of Operations Research	4

Sl. No	Module	Description of the Topics	Number of Lectures
02	02	Introduction to Linear Programming Problem **(LPP);** Requirements of LPP, Mathematical Formulation of LPP, Case Studies of LPP**;** Algebraic Method for LLP Solution**;** Applications, Advantages, Limitations.	**10**
		Graphical Analysis of Linear Programming Problems: Introduction, Graphical Analysis, Some Basic Definitions, Graphical Methods to Solve LPP, Important Geometric Properties of LPP**; Related Problem**	
		Introduction to **Simplex Method** Standard Form of LPP, Fundamental theorem of LPP, Solution of LPP - Simplex Method, The Simplex Algorithm, Penalty Cost Method or **Big M-method**,**; Related Problem**	
		Duality in Linear Programming Problem: Introduction, Importance of Duality Concepts, Formulation of Dual Problem, Economic Interpretation of Duality**; Related Problem**	
03		Introduction to **Transportation Problem**, Formulation of Transportation Problem (TP), Transportation Algorithm (MODI Method), the Initial Basic Feasible Solution, Moving Towards Optimality**; Related Problem**	**03**
04		Introduction to **Assignment Problem**, Mathematical Formulation of the Problem, Hungarian Method Algorithm**; Related Problem**	**03**
05	03	Introduction to **Queuing Theory;** Basis of Queuing theory, elements of queuing theory, Operating characteristics of a queuing system, Queue discipline, Service Mechanism, Classification of Queuing models, [M/M/1]:{//FCFS} Queue System**; Related Problem**	**03**
06		Introduction to **Inventory Control;** Inventory classification, Different Costs Associated to Inventory, Inventory Models - EOQ, Inventory Classification Systems	**04**
07		Introduction to **Project Management;** Project Scheduling and PERT-CPM: Introduction, Basic Difference between PERT and CPM, PERT/CPM Network Components and Precedence Relationship, Project Management – PERT**; Related Problem**	**04**
04	04	Introduction to **Job Sequencing** and Scheduling models: n job 2-Machines problem, n job 3-Machines problem**; Related Problem**	**03**
09		Introduction to **Decision Theories;** Decision Under Certainty, Decision Under Risk, Decision Under Uncertainty: Laplace Criterion, MaxiMin Criterion, MiniMax Criterion, Savage MiniMax Regret Criterion, Hurwicz Criterion**; Related Problem;**	**03**
10		Introduction to **Replacement Theories;** Replacement of capital equipment which depreciated with time, Replacement by alternative equipment, Group and individual replacement policy**; Related Problem**	**03**

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ME-305.1	**Apply** forecasting methods for predicting demands.	Apply	P (L3)
ME-305.2	**Identify** decisions under certainty, uncertainty and conflicting situations.	Identify	A (L4)
ME-305.3	**Apply** linear programming tools and PERT/CPM for project scheduling for optimal utilization of resources in various types of industries with resource allocation in an optimal way.	Apply	P (L3)
ME-305.4	**Solve** transportation problems to minimize cost and understand the principles of assignment of jobs and recruitment polices.	Solve	P (L3)
ME-305.5	**Understand** the basic elements of a Queuing Model and Job Scheduling.	Understand	U (L2)
ME-305.6	**Manage** inventory with cost effectiveness.	Manage	P (L3)

7. Mapping of course outcomes to module / course content

Sl. No	Module	Description of the Topics	Mapped with CO
01	01	**Introduction** to Operations Research**;** Background, Purpose, Scope and Features of Operations Research; Phases of Operations Research, Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools, Structure of the Mathematical Model, Limitations of Operations Research	CO1
02	02	Introduction to Linear Programming Problem **(LPP);** Requirements of LPP, Mathematical Formulation of LPP, Case Studies of LPP**;** Algebraic Method for LLP Solution**;** Applications, Advantages, Limitations.	CO3
		Graphical Analysis of Linear Programming Problems: Introduction, Graphical Analysis, Some Basic Definitions, Graphical Methods to Solve LPP, Important Geometric Properties of LPP**; Related Problem**	
		Introduction to **Simplex Method** Standard Form of LPP, Fundamental theorem of LPP, Solution of LPP - Simplex Method, The Simplex Algorithm, Penalty Cost Method or **Big M-method**,**; Related Problem**	
		Duality in Linear Programming Problem: Introduction, Importance of Duality Concepts, Formulation of Dual Problem, Economic Interpretation of Duality**; Related Problem**	
03		Introduction to **Transportation Problem**, Formulation of Transportation Problem (TP), Transportation Algorithm (MODI Method), the Initial Basic Feasible Solution, Moving Towards Optimality**; Related Problem**	CO4
04		Introduction to **Assignment Problem**, Mathematical Formulation of the Problem, Hungarian Method Algorithm**; Related Problem**	CO4
05	03	Introduction to **Queuing Theory;** Basis of Queuing theory, elements of queuing theory, Operating characteristics of a queuing system, Queue discipline, Service Mechanism, Classification of Queuing models, [M/M/1]:{//FCFS} Queue System**; Related Problem**	CO5
06		Introduction to **Inventory Control;** Inventory classification, Different Costs Associated to Inventory, Inventory Models - EOQ, Inventory Classification Systems	CO6
07		Introduction to **Project Management;** Project Scheduling and PERT-CPM: Introduction, Basic Difference between PERT and CPM, PERT/CPM Network Components and Precedence Relationship, Project Management – PERT**; Related Problem**	CO3
04	04	Introduction to **Job Sequencing** and Scheduling models: n job 2-Machines problem, n job 3-Machines problem**; Related Problem**	CO4
09		Introduction to **Decision Theories;** Decision Under Certainty, Decision Under Risk, Decision Under Uncertainty: Laplace Criterion, MaxiMin Criterion, MiniMax Criterion, Savage MiniMax Regret Criterion, Hurwicz Criterion**; Related Problem;**	CO2
10		Introduction to **Replacement Theories;** Replacement of capital equipment which depreciated with time, Replacement by alternative equipment, Group and individual replacement policy**; Related Problem**	CO6

6. Reference

Text Book:

1) **F.S. Hillier, G.J. Lieberman, B. Nag and P. Basu,** Introduction to Operation Research, 10th Edition, McGraw Hill
2) **J.K. Sharma,** Operation Research: Theory and Applications, 5th Edition, Macmillan Pub.,
3) **Basu, S. K., Pal, D. K., Bagchi, H.,** Operation Research for Engineers, 2nd Edition, Oxford & IBH Publishing Co. Pvt. Ltd.,

7. Reference Books:

1) **H.A. Taha,** Operations Research - An Introduction, 7th Edition, Prentice Hall
2) **L.W. Wayne,** Operations Research Applications and Algorithms, 4th Edition, Brooks/Cole, USA
3) **Bronson and Naadimuthu,** Operations Research – Schaum's Outline Series: McGraw-Hill (2nd Edition)

WEB-RESOURCES

http://nptel.ac.in

8. Mapping of course outcomes to module / course content

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

9. Mapping of the Course Outcomes to Program Outcomes

COs	CO-PO Correlation Level											BT
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	
ME 305.1	1	2	1	2	1	1	1	1	1	2	1	P (L3)
ME 305.2	2	2	3	3	2	2	1	1	1	1	1	A (L4)
ME 305.3	1	-	2	2	2	-	1	1	1	2	1	P (L3)
ME 305.4	2	1	2	1	1	1	1	-	1	1	1	P (L3)
ME 305.5	1	2	-	-	1	1	1	1	1	1	1	U (L2)
ME 305.6	2	1	2	2	3	1	2	2	1	2	1	P (L3)
AVERAGE	**1.5**	**1.6**	**2**	**1.6**	**1.6**	**1.2**	**1.2**	**1.2**	**1**	**1.3**	**1.7**	

10. Mapping to Program Specific Outcome (PSO)

COs	PSO Level	
	PSO-1	PSO-2
ME 305.1	**2**	**1**
ME 305.2	**2**	**1**
ME 305.3	**2**	**1**
ME 305.4	**2**	**1**
ME 305.5	**2**	**1**
ME 305.6	**2**	**1**
AVERAGE	**2**	**1**

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

Course Name: Machine Drawing Lab
Code: ME-306 (Semester V)
Course Broad Category: Professional Core Courses

1. Course Prerequisite: **Engineering Drawing, Machine Drawing, Machine Design Theory**

2. **Course Learning Objectives:** The objectives of the Design Practice Lab (PC ME591) are to provide students with a strong foundation in machine design principles and the systematic design process for mechanical components. The lab aims to develop skills in analyzing failure modes, evaluating their causes, and suggesting design modifications to improve performance and reliability. Students will also learn to evaluate the strength and performance of mechanical components using theoretical design principles and standard codes to ensure structural integrity. Additionally, the course emphasizes the practical application of engineering design principles to real-world challenges, preparing students for effective mechanical design problem-solving

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

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

4. **Course Content:**

Course Name: Design Practice Lab
Semester: Third
Course Code: ME 306
Hours per Week: 0L: 0T: 4P
Credits: 2

5. List of Experiments

A) Manual Drafting and Design Calculation (On Drawing Board), Number of Week: 10

Module # 01 Simple Mechanical Designing

a. Design of Butt Rivets Joints
b. Design of Lap Rivets Joints
c. Design of Butt Welded Joints
d. Design of Lap Welded Joints
e. Design of Shafts, Key and Couplings
(e.g. Protected Flange Coupling)
f. Design of Cotter Joints
g. Design of Knuckle Joints
h. Design of Gear (e.g. Spar Gear)
i. Design for Screw Jack

B) Computer Modelling based applications, Number of Week: 04
Module # 02
(At least six design sheets & weekly Assignment)

6. Course Outcomes (CO):

Course Outcome	Details/Statement	Action Verb	Knowledge Level
CO 1	**Understand** the fundamental concepts of machine design and identify the design process for various mechanical components.	Understand	U (L2)
CO 2	**Apply** the principles of machine design to calculate design parameters for mechanical components such as riveted joints, welded joints, shafts, keys, couplings, etc.	Apply	A (L3)
CO 3	**Analyze** different failure modes of mechanical components and suggest design modifications for better performance	Analyze	N (L4)
CO 4	Evaluate the strength and performance of mechanical components using theoretical design principles and standard codes	Evaluate	E (L5)
CO 5	**Create** detailed mechanical component drawings manually for a wide range of mechanical systems, adhering to engineering	Create	C (L6)
CO 6	**Apply** CAD tools to design, model, and simulate mechanical components and systems, improving efficiency and accuracy	Apply	A (L3)

7. Mapping of course outcomes to module / course content

MODULE	CO1	CO2	CO3	CO4	CO5	CO6
1	**3**	**3**	**3**	**3**	**3**	
2						**3**

8. Mapping of the Course outcomes to Program Outcomes

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

9. Mapping to Program Specific Outcome (PSO)

	PSO 1	PSO 2
CO1	3	1
CO2	3	1
CO3	3	1
CO4	3	1
CO5	3	1
CO6	3	1

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

Course Name: Dynamics of Machinery Lab
Course Code: ME-307
(Semester V)
Course Broad Category: Mechanical Engineering

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1. **Course Prerequisite:**
   Concept of Theory of Machines

2. **Course Learning Objectives:**
   The "Dynamics of Machinery Lab" aims to give students practical experience in analyzing forces and motions in mechanical systems, such as balancing rotating masses, studying vibrations, understanding governors, and exploring gyroscopic forces. Students apply theoretical knowledge through hands-on experiments with equipment like balancing machines, vibration analyzers, and governor models.

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: Dynamics of Machinery Lab
   Course Code: ME-307 Hours per Week: 0L: 0T:
   2P **Credits:** 1

5. **List of Experiments**

1. Determination of Velocity Ratios of Simple, Compound, Epicyclic and Differential gear train

2. Studying kinematics of four bar, slider crank, crank rocker, double crank, double rocker, and oscillating cylinder mechanism

3. Studying kinematics of typical mechanisms like pantograph, some straight line motion mechanisms, wiper, drafter etc.

4. Motion Studies of different cams and followers

5. Solving simple balancing problem experimentally

6. Study gyro effect on motorised gyroscope apparatus

7. Study the characteristics of different governor like porter, proell and hartnell governor

8. Single degree of freedom Spring-mass-damper system: determination of natural frequency and damping coefficient

9. Determination of torsional natural frequency of single and double rotor system undamped and damped natural frequency

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Understand Velocity Ratio of of Simple, Compound, Epicyclic and Differential gear train	Understand	Understand
CO2	Understand working principle of kinematics of four bar, slider crank, crank rocker, double crank, double rocker, and oscillating cylinder mechanism	Understand	Understand
CO3	Understand kinematics of pantograph, some straight line motion mechanisms, wiper, drafter etc	Understand	Understand
CO4	Analyse motions of different cams & followers and balancing problems	Analyse	Analyse
CO5	Analyse the working principles of gyroscope and governors.	Analyse	Analyse
CO6	Analyse the vibrational behaviour of systems.	Analyse	Analyse

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	
7					3	
8						3
9						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	2	-	-	1	2	1	-	2
CO2	2	2	2	2	-	-	1	2	1	-	2

CO3	2	2	2	2	-	-	1	2	1	-	2
CO4	2	3	2	2	-	-	1	2	1	-	2
CO5	2	3	2	2	-	-	1	2	1	-	2
CO6	2	3	2	2	-	-	1	2	1	-	2

9. Mapping to Program Specific Outcome (PSO)

	PSO1	**PSO2**
CO1	2	1
CO2	2	1
CO3	2	1
CO4	3	1
CO5	3	1
CO6	3	1

End of Syllabus

Course Name: Fluid Mechanics & Fluid Machines Lab
Course Code: ME 308
(Semester V)
Course Broad Category: Professional Core

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1. **Course Prerequisite:**

   Concept of Fluid Mechanics and fluid Machines

2. **Course Learning Objectives:**

   To understand the principles and performance characteristics of flow devices.
   To know about the measurement of the fluid properties.

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: Fluid Mechanics & Fluid Machines Lab
   Course Code: ME 308
   Hours per Week: 0L: 0T: 2P
   Credits: 1

5. **List of Experiments**

1. Fluid flow measurements: Determining coefficient of discharge for Venturimeter, Orifice meter, Weirs;
2. Experiment to verify Bernouli's theorem;
3. Flow through pipes: Reynold's experiments; Pitot tube experiments on viscous flow;
4. Determination of metacentric height of a floating vessel;
5. Experiments on Fluid Machinery : Pumps (Reciprocating and centrifugal), Compressors;
6. Experiments on Hydro-Turbines: Francis, Kaplan and Pelton turbines.
7. Determination of viscosity of a fluid (by Saybolt viscometer).

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ME 308.1	**Apply** Bernoulli's equation to measure flow through pipes using venture-meter & orifice-meter.	Identify	Remember
ME 308.2	**Measurement** of flow through open channel flow through triangular, rectangular notches and estimation of coefficients.	Explain	Understand
ME 308.3	**Evaluate** hydraulic and overall efficiencies, determine unit and specific quantities of impulse (Pelton).	Implement	Apply
ME 308.4	**Evaluate** hydraulic and overall efficiencies Reaction turbines(Francis and Kaplan)	Organize	Analyze
ME 308.5	**Evaluate** overall efficiencies, unit and specific quantities, cavitations of rotodynamic pump (centrifugal).	Assess	Evaluate
ME 308.6	**Calculate** slip and **inspect** the chance of cavitations**,** single & double acting positive displacement type pump (Reciprocating).	Construct	Create

7. Mapping of course outcomes to module / course content

Experiment no	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	2	-	1
2	1	3	-	1	-	1
3	1	1	3	2	-	1
4	1	-	-	2	-	1
5	1	-	-	1	3	1
6	1	-	-	3	-	2
7	1	-	-	3	-	2

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ME 308.1	3	2	2	1	1	-	1	1	-	1	2
ME 308.2	2	3	2	1	1	-	1	1	-	1	2
ME 308.3	2	3	2	1	1	-	1	1	-	1	2
ME 308.4	3	2	1	1	2	-	1	1	-	1	2
ME 308.5	3	2	2	1	1	-	1	1	-	1	2
ME 308.6	3	2	2	1	1	-	1	1	-	1	2

9. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
ME 308.1	2	3
ME 308.2	2	3
ME 308.3	2	3
ME 308.4	2	3
ME 308.5	2	3
ME 308.6	2	3

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

Course Name: AI and Data Science in Mechanical Engineering lab.
Course Code: ME309
(Semester V)
Course Broad Category: Open Elective

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1. **Course Prerequisite:**

   Basic Programming Skill and Fundamentals of Mechanical Engineering

2. **Course Learning Objectives:**

   - Understand the basics of AI and Data Science
   - Apply AI and Data Science techniques to mechanical engineering problems
   - Analyze and interpret data from mechanical systems
   - Develop intelligent systems for mechanical engineering applications

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 (60Marks)-Formative Continuous Assessment [Continuous Assessment]
B. End-Semester Exam (40Marks) – Summative Assessment.

4. **Course Content:**
   Course Name: AI and Data Science in Mechanical Engineering Lab.
   Course Code: ME-309

   Hours per Week: 0L:2T:2P
   Credits: 3

5. **List of Experiments**

Module 1:	**Introduction to AI and Data Science Tools**. **Objective:** Install and configure Python, Jupyter Notebook, and relevant AI/ML libraries (NumPy, Pandas, Scikit-learn, Tensor Flow, Keras) **Exercise:** Explore basic Python and data science tools for data Manipulation and exploration.
Module 2:	**Data Preprocessing and Visualization for Mechanical Engineering** Objective: Apply data preprocessing techniques (handling missing values, normalization, feature scaling). Exercise: Use a mechanical engineering dataset (e.g., material properties Or manufacturing data) for preprocessing and visualize data using Matplotlib and Seaborn.
	Supervised Learning for Process Optimization Objective: Implement linear and logistic regression for optimizing

	Mechanical process parameters. Exercise: Use regression models to predict and optimize parameters like surface roughness or material removal rate in turning operations.
	Unsupervised Learning for Mechanical Engineering Objective: Apply clustering techniques to mechanical datasets. Exercise: Implement K-means clustering to analyze and classify mechanical components based on properties such as hardness, tensile strength, or wear resistance.
Module 3:	**Neural Networks for Mechanical Applications** Objective: Build and train a basic artificial neural network (ANN) for regression or classification tasks. Exercise: Use an ANN model to predict outcomes such as failure modes in mechanical systems or classifications of materials based on micro Structural data.
	Deep Learning with CNN for Mechanical Defect Detection Objective: Apply Convolution Neural Networks (CNN) for defect detection in manufacturing. Exercise: Implement a CNN model to detect surface defects or cracks in images of mechanical components
	Predictive Maintenance using RNN/LSTM Objective: Implement Recurrent Neural Networks (RNN) and Long Short-Term Memory (LSTM) for predictive maintenance. Exercise: Use RNN/LSTM models to predict equipment failure based on time-series data such as vibration analysis or temperature fluctuations.
	Generative Design using AI Techniques Objective: Explore AI-driven generative design for mechanical structures. Exercise: Use AI/ML techniques to optimize and generate designs for mechanical components with weight, strength, and durability constraints.
	Topology Optimization for Structural Design Objective: Apply topology optimization techniques using AI for lightweight and efficient mechanical component design. Exercise: Optimize a mechanical part using an AI model to reduce Material usage while maintaining structural integrity.
Module 4:	**Thermal Engineering Optimization using AI** Objective: Optimize thermal system design using AI techniques. Exercise: Use AI models to optimize heat exchanger design or cooling System performance based on thermal efficiency parameters.
	Energy Efficiency Optimization in Mechanical Systems Objective: Use machine learning techniques to improve the energy efficiency of mechanical systems. Exercise: Implement regression models to optimize the energy Consumption of motors, pumps, or HVAC systems in industrial applications.
	Project Implementation and Presentation Objective: Develop and present a mini-project based on a real-world mechanical engineering problem. Exercise: Work in teams to collect data, preprocess it, build and evaluate AI/ML models, and present findings.

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ME-309.1	Understand the Fundamentals of AI and Data Science	Identify	Remember
ME-309.2	Apply Machine Learning Techniques in Mechanical Engineering	Explain	Understand
ME-309.3	Analyze Mechanical Engineering Data Using Statistical and Visualization Tools	Implement	Apply
ME-309.4	Evaluate Deep Learning Models for Mechanical Engineering Applications	Organize	Analyze
ME-309.5	Design AI/ML Models for Machine and Thermal Engineering Problems	Assess	Evaluate
ME-309.6	Develop and Present a Complete AI-Based Project for Mechanical Engineering	Construct	Create

7. Mapping of course outcomes 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	3	-	-	2	-	1
5	2	-	-	1	3	1

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	2	1	1	2	3	1	-	1	1	-	1
CO2	2	1	1	2	3	1	-	1	1	-	1
CO3	2	1	1	2	3	1	-	1	1	-	1
CO4	2	1	1	2	3	1	-	1	1	-	1
CO5	2	1	1	2	3	1	-	1	1	-	1
CO6	2	1	1	2	3	1	-	1	1	-	1

9. Mapping to Program Specific Outcome (PSO)

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

*****EndofSyllabus*****

Course Name: PROJECT-II Minor

Course Code: ME- 310

(Semester V) Category: Minor

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1. Course Prerequisite:

Skills up to the previous semester level in Mechanical Engineering

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-II Minor

Course Code: ME-310

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

Credits: 2

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-310.1	Apply knowledge of research methodology to identify a research problem and develop a research proposal	Apply	Apply
ME-310.2	Conduct independent research and collect data	Conduct	Analyze
ME-310.3	Communicate research findings effectively through a thesis	Communicate	Understand
ME-310.4	Apply critical thinking and problem-solving skills to analyze complex data	Apply	Analyze
ME-310.5	Demonstrate expertise in a specialized area of research	Demonstrate	Evaluate
ME-310.6	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