

2. S.E Syllabus

SEM III MECHANICAL ENGINEERING

Theme: Sustainable Engineering Solutions for Climate Action and Industrial Innovation

Aligned with UNSDG 9: Industry, Innovation and Infrastructure, UNSDG 13: Climate Action, UNSDG 8: Decent Work and Economic Growth

Keywords: Accessible, digital literacy, disabilities

This theme allows students to apply their technical knowledge from subjects like thermodynamics, materials science, and strength of materials toward solving real-world sustainability challenges while developing entrepreneurial skills to implement these solutions commercially. The integration of environmental science ensures they understand the broader impact of their engineering decisions.

For Decent Work and Economic Growth (UNSDG 8):

- **Employment Opportunities:** Aims to reduce unemployment and underemployment, especially among youth and marginalized groups.
- **Inclusive Economic Growth:** Encourages GDP growth that benefits all segments of society, ensuring equity and poverty reduction.
- **Promotes Workers' Rights:** Advocates for safe work environments, fair wages, and labor rights across industries.
- **Boosts Productivity and Innovation:** Encourages entrepreneurship, skill development, and technology integration for sustainable growth.

For Industry, Innovation and Infrastructure (UNSDG 9):

- **Resilient Infrastructure:** Supports construction and maintenance of roads, bridges, and networks vital for economic and social development.
- **Encourages Technological Progress:** Drives innovation and research, which are key to sustainable development and competitiveness.
- **Industrial Development:** Strengthens domestic industries, supports SMEs, and creates job opportunities in manufacturing and technology sectors.
- **Reduces Inequalities:** Inclusive infrastructure and technology access help bridge urban-rural divides and support equitable development.

For Climate Action (UNSDG 13):

- **Mitigates Global Warming:** Focuses on reducing greenhouse gas emissions to limit global temperature rise.
- **Enhances Disaster Preparedness:** Promotes resilience to climate-related disasters like floods, droughts, and storms.
- **Protects Ecosystems:** Helps preserve biodiversity, forests, and natural resources threatened by climate change.
- **Encourages Global Cooperation:** Promotes climate justice, international agreements (like the Paris Agreement), and sustainable policies worldwide.

Problem Statement

Problem Statement 1. A Smart Solar-Powered Water Purification System

Solar-powered water purification system for rural communities that can process 1000 liters/day of contaminated water. The system must be cost-effective, environmentally sustainable, and manufacturable with precise tolerances.

Problem Statement 2: Autonomous Electric Vehicle Charging Station with Renewable Energy Integration

An autonomous electric vehicle charging station powered by hybrid renewable energy sources (solar + wind) with intelligent load management and structural durability for 20-year lifespan in harsh weather conditions.

Problem Statement 3: Intelligent Waste-to-Energy Conversion System for Industrial Applications

A modular waste-to-energy system that converts industrial organic waste into usable energy while meeting environmental regulations. The system must be scalable, efficient, and economically viable for small-to-medium enterprises.

Problem Statement 4: Smart Precision Agriculture Drone with Autonomous Operations

A fully autonomous agricultural drone system for precision farming that can monitor crop health, apply fertilizers/pesticides with precision, and operate continuously with minimal human intervention while being environmentally responsible.

Problem Statement 5: Hybrid Renewable Energy System for Remote Healthcare Facilities

A reliable hybrid renewable energy system (solar, wind, biogas) for remote healthcare facilities that ensures 24/7 power supply for critical medical equipment while maintaining cost-effectiveness and minimal environmental impact.

Problem Statement 6: Smart Manufacturing Cell for Sustainable Automotive Component Production

Industry 4.0 smart manufacturing cell for producing lightweight automotive components using sustainable materials and processes. The system must achieve zero waste, optimal energy efficiency, and real-time quality control while being economically competitive.

R-2025- Mechanical Engineering

S.E SEM III

Course Code	Course Name	Teaching Scheme (Contact Hours Per week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
16211301	Integral Transform and Statistical Techniques	2	1	--	30	15	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-1+IAT-2					
16211301	Integral Transform and Statistical Techniques	20	20	40	60	2.5	25	--	125

Rationale:

In second-year Mechanical Engineering, mathematical tools like transforms, statistics, and numerical methods are essential for analyzing real-world systems. The Laplace Transform helps model dynamic behavior in systems like vibrations and control mechanisms, while the Inverse Laplace Transform allows engineers to interpret time-domain responses such as in spring-damper systems. Fourier Series are useful in analyzing periodic forces acting on rotating or reciprocating machinery. The Z-Transform supports the study of digital control systems used in automation and robotics. Statistical Techniques enable quality control and data analysis, such as evaluating product tolerance or reliability. Numerical Solutions of PDEs are crucial for simulating heat transfer, stress distribution, or fluid flow where analytical methods are insufficient. These topics build a strong foundation for modeling and solving mechanical engineering problems effectively.



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R-2025- Mechanical Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours Per week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
16211301	Integral Transform and Statistical Techniques	2	1	--	30	15	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
16211301	Integral Transform and Statistical Techniques	20	20	40	60	2.5	25	--	125

Rationale:

In second-year Mechanical Engineering, mathematical tools like transforms, statistics, and numerical methods are essential for analyzing real-world systems. The Laplace Transform helps model dynamic behavior in systems like vibrations and control mechanisms, while the Inverse Laplace Transform allows engineers to interpret time-domain responses such as in spring-damper systems. Fourier Series are useful in analyzing periodic forces acting on rotating or reciprocating machinery. The Z-Transform supports the study of digital control systems used in automation and robotics. Statistical Techniques enable quality control and data analysis, such as evaluating product tolerance or reliability. Numerical Solutions of PDEs are crucial for simulating heat transfer, stress distribution, or fluid flow where analytical methods are insufficient. These topics build a strong foundation for modeling and solving mechanical engineering problems effectively.



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Course Objectives:

1. To explain the Laplace transform and its use in solving linear differential equations in mechanical systems.
2. To demonstrate techniques for obtaining time-domain solutions using inverse Laplace transforms.
3. To illustrate how periodic functions are represented using Fourier series in mechanical vibrations and heat transfer.
4. To introduce Z-transforms for analyzing discrete-time systems relevant to digital control in mechanical systems.
5. To teach statistical methods for interpreting experimental data and quality control in mechanical processes.
6. To present numerical methods for solving partial differential equations (PDEs) related to heat and fluid flow.

Course Outcomes:

1. Students will be able to apply Laplace transforms to analyze mechanical systems such as mass-spring-damper models.
2. Students will solve mechanical system responses by computing inverse Laplace transforms of transfer functions.
3. Students will construct Fourier series to analyze periodic behavior in systems such as vibrating beams or rotating shafts.
4. Students will use Z-transform techniques to evaluate the behavior of sampled mechanical control systems.
5. Students will apply statistical tools to interpret data from experiments such as fatigue testing or tolerance analysis.
6. Students will solve PDEs using methods like finite difference to simulate temperature distribution in a heat exchanger or velocity fields in fluid flow.

Prerequisite:

1. Basics of integration and its properties.
2. Partial differentiation.



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R-2025- Mechanical Engineering DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Laplace Transform	Definition of Laplace transform, Condition of Existence of Laplace transform.	05	CO1
		Laplace Transform (L) of Standard Functions like e^{at} , $\sin(at)$, $\cos(at)$, $\sinh(at)$, $\cosh(at)$ and $t^n, n \geq 0$.		
		Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by t , Division by t , Laplace Transform of derivatives and integrals (Properties without proof).		
		Evaluation of integrals by using Laplace Transformation.		
		Self-learning Topics: 1. Heaviside's Unit Step function. 2. Laplace Transform. of Periodic functions. 3. Dirac Delta Function.	08	
II	Inverse Laplace Transform	Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives.	05	CO2
		Partial fractions method to find inverse Laplace transform		
		Inverse Laplace transform using Convolution theorem (without proof).		
		Self-learning Topics: 1. Applications of Laplace Transforms for solutions to ODE to electrical & electronics circuit problems. 2. Applications to solve initial and boundary value problems involving ordinary differential equations.	07	



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III	Fourier Series	Dirichlet’s conditions, Definition of Fourier series and Parseval’s Identity (without proof).	05	CO3
		Fourier series of periodic function with period 2π and $2l$.		
		Fourier series of even and odd functions.		
		Self-learning Topics: 1. Half range Sine and Cosine Series. 2. Complex form of Fourier Series. 3. Fourier Integral	08	
IV	Z-Transform	Definition and Region of Convergence,	05	CO4
		Transform of Standard Functions: $\{k^na^k\}$, $\{a^k\}$, $\{c^k\sin(\alpha k+\beta)\}$, $\{c^k\sinh a^k\}$, $\{c^k\cos(\alpha k+\beta)\}$, $\{c^k\cosh a^k\}$		
		Properties of Z Transform: Change of Scale, Shifting Property, Multiplication, and Division by k.		
		Convolution theorem.		
		Inverse Z transform: Partial Fraction Method	07	
		Self-learning Topics: 1. Initial value theorem. 2. Final value theorem. 3. Inverse Using Convolution Theorem. 4. Inverse using Binominal expansion. 5. Inverse using long division.		
V	Statistical Techniques	Spearman’s Rank correlation coefficient (R) (with repeated and non-repeated ranks)	05	CO5
		Lines of regression		
		Fitting of first- and second-degree curves.		



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		Self-learning Topics: 1. Karl Pearson's Coefficient of correlation(r). 2. Fitting of exponential curve. 3. Fitting of logarithmic curve. 4. Covariance	07	
VI	Numerical methods for PDE	Introduction of Partial Differential equations, method of separation of variables. Vibrations of string.	05	CO6
		Analytical method for one dimensional heat and wave equations. (only problems)		
		Crank Nicholson method		
		Bender Schmidt method		
		Self-learning Topics: 1. Analytical methods of solving two- and three-dimensional problems. 2. Partial differential equations with constant coefficients 3. Classifications of second order linear partial differential equations.	08	

Text Books:

1. Grewal B. S.: "Higher Engineering Mathematics", Khanna Publishers, 44th Ed., 2021.
2. Kreyszig E.: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed., 2018.
3. Dass H. K.: "Higher Engineering Mathematics", S Chand & Company Ltd, 12th Ed., 2004.
4. Narayan S.: "Differential Calculus", S.Chand Publications, 30th Ed., 2005.

References:

1. Stewart J.: "Multivariable Calculus" Cengage Publications, 7th Ed., 2019.

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2. Bali N.P and Goyal M.: “A Textbook of Engineering Mathematics” Laxmi Publications, 10th Ed., 2022.
3. Wylie C. R, Barrett L.C.: “Advanced Engineering Mathematics” McGraw Hill Book Co., New York, 6th Ed., 2017.
4. Ramana B.V.: “Higher Engineering Mathematics”, Tata McGraw-Hill Publishing Company Limited, 1st Ed., 2006.
5. Pal S. & Bhunia S. C.: “Engineering Mathematics” Oxford University Press, 3rd Ed., 2016.

Online References:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/111/106/111106139/
2.	https://www.youtube.com/watch?v=LGxE_yZYigI
3.	https://www.youtube.com/watch?v=lkAvgVUvYvY
4.	https://www.youtube.com/watch?v=XfmbrUBrs5Q

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test.

Term work (TW) for 25 marks:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per the university pattern for practical.
2. Students must be encouraged to write **at least 10** class tutorials on entire syllabus.



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3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1. Regularity and active involvement (Theory and Tutorial) 05 marks.
2. Class Tutorials on entire syllabus 10 marks.
3. Mini Project 10 marks.



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		L	T	P	L	T	P	SL	Notional Learning Hour	
16211302	Mechanics of Solid	3	-	--	45	--	--	45	90	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	IAT 1+ IAT 2					
1621130 2	Mechanics of Solid	20	20	40	60	2.5	--	--	100

Rationale :

Most of the engineering branches are being off-spring of **Mechanical Engineering**, which forms the base for understanding material behavior and structural analysis. The *Mechanics of Solids* course helps

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students learn how forces cause stress, strain, bending, deflection, and failure in components like beams, shafts, and columns.

It builds essential knowledge and skills for designing safe and efficient mechanical systems, and prepares students for advanced subjects like Machine Design and Structural Analysis. This subject is useful across many fields, including Civil, Aerospace, and Automobile Engineering.

Course Objectives:

1. **Explain** the basic concepts of different types of forces, loading conditions, and resulting stresses and strains in mechanical components.
2. **Construct** Shear Force Diagrams (SFD) and Bending Moment Diagrams (BMD) for various types of loading and support conditions.
3. **Analyze** shear and bending stresses developed in structural members under external loads.
4. **Evaluate** deflection in beams and stresses in circular shafts using standard methods.
5. **Estimate** deflection and strain energy stored in mechanical elements under different loading conditions.
6. **Examine** the critical buckling load for different types of columns under axial loading.

Course Outcomes: Six Course outcomes (Based on Bloom's Taxonomy)

- 1) Demonstrate fundamental knowledge about various types of loading and stresses induced.
- 2) Draw the SFD and BMD for different types of loads and support conditions.
- 3) Analyse the bending and shear stresses induced in the beam.
- 4) Analyze the deflection in beams and stresses in the shaft.
- 5) Analyse the stresses and deflection in beams and estimate the strain energy in mechanical elements.
- 6) Analyse buckling phenomenon in columns

Prerequisite: Knowledge of Engineering Mechanics.

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DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Types of forces and free body diagrams, Conditions of equilibrium, Centroid and moment of inertia (basics), Basic concepts of friction, Newton's laws of motion (overview)		
I	Introduction	Introduction -Concept of Stress Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses, Stress Strain Diagram, elastic constants and their relations volumetric, linear and shear strains. Composite sections, Thermal stress and strain.	08	CO1
		Self-learning Topics: Principal stresses and Principal planes- Mohr's circle. Moment of inertia about an axis and polar moment of inertia	08	
II	SFD & BMD	Shear Force and Bending Moment in Beams: Introduction to types of beams, supports and loadings. Definition of bending moment and shear force, Sign conventions, relationship between load intensity, bending moment and shear force. Shear force and bending moment diagrams for statically determinate beams subjected to points load, uniformly distributed loads, uniformly	10	CO2

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		varying loads, couple and their combinations		
		Self-learning Topics: Beams with multiple loads (point + UDL) Beams with inclined loads (resolve components) Beams with moments applied directly	10	
III	Stresses in Beams:	Stresses in Beams: Theory of bending of beams, bending stress distribution, shear stress distribution for point and distributed loads in simply supported and overhanging beams, cantilevers.	07	CO3
		Self-learning Topics: Bending + shear Bending + axial loading (e.g., eccentric load) Mohr's Circle for stress transformation	07	
IV	Deflection of Beams:	Deflection of a beam: Double integration method, Maxwell's reciprocal theorems for computation of slopes and deflection in beams for point and distributed loads. Torsion: Stresses in solid and hollow circular shafts.	08	CO4
		Self-learning Topics: Torsion: Stresses in solid and hollow circular shafts.	08	
V	Thin Cylindrical and Spherical Shells and Strain energy	Self-learning Topics: Strain energy stored in the member, Rankine formula	06	CO5
		Thin Cylindrical and Spherical Shells: Stresses and deformation in Thin Cylindrical and Spherical Shells subjected to internal pressure Strain Energy, Buckling load, Types of end	06	

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		conditions for column, Euler's column theory and its limitations.		
VI	Columns	Self-learning Topics: Stress and Strain in eco-friendly and precision components	06	CO6
		Elastic Constants & Stress-Strain Diagrams for sustainable materials Torsion in Shafts – for energy systems and smart devices Bending and Shear in Beams – for drones, solar frames, and reactors Principal Stresses and Combined Loading – in modular and hybrid systems Factor of Safety & Material Selection – with focus on green design and durability	06	

Text Books:

- 1 R. K. Bansal – *A Textbook of Strength of Materials*, Laxmi Publications
- 2 S. S. Bhavikatti – *Strength of Materials*, Vikas Publishing House
- 3 R. K. Rajput – *Strength of Materials*, S. Chand
- 4 B. C. Punmia, Ashok Jain, Arun Jain – *Mechanics of Materials*, Laxmi Publications
- 5 Dr. Sadhu Singh – *Strength of Materials*, Khanna Publishers

References:

- 1 Mechanics of Materials by S.S.Ratan, Tata McGraw Hill Pvt. Ltd
- 2 Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd
- 3 Strength of Materials by R. Subramanian, Oxford University Press, Third Edition 2016

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Online References:

Sr. No.	Website Name
1.	http://www.nptelvideos.in/2012/11/strength-of-materials-prof.html 2.
2.	https://swayam.gov.in/nd1_noc20_ce34
3.	https://www.youtube.com/watch?v=7noPM9bGnFs&list=PL9H2IJVEgfm_wwJm0GIfeCWjHZtpG5VQI



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		L	T	P	L	T	P	SL	Notional Learning Hour	
16211303	Engineering Thermodynamics	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs.)			
		IAT- 1	IAT-2	IAT-1 + IAT-2					
16211303	Engineering Thermodynamics	20	20	40	60	2.5	--	--	100

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Rationale:

Thermodynamics concepts are useful in understanding and designing systems involving energy transfer and energy transformation.

Course Objectives:

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

Course Outcomes:

1. Demonstrate application of the laws of thermodynamics to a wide range of systems.
2. Compute heat and work interactions in thermodynamic systems
3. Demonstrate the interrelations between thermodynamic functions to solve practical problems.
4. Compute thermodynamic interactions using the steam table and Mollier chart
5. Compute efficiencies of heat engines, power cycles.
6. Apply the fundamentals of compressible fluid flow to the relevant systems

Prerequisite:

Thermodynamics system and types, Microscopic and Macroscopic approach, System, Boundary and Surrounding, Thermodynamic properties, Zeroth Law of Thermodynamics



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DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Thermodynamics system and types, Microscopic and Macroscopic approach, System, Boundary and Surrounding, Thermodynamic properties, Zeroth Law of Thermodynamics, First law of thermodynamics, Internal Energy, Concept of Enthalpy and Entropy	0	
I	Introduction	Introduction and Basic Concepts of Thermodynamics: Thermodynamic state, path, process and cycle, Point and Path functions, Quasi-static process & Equilibrium, Characteristic gas equation, Heat and Work. Concept of PdV work. First Law of Thermodynamics: Statement & Equation, First law for Cyclic process (Joule's experiment), Perpetual Motion Machine of the First Kind, Application of first law to non-flow systems (Ideal gas processes with numerical)	6	CO1

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		First law applied to flow system: Concept of flow process and flow energy, Concept of the steady flow process, Energy balance in a steady flow, Application of steady flow energy equation to nozzle, turbine, compressor, pump, boiler, condenser, heat exchanger, throttling device. Steady flow work, Significance of – VdP work, Relation between flow and non-flow work.		
		Self-learning Topics: Ideal gas properties	6	
II	Second Law of Thermodynamics:	Second Law of Thermodynamics: Limitation of the first law of thermodynamics, Thermal reservoir, Statement of the second law of thermodynamics, Reversible and irreversible Process, Causes of irreversibility, Perpetual Motion Machine of the second kind, Carnot cycle, Carnot theorem. Entropy: Clausius theorem, Entropy is property of a system, Temperature-Entropy diagram, Clausius inequality, Increase of entropy principle, T ds relations, Entropy change During a process.	8	CO2
		Self-learning Topics: Concept of heat engine, Heat pump and Refrigerator	8	

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III	Availability:	Availability: High grade and low grade energy, Available and Unavailable energy, DeadState, Useful work, Irreversibility, Availability of closed system & steady flow process, Helmholtz & Gibbs function Thermodynamic Relations: Maxwell relations, Clausius-Clapeyron Equation, Mayer relation, Joule-Thomson coefficient	8	CO3
		Self-learning Topics: Concept of Thermal Reservoir.	8	
IV	Properties of Pure Substance:	Properties of Pure Substance: Advantages and applications of steam, Phase change process of water, Saturation pressure and temperature, Terminology associated with steam, Different types of steam. Property diagram: T-v diagram, p-v diagram, p-T diagram, Critical and triple point, T-s and an h-s diagram for water, Calculation of various properties of wet, dry and superheated steam using the steam table and Mollier chart. Vapour Power cycle: Carnot cycle and its limitations as a vapour cycle, Rankine cycle with different turbine inlet conditions, Mean	9	CO4

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		temperature of heat addition, Reheat Rankine Cycle.		
		Self-learning Topics: Principal components of a simple steam power plant,	9	
V	Gas Power cycles:	Gas Power cycles: Nomenclature of a reciprocating engine, Mean effective pressure, Assumptions for Air Standard Cycle, Otto cycle, Diesel Cycle and Dual cycle, Comparison of Otto and Diesel cycle for same compression ratio, Brayton Cycle. Sterling Cycle, Ericsson Cycle, Lenoir cycle, and Atkinson cycle (Only theory).	6	CO5
		Self-learning Topics: Assumptions for Air Standard Cycle	6	
VI	Waste-to-Energy Thermodynamics :	Thermochemical conversion: combustion, pyrolysis, gasification Thermodynamic modeling of conversion processes Energy balance and mass balance in waste conversion systems	8	CO6
		Self-learning Topics: Biochemical conversion: anaerobic digestion	8	

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R-2025- Mechanical Engineering

Text Books:

Text / References Books:

1. Thermodynamics by P K Nag, 6th Edition, TMH
2. Thermodynamics by Onkar Singh, 4th Edition New Age International
3. Thermodynamics by C P Arora, 1st Edition TMH
4. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael A. Boles, 9th edition, TMH
5. Basic Engineering Thermodynamics by Rayner Joel, 5th edition, Longman Publishers
6. Engineering Thermodynamics by P Chattopadhyay, 2nd edition, Oxford University Press India
7. Engineering Thermodynamics Through Examples by Y V C Rao, Universities Press (India) Pvt Ltd
8. Fundamentals of Thermodynamics by Moran & Shapiro, Eighth Edition, Wiley
9. Thermodynamics by W.C. Reynolds, McGraw-Hill & Co
10. Thermodynamics by J P Holman, 4th Edition McGraw-Hill & Co

Online References:

Sr. No.	Website Name
1	https://nptel.ac.in/courses/112/105/112105266
2	https://nptel.ac.in/courses/112/103/112103275
3	https://nptel.ac.in/courses/112/105/112105220
4	https://nptel.ac.in/courses/101/104/101104063



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R-2025-Mechanical Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
16211304	Material Science	3	-	--	45	--	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	IAT 1+IA T 2					
16211304	Material Science	20	20	40	60	2.5	--	--	100

Rationale :

Material Science is a foundation subject that helps engineers understand the relationship between the structure, properties, processing, and performance of materials. It plays a key role in selecting the right materials for various applications in mechanical, civil, electrical, and electronics engineering.

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Understanding traditional and advanced materials along with failure mechanisms like fatigue and fracture is essential for efficient and safe engineering design.

Course Objectives: Six Course Objectives

1. To classify various types of engineering materials based on their structure and properties.
2. To understand failure mechanisms like fracture, fatigue, creep.
3. To interpret phase diagrams for understanding alloy formation and microstructures.
4. To analyze the impact of heat treatment processes on material properties.
5. To identify and compare advanced engineering materials and their applications.
6. To understand basic NDT methods.

Course Outcomes: Six Course outcomes (Based on Blooms Taxonomy)

- 1) To classify the different types of materials used in engineering applications and identify various crystal imperfections, deformation mechanisms and strengthening mechanisms.
- 2) To describe the various modes of failure mechanisms in engineering materials like fracture, fatigue and creep failure.
- 3) To interpret iron-iron carbide phase diagram, outline various phases present at different conditions and describe the theory of alloying.
- 4) To discuss various heat treatment processes, their effects and applications for different ferrous alloys reviewing iron-iron carbide phase diagram and TTT diagram and also explain the effect of alloying elements on properties of various steels and distinguish between tool steel and stainless steel.
- 5) To distinguish between composites, Nano-materials and smart materials.
- 6) To classify the different types of NDT used in Engineering Applications

Prerequisite: Knowledge of Physics and Chemistry.

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DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Knowledge of physics :Miller indices, crystal structure and Chemistry: Engineering Materials.		CO1
I	Introduction	Concepts of crystals- Crystalline and Non-Crystalline Materials Unit cell, Crystal structures of metals, Crystal systems, Crystallographic planes and directions Crystal Defects: Crystal Imperfections-definition, classification and significance of imperfections -point defects, line defects, Surface defects and volume defects. Importance of dislocations in deformation and its mechanisms. Critical Resolved shear stress, Cold Working and Recrystallization annealing: Definition, effects and mechanism of cold work, Need for Recrystallization Annealing, the stages of recrystallization annealing and factors affecting it, Slip systems and deformability of FCC, BCC and HCP lattice systems	10	CO1
		Self-learning Topics: Definition of Materials, Engineering Materials and Applications, Classification of materials: Introduction to engineering materials – significance of structure	10	

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		property correlations in all classes of engineering materials		
II	Fracture, fatigue and creep	Fracture of metals, Ductile to Brittle Transition Temperature (DBTT), Griffith's criteria Fatigue – Endurance limit of ferrous and non-ferrous metals -Fatigue test, S-N curves, factors affecting fatigue, structural changes accompanying fatigue; Creep – mechanism of creep – stages of creep and creep test, creep resistant materials	08	CO2
		Self-learning Topics: Strengthening mechanisms in materials, Principles of Fracture ,fatigue and Creep, Difference between Ductile Fracture and Brittle Fracture	08	
III	Alloy and Phase diagrams	Solidification of metals and - alloys– Cooling curves Classification of Alloys based on phases and phase Diagram-Binary alloy phase diagram – Isomorphous, Eutectics type I and II, Peritectic Iron-Iron carbide phase diagram – Invariant reactions – microstructural changes of hypo and hyper-eutectoid steel- TTT and CCT Diagram- Hardenability and its tests, Graphitization in cast irons.	06	CO3
		Self-learning Topics: Mechanism of Crystallization- Nucleation-	06	

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		Homogeneous and Heterogeneous Nucleation and Growth		
IV	Heat Treatment	Heat treatment: Annealing and types, normalizing, hardening and tempering, austempering and martempering – microstructure changes Surface hardening processes: Carburizing –, nitriding – cyaniding and carbonitriding, induction and flame hardening, Laser and Electron beam hardening– principles and case depths Alloy steels- Tool steels, Maraging steels and Ausformed steels	08	CO4
		Self-learning Topics: Heat treatment: Overview – Objectives – Thorough treatments: Types of annealing, Microstructure changes during heat treatment, Surface hardening processes, Alloy steels-Stainless steels	08	
V	Advanced materials	Self-learning Topics: Engineering Materials and their properties, Basic concepts of composites, nano materials, Polymers, Engineering Polymers and Ceramics-types and their advantages over metallic materials	08	CO5
		Composites: Processing of composites, advantages over metallic materials, various types of composites and their applications Nano Materials: synthesis of nanomaterials, examples, applications and Nano composites	08	

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		Processing of ceramics and composites through Injection Moulding, Introduction to Smart materials: Classification, Shape Memory Alloys and its applications		
VI	NDT and its Role in Sustainability	Introduction to NDT and its Role in Sustainability – Importance in zero-waste manufacturing, structural health monitoring, Nondestructive Testing of Materials-ultrasonic testing, radiographic methods, magnetic particle testing, Evaluation of Smart and Sustainable Materials using NDT – Testing of composites, polymers, recycled alloys Case Studies & Selection of NDT Methods for Problem-Specific Needs – Choosing appropriate NDT for drones, EV stations, modular energy units Self-learning Topics: Testing of Materials, Principle and types of Ultrasonic Testing (UT) , Principle and safety in Radiographic Testing (RT) , Difference between X-rays and Gamma rays , Basics of Magnetic Particle Testing (MPT) , Equipment used in UT, RT, and MP, Applications and limitations of each method	05	CO6
			05	

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Text Books:

- 1 **Callister's** Materials Science and Engineering, 2nd edition by R.Balasubramaniam Wiley India Pvt. Ltd
- 2 **V. Raghavan** – *Materials Science and Engineering*, Prentice Hall
- 3 **S. H. Avner** – *Introduction to Physical Metallurgy*, McGraw Hill
- 4 **Kodgire & Kodgire** – *Material Science and Metallurgy*, Everest Publishing House
- 5 **William D. Callister Jr.** – *Materials Science and Engineering: An Introduction*, Wiley
- 6 **R. S. Khurmi & R. S. Sedha** – *Material Science*, S. Chand

References:

- 1 **L. H. Van Vlack** – *Elements of Materials Science and Engineering*, Pearson
- 2 **Donald R. Askeland & Wendelin J. Wright** – *The Science and Engineering of Materials*, Cengage Learning
- 3 **S.K. Hajra Choudhury & A.K. Hajra Choudhury** – *Materials Science and Processes*, Indian Book Distributing Co.
- 4 **R.A. Higgins** – *Engineering Metallurgy: Part I – Applied Physical Metallurgy*, ELBS
- 5 **Balasubramanian** – *Materials Science*, Wiley India

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm09/
2.	https://nptel.ac.in/courses/113/102/113102080/
3.	https://nptel.ac.in/courses/112/104/112104229/
4.	https://nptel.ac.in/courses/118/104/118104008/

R-2025-Mechanical Engineering

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**
- Question Paper will comprise of a total of **six questions each carrying 15 marks** Q.1 will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered



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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
16212305	Material Science Lab	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	IAT 1+IAT 2				
16212305	Material Science Lab	--	--	--	--	25	25	50

Lab Objectives:

- 1) To **understand** the working of metallurgical microscopes and characterization techniques.
- 2) To **prepare** metallographic samples and **apply** suitable etching techniques.
- 3) To **compare** microstructures and hardness of medium carbon steel before and after heat treatment.
- 4) To **perform** tensile tests to determine mechanical properties like yield strength and modulus of elasticity.
- 5) To **conduct** torsion and impact tests to assess material behavior under different loading conditions.
- 6) To **analyze** the influence of heat treatment and loading on mechanical properties.

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Lab Outcomes:

- 1) **Demonstrate** the use of a metallurgical microscope and explain the principle behind it.
- 2) **Prepare** and **etch** metallographic samples for microstructural examination.
- 3) **Analyze** the effect of annealing, normalizing, and hardening on microstructure and hardness.
- 4) **Perform** tensile testing and **determine** yield strength, ultimate strength, and modulus of elasticity.
- 5) **Conduct** torsion and impact tests and **interpret** the material behavior under different loads.
- 6) **Evaluate** structure-property relationships based on experimental observations.

List of Experiments.

Sr No	List of Experiments	Hrs
01	Study of Metallurgical Microscope	2
02	Study of Characterization techniques and Metallographic sample preparation and etching	2
03	Comparison of Microstructures and hardness before and after Annealing, Normalizing and Hardening in medium carbon steel	2
04	Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity)	2
05	Torsion test on mild steel bar / cast iron bar	2
06	Impact test on metal specimen (Izod/Charpy Impact test)	2

Sr No	List of Assignments / Tutorials	Hrs
01	Simple stress strain	
02	SFD and BMD	
03	Stresses in beams	
04	Torsion and deflection.	
05	Thin cylinder and strain energy	
06	Buckling of Columns	

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1. R. K. Rajput – *Strength of Materials*, S. Chand
2. Kodgire & Kodgire – *Material Science and Metallurgy*, Everest Publishing
3. S. S. Bhavikatti – *Strength of Materials*, Vikas Publishing House
4. V. Raghavan – *Materials Science and Engineering*, Prentice Hall
5. T. K. Pal & H. S. Ray – *Laboratory Manual in Materials Science*, New Age International

References:

1. William D. Callister Jr. – *Materials Science and Engineering: An Introduction*, Wiley
2. S. H. Avner – *Introduction to Physical Metallurgy*, McGraw Hill
3. Donald R. Askeland & Wendelin Wright – *The Science and Engineering of Materials*, Cengage
4. E. P. Popov – *Engineering Mechanics of Solids*, Pearson
5. Gere & Timoshenko – *Mechanics of Materials*, CBS Publishers

Online Resources:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/112104034
2.	https://nptel.ac.in/courses/113104070
3.	https://swayam.gov.in/nd1_noc23_me48/preview
4.	https://vlab.amrita.edu/index.php?sub=1&brch=282
5.	https://nptel.ac.in/courses/112105124

Assessment:

Term Work: Term Work shall consist part (a) + (b)

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.



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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
16212306	Machine Drawing-GD & T	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	IAT1 +IAT 2				
16212306	Machine Drawing-GD & T	--	--	--	--	25	25	50

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Lab Objectives:

1. To familiarize with different types of drawings and symbols used in working drawings
2. To impart fundamentals of - limits, tolerances and fits used in working drawings
3. To impart fundamentals of- surface roughness, machining symbols and working drawing reading
4. To impart fundamentals of GD & T
5. To familiarize with symbols, rules and datum's used in GD & T
6. To familiarize with form, orientation and position used in GD & T

Lab Outcomes:

After completion of this laboratory course, the students will be able to

- 1) Read and Interpret appropriate symbols used in working drawings
- 2) Read and Interpret tolerances used in working drawings
- 3) Represent the surface roughness components on the working drawing and read the working drawings
- 4) Show geometric characteristic symbols on a working drawing
- 5) Apply GD & T symbols in a working drawing
- 6) Show form and orientation on a part drawing

Prerequisite: ESC201: Engineering Graphics, ESL201: Engineering Graphics Lab



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DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO (Lab Outcome) Mapping
0	Prerequisite	Engineering Graphics, Engineering Graphics Lab		
I	Introduction	Classification of drawings- machine drawing, production drawing, part drawing, assembly drawing and its types, patent drawing, Need of working drawing, difference between machine drawing and working drawing. Conventional representation (symbols) of materials, conventional representation of machine components – screw threads, welded joints, springs, gears, shafts bearings, knurling, Standard drafting and material abbreviations	04	LO1
II	Limits, tolerances and fits	Limit systems and terms used – tolerance, limits, deviation, actual deviation, upper deviation, lower deviation, allowance, basic size, design size, actual size. Tolerances- graphical illustration of tolerance zones, fundamental tolerances, fundamental deviation, calculation of fundamental shaft deviation, calculation of fundamental hole deviation Fits- types of fits with symbols and applications, hole basis and shaft basis systems	04	LO2

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III	Surface roughness, Machining symbols, working drawing	Surface roughness representation, indication of surface roughness, symbols specifying direction of lay, indication of machining allowance and surface roughness allowance on drawings, Reading a working drawing	06	LO3
IV	Introduction to GD & T	What is GD & T, when to use GD & T, advantages of GD & T over Coordinate Dimensioning and Tolerance, Geometric characteristic symbols like- Form, Profile, Orientation, Run out, Location, etc.	04	LO4
V	Symbols, Rules and Datums	Geometric characteristic Symbols The feature control frame Rules Form- flatness, straightness, circularity, cylindricity Orientation- Parallelism, Perpendicularity, Angularity Position (general) - Specifying the Position Tolerance, Regardless of Feature Size, MMC, Shift Tolerance, LMC	08	LO5
VI	Precision Assembly Design with GD&T	Apply GD&T to ensure fit/function of filter casing, rotating valve, and manual pump, Use GD&T to ensure the alignment of rotating shafts, baffles, and drum housing, GD&T applied on hinges, modular joints, and locking systems	04	LO5

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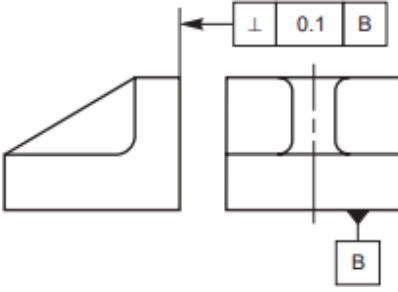
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List of Experiments.

Sr No	List of Exercises (Using AutoCAD)	Hrs
01	Draw a simple mechanical part (sample part is shown in figure below) and write an interpretation of the meaning of the geometrical tolerances for it by means of neat sketches and explanatory notes.  Figure for sample exercise: Sample mechanical part	
02	Students shall draw a simple mechanical part and indicate the following surface roughness components on it: - Symmetrical surfaces requiring the same quality - Cylindrical part - Same surface quality all over	
03	Students shall draw a working drawing of any mechanical component and show following geometric characteristic symbol on it - - Form (straightness/flatness/circularity/cylindricity) - Profile (line/surface) - Orientation (angularity/perpendicularity/parallelism) - Runout (circular/total) - Location (position/concentricity/symmetry)	



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Students shall draw the given mechanical part and complete the feature control frames with datum and material condition symbols (few sample exercises are shown here)

Sample exercise 1:

Students shall draw the mechanical part and complete the feature control frames with datums and material condition symbols to reflect the drawing shown in figure below-

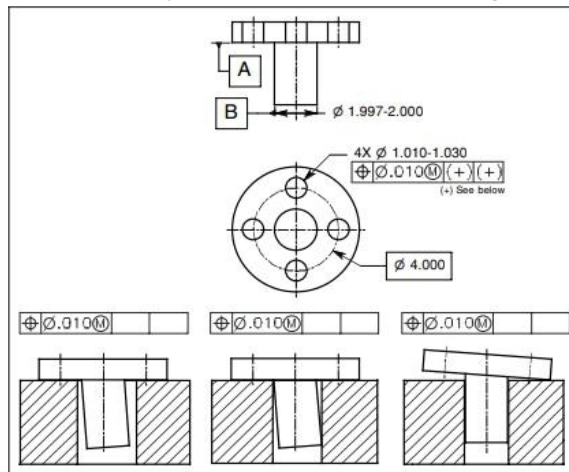


Figure for sample exercise 1: Datums at MMC and RFS

04 Sample exercise 2:

Students shall draw the mechanical part and provide the appropriate datum feature symbols on the drawing and datums in the feature control frames in the datum exercise shown in the figure below-

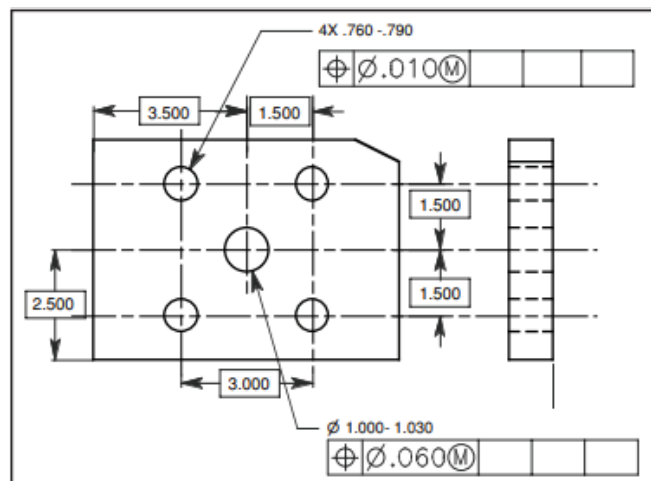


Figure for sample exercise 2: Specifying datums and datum feature symbols



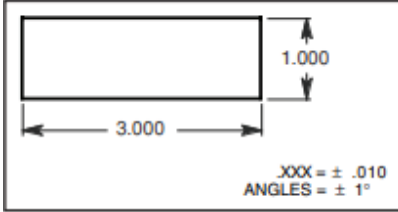
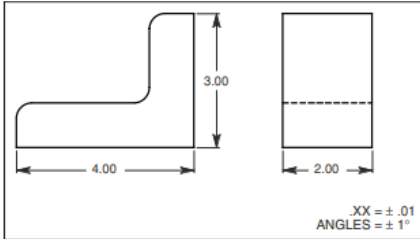
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05	Draw a simple mechanical part and specify following on it – - Form- flatness, straightness, circularity, cylindricity - Orientation- Parallelism, Perpendicularity, Angularity Position (General) - Specifying the Position Tolerance, Regardless of Feature Size, MMC, Shift Tolerance, LMC Sample exercise (form): Students shall draw the mechanical part shown in figure below and specify a flatness control of .005 for the top surface of the part-  Sample exercise (orientation): Specify the 3cm surface of the part perpendicular to the bottom and back surfaces within a tolerance of 0.010 shown in figure below: 	
----	--	--

Sr No	List of Assignments	Hrs
01	To write an assignment showing – - Conventional representation (symbols) of materials - conventional representation of machine components – screw threads, welded joints, springs, gears, shafts bearings, knurling, - Standard drafting and material abbreviations	



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02	Copy of a working drawing of mechanical components (such as- rear tool post, pump housing, gear box cover, steam stop valve, milling fixture, etc.) to be provided to the students along with the questions based on the drawing reading and students shall write answers to the questions based on the drawing reading. Sample questions are provided here- What is the overall size? How many bolts are provided? How many screws are provided? What is the size of the tap? How is the cover fixed to the gear box? (Note: These are sample questions and to be customized based on the type of component)	
03	To write an assignment covering - the feature control frame, Material conditions - Regardless of feature size (RFS), Maximum material condition (MMC), Least material condition (LMC), Material condition symbols and abbreviations	

Text Books:

- 1) Narayana KL, Kannaiah P, Reddy VK, Machine Drawing, by New Age International Publishers
- 2) Bhatt ND, Machine Drawing, Charotar Publishing House Pvt. Ltd., 50th Edition, ISBN-13: 978 9385039232, 2014

References:

- 1) Cogorno GR, Geometric Dimensioning and Tolerancing for Mechanical Design: A Self-Teaching Guide to ANSI Y 14.5M1982 and ASME Y 14.5M1994 Standards / Edition 1 by The McGraw-Hill Companies, Inc.
- 2) Kampbell RG, Roth ES, Integrated Product Design and Manufacturing Using Geometric Dimensioning and Tolerancing, by Marcel Dekker, Inc.
- 3) Meadows JD, Geometric dimensioning and tolerancing, by B.S Publications.

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Online Resources:

Sr. No.	Website Name
1	https://www.gdandtbasics.com/
2	https://www.asme.org/codes-standards/y14-standards
3	http://www.ttc-cogorno.com/Courses/BluePrint.pdf

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also, Term work Journal must include all the 05 exercises (prints) and 03 assignments.

Term Work Marks: 25 Marks (Total marks) = 20 Marks (Experiment/assignments) + 5 Marks

(Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
98431308	Entrepreneurship Development	2	-	-	30		-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	IAT1 +IAT 2					
98431308	Entrepreneurship Development	--	--	--	--	--	25	--	25

Rationale :

Entrepreneurship is a crucial skill in the 21st century, fostering innovation, self-employment, and economic development. This course is designed to equip students with practical entrepreneurial competencies such as ideation, business model development, financial planning, legal frameworks, and pitching.

Course Objectives:

1. Understand and explain the fundamentals of entrepreneurship and startup ecosystems.
2. Generate, validate, and refine business ideas using structured techniques.
3. Develop comprehensive business plans and financial strategies.
4. Explore legal and funding options for startups in India.

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5. Apply marketing, digital tools, and CRM for business growth.
6. Design prototypes and present business pitches to stakeholders.

Course Outcomes:

On successful completion of the course learner will be able to:

- 1) Explain entrepreneurial concepts and analyze types and traits of entrepreneurs.
- 2) Apply ideation techniques and validate business ideas using customer discovery tools.
- 3) Create business plans with financial projections and risk analysis.
- 4) Evaluate funding sources and legal requirements for a startup.
- 5) Implement digital marketing and branding strategies effectively.
- 6) Prepare and deliver compelling business pitches with basic prototyping.

Prerequisite: Fundamentals of communication and leadership skills.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Fundamentals of communication and leadership skills.		
I	Introduction to Entrepreneurship	Definition, Characteristics, and Types of Entrepreneurs. Entrepreneurial Motivation and Traits. Start-up Ecosystem in India. Challenges in Entrepreneurship	4	CO1
		Self-learning Topics: Evolution of Indian startup ecosystem post-2010 Case Study: Nirma – A middle-class entrepreneur revolutionizing detergents.	4	
II	Business Idea	Ideation Techniques: Design Thinking, Brainstorming, Mind Mapping.	5	CO2



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	Generation & Validation	Business Model Canvas (BMC). Market Research & Customer Validation. Minimum Viable Product (MVP) Concept.		
		Self-learning Topics: Lean Canvas, Persona Creation Case Study: Airbnb – Validating the concept with MVP	5	
III	Business Planning & Strategy	Writing a Business Plan. SWOT Analysis and Competitive Analysis. Financial Planning and Budgeting. Risk Assessment and Management.	5	CO3
		Self-learning Topics: Financial forecasting using Excel/Google Sheets. Case Study: Zomato – Expansion through mergers & strategic pivots	5	
IV	Funding and Legal Framework	Sources of Funding: Bootstrapping, Angel Investors, Venture Capital Government Schemes & Start-up India Initiatives. Business Registration & Legal Formalities. Intellectual Property Rights (IPR) & Patents	6	CO4
		Self-learning Topics: DPIIT recognition process and types of funding Case Study: Paytm – From Wallet to IPO: Funding journey	6	
V	Marketing & Digital Presence	Branding and Digital Marketing. Social Media Marketing & SEO. Customer Relationship	5	CO5

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		Management (CRM). E-commerce & Online Business Models.		
		Self-learning Topics: Use of Canva, Google Analytics Case Study: Lenskart – Omnichannel e-commerce marketing	5	
VI	Business Pitching & Prototype Development	Pitch Deck Preparation & Presentation Techniques. Prototyping with Open-source Tools. Elevator Pitch & Investor Pitch.	5	CO6
		Self-learning Topics: Canva for pitch deck or Successful Start-ups Case Study: Dunzo – MVP to final app evolution	5	
Total			30	

Text Books:

1. "Entrepreneurship Development and Small Business Enterprises" – Poornima M. Charantimath, Pearson, 3rd Edition, 2021.
2. "Innovation and Entrepreneurship" – Peter F. Drucker, Harper Business, Reprint Edition, 2019.
3. "Startup and Entrepreneurship: A Practical Guide" – Rajeev Roy, Oxford University Press, 2022.
4. "Essentials of Entrepreneurship and Small Business Management" – Norman Scarborough, Pearson, 9th Edition, 2021.
5. "The Lean Startup" – Eric Ries, Crown Publishing, 2018.

References:

1. "Disciplined Entrepreneurship: 24 Steps to a Successful Startup" – Bill Aulet, MIT

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- Press, 2017.
2. "Zero to One: Notes on Startups, or How to Build the Future" – Peter Thiel, 2014.
 3. "The \$100 Startup" – Chris Guillebeau, Crown Business, 2019.
 4. "Business Model Generation" – Alexander Osterwalder & Yves Pigneur, Wiley, 2020.
 5. "Blue Ocean Strategy" – W. Chan Kim & Renée Mauborgne, Harvard Business Review Press, 2019.

Online References:

Sr. No.	Website Name
1.	Startup India Portal – https://www.startupindia.gov.in
2.	MIT OpenCourseWare – Entrepreneurship – https://ocw.mit.edu/courses/sloan-school-of-management/
3.	Coursera – Entrepreneurship Specialization – https://www.coursera.org/specializations/entrepreneurship

Assessment:

Term Work: Term Work shall consist of at least 4 to 5 **Case Study Analysis , Presentation** based on the above list. Also, Term work Journal must include at least 2 to 3 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Case Study report)+ 5 Marks (Assignments) + 5 Marks (Attendance)

R-2025- Mechanical Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
98451309	Environmental Science	2	-	-	30		-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs.)			
		IAT 1	IAT 2	IAT1 +IAT 2					
98451309	Environmental Science	20	20	40	60	2.5	--	--	100

Rationale:

Environmental Science provides a multidisciplinary perspective to understand, analyze, and solve ecological challenges. With growing global concern over climate change, pollution, and sustainable development, it is essential to equip students with the knowledge, skills, and values needed to contribute to sustainable solutions.

Course Objectives:

1. To understand the interrelationship between human activities and the environment.
2. To explore natural ecosystems and biodiversity conservation techniques.

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3. To identify causes, effects, and mitigation strategies for various types of environmental pollution.
4. To analyze key environmental policies, laws, and sustainability practices.
5. To develop awareness, ethics, and responsibility towards environmental protection.
6. To promote sustainable development through informed decision-making and community participation.

Course Outcomes:

On successful completion of the course learner will be able to:

- 1) Explain core concepts of environmental science and ecological balance.
- 2) Identify sources and impacts of pollution on ecosystems and human health
- 3) Evaluate biodiversity importance and conservation strategies.
- 4) Analyze climate change, global warming, and their mitigation approaches.
- 5) Interpret government policies and sustainable practices for environment management.
- 6) Propose solutions for environmental issues at local and global levels.

Prerequisite: Basic Science Knowledge, General Awareness – About environmental issues, public policies, and civic responsibilities.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic Science Knowledge, General Awareness – About environmental issues, public policies, and civic responsibilities.		
I	The Multidisciplinary Nature of Environmental Studies	Definition, scope and importance. Need for public awareness. Role of information technology in environment and human health. Human population and the Environment. Population growth, variation	5	CO1



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		among nations. Population Explosion- family welfare program. Environment and human health Women and child welfare.		
		Self-learning Topics: Environmental ethics Case Study: Chipko Movement (India) – Grassroot conservation.	5	
II	Natural Resources	Renewable and non-renewable resources. Natural resources & associated problems: a. Forest resources: b. Water resources: Natural resources & associated problems c. Mineral resources: d. Food resources: e. Energy resources: Role of an c. Mineral resources: d. Food resources: e. Energy resources: Role of an individual in conservation of natural resources: f. Equitable use of resources for sustainable lifestyles.	5	CO2
		Self-learning Topics: Carbon footprint calculators Case Study: Rainwater Harvesting	5	
III	Ecosystems	Concepts of an ecosystem. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem	5	CO3



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		b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystem (ponds, streams, lakes, rivers, Oceans, estuaries). Case study on various ecosystems in India.		
		Self-learning Topics: Biodiversity in Indian context Case Study: various ecosystems in India.	5	
IV	Biodiversity and its Conservation	Introduction-Definition: genetic species and ecosystem diversity. Bio-geographical classification of India Value of biodiversity : Consumptive use, productive use, social, ethical, aesthetic and option values, Bio-diversity at global, national, local levels India as a mega diversity nation Case study on Bio diversity in India.	5	CO4
		Self-learning Topics: Indoor pollution sources	5	
V	Environmental Pollution Definition	Causes of Pollution , effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution. Solid waste management: Causes, effect and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.	5	CO5
		Self-learning Topics: Greenhouse gases	5	

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		Case study: Pollution Disaster management: floods, earthquake, cyclone and landslides. Carbon Credits for pollution prevention		
VI	Social Issues and Environment	From unsustainable to sustainable development Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Environmental ethics: issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Consumerism and waste products. Environment protection act. Public awareness.	5	CO6
		Self-learning Topics: Environmental audit methods. Case Study: Environmental Ethics.	5	
Total			30	

Text Books:

1. Environmental Science: Towards a Sustainable Future, G. Tyler Miller and Scott Spoolman, 13th Edition, Cengage Learning 2021
2. Environmental Management: Text and Cases, Bala Krishnamoorthy, 3rd Edition, PHI Learning, Publication Year: 2016
3. Green IT: Concepts, Technologies, and Best Practices, Markus Allemann 1. Springer 2008
4. Sustainable IT: Slimming Down and Greening Up Your IT Infrastructure, David F. Linthicum, IBM Press 2009

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5. Environmental Modelling: Finding Solutions to Environmental Problems, David L. Murray, Cambridge University Press 2016
6. Remote Sensing and Image Interpretation, Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman, 9th Edition, John Wiley & Sons 2020
7. Business Ethics: Concepts and Cases, Manuel Velasquez, Pearson 2012

References:

1. Environmental Law and Policy in India, Shyam Divan and Armin Rosencranz, 2nd Edition, Oxford University Press 2018.
2. The International Handbook of Environmental Laws, David Freestone and Jonathon L. Rubin, Edward Elgar Publishing 2000.
3. E-Waste Management: Challenges and Opportunities in Developing Countries, Ruediger Kuehr and Ram K. Jain, Springer 2008.
4. The E-Waste Handbook: Managing Electronic Waste, Klaus Hieronymi, Ruediger Kuehr, and Ram K. Jain, Earth 2009.
5. Environmental Ethics: An Introduction, J. Baird Callicott, University of Georgia Press, 1999.

Online References:

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



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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
16612310	IDEA LAB - (Innovation Design Engineering and Apply)	1	--	2	15	--	30	15	60	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	IAT1 + IAT 2				
16612310	IDEA LAB - 1(Innovation Design Engineering and Apply)	--	--	--	--	50	50	100

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Rationale:

Aligned with the National Education Policy (NEP) 2020, the institution emphasizes experiential, interdisciplinary, and project-based learning through the IDEA Lab—a central hub for hands-on innovation.

To strengthen the undergraduate research ecosystem, the institution has adopted a theme-based academic model aligned with UN SGD. Each semester features six curated problem statements based on local need and aligned with core subjects in the same semester, enabling students to apply classroom knowledge to real-world challenges. Every student selects one problem and develops an individual, subject-integrated solution—enhancing both academic understanding and research skills.

The IDEA Lab supports this initiative with facilities for design thinking, prototyping, and product development. Students maintain a project logbook throughout the semester to track their progress and reflections.

To ensure academic accountability, a two-tier assessment framework is implemented:

- Project Assessment based on standardized IDEA Lab rubrics.
- Subject-Based Term Work Assessment focused on the application of same-semester subject knowledge in the project.

Lab Objectives:

1. To promote experiential and project-based learning that bridges theoretical knowledge with real-world problem-solving.
2. To encourage interdisciplinary integration by enabling students to apply concepts from multiple subjects within a single cohesive project.
3. To develop innovation and design thinking skills through hands-on activities and iterative solution development.
4. To foster critical thinking and creativity by engaging students in open-ended problems with multiple solution pathways.
5. To enhance communication, collaboration, and documentation skills essential for professional engineering practice.
6. To build an entrepreneurial and research mindset by guiding students to develop scalable, socially-relevant, and technically viable prototype



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Lab Outcomes: Student will be able to

1. Recall and articulate key concepts from core and allied subjects relevant to the assigned project.
2. Explain the interdisciplinary nature of the problem and the role of each subject in addressing it.
3. Apply appropriate tools, techniques, and theoretical knowledge to develop project components.
4. Analyze problem constraints and user requirements to structure a feasible and efficient solution.
5. Evaluate multiple design options and justify the chosen solution based on technical and practical considerations.
6. Create a functional prototype or solution that demonstrates innovation, utility, and integration of interdisciplinary knowledge

1) Guidelines for IDEA Project

a) Project Guidelines (Interdisciplinary Project Execution in IDEA Lab)

- Each student works on an individual interdisciplinary project aligned with the semester theme.
- Faculty in-charges for the IDEA Lab are assigned according to the complexity of the project and the capacity of the respective departments.
- Faculty in-charges mentor both the academic and technical aspects, and track weekly progress.
- Project assessment will be rubric-based, ensuring depth, innovation, documentation, and ownership.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- Faculty in-charges must attend relevant FDPs to ensure uniformity in mentoring and

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evaluation.

b) Guidelines for same semester Subject Concepts Applied within the Project

- Termwork for each subject will partially reflect how well a student applies subject-specific concepts in their interdisciplinary project.
- Internal assessment panel will collaborate to align project components with subject learning outcomes.

c) Role of Faculty In-Charges in IDEA Lab Projects

Faculty in-charges play a pivotal role in the success of interdisciplinary, theme-based projects under the IDEA Lab. Their responsibilities extend beyond technical supervision to include academic alignment, innovation facilitation, and active student engagement. Their key roles include:

1. **Motivating and Inspiring Students**
 - Encourage students to take ownership of their learning and projects.
 - Cultivate a mindset of curiosity, exploration, and social relevance.
 - Foster an environment where students feel empowered to take creative risks.
2. **Conducting Brainstorming and Ideation Sessions**
 - Organize structured brainstorming sessions at the start of the semester to help students define their problem statements and solution pathways.
 - Promote collaborative thinking, design exploration, and interdisciplinary integration.
3. **Arranging Guest Lectures and Expert Talks**
 - Identify and invite industry experts, researchers, and innovators for guest lectures aligned with the semester's theme or subject areas.
 - Facilitate exposure to real-world challenges, current trends, and future opportunities.
4. **Ensuring Uniqueness and Originality of Projects**
 - Actively review proposed ideas to ensure **no duplication of solutions** across students.
 - Encourage students to explore novel approaches, technologies, and perspectives.
5. **Promoting Discussion and Collaborative Learning**
 - Create platforms for students to present, discuss, and receive peer and mentor feedback.
 - Facilitate idea refinement through regular discussions and group engagement.



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6. Aligning Subject Content Beyond Syllabus

- Faculty in-charges must **align subject content beyond the syllabus of the same semester** with the **IDEA Lab theme and assigned problem statements**.
- This ensures relevance, depth, and meaningful interdisciplinary integration.

7. Same Semester Faculty Requirement

- Faculty in-charges must be teaching subjects in the **same semester** as the students' project to ensure seamless academic integration and contextual understanding.

8. Monitoring and Documentation

- Oversee project logbook maintenance, milestone tracking, and submission of progress reports.
- Provide ongoing feedback and ensure project alignment with learning outcomes.

9. Coordination with Subject Faculty

- Work in collaboration with other subject faculty to help students embed theoretical and practical aspects of their coursework into the project.
- Facilitate subject-term mapping and contribute to termwork assessment based on evidence.



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R-2025- Mechanical Engineering

2) Implementation Strategy

a) Project Implementation in IDEA Lab

Aspect	Implementation Strategy
Faculty in-charges	Faculty in-charges assigned based on project nature and department capacity.
Mentoring Role	Faculty in-charges oversee academic/technical development, interdisciplinary integration, and timely documentation.
Capacity Building	Faculty in-charges undergo workshops on design thinking, innovation, assessment rubrics, and outcome-based mentoring.
Assessment Contribution	Faculty in-charges contribute to 25 marks allocated for the IDEA Lab project termwork. The remaining assessments are conducted by the external examiner.
Recognition & Incentives	Faculty in-charges receive workload credits or are formally acknowledged in performance reviews.

b) Implementation of Subject-Term Work Mapping within Projects

Aspect	Implementation Strategy
Mapping Subject Outcomes	Faculty in-charges align their content beyond syllabus with the student's project by coordinating with the assigned project guide.
Independent Evaluation	Internal assessment panel evaluate students based on their application of subject-specific concepts within the project. This contributes to a separate 25 marks allocated for termwork based on subject application.
Evidence Sources	Evaluation is supported by project logbooks, subject-specific deliverables (e.g., tools, simulations, models), and review presentation inputs.
Outcome Assurance	Ensures practical demonstration of subject understanding and its integration into the interdisciplinary solution.



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Implementation Notes:

- Guide faculty assess their course's contribution using specific evidence such as:
 - Logbooks
 - Subject-specific outputs (e.g., simulations, designs)
 - Paper publications or review presentations

2) Guidelines for Assessment

Two-tier rubrics are applied independently to evaluate subject concept application and innovation within the project.

a) Assessment of IDEA Lab Projects (Individual Interdisciplinary Projects) (25 Marks)

Presentation-Based Assessment Structure (Total: 25 Marks)

Assessment Month	Weightage	Marks
Month 1 (Formative 1)	20%	5 marks
Month 2 (Formative 2)	40%	10 marks
Month 3 (Formative 3)	40%	10 marks



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R-2025- Mechanical Engineering

Rubric-Based Evaluation Criteria

Criteria	Month 1 (5)	Month 2 (10)	Month 3 (10)
Problem Understanding	Connects problem to subjects	Defines interdisciplinary scope	Demonstrates deep conceptual grasp
Subject Knowledge Application	Identifies relevant concepts	Applies principles in design	Integrates multiple subject areas correctly
Innovation & Design Thinking	Proposes creative idea	Develops and tests feasible solution	Final solution shows originality and utility
Documentation & Presentation	Logbook initiated, plan presented	Mid-design log and visuals	Final report and demo completed
Progress & Ownership	Meets deadlines, shows planning	Demonstrates self-motivation	Completes project independently with reflection



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b) Term Work Assessment of Subject Concepts Applied in Projects (25 Marks)

Applicable to All Subjects Integrated with Interdisciplinary Projects

To reflect meaningful application of subject knowledge, each subject will be assessed through the following rubric:

Criteria	Marks	Description
Subject Knowledge Application	8	Depth and accuracy of concept integration into the project
Practical Design or Tool Usage	5	Use of subject-specific hardware/software/simulation/tools
Documentation	4	Quality and clarity of subject-related logs and reports
Viva/Presentation	4	Ability to explain subject's relevance and role in the project
Continuous Engagement	4	Evidence of consistent participation via logbooks and feedback

c) Total Assessment Structure

Component	Marks	Assessed By
Termwork – Project Execution	25 Marks	Project Guide
Termwork – Application of Subject Concepts	25 Marks	IDEA Lab Panel
Viva Voce (Final Evaluation)	50 Marks	External Examiner

R-2025- Mechanical Engineering

S.E SEM IV

Sem IV

Theme: Digital Manufacturing Innovation for Sustainable Industrial Transformation

Aligned with **UNSDG 9: Industry, Innovation and Infrastructure**, **UNSDG 8: Decent Work and Economic Growth**, **UNSDG 12: Responsible Consumption and Production**, **UNSDG 13: Climate Action**

Keywords: Digital Manufacturing, Sustainable Industrial Transformation, Green Manufacturing

This theme enables students to leverage digital tools (CAD, FEA) and modern manufacturing knowledge to create innovative, sustainable solutions while developing business acumen through design thinking and business model development. The integration ensures they can design, analyze, manufacture, and commercialize products that contribute to sustainable industrial development and climate action.

For Industry, Innovation and Infrastructure (UNSDG 9):

- **Strengthens economic growth** through the development of reliable infrastructure that supports industries and services.
- **Encourages innovation** and technological advancements that increase productivity and global competitiveness.
- **Sustainable industrialization**, which creates jobs and promotes environmentally responsible manufacturing.
- **Reduces regional inequalities** by improving connectivity and infrastructure in underdeveloped and rural areas.

For Decent Work and Economic Growth (UNSDG 8):

- **Promotes economic development** that lifts people out of poverty and ensures equal opportunities for all.
- **Creates productive employment** and decent work conditions, contributing to social stability and individual well-being.
- **Encourages entrepreneurship and innovation**, which are critical drivers of long-term economic resilience.
- **Ensures equal opportunities** fair wages, labor rights, and safe working environments, reducing exploitation and inequalities in the workforce.

For Responsible Consumption and Production (UNSDG 12):

- **Reduces environmental degradation** by encouraging efficient use of resources and minimizing waste generation.
- **Promotes sustainable business** practices that balance economic growth with environmental stewardship.
- **Encourages consumers to adopt eco-friendly lifestyles**, reducing the ecological footprint and promoting sustainability.
- **Enhances supply chain** responsibility, ensuring ethical sourcing, production, and disposal processes.

For Climate Action (UNSDG 13):

- **Reduces greenhouse gas emissions** to mitigate the adverse effects of climate change on ecosystems and communities.
- **Promotes national and global policies** aimed at climate resilience and low-carbon development.
- **Strengthens disaster risk management** and preparedness to reduce the impact of climate-related hazards.
- **Encourages public awareness** and education on climate issues, fostering global participation in climate solutions.

Problem Statement

Problem Statement 1: Smart Modular Wind Turbine System for Urban Applications

A modular, small-scale wind turbine system for urban environments that can be mass-produced, easily assembled, and optimized for varying wind conditions. The system must be cost-effective, noise-minimized, and suitable for rooftop installations.

Problem Statement 2: Autonomous Precision Manufacturing Cell for Medical Device Production

An autonomous manufacturing cell capable of producing high-precision medical implants with real-time quality control, traceability, and regulatory compliance. The system must ensure 100% quality while being economically viable for small batch production.

Problem Statement 3: Sustainable Packaging Machine for Food Industry with Zero Waste Goal

An intelligent packaging machine that uses biodegradable materials, minimizes waste, adapts to different product sizes, and integrates with existing food production lines while maintaining food safety standards and economic competitiveness.

Problem Statement 4: Intelligent Prosthetic Limb with Adaptive Control and Affordable Manufacturing

An intelligent prosthetic limb with adaptive control that learns user behavior, provides natural movement, and can be manufactured affordably using advanced manufacturing techniques while ensuring comfort and durability.

Problem Statement 5: Smart Agricultural Harvesting Robot for Small-Scale Farmers

An affordable, autonomous harvesting robot for small-scale farmers that can identify ripe crops, harvest with minimal damage, operate on uneven terrain, and provide data analytics for farm management while being maintainable in rural environments.

Problem Statement 6: Modular Electric Vehicle Charging Infrastructure with Smart Grid Integration

A modular, scalable electric vehicle charging infrastructure that integrates with smart grids, provides fast charging capabilities, adapts to different vehicle types, and can be manufactured efficiently while supporting grid stability and renewable energy integration.



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		L	T	P	L	T	P	SL	Notional Learning Hour	
16111401	Sampling Theory and Optimization	2	1	--	30	15	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	IAT-1 + IAT-2					
16111401	Sampling Theory and Optimization	20	20	40	60	2.5	25	--	125

Rationale:

In second-year Mechanical Engineering, understanding statistical and optimization methods is crucial for improving design accuracy, manufacturing quality, and operational efficiency. Probability and normal distributions help model variations in material strength, dimensions, and system performance. Large and small sample tests support quality checks—for example, testing if manufactured parts meet tolerance standards. Chi-square and F-tests are useful in comparing variability across different machines or analyzing failure data. Linear programming and the Simplex method are applied in optimizing production schedules, material use, and cost efficiency, while Duality provides insight into resource constraints. For nonlinear problems, such as minimizing energy loss in thermal systems or optimizing stress distribution, Kuhn-Tucker conditions offer solutions under complex constraints. Transportation and Assignment Models are used in plant logistics—for instance, assigning jobs to machines or distributing raw materials efficiently. These tools prepare students to analyze and optimize mechanical systems and industrial processes with precision.



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Course Objectives:

1. To explain probability distributions, especially the normal distribution, to model variations in mechanical systems.
2. To describe hypothesis testing methods to evaluate sample data reliability in mechanical engineering experiments.
3. To understand the application of Chi-square and F-tests for variance and independence analysis in mechanical systems.
4. To understand linear programming methods for optimizing resource allocation in mechanical engineering projects.
5. To explain nonlinear constrained optimization techniques relevant to mechanical design problems.
6. To describe transportation and assignment models to optimize material handling and workforce scheduling.

Course Outcomes:

1. Students will be able to apply normal distribution to analyze variability in material properties like tensile strength.
2. Students will be able to whether the mean fatigue life of a component meets specifications using Z-test and t-test.
3. Students will be able to analyze the consistency of manufacturing process variables using Chi-square and F-tests.
4. Students will be able to linear optimization problems for minimizing cost or maximizing output using simplex method and duality.
5. Students will be able to apply Kuhn-Tucker conditions to solve nonlinear constrained optimization problems in mechanical design.
6. Students will be able to optimize transportation and assignment of machines or labor to minimize cost and time.

Prerequisite:

1. Definition of probability, Exhaustive events, Pair wise independent events, Multiplicative law of probability, Conditional probability, Baye's theorem.



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DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Probability Distribution	Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables	05	CO1
		Normal distribution.		
		Expectation, Variance, Moment generating function, Raw and central moments up to 4 th order.		
		Central limit theorem.		
		Self-learning Topics: 1. Skewness and Kurtosis of distribution (data). 2. Discrete distribution: Bernoulli, Binomial, Poisson.	07	
I	Sampling theory-I	Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two tailed test, Degree of freedom.	05	CO2
		Test significance for large samples. Test the significance of mean.		
		Students' t-distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t- test)		
		Self-learning Topics: 1. Estimate parameters of a population. 2. Test of significance of large samples, Proportion test. 3. Difference between the means of two large samples.	08	
III	Sampling theory-II	Chi-square test: Test of goodness of fit and independence of attributes (Contingency table) including Yate's Correction.	05	CO3



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		Analysis of variance: F-test (significant difference between variances of two samples).		
		Self-learning Topics: 1. ANOVA: One way classification, 2. ANOVA: Two-way classification (short-cut method).	07	
IV	Linear Programming Problems	Types of solutions, Standard and Canonical of LPP, Basic and Feasible solutions, slack variables, surplus variables.	05	CO4
		Simplex method.		
		Duality, Dual of LPP.		
		Dual Simplex Method.		
		Self-learning Topics: 1. Artificial variable method, Big M method. 2. Sensitivity Analysis, Two-Phase Simplex Method, Revised Simplex Method.	08	
V	Nonlinear Programming Problems	NLPP with one equality constraint (two or three variables) using the method of Lagrange's multipliers	05	CO5
		NLPP with one inequality constraint (two variables): Kuhn-Tucker conditions		
		Self-learning Topics: 1. NLPP with one equality constraint (three variables) using the method of Lagrange's multipliers 2. NLPP with one inequality constraint (three variables): Kuhn-Tucker conditions	07	
VI	Transportation and	Transportation Problem Basics & Formulation	05	CO6
		North-West Corner Rule		



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	Assignment Models	Least Cost Method		
		Vogel's Approximation Method (VAM), Optimality Check (MODI Method)		
		Assignment Problem Basics, Hungarian Method		
		Self-learning Topics: 1. Introduction & Concepts of PERT and CPM 2. Earliest Start (ES) and Earliest Finish (EF). 3. CPM Backward Pass & Critical Path 4. PERT Expected Time & Variance. 5. PERT Network Forward and Backward Pass. 6. Probability Calculations.	08	

Text Books:

1. Operations Research, Hira and Gupta, S. Chand Publication.
2. Fundamentals of Statistics, S. C. Gupta.
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa.
4. Murray Spiegel, "Schaum's Outline of Probability and Statistics", 4th Edition, Tata McGraw-Hill.

References:

1. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons.
2. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
3. Operations Research: An Introduction, Hamdy A Taha, Pearson.
4. Engineering Optimization: Theory and Practice, S.S Rao, Wiley-Blackwell.



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5. S. D. Sharma, "Operations Research", Kedarnath Ramnath Publishing, Meerut, 8th Edition, 2015.

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/117103017
2.	https://ocw.mit.edu/courses/res-6-012-introduction-to-probability-spring-2018/
3.	https://archive.nptel.ac.in/courses/117/103/117103017/
4.	https://archive.nptel.ac.in/courses/111/102/111102111/
5.	https://www.youtube.com/playlist?list=PLyqSpQzTE6M_JcleDbrVyPnE0PixKs2JE



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		L	T	P	L	T	P	SL	Notional Learning Hour	
16211402	Heat Transfer	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	IAT-1 + IAT-2					
16211402	Heat Transfer	20	20	40	60	2.5	--	--	100

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R-2025 Mechanical Engineering

Rationale

Heat transfer is a fundamental subject in engineering that deals with the movement of thermal energy in different modes—conduction, convection, and radiation. Understanding these mechanisms is essential for designing and optimizing systems such as engines, HVAC systems, electronics cooling, and power plants. This course equips learners with analytical and computational tools to model and solve practical heat transfer problems, including transient phenomena and phase change processes like boiling and condensation. Students also gain insights into the performance analysis of heat exchangers, enabling them to contribute effectively to energy efficiency and thermal system innovation in various industries.

Course Objectives:

1. **Understand** the fundamental principles of conduction, convection, and radiation.
2. **Explain** the physical significance and mechanisms of various heat transfer modes.
3. **Formulate** mathematical models for steady-state and unsteady-state heat conduction.
4. **Develop** analytical and numerical solutions for transient heat transfer problems.
5. **Describe** the processes of phase change heat transfer, including boiling and condensation.
6. **Evaluate** the design and performance characteristics of different types of heat exchangers.

Course Outcomes:

1. **Identify** the three modes of heat transfer (conduction, convection, and radiation). (*Remembering*)
2. **Illustrate** basic modes of heat transfer. (*Understanding*)
3. **Develop** mathematical models for each mode of heat transfer. (*Applying*)
4. **Develop** mathematical models for transient heat transfer. (*Applying*)
5. **Demonstrate and explain** the mechanism of boiling and condensation. (*Understanding and Applying*)
6. **Analyse** different heat exchangers and **quantify** their performance. (*Analysing and Evaluating*)

Prerequisite: A basic understanding of thermodynamics, fluid mechanics, and engineering mathematics is essential. Learners should be familiar with energy concepts, fluid flow, and differential equations to model and analyze heat transfer processes effectively.



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DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Engineering Thermodynamics: Understanding of the laws of thermodynamics Concepts of energy, entropy, and thermodynamic cycles Fluid Mechanics: Basic fluid properties, flow regimes, and conservation equations Concepts of boundary layers and convective flows Engineering Mathematics: Differential equations (ordinary and partial) Multivariable calculus and linear algebra	00	
I	Basic concepts of heat transfer	Define heat transfer and its importance in engineering applications, Difference between heat transfer and Thermodynamics, Physical Mechanism of modes of heat transfer, Governing laws of heat transfer, Conduction mode: Thermal conductivity, Thermal diffusivity, Convection mode: Free and Forced convection, Heat transfer Coefficient, Radiation mode: Emissivity, transmissivity, reflectivity, absorptivity, Black body, Grey body, Opaque body Steady and unsteady heat transfer, One dimensional, two dimensional and three dimensional heat transfer, Thermal resistance concept in heat transfer, Thermal contact resistance	04	CO1
		Self-learning Topics: Identify instances where all three modes of heat transfer used	04	

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II	Conduction	Assumptions in heat conduction, Generalized heat conduction equation in rectangular, cylindrical coordinates, Initial and boundary conditions, Steady state heat conduction through plane wall, Composite wall, cylinder, composite cylinder wall, sphere, Internal Heat generation concept, Heat conduction with heat generation in plane wall, solid cylinder and solid sphere, Critical radius of insulation in cylinder and sphere	09	CO2
		Self-learning Topics: Derive differential equation of conduction in cylindrical and spherical coordinates	09	
III	Unsteady State Heat Transfer & Extended Surface	Heat transfer from Extended Surface: Types of extended surface and its significance, Governing differential equation for fin and its solution, Fin performance: Fin effectiveness and Fin efficiency, Thermo Well Unsteady state heat transfer: Applications of unsteady state heat transfer, lumped system analysis, Criteria for lumped system analysis: characteristic length, Biot Number, Thermal time constant and Response of a thermocouple, Heisler Charts	08	CO3
		Self-learning Topics: Analyze conical fin	08	
IV	Convection	Determination of heat transfer coefficient, Dimensional Analysis, Dimensionless numbers in free and forced convection and their significance External Flow: Velocity Boundary layer and Thermal Boundary layer, Laminar and turbulent flow over a flat plate, Flow across cylinder and sphere, Flow across bank of tubes	08	CO4

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R-2025 Mechanical Engineering

		Self-learning Topics: Analyze heat transfer coefficients for different arrangements	08	
V	Radiation	Basic laws of radiation, Black body radiation, Planck's law, Kirchhoff's law, Wein displacement law, Lambert cosine law, Radiation intensity, Radiation heat exchange between black bodies, Shape factor algebra, Radiation heat exchange between nonblack bodies, Electrical network approach for radiation heat exchange: Radiosity and irradiation, Radiation shield	08	CO5
		Self-learning Topics: Analyses temperature of sun and other surfaces	08	
VI	Boiling and Condensation Heat Exchangers	Boiling heat transfer, Pool boiling: different regimes and pool boiling curve, Flow boiling: Different Regimes and Boiling curve, Condensation heat transfer, Film condensation, Dropwise Condensation Types of heat exchangers, Overall heat transfer coefficient, Fouling factor, Analysis of heat exchangers, LMTD, Effectiveness –NTU method, Correction factor, Effectiveness of heat exchangers Construction and Application of Heat Pipe	08	CO6
		Self-learning Topics: Design heat exchanger for industrial application	08	

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Text Books / References:

1. Introduction to thermodynamics and Heat transfer by Yunus A Cengel 2nd Edition, McGraw Hill International
2. Fundamentals of Heat and Mass Transfer by F P Incropera and D P deWitt, Wiley India
3. Heat Transfer by P S Ghoshdastidar, 2nd Edition, Oxford University Press
4. Heat and Mass Transfer, by R Rudramoorthy and L Malaysamy, 2nd Edition, PEARSON
5. Heat Transfer by J P Holman, McGraw Hill
6. Heat Transfer by S P Sukhatme, University Press
7. Heat and Mass Transfer by PK Nag, TMH
8. Heat and Mass Transfer by Mahesh Rathod, Laxmi Publications
9. Heat and Mass Transfer by R K Rajput, S Chand and company

Online References:

Sr. No.	Website Name
1	https://onlinecourses.nptel.ac.in/noc22_me63
2	https://onlinecourses.nptel.ac.in/noc23_ch65
3	https://www.youtube.com/watch?v=qa-PQOjS3zA&list=PL5F4F46C1983C6785

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		L	T	P	L	T	P	SL	Notional Learning Hour	
16211403	Theory of Machines	3	--	--	45	--	--	45	90	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs.)			
		IAT 1	IAT 2	IAT1 +IAT 2					
16211403	Theory of Machines	20	20	40	60	2.5	--	--	100

Rationale:

Theory of Machines is an important subject in mechanical engineering that helps us understand

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how different parts of a machine move and work together. It teaches us how to study motion, design mechanisms, and analyze forces in machines.

Course Objectives:

1. To acquaint myself with the basic concept of kinematics of machine elements.
2. To familiarize with basic and special mechanisms.
3. To study the functioning of motion transmission machine elements.
4. To study the functioning of power transmission machine elements
5. To acquaint with working principles and applications of Governors
6. To acquaint with working principles and applications of Gyroscope

Course Outcomes:

1. Identify various components of mechanisms and develop mechanisms to provide specific motion
2. Draw and analyse velocity and acceleration diagrams for various mechanisms
3. Development of cam profile for the specific follower motion.
4. Predict conditions for maximum power transmission in the case of a belt drive
5. Demonstrate working Principles of different types of governors and Gyroscopic effects on the mechanical systems.
6. Illustrate requirements for an interference-free gear pair

Prerequisite:



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DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Engineering Mechanics – Statics and Dynamics, Differential and Integral Calculus, Linear Algebra and Matrices, Ordinary Differential Equations Basic Mechanical Engineering Concepts, Simple Machines (levers, pulleys, gears), Machine Elements (gears, cams, shafts, flywheels), Engineering Drawing / CAD, Kinematic Diagrams and 3D Visualization, Strength of Materials (stress, strain, deformation), Material Properties Newton's Laws of Motion, Free Body Diagram Analysis, Work and Energy Principles, Basics of Rotational Motion		
I	Introduction	Basic Kinematics Kinematic link & its types, Kinematic pairs, Types of Kinematic pairs, Kinematic chains, Types of constrained motions, Mechanism, Machine, Structure, Types of joints, Degree of freedom (mobility), Kutzbach mobility criterion, Gröbler's criterion & its limitations. Four bar chain and its inversions, Slider crank chain and its inversions, Double slider crank chain and its inversions	06	CO1
		Self-learning Topics: Hooks Joint (Single and double)	08	
			08	
II		Velocity Analysis of Mechanisms (mechanisms up to 6 links)	09	CO2

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	Velocity and Acceleration Analysis	2.1 Velocity analysis by relative velocity method (Graphical approach) 2.2 Acceleration Analysis of Mechanisms (mechanisms up to 6 links) Acceleration analysis by relative method (Graphical approach).		
		Self-learning Topics: Coriolis acceleration (Graphical approach)	09	
III	Cam and Follower Mechanism	3.1 Cam and follower; Classification Cam and follower terminology; 3.2 Motions of the follower: Uniform Velocity, SHM, Constant acceleration and deceleration (parabolic),	06	CO3
		Self-learning Topics: Cycloidal (Displacement, Velocity and acceleration Plots)	06	
IV	Power Transmission	Power Transmission Belts, Chains and Gear 4.1 Belts: Introduction, Types, Dynamic analysis –belt tensions, condition of maximum power transmission 4.2 Chains: Introduction to Chain Drives, Classification of chains, length of chain. Types of brakes Introduction and Classification.(No Numerical) 4.3 Gears: Law of gearing, Forms of tooth, Details of gear terminology, Path of contact, Arc of contact,	10	CO4

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		Contact ratio, Interference in involutes gears,		
		Self-learning Topics: Minimum number of teeth for interference free motion	10	
V	Governors and Gyroscopes	5.1 Governors: Introduction to Centrifugal and Inertia governors, Study and Force analysis of Porter and Hartnell governors. 5.2 Gyroscope: Introduction, Gyroscopic couple and its effect on spinning bodies,	06	CO5
		Self-learning Topics: naval ship during steering, pitching, rolling and their stabilization.	06	
VI	Gear and Gear Train	Design of compound gear trains for synchronized multi-station operations, Application of planetary gear systems in rotary packing heads	06	CO6
		Self-learning Topics: Timing belt drives vs gear drives in low-vibration operations	06	

Text Books:

Text / References Books:

1. S.S. Ratan, —Theory of Machines, Tata McGraw Hill
2. Ghosh and A.K. Mallik, —Theory of Mechanisms and Machines, East-West Press
3. Theory of Machines by Jagdish Lal Metropolitan Book New Delhi, Company, Daryaganj, Delhi
4. I.J.J. Uicker, G.R. Pennock, and J.E. Shigley, —Theory of Machines and Mechanism, Oxford Higher Education
5. P.L. Ballaney, —Theory of Machines, Khanna Publishers
6. M.A. Mostafa, —Mechanics of Machinery, CRC Press

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7. R.L. Norton, —Kinematics and Dynamics of Machinery, McGraw Hill
8. A.G. Erdman, G.N. Sander, and S. Kota, —Mechanism Design: Analysis and Synthesis Vol II, Pearson
9. Theory of Machines Thomas Bevan CSB Publishers & Distributor

Online References:

Sr. No.	Website Name
1	https://nptel.ac.in/courses/112/105/112105268/
2	https://www.youtube.com/playlist?list=PLYRGB44zNZWVibVLmWANp-7obQzOhJLRt
3	http://www.nptelvideos.in/2012/12/kinematics-of-machines.html

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		L	T	P	L	T	P	SL	Notional Learning Hour	
16212404	Theory of Machines Lab	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	IAT1 +IAT 2				
16212404	Theory of Machines Lab	--	--	--	--	25	25	50

Lab Objectives:

1. To familiarize with various mechanisms and inversions
2. To acquaint with basics of power transmission systems
3. To acquaint velocity and acceleration of mechanisms
4. To acquaint motion and power transmission
5. To acquaint with working principles and applications of governors

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6. To acquaint with working principles and applications of gyroscope

Lab Outcomes:

- 1) Develop and build mechanisms to provide specific motion
- 2) Find velocity of a mechanism by using Relative method
- 3) Analyze velocity and acceleration of a specific link of a slider crank mechanism using graphical approach by Relative method.
- 4) Plot displacement-time, velocity-time, and acceleration-time diagrams of follower motion and Draw cam profile for the specific follower motion
- 5) Plot and analyze governor characteristics
- 6) Analyze principle of gyroscopic on laboratory model

List of Experiments.

Sr No	List of Experiments	Hrs
01	Using Virtual lab any one experiment on mechanism	
02	Analysis of velocity of mechanisms by Relative Velocity method – 3 to 5 problems	
03	Analysis of acceleration of mechanism by Relative method including pairs involving Coriolis acceleration – 3 to 5 problems	
04	Motion analysis and plotting of displacement-time, velocity-time and acceleration-time, jerk-time, and layout of cam profiles - 2 to 3 problems	
05	Experiments on Governors- Porter Governor, Hartnell Governor	
06	To verify the Gyroscopic couple experimentally	

Sr No	List of Assignments / Tutorials	Hrs
01	Basics of Kinetics and Kinematics	
02	Belts and Chains	

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03	Gears	
04	Governors & Gyroscope	

Part C

Course project on design and fabrication of any one mechanism for a group of maximum 4 students

Text Books:

1. S.S. Ratan, —Theory of Machines, Tata McGraw Hill
2. Ghosh and A.K. Mallik, —Theory of Mechanisms and Machines, East-West Press
3. Theory of Machines by Jagdish Lal Metropolitan Book New Delhi, Company, Daryaganj, Delhi

References:

1. J.J. Uicker, G.R. Pennock, and J.E. Shigley, —Theory of Machines and Mechanism, Oxford Higher Education
2. P.L. Ballaney, —Theory of Machines, Khanna Publishers
3. M.A. Mostafa, —Mechanics of Machinery, CRC Press
4. R.L. Norton, —Kinematics and Dynamics of Machinery, McGraw Hill
5. A.G. Erdman, G.N. Sander, and S. Kota, —Mechanism Design: Analysis and Synthesis Vol II, Pearson
6. Theory of Machines Thomas Bevan CSB Publishers & Distributor

Online Resources:

Sr. No.	Website Name
1	https://nptel.ac.in/courses/112/105/112105268/
2	https://www.youtube.com/playlist?list=PLYRGB44zNZWVibVLmWANp-7obQzOhJLRt
3	http://www.nptelvideos.in/2012/12/kinematics-of-machines.html

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Assessment:

Term Work: Term Work shall consist part (a) + (b) +(c).

Term Work Marks: 25 Marks (Total marks) = 10 Marks (Experiment) + 5 Marks (Assignments)

+ 5 Marks (Course Project) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.



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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
16612405	IDEA LAB- 2 (CAD Modeling)	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IA T 1	IAT 2	IAT1 +IAT 2				
16612405	CAD Modeling	--	--	--	--	50	50	100

Lab Objectives:

1. To familiarize geometric modeling techniques
2. To impart 2D sketching skills using CAD software

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3. To impart the 3D Solid Modeling skills for the development of 3D models of engineering components
4. To impart the 3D surface modeling skills for development of 3D models of basic engineering components
5. To impart the 3D modeling skills for assembling different parts made in 3D modeling software
6. To introduce Product data exchange among CAD systems.

Lab Outcomes:

- 1) Use appropriate techniques for geometric modeling.
- 2) Apply 2D sketching tools to prepare sketches of a given object using 3D CAD software.
- 3) Create a solid model of the object using 3D CAD software.
- 4) Develop the surface model of a given object using 3D CAD software.
- 5) Generate assembly of given objects using assembly tools of a 3D CAD software
- 6) Use product data exchange formats to perform product data exchange among CAD systems.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	1. ESL201: Engineering Graphics laboratory 2. PLC 303: Working Drawing – GD & T laboratory	02	
I	Introduction to CAD	Different modelling techniques (solid modeling, surface modeling, parametric modeling, feature based modeling) for creation of CAD models, creation of CAD models from different perspectives.	02	CO1
II	Sketching using 2D sketch tools	Setting the sketch environment, creating sketch from a geometry using the sketching commands like- line, circle, arc, etc., modification in sketches using commands like- move, trim, rotate, etc.), use of viewing commands	08	CO2



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		like- pan, zoom, rotate, etc., use of sketch constraints.		
III	Solid Modelling	Settings environment for part modeling, creating machine/engineering parts/components using features like – extrude, revolve, mirror, threading, fillet, hole, bend, rib, patterns (rectangular, circular, etc.), etc.	12	CO3
IV	Surface Modelling	Generation of surfaces from open profiles using create tools like extrude, sweep, loft, trim, etc., path & guide surface option commands like – extend, trim, shell, patch, etc., mesh of curves, free form surfaces	10	CO4
V	Assembly and Data Exchange	Constraints, exploded views, interference check, drafting (layouts, standard & sectional views, detailing & plotting), use of transformations and manipulation commands (translate, rotate, scale, etc.) to modify and assemble the created CAD models. CAD data exchange formats Like IGES, PDES, PARASOLID, DXF and STL along with their comparison and applicability	16	CO5
VI	3D Design and Development of Eco- Innovative Systems	Design and 3D Modeling of a Manual Greywater Filter and Pump System, 3D Mo3D Design and Animation of a Rotating Drum Composting Machine Modeling of a Smart Vertical Farming Rack with Rotary Tray System,	02	CO6



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List of Exercises.

Sr No	List of Experiments	Hrs
01	3D modeling of basic Engineering components like - Nuts, Bolts, Keys, cotter, Screws, Springs etc. (Note: Any two out of above)	
02	3D modeling of basic machine components like - Clapper block, Single tool post, Lathe and Milling tail stock, Shaper tool head slide, jigs and fixtures Cotter, Knuckle joint, Couplings: simple, muff, flanged Protected flange coupling, Oldham's coupling, Universal coupling, element of engine system and Miscellaneous parts. (Note: Any two out of above)	
03	Generation of surface model of any two objects like - hull of a ship, aero plane wing, etc. using various surface creation tools in CAD software.	
04	1) Generation of an assembly model (minimum five child parts) along with working (production) drawing of the system, creation of 3D models with assembly constraints, interference check, exploded view, GD&T, tolerance table and fit table, bill of material. 2) Reverse Engineering of a physical model: disassembling of physical model having not less than five parts, measuring the required dimensions of each component, sketch the minimum views required for each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions (Note: Any one out of above)	



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Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 50 Marks (Experiment/Assignments)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.



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R-2025 Mechanical Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
16212406	Heat Transfer Laboratory	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-1	IAT-2	IAT-1 + IAT-2				
16212406	Heat Transfer Laboratory	--	--	--	--	25	25	50

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Lab Objectives:

1. **Determine** the thermal conductivity of metals, non-metals, and liquids using standard experimental techniques.
2. **Evaluate** heat transfer coefficients under natural and forced convection using theoretical and experimental approaches.
3. **Measure and interpret** the emissivity of a grey body through experimental setup and data analysis.
4. **Calculate** fin effectiveness and efficiency by analyzing temperature distribution and heat transfer from extended surfaces.
5. **Assess** the performance of different types of heat exchangers using effectiveness-NTU and LMTD methods.
6. **Apply** the principle of energy balance to real-world heat exchanger systems by quantifying heat lost and gained.

Lab Outcomes:

1. **Estimate** the thermal conductivity of metals, non-metals, and liquids using appropriate experimental methods.
2. **Compute** the heat transfer coefficient in both natural and forced convection through theoretical and practical approaches.
3. **Measure** the emissivity of a grey body using experimental techniques and interpret the results.
4. **Quantify** the effectiveness and efficiency of fins by analyzing temperature profiles and heat dissipation.
5. **Analyze** the performance of heat exchangers using NTU, effectiveness, and LMTD methods.
6. **Demonstrate** the energy balance in a heat exchanger by evaluating inlet and outlet energy flows.



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- a. Experiments:** Students should use the commercial software or open source application programs, to verify the results obtained by manual calculations. The input data and output results of the problem solved using the computer programs (Minimum 6) should be included in the Journal.

The proposed list is given below:

Sr No	List of Experiments	Hrs
01	Conduction: (Any One) 1. Measurement of thermal conductivity of metal rod 2. Measurement of thermal conductivity of insulating material	4
02	Convection: (Any Two) 1. Measurement of heat transfer coefficient in natural convection 2. Measurement of heat transfer coefficient in forced convection 3. Comparison of heat transfer coefficient of free and forced convection	4
03	Radiation: (Any One) 1. Verification of Stefan Boltzmann Law 2. Measurement of Emissivity of Grey surface	4
04	Transient Conduction: 1. Unsteady state heat transfer in cylinder/rod/wall	4
05	Fins: (Any One) 1. Determination of fin efficiency and fin effectiveness 2. Comparison of fin performance of Various type of fins	4
06	Boiling and Condensation: (Any One) 1. Measurement of heat transfer coefficient in boiling process of water. 2. Measurement of heat transfer coefficient in condensation of saturated steam.	4
07	Heat Exchangers: (Any One) 1. Estimation of overall heat transfer coefficient and effectiveness of double pipe heat exchanger (parallel flow and Counter flow arrangement) 2. Estimation of overall heat transfer coefficient and effectiveness of shell and tube heat exchanger (parallel flow and Counter flow arrangement) 3. Estimation of overall heat transfer coefficient and effectiveness of plate type heat exchanger	6

- b. Course Project:** (Any one task out of the following proposed list)

A group of not more than four students, shall do

- 1) Develop the program to verify the results obtained by manual calculations for any above mentioned experiment using Python, MATLAB programming platform etc.
- 2) Develop experimental setup which will be useful for understanding concepts of heat transfer

R-2025 Mechanical Engineering

End Semester Practical/Oral examination

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Duration of practical examination is 2 hour
3. Distribution of marks for practical/viva examination shall be as follows:
 - a. Practical performance **15** marks
 - b. Oral..... **10** marks

Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.

Students work along with evaluation report to be preserved till the next examination.

Text Books / References:

1. Introduction to thermodynamics and Heat transfer by Yunus A Cengel 2nd Edition, McGraw Hill International
2. Fundamentals of Heat and Mass Transfer by F P Incropera and D P deWitt, Wiley India
3. Heat Transfer by P S Ghoshdastidar, 2nd Edition, Oxford University Press
4. Heat and Mass Transfer, by R Rudramoorthy and L Malaysamy, 2nd Edition, PEARSON
5. Heat Transfer by J P Holman, McGraw Hill
6. Heat Transfer by S P Sukhatme, University Press
7. Heat and Mass Transfer by PK Nag, TMH
8. Heat and Mass Transfer by Mahesh Rathod, Laxmi Publications
9. Heat and Mass Transfer by R K Rajput, S Chand and company

Online Resources:

Sr. No.	Website Name
1.	https://aero04-iitb.vlabs.ac.in/exp3/index.html
2.	https://vlab.amrita.edu/index.php?sub=1&brch=194
3.	https://htv-au.vlabs.ac.in

Assessment:

Term Work: Term Work shall consist of at least 6 practicals based on the above list. Also, Term work Journal must include project based on industrial application

Term Work Marks: 25 Marks (Total marks) = 10 Marks (Experiment) + 10 Marks (Project) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.



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R-2025 Mechanical Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
993117WW	Smart Manufacturing in Assembly Line	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	IAT 1+ IAT 2					
993117WW	Smart Manufacturing in Assembly Line	20	20	40	60	2.5	--	--	100

Rationale :

Smart Manufacturing in Assembly Lines enhances productivity and quality by integrating automation, data analytics, and real-time monitoring. It enables faster decision-making, reduces downtime, and supports mass customization in modern industrial systems.

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Course Objectives:

1. Understand smart manufacturing concepts and technologies.
2. Learn automation and robotics in assembly lines.
3. Introduce IIoT architecture and industrial use.
4. Understand data analytics and AI in manufacturing.
5. Learn metal forming and shaping processes.
6. Understand fundamentals of machining processes.

Course Outcomes:

1. Explain key smart manufacturing principles.
2. Design automation and robotic solutions for assembly.
3. Describe IIoT connectivity and data exchange.
4. Apply data analytics and AI for process improvement.
5. Explain machining operations and tool selection.
6. Identify and compare forming and shaping methods.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Engineering materials, basic mechanical properties, simple engineering drawing interpretation, basic shop floor safety and practices.	0	
I	Introduction to Smart Manufacturing	• Overview of Manufacturing Evolution ○ Industry 1.0 to Industry 5.0 ○ Traditional vs Smart Manufacturing ○ Key Technologies Enabling Smart Manufacturing	8	CO1
		Self-learning: Concepts of Smart Manufacturing and Smart Factories	8	
II	Automation and Robotics in Assembly Lines	• Basics of Industrial Automation • Types of Assembly Line Robots • PLCs and SCADA Systems • Robotic Arms, AGVs, and Cobots • IoT, Big Data, AI/ML, Robotics, Cloud	7	CO2

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		Computing Interoperability, Data Security, Skills Gap		
		Self-learning: Key components of a robotic system: actuators, sensors, controllers	7	
III	Industrial Internet of Things (IIoT)	- Introduction to Industrial Robots - Kinematics & Robot Programming - Human-Robot Collaboration (Cobots) - Vision Systems and Object Recognition - IoT and Edge Computing for CPS - Architecture and Deployment Strategies	7	CO3
		Self-learning: CPS architecture and real-time systems	7	
IV	Data Analytics and AI in Smart Manufacturing	- Data Collection & Cleaning in Production - Predictive Maintenance and Quality Control - Machine Learning in Assembly Optimization - Real-time Monitoring & Dashboards (e.g., Power BI)	7	CO4
		Self-learning: study of multi point cutting tool	7	
V	Fundamentals of Machining	- Introduction to Metal Cutting - Types of Machining: Turning, Milling, Drilling, Grinding - Tool Geometry and Materials - Chip Formation and Cutting Fluids	8	CO5
		Self-learning: Surface finishing processes – lapping, honing, superfinishing	8	
VI	Forming and Shaping Processes	- Fundamentals of forming – Hot and Cold working - Forging, Rolling, Extrusion, Drawing – principles and applications - Sheet metal working – shearing, bending, deep drawing	8	CO6

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		Self-learning: Powder metallurgy – basic steps and applications	8	
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Text / References Books:

- Smart Manufacturing: Concepts and Methods – Masoud Soroush
- Industrial Internet of Things – Sabina Jeschke et al.
- Introduction to Robotics: Mechanics and Control – John J. Craig
- Artificial Intelligence for Manufacturing – Jay Lee & Hung-An Kao
- Manufacturing Engineering and Technology – Kalpakjian & Schmid
- Fundamentals of Modern Manufacturing – Mikell P. Groover

Online Resources:

Sr. No.	Website Name
1	https://nptel.ac.in/courses/112/107/112107145/
2	https://nptel.ac.in/courses/112/105/112105127/



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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
993128WW	Smart Manufacturing in Assembly Line	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	IAT 1+ IAT2				
993128W W	Smart Manufacturin g in Assembly Line	--	--	--	--	25	25	50

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Lab Objectives:

1. Understand and apply principles of smart manufacturing through design and layout of intelligent assembly lines.
2. Analyze real-world smart manufacturing implementations using automotive industry case studies.
3. Design and simulate cyber-physical systems (CPS) integrating sensors, computation, and control.
4. Study and evaluate the design and functionality of multi-point cutting tools used in advanced machining.
5. Implement IoT-based monitoring systems for die casting processes and assess their effectiveness.
6. Explore and understand powder metallurgy processes through virtual or simulated environments.

Lab Outcomes:

1. Understand and apply principles of smart manufacturing through design and layout of intelligent assembly lines.
2. Analyze real-world smart manufacturing implementations using automotive industry case studies.
3. Design and simulate cyber-physical systems (CPS) integrating sensors, computation, and control.
4. Study and evaluate the design and functionality of multi-point cutting tools used in advanced machining.
5. Implement IoT-based monitoring systems for die casting processes and assess their effectiveness.
6. Explore and understand powder metallurgy processes through virtual or simulated environments.

List of Experiments.

Sr No	List of Experiments	Hrs
01	Design a Smart Assembly Line Layout	2
02	Case Study Analysis: Automotive Smart Line,	2
03	Design and Simulate a CPS Architecture	2
04	Single/Multi-Point Cutting Tool Analysis	2
05	Build a simple IoT-based die casting monitoring system	2
06	Study powder metallurgy steps via a virtual lab or recorded experiment	2

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Sr No	List of Assignments / Tutorials	Hrs
01	Design a SCADA screen for a process of your choice.	2
02	Compare cloud vs edge computing in smart factory use cases.	2
03	Virtual lab observation reports (e.g., Amrita VLABs).	2

Part C

Course project on design and fabrication of any one mechanism for a group of maximum 4 students

References:

- Groover, M. P., *Automation, Production Systems, and CIM*, Pearson, 2015.
- Kagermann, H. et al., *Industrie 4.0: Final Report*, 2013.
- Lee, J. et al., *CPS Architecture for Industry 4.0*, *Manufacturing Letters*, 2015.
- Zuehlke, D., *SmartFactory – Factory-of-Things*, *Annual Reviews in Control*, 2010.
- Rajput, R. K., *Manufacturing Technology*, Laxmi Publications, 2016.
- Krar, S. et al., *Technology of Machine Tools*, McGraw-Hill, 2020.
- Mourtzis, D. et al., *IoT and Big Data in Manufacturing*, *Procedia CIRP*, 2016.
- ASTM E407 – *Standard for Powder Metallurgy and Casting Processes*, 2015.

Online Resources:

Sr. No.	Website Name
1	https://archive.nptel.ac.in/courses/106/105/106105195/
2	NPTEL: Industry 4.0 & IIoT (IIT Kharagpur)

Assessment:

Term Work: Term Work shall consist part (a) + (b) +(c).

Term Work Marks: 25 Marks (Total marks) = 10 Marks (Experiment) + 5 Marks (Assignments)

+ 5 Marks (Course Project) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

R-2025- S.E Mechanical Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours)			Teaching Scheme (Contact Hours Per Semester)					Total
		L	T	P	L	T	P	SL	Notional Learning Hour	
9951149WW	Open Elective	2	-	-	30	-	-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	IAT-1+IA T-2					
9951149WW	Open Elective	--	--	--	--	--	25	--	25

Students must select a course for Open Elective from a bucket provided by the Rahul Education Group.

Term Work Assessment: 25 Marks (Total marks) = 15 Marks (Case Study/Activity) + 5 Marks (Assignments) + 5 Marks (Attendance)



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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned					Total Credits (C)
		L	T	P	L	T	P	SL	Notional Learning Hour	(Notional Learning Hour/30
98451410	Design Thinking	2	-	-	30		-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	IAT1 +IAT 2					
98451410	Design Thinking	20	20	40	60	2.5	--	--	100

Rationale:

Design Thinking is a human-centered approach that fosters creativity, empathy, and problem-solving. This course equips students with tools to understand user needs, generate innovative ideas, and develop practical solutions for real-world challenges.

Course Objectives:

1. Introduce the core principles and stages of the Design Thinking process.
2. Develop an empathetic mindset to understand user needs.
3. Frame clear problem statements using user-centered tools.
4. Apply ideation techniques to generate creative solutions.
5. Understand various types of prototypes and their role in product development.
6. Learn the process of testing and refining ideas based on feedback.

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Course Outcomes:

On successful completion of the course learner will be able to:

1. Compare traditional and design thinking-based approaches to problem solving.
2. Define user personas using empathy and mapping techniques.
3. Frame actionable problem statements using POV and problem definition tools.
4. Apply ideation techniques to develop diverse solution sets.
5. Differentiate between low and high-fidelity prototypes and understand their usage.
6. Explain how to test prototypes based on desirability, feasibility, and usability..

Prerequisite: Fundamentals of communication and leadership skills.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Fundamentals of communication and leadership skills		
I	Introduction to Design Thinking	Introduction to Design Thinking: Definition, Comparison of Design Thinking and traditional problem-solving approach, Need for Design Thinking approach, Key tenets of Design Thinking, 5 stages of Design Thinking (Empathize, Define, Ideate, Prototype, Test)	4	CO1
		Self-learning Topics: Design thinking case studies from various domains. Link: https://www.design-thinking-association.org/explore-design-thinking-topics/external-links/design-thinking-case-study-index	4	



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II	Empathy	Foundation of empathy, Purpose of empathy, Observation for empathy, User observation technique, Creation of empathy map.	5	CO2
		Self-learning Topics: Creation of empathy maps Link: https://www.interaction-design.org/literature/topics/empathy-mapping Case Study: Designing MRI for Children – GE Healthcare	5	
III	Define	Significance of defining a problem, Rules of prioritizing problem solving, Conditions for robust problem framing, Problem statement and POV	5	CO3
		Self-learning Topics: Creating a Persona – A step-by-step guide with tips and examples Link: https://uxpressia.com/blog/how-to-create-persona-guide-examples	5	
IV	Ideate	What is ideation? Need for ideation, Ideation techniques, Guidelines for ideation: Multi-disciplinary approach, Imitating with grace, Breaking patterns, Challenging assumptions, Looking across value chain, Looking beyond recommendation, Techniques for ideation: Brainstorming, Mind mapping	6	CO4
		Self-learning Topics: How To Run an Effective Ideation Workshop: A Step-By-Step Guide Link: https://uxplanet.org/how-to-	6	

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		run-an-effective- ideation-workshop-a-step-by-step-guide-d520e41b1b96		
V	Prototype	Low and high-fidelity prototypes, Paper prototype, Story board prototype, Scenario Prototype.	4	CO5
		Self-learning Topics: IDEO Prototyping Toolkit	4	
VI	Test	5 guidelines of conducting test, The end goals of test: Desirability, Feasibility and Viability, Usability testing	6	CO6
		Self-learning Topics: Real-world Testing Examples from Stanford d.school or IDEO Case Study: IDEO's Shopping Cart Redesign – A classic innovation sprint (All stages)	6	
Total			30	

Textbooks:

1. Design Your Thinking: The Mindsets, Toolsets, and Skill Sets for Creative Problem-solving, Pavan Soni, Penguin, Random House India Private Limited
2. Design Thinking: Methodology Book, Emrah Yayichi, 2016
3. Handbook of Design Thinking: Christian Mueller-Roterberg, 2018

Reference books:

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



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Online References:

Sr. No.	Website Name
1.	Design Thinking and Innovation by Ravi Poovaiah https://onlinecourses.swayam2.ac.in/aic23_ge17/preview
2.	Introduction to Design Thinking by Dr. Rajeshwari Patil, Dr. Manisha Shukla, Dr Deepali Raheja, Dr. Mansi Kapoor https://onlinecourses.swayam2.ac.in/imb24_mg37/preview
3.	Usability Testing https://www.interaction-design.org/literature/topics/usability-testing

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
98431411	Business Model Development	2	-	-	30		-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	IAT1 +IAT 2					
98431411	Business Model Development	--	--	--	--	--	25	--	25

Rationale:

Entrepreneurship is the backbone of innovation and economic growth. In the 21st-century knowledge economy, students must be equipped not just with employment-ready skills but with a problem-solving and innovation mindset to become job creators. This course blends core entrepreneurship principles with business model design, startup financing, and digital business strategies.

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Course Objectives:

1. To introduce students to entrepreneurship and its socio-economic relevance.
2. To enable understanding of different business structures and MSME significance.
3. To familiarize learners with funding mechanisms for startups.
4. To introduce the basics of IPR and ethical innovation practices.
5. To equip students with tools for building business models and MVPs.
6. To explore digital marketing and disruption in online business ecosystems.

Course Outcomes:

On successful completion of the course learner will be able to:

1. Define and explain entrepreneurship and its key types.
2. Analyze the legal and operational structure of business ownership.
3. Identify and compare startup funding models and sources.
4. Apply the fundamentals of IPR to protect entrepreneurial innovations.
5. Create comprehensive business models using BMC tools.
6. Evaluate and apply digital marketing techniques for online business models.

Prerequisite: Basic Design Thinking principles.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic Design Thinking principles		
I	Introduction to Entrepreneurship	Definition, the role of entrepreneurship in the economic development, The entrepreneurial process, Women entrepreneurs, Corporate entrepreneurship, Entrepreneurial mindset.	5	CO1
		Self-learning Topics: Case studies: Henry Ford	5	



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		https://www.thehenryford.org/docs/default-source/default-document-library/default-document-library/henryfordandinnovation.pdf?sfvrsn=0 The Tatas: How a Family Built a Business and a Nation by Girish Kuber, April 2019, Harper Business		
II	Entrepreneurship Development	Types of business ownerships: Proprietorship, Public and Private Companies, Co-operative businesses, Micro, Small and Medium Enterprises (MSME): Definition and role of MSMEs in economic development.	4	CO2
		Self-learning Topics: MSME Act and Udyam Registration portal Case Study: Amul – Co-operative innovation in dairy sector	4	
III	Start-up financing	Start-up financing: Cost and revenue models, Sources of start-up fundings: Angel investors, Venture capitalists, Crowd funding, Government schemes funding(e.g., SIDBI, Startup India).	5	CO3
		Self-learning Topics: Successful business pitching. Case Study: Shark Tank pitch breakdown.	5	
IV	Intellectual Property Rights (IPR)	Types of IPR: Patents, trademarks and copyrights, Patent search and analysis, Strategies for IPR protection, Ethics in technology and innovation.	5	CO4

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		Self-learning Topics: Case Study: WIPO Patent Search Exercise	5	
V	Business Model Development	Types of business models, Value proposition, Customer segments, Customer relationships, Channels, Key partners, Key activities, Key resources, Prototyping and MVP.	6	CO5
		Self-learning Topics: The Art of the Start 2.0: The Time-Tested, Battle- Hardened Guide for Anyone Starting Anything by Guy Kawasaki Case Study: The Rise of Zomato – A Disruptive Food Delivery Platform	6	
VI	Digital Business Management	Digital Business models (Subscription, Freemium <i>etc</i>), Digital marketing: Search Engine Optimization (SEO), Search Engine Marketing (SEM), Social media and influencer marketing, Disruption and innovation in digital business.	5	CO6
		Self-learning Topics: Case study: Airbnb https://www.prismetric.com/airbnb-business-m	5	
Total			30	



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Sr No	List of Assignments	Hrs
01	Presentation on case study of a failed business model	2
02	Presentation on case study of a woman entrepreneur	2

Textbooks:

1. Entrepreneurship: David A. Kirby, McGraw Hill, 2002
2. Harvard Business Review: Entrepreneurs Handbook, HBR Press, 2018
3. Business Model Generation; Alexander Ostlewalder and Yves Pigneur, Strategyzer, 2010
4. E- Business & E- Commerce Management: Strategy, Implementation, Practice – Dave Chaffey, Pearson Education

Reference books:

1. Entrepreneurship: New venture creation by David Holt, Prentice Hall of India Pvt. Ltd.
2. E- Business & E- Commerce Management: Strategy, Implementation, Practice – Dave Chaffey, Pearson Education

Online References:

Sr. No.	Website Name
1.	Startup India Portal – https://www.startupindia.gov.in
2.	Entrepreneurship by Prof. C Bhaktavatsala Rao https://onlinecourses.nptel.ac.in/noc20_mg35/preview
3.	Innovation, Business Models and Entrepreneurship by Prof. Rajat Agrawal, Prof. Vinay Sharma https://onlinecourses.nptel.ac.in/noc21_mg63/preview
4.	Sarasvathy's principles for effectuation https://innovationenglish.sites.ku.dk/model/sarasvathy-effectuation/
5.	WIPO Patent Search https://www.wipo.int/portal/en/index.html
6.	Airbnb Business Model Case https://www.prismetric.com/airbnb-business-model/
7.	BMC Tool https://www.strategyzer.com/canvas/business-model-canvas

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Assessment:

Term Work: Term Work shall consist of at least 4 to 5 **Case Study Analysis , Presentation** based on the above list. Also, Term work Journal must include at least 2 to 3 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Case Study report)+ 5 Marks (Assignments) + 5 Marks (Attendance).