MITS
Kochi
Muthoot
Institute of
Technology and
Science
(Autonomous)

B. TECH
MECHANICAL ENGINEERING
CURRICULUM & SYLLABUS
SEMESTER 3
2025 REGULATION

B.Tech in MECHANICAL ENGINEERING

2025 REGULATION CURRICULUM & SYLLABUS

CONTENTS

SEMESTER 3

CURRICULUM

SLOT	COURSE CATEGORY	COURSE CODE	COURSE NAME	L	T	J	P	S	C
A	BST	B250902/MA300A	Mathematics for Physical Science - 3	3	1	0	0	2	3
B	PCT	B250002/ME300B	Mechanics of Solids	3	1	0	0	4	4
C	PCT	B250002/ME300C	Fluid Mechanics and Machinery	3	1	0	0	4	4
D	PCB	B250002/ME320D	Manufacturing Process	2	1	1	0	4	4
E	EST	B250002/ME300E	AI for Mechanical Engineering	3	0	0	0	5	4
F	HMT	B250908/HU900F	Engineering Economics	3	0	0	0	1	2
		B250908/CN900F	Management for Engineers						
T	PCL	B250002/ME330T	Material Testing Lab	0	0	0	3	1	2
U	PCL	B250002/ME330U	Fluid Mechanics and Hydraulic Machines Lab	0	0	0	3	1	2
	M		Minor	3	1	0	0	4	4

(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work, C- Credit)

COURSE DESCRIPTION							
REGULATION	**2025**	**L-T-J-P-S**	**3-1-0-0-2**	**VERSION**	**25/0**	**CREDITS**	**3**
(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)							

COURSE CODE	COURSE NAME	COURSE CATEGORY
B250902/ MA300A	**MATHEMATICS FOR PHYSICAL SCIENCE -3**	**BST**

PRE-REQUISITE

- Sound knowledge in calculus of single variable and multi-variable functions
- Basic knowledge in complex numbers

PREAMBLE

This course explores advanced mathematical concepts critical to engineering applications. It begins with partial differential equations and their role in modelling physical systems, including wave propagation, along with analytical solution methods such as separation of variables. It further develops the theory of complex functions, focusing on analyticity, harmonic functions, and the classification of singularities. Finally, the course covers complex integration and fundamental theorems, enabling the evaluation of integrals and reinforcing analytical problem-solving skills.

RATIONALE

- Develops the ability to model, analyse, and solve problems using advanced mathematical techniques.
- Enhances understanding of physical phenomena such as heat conduction, wave propagation, and vibrations through the study of one-dimensional heat and wave equations.
- Concepts from complex analysis, including analytic functions, integration techniques, and conformal mapping, provide systematic approaches for evaluating functions, transforming complex domains, and solving engineering and physical science problems.
- Strengthens analytical thinking and problem-solving skills in scientific and engineering applications.

COMPETENCY STATEMENT/s

Demonstrate the ability to apply the concepts of partial differential equations and complex functions to analyze mathematical models of physical systems.

CO	CO Statement	Cognitive (C)	Psychomotor (P)	Affective (A)
CO 1	**Apply** the techniques of partial differential equations to model and solve one-dimensional wave propagation and heat conduction problems.	Applying		Responding
CO 2	**Apply** conformal mapping techniques to transform regions from Z plane to W plane.	Applying		Responding
CO 3	**Apply** the principles of complex integration to evaluate complex line integrals using various methods.	Applying		Responding
CO 4	**Apply** residue theorem in the evaluation of real definite integrals.	Applying		Responding
CO 5	**Determine** the Taylor and Laurent's series representation of functions in the region of convergence.	Applying		Responding

TEACHING AND ASSESSMENT SCHEME													
Teaching Scheme / Week					**Hours / Semester**	**Credit**	**Examination Scheme**						
							Theory			**Practical**			**Total**
L	**T**	**J**	**P**	**S**	**90**	**C**	**CIA**	**ESE**	**Total**	**CIA**	**ESE**	**Total**	

3	1	0	0	2		3	40	60	100	-	-	-	100

***L**: Lecture (One unit is of one-hour duration), **T**: Tutorial (One unit is of one-hour duration), **P**: Practical (One unit is of one-hour duration), **J**: Project (One unit is of one-hour duration), **S**: Self-Learning & Team Work (One unit is of one-hour duration), **CIA**: Continuous Internal Assessment, **ESE**: End Semester Examination*

SYLLABUS (Major Topics)

Module	Title	Major Topics	Hrs
1	Partial Differential Equations	Introduction to partial differential equations, formation of partial differential equations, Method of separation of variables, Vibrations of a stretched string - wave Equation, Solutions of one-dimensional wave equation using method of separation of variables and problems, One-dimensional Heat equation, Solutions of One-Dimensional Heat equation - A long insulated rod with ends at zero temperatures. **(Relevant topics from sections 17.1,17.2, 18.2,18.4,18.5 of Text 1)**.	12
2	Complex Differentiation and Conformal Mapping	Complex Function, Limit, Continuity, Derivative, Analytic functions, Cauchy-Riemann Equations (without proof), Laplace's Equations, Harmonic functions, Finding harmonic conjugate, Conformal mapping, Mappings of $w = z^2$, $w = e^z$, $w = \frac{1}{z}$. $w = sinz$. **(Relevant topics from sections 13.3, 13.4, 17.1, 17.2, 17.4 of Text 2)**	12
3	Complex Integration	Line integrals in the complex plane (Definition & Basic properties), First evaluation method, second evaluation method, Cauchy's integral theorem on simply connected domain and multiply connected domain (without proof), Independence of path, Cauchy's Integral formula (without proof). **(Relevant topics from sections 14.1, 14.2, 14.3 of Text 2)**	10
4	Series representations and Residue integration method	Introduction to convergence and divergence of sequences and series, Taylor series and Maclaurin series, Laurent's theorem (without proof), Singularities and Zeros – Isolated Singularity, Poles, Essential Singularities, Removable singularities, Zeros of Analytic functions – Poles and Zeros, Formulas for Residues, Residue theorem (without proof), Evaluation of real definite integrals- Integral of Rational Functions of $cos\theta$ and $sin\theta$. **(Relevant topics from sections 15.4, 16.1, 16.2, 16.3, 16.4 of Text 2)**	11

Sl. No	Self-learning / Team Work Description
1	D'Alembert's solution of the wave equation (2 Hours) Practice problems on formation of partial differential equations, Method of separation of variables and Solutions of one-dimensional wave equation and Heat equation using method of separation of variables (4 Hours) Team Work - Select a real-world problem that leads to a one-dimensional wave equation or heat equation. Formulate the governing partial differential equation (PDE) for the system based on physical laws. Solve the PDE using an appropriate method and give the interpretation of the solution. Use tools such as MATLAB/Python or graphical methods to visualize the behaviour of the solution. (2 Hours).
2	Linear fractional transformations (1 Hour) Practice problems on Analytic functions, Cauchy-Riemann Equations, Harmonic functions and Conformal mapping (4 Hours) Team Work - Choose any one of the functions $w = z^2$, $w = e^z$, $w = \frac{1}{z}$. $w = sinz$.Visualize the transformation of basic curves using Python / GeoGebra / MATLAB. (2 Hours)
3	Cauchy's integral formula for derivatives (1 Hour) Practice problems on First evaluation method, second evaluation method, Cauchy's integral theorem, and Cauchy's Integral formula (5 Hours)

	Team Work - Evaluate the complex line integrals using Python or MATLAB. (2 hours)
4	Evaluation of real definite integrals of the form $\int_{-\infty}^{\infty} f(x)dx$ (1 Hour) Practice problems on Taylor series and Maclaurin series, Laurent's theorem, Singularities and Zeros, Residue theorem, and Integral of Rational Functions of $cos\theta$ and $sin\theta$. (4 Hours) Team Work - Find and plot all possible Laurent series representations for a complex function $f(z)$ using Python or MATLAB. (2 hours)

SUGGESTED LEARNING RESOURCES

Text Book

Sl. No.	Title of Book	Author	Publication
1	Higher Engineering Mathematics	B S Grewal	Khanna Publishers,44th edition,2017
2	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons,10th edition, 2016

Reference

Sl. No.	Title of Book	Author	Publication
1	Advanced Engineering Mathematics	H.C Taneja	I.K. International publishing House Pvt. Ltd, 2014.
2	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill Education, 39th Edition, 2023 (REF2)
3	Engineering Mathematics	Babu Ram	Dorling Kindersley (India) Pvt. Ltd, 2010
4	Complex Analysis	Dennis G. Zill & Patrick D. Shanahan, Jones & Bartlett,	3rd Edition, 2015 (REF1)
5	Fast Fourier Transform - Algorithms and Applications	K.R. Rao, Do Nyeon Kim, & Jae Jeong Hwang	Springer, 1st Edition, 2011 (REF4)

Web Resource

1	Lecture 27: Introduction to Fourier Transform
2	Mathematical Methods for Engineers
3	https://www.youtube.com/watch?v=gFjlBKW8aZU
4	Introduction - Complex Analysis
5	Advanced Engineering Mathematics - Course

DETAILED SYLLABUS

Module	Title	Topic	Mode of Delivery	CO	Learning Domain			Hrs
					C	P	A	
1	Partial Differential Equations	Introduction to partial differential equations	L	CO 1	2			1
		Formation of a partial differential equation by the elimination of arbitrary constants	L	CO 1	2			1
		Formation of a partial differential equation by the elimination of arbitrary functions	L	CO 1	2			1
		Solutions of a partial differential equation - Method of separation of variables	L	CO 1	2			2
		Vibrations of a stretched string - wave Equation	L	CO 1	3			1
		Solutions of the one-dimensional wave equation using the method of separation of variables and problems	L	CO 1	3			3

		One-dimensional Heat equation, Solutions of One-Dimensional Heat equation	L	CO 1	2			1
		A long-insulated rod with ends at zero temperatures	L	CO 1	3			2
		Tutorial	T	CO 1			2	4
2	Complex Differentiation	Complex Function	L	CO 2	2			1
		Limit, Continuity and Derivative of a complex function	L	CO 2	2			2
		Analytic functions	L	CO 2	2			2
		Cauchy-Riemann Equations (without proof), Laplace's Equations	L	CO 2	3			2
		Harmonic functions, Finding harmonic conjugate	L	CO 2	3			2
		Conformal mapping, Mappings of $w = z^2$, $w = e^z$, $w = \frac{1}{z}$. $w = sinz$	L	CO 2	3			3
		Tutorial	T	CO 2			2	4
3	Complex Integration	Line integrals in the complex plane (Definition & Basic properties),	L	CO 3	2			1
		First evaluation method	L	CO 4	3			2
		Second evaluation method	L	CO 4	3			2
		Cauchy's integral theorem on simply connected domain and multiply connected domain (without proof), Independence of path	L	CO 4	3			2
		Cauchy's Integral formula (without proof)	L	CO 4	3			3
		Tutorial	T	CO 3			2	3
4	Series representations and Residue integration method	Introduction to convergence and divergence of sequences and series	L	CO 5	2			1
		Taylor series and Maclaurin series	L	CO 5	2			1
		Laurent's theorem (without proof)	L	CO 5	2			2
		Singularities and Zeros – Isolated Singularity, Poles, Essential Singularities, Removable singularities	L	CO 4	2			1
		Zeros of Analytic functions – Poles and Zeros	L	CO 4	2			1
		Formulas for Residues, Residue theorem (without proof),	L	CO 4	3			3
		Evaluation of real definite integrals - Integral of Rational Functions of $cos\theta$ and $sin\theta$.	L	CO 4	3			2
		Tutorial	T	CO 4 & 5			2	4

TABLE OF SPECIFICATIONS (ToS) (ESE Question Paper Design) (Use √)

Module	Module Title	Distribution of Marks (RBL)						Total Marks
		R	U	A	An	E	C	
1	Partial Differential Equations	√	√	√				15
2	Complex Differentiation	√	√	√				15
3	Complex Integration	√	√	√				15
4	Series representations and Residue integration method	√	√	√				15

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN

Assessment		**Marks**
Continuous Internal Assessment		40
1	Internal Examination	20
2	Learning Activity	15
3	Regularity	5
End Semester Examination - Theory		60
Total		**100**

THIRD SEMESTER B. TECH DEGREE (REGULAR) EXAMINATION, NOVEMBER 2026 (2025 SCHEME)			
Course Code:	**B250902/MA300A**		
Course Name:	**MATHEMATICS FOR PHYSICAL SCIENCE -3**		
Max. Marks	**60**	**Duration**:	2 hours 30 minutes
Common to CE and ME			

PART A			
(Answer all questions. Each question carries 3 marks)			
No.	***Question***	***CO***	***Marks***
1	(i) Which of the following is a linear partial differential equation? (a) $\frac{\partial z}{\partial x} + z = 0$ (b) $\left(\frac{\partial z}{\partial x}\right)^2 + z = 0$ (c) $z\frac{\partial z}{\partial x} = 0$ (d) $\frac{\partial^2 z}{\partial x^2} + \frac{\partial^2 z}{\partial y^2} = 0$ (ii) The PDE formed by eliminating arbitrary constants from $z = ax + by$ is (a) $p + q = 0$ (b) $z = xp + yq$ (c) $p - q = 1$ (d) $pq = 0$ (iii) For a string fixed at both ends, boundary conditions are (a) $u(0,t) = 0,\ u(l,t) = 0$ (b) $u(x,0) = 0$ (c) $u_t = 0$ (d) $u_x = 0$	CO1	(3)
2	The temperature field over a metallic surface is modelled by $T = (x + y)f(x^2 - y^2)$ where f depends on boundary heating conditions. Form the partial differential equation by eliminating the arbitrary function.	CO1	(3)
3	Consider the function, $f(z) = \{\frac{Re\ (z)}{1-\lvert z\rvert}, z \neq 0, 0, z = 0.$ (i) Determine whether $f(z)$ is continuous at $z = 0$. (ii) Justify your answer.	CO2	(3)
4	The region of a circular plate in a plane is given by, $\lvert\ z - (1 - i)\ \rvert \leq \sqrt{2}$. Sketch and shade the region, and determine its centre and radius.	CO2	(3)
5	A complex function is given by, $f(z) = \frac{z^2+1}{z-3}$. Let C be a closed contour in the complex plane such that the point $z = 3$ lies outside C. Evaluate the integral, $\oint_C \quad f(z)\,dz$.	CO3	(3)
6	Let $f(z) = u(x,y) + iv(x,y)$ be an analytic function in a domain D, where the real part $u(x,y)$ is constant throughout the domain. Show that the function $f(z)$ is constant. **[Hint: Use Cauchy-Riemann Equations]**	CO3	(3)
7	Consider the function, $f(z) = \frac{sinhsinh\ z}{z^4}$. (i) Identify the nature and order of the singularity. (ii) Determine the residue of $f(z)$ at its pole(s).	CO4	(3)

8	Match the columns A and B and justify the reason for your choice.	CO4	(3)

Column A	Column B
(a) Maclaurin Series	(i) Includes negative powers of z
(b) Removable singularity	(ii) $(a)^n$
(c) Pole of order n	(iii) Expansion about origin
(d) Essential Singularity	(iv) $\frac{1}{(a)^n}$
(e) Laurent Series	(v) Infinite number of negative powers
(f) Zero of order n	(vi) $\frac{sinz}{z}$ at z = 0

PART B

(Answer any one full question from each module, each question carries 9 marks)

No.		***Question***	***CO***	***Marks***
		MODULE I		
9	a)	The thermal response $u(x,t)$ in a moving metallic strip used in manufacturing is modelled by $\frac{\partial u}{\partial x} = 2\frac{\partial u}{\partial t} + u$ where $u(x,0) = 6e^{-3x}$. Using the method of separation of variables, determine $u(x,t)$.	CO1	(4)
	b)	A suspended transmission cable of length L vibrates due to wind disturbance. The transverse displacement $u(x,t)$ satisfies the one-dimensional wave equation $\frac{\partial^2 u}{\partial t^2} = c^2\frac{\partial^2 u}{\partial x^2}$ with fixed ends $u(0,t) = 0, u(L.t) = 0$. If the initial displacement is $u(x,0) = Asin\frac{\pi x}{L}$ and the cable is released from rest, then find the displacement $u(x,t)$.	CO1	(5)
		OR		
10	a)	In a vertical storage vessel, spherical sensing zones of fixed radius a are arranged with their centres along the z-axis to monitor the movement of materials inside the vessel. Determine the differential equation of this family of spheres by eliminating the arbitrary constant.	CO1	(4)
	b)	A rod of length l is heated in such a way that its ends A and B are at zero temperature. If initially its temperature is given by $u(x,0) = \frac{cx(l-x)}{l^2}, 0 \le x \le l$, find the temperature $u(x,t)$ at any time t.	CO1	(5)
		MODULE II		
11	a)	A boundary of an engineering domain, where geometric transformations are used to study changes in flow regions or stress fields, is represented by the circle, $\mid z - 1 \mid = 1$ and is transformed using the mapping $w = \frac{1}{z}$. Determine the image of the given boundary under the transformation and sketch both the original and transformed regions.	CO2	(4)
	b)	In steady-state heat conduction problem, the potential function is given by, $u(x,y) = e^x\ sin\ sin\ y$, where $u(x,y)$ represents the velocity potential in a region. (i) Verify whether the given function represents a harmonic function. (ii) Determine the corresponding stream function $v(x,y)$. **[Hint: Use Laplace's Equations]**	CO2	(5)
		OR		
12	a)	A region in the complex plane representing a sector of a material domain is given by, $1 <\mid z \mid< 2, 0 < arg\ z < \frac{\pi}{2}$. (i) Determine the image of the given region under the mapping $w = z^2$. (ii) Sketch both the original region in the z-plane and its image in the w-plane.	CO2	(4)

	b)	Show that $f(z) = \lvert z\rvert^2$ is differentiable only at $z = 0$ and hence it is nowhere analytic.	CO2	(5)
		MODULE III		
13	a)	A complex function representing a signal is given by, $f(z) = z + \frac{1}{z}$. Let C be the unit circle traversed counterclockwise. Evaluate the contour integral, $\oint_C \left(z + \frac{1}{z}\right) dz$. **[Hint: Use polar form of the circle]**	CO3	(4)
	b)	A discrete-time control system is described by the transfer function $$H(z) = \frac{z}{z^2 - 0.5z + 0.06}.$$ (i) Determine the poles of the system. (ii) Using Cauchy's Integral formula, evaluate, $\oint_C H(z)\,dz$, where C is the unit circle $\lvert z \rvert = 1$.	CO3	(5)
		OR		
14	a)	The velocity potential of a two-dimensional flow is related to the scalar function, $\phi(x, y) = 2xy$. Using complex representation, the boundary effect is expressed as a line integral over a closed path. Let C be the triangular boundary with vertices 0, 1, and i, traversed counterclockwise. Evaluate the integral, $\oint_C \phi(x, y)\,dz$.	CO3	(4)
	b)	A rational function is given by, $f(z) = \frac{5z+7}{z^2+2z-3}$. Let C be the circle $\lvert z - 2 \rvert = 2$, traversed counter clockwise. Evaluate the contour integral $\oint_C f(z)\,dz$ using an appropriate method. **[Hint: Apply Cauchy's Integral formula]**	CO3	(5)
		MODULE IV		
15	a)	A system response is modelled by the complex function, $f(z) = \frac{z+1}{z-1}, z \neq 1$. To analyse the local behaviour near $z = -1$, expand $f(z)$ as a Taylor series about that point.	CO4	(4)
	b)	Consider the function, $f(z) = \frac{z-1}{(z+1)^2(z-2)}$. Let C be the circle $\lvert z - i \rvert = 2$. (i) Identify the singularities of the function and determine which lie inside the contour C. (ii) Evaluate the contour integral, $\oint_C \frac{z-1}{(z+1)^2(z-2)}\,dz$ using the residue theorem.	CO4	(5)
		OR		
16	a)	A rational function representing a system response is given by, $f(z) = \frac{z}{(z+1)(z+2)}$. To analyze the behaviour of the function near the point $z = -2$, expand $f(z)$ as a Laurent series valid in the region $0 < \lvert z + 2 \rvert < 1$.	CO4	(4)
	b)	A periodic signal representing the response of a mechanical system is given by, $f(\theta) = \frac{1}{5 + 4coscos\,\theta}$. Determine the average value of the signal over one complete cycle, given by, $\frac{1}{2\pi}\int_0^{2\pi} \frac{1}{5 + 4cos\,\theta}\,d\theta$.	CO4	(5)

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COURSE DESCRIPTION							
REGULATION	**2025**	**L-T-J-P-S**	**3-1-0-0-5**	**VERSION**	**25/0**	**CREDITS**	**4**
(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)							

COURSE CODE	COURSE NAME	COURSE CATEGORY
B250002/ME310B	**MECHANICS OF SOLIDS**	**PCE**
PRE-REQUISITE		
Engineering Physics, Engineering Mechanics		

PREAMBLE
This course introduces the fundamental principles governing the behavior of deformable bodies under various loading conditions, including axial, torsional, and bending effects. It enables students to analyze stress, strain, deflection, and failure characteristics of structural members for safe and efficient engineering design.

RATIONALE
This course provides the analytical foundation for predicting the mechanical behavior of structural elements under various loading conditions. It equips students with essential tools for safe design, material selection, and failure assessment in engineering applications.

COMPETENCY STATEMENT/s
1. Apply fundamental principles of stress, strain, and material properties to analyze deformation in structural members under axial and thermal loading.
2. Analyze and design structural elements subjected to torsion and bending, including construction and interpretation of shear force and bending moment diagrams.
3. Evaluate bending stresses and deflections in beams using appropriate analytical methods and validate results through experimental approaches.
4. Assess complex stress states, failure criteria, and structural stability, including stress transformation, failure theories, and column buckling behavior.

CO	CO Statement	Cognitive (C)	Psychomotor (P)	Affective (A)
1	Apply fundamental concepts of stress, strain, and material properties to analyze deformation in axially loaded members, including composite bars and thermal effects.	A		
2	Analyze torsional behavior of circular shafts and construct shear force and bending moment diagrams for beams under various loading conditions.	A		
3	Evaluate bending stresses and deflections in beams using flexural theory and analytical methods such as double integration and Macaulay's method.	A		
4	Determine stress transformations, principal stresses, and failure criteria, and analyze stability of columns using buckling theories and Mohr's circle.	An		

TEACHING AND ASSESSMENT SCHEME													
Teaching Scheme / Week					**Hours / Semester**	**Credit**	**Examination Scheme**						**Total**
							Theory			**Practical**			
L	**T**	**J**	**P**	**S**		**C**	**CIA**	**ESE**	**Total**	**CIA**	**ESE**	**Total**	

3	1	0	0	5		4	40	60					100

***L**: Lecture (One unit is of one-hour duration), **T**: Tutorial (One unit is of one-hour duration), **P**: Practical (One unit is of one-hour duration), **J**: Project (One unit is of one-hour duration), **S**: Self-Learning & Team Work (One unit is of one-hour duration), **CIA**: Continuous Internal Assessment, **ESE**: End Semester Examination*

SYLLABUS (Major Topics)

Module	Title	Major Topics	Hrs
1	Introduction to deformable bodies and axially loaded bars	Introduction to analysis of deformable bodies. Types of external loads - Normal, Shear, Bending, and Bearing stress- Linear and Shear strains. Hooke's law – Universal testing machine and Stress-Strain diagrams- Young's Modulus, Bulk Modulus, and Rigidity Modulus. Poisson's ratio - Relationship between elastic constants, concepts of Isotropy, Orthotropy, Anisotropy, Brinell, Vickers, and Rockwell hardness test. Deformation in axially loaded bars –uniform cross section, varying cross section, principle of superposition, dissimilar materials, composite bars. Thermal effects – simple, composite bars.	15
2	Torsion of shafts and SFD and BMD concept	Torsion: Shafts - torsion theory of elastic circular bars – assumptions and limitations – polar modulus - torsional rigidity – shaft design for torsional load, determining rigidity modulus using torsion testing machine. Beams- Classification - Diagrammatic conventions for supports and loading. Differential equations between load, Shear Force, and Bending Moment- Shear Force and Bending Moment Diagrams of Cantilever and Simply supported beam with Point load/UDL. Point of Inflection.	14
3	Pure bending and deflection of beams	Stresses in Beams: Pure Bending – Flexure formula for beams, assumptions and limitations – Section Modulus - Flexural Rigidity - derivation and problems for rectangular section only -assumptions and limitations. Flexural stiffness determination using UTM. Deflection of Beams: Moment-Curvature relation – assumptions and limitations - Double Integration method – Macaulay's method.	15
4	Stresses on inclined plane and analysis of columns	Stress on an inclined plane due to Uniaxial stress- Stress on an inclined plane due to Biaxial stress- Stress on an inclined plane due to two Normal Stresses accompanied by Shear stresses- principal planes and stresses. Mohr's circle of stress, Thin cylinders, Basics of failure theories: Rankine, Tresca, and Von Mises (only theory) Buckling and stability of long Columns-Euler's buckling/crippling load for columns with different end conditions- Euler equation derivation for both ends hinged only- Rankine's formula.	16

Sl. No	Self-learning / Team Work Description
1	Understand basic software tools useful for analyzing stresses and loads on structures
2	Analysis of axially loaded bars using simulation software
3	Analysis of torsion in shafts using simulation software
4	Analysis of bending and deflection in beams using simulation software
5	Analyzing buckling of columns using software tools

SUGGESTED LEARNING RESOURCES

Text Book

Sl. No.	Title of Book	Author	Publication
1	Mechanics of Solids	R K Bansal	Laxmi Publications
2	Mechanics of Solids	S. S. Bhavikatti	New Age International

Reference

Sl. No.	Title of Book	Author	Publication
Sl. No.	Title of Book	Author	Publication

1	Mechanics of Materials	R. C. Hibbeler	Pearson Higher Education
2	Engineering Mechanics of Solids	Popov E	PHI
3	Mechanics of Materials	Beer & Johnston	McGraw Hills

Web Resource	
	https://www.youtube.com/watch?v=La4UEa7hA7Q&list=PLJoALJA_KMOARYNi50T6b488kPUBbOIsX
	https://eerc01-iiith.vlabs.ac.in/List%20of%20experiments.html

DETAILED SYLLABUS

Module	Title	Topic	Mode of Delivery	CO	Learning Domain			Hrs
					C	P	A	
1	Introduction to deformable bodies and axially loaded bars	Introduction to the analysis of deformable bodies	L	1	U		R	L-1
		Types of external loads - Normal, Shear, Bending, and Bearing stress- Linear and Shear strains.	L	1	U		R	L-1
		Hooke's law – Universal testing machine and Stress-Strain diagrams	L, P	1	U	M	R	L- 1
		Young's Modulus, Bulk Modulus, and Rigidity Modulus. Poisson's ratio	L	1	U		R	L-1
		Relationship between elastic constants, concepts of Isotropy, Orthotropy, Anisotropy, Brinell, Vickers, and Rockwell hardness test.	L, P	1	U	P	R	L-1
		Deformation in axially loaded bars –uniform cross section	L	1	U		R	L-1
		problems	T	1	A		R	T-1
		Deformation in axially loaded bars –varying cross-section	L	1	U		R	L-1
		problems	T	1	A		R	T-1
		principle of superposition, dissimilar materials, composite bars	L	1	U		R	L-1
		Thermal effects – simple bars	L	1	U		R	L-1
		Problems	T	1	A		R	T-1
		Thermal effects – Composite bars	L	1	U		R	L-1
		Problems	L	1	A		R	L-1
		Problems	T	1	A		R	T-1
2	Torsion of shafts and SFD and BMD concept	Introduction to torsion of shafts	L	2	U		R	L-1
		torsion theory of elastic circular bars – assumptions and limitations	L	2	U		R	L-1
		polar modulus - torsional rigidity – shaft design for torsional load	L	2	U		R	L-1
		Determining rigidity modulus using a torsion testing machine.	L, P	2	U	M	R	L-1
		Problems	L	2	A		R	L-1
		Problems	T	2	U		R	T-1
		Beams- Classification - Diagrammatic conventions for supports and loading.	L	2	U		R	L-1
		Differential equations between load, Shear Force, and Bending Moment	L, P	2	U	I	R	L-1

		Shear Force and Bending Moment Diagrams of a Cantilever Beam	L	2	U		R	L-1
		Problems	L	2	A		R	L-1
		Problems	T	2	A		R	T-1
		Shear Force and Bending Moment Diagrams of a Simply Supported Beam with a point load and UDL	L	2	U		R	L-1
		Problems	L	2	A		R	L-1
		Point of inflection	L	2	U		R	L-1
3	Pure bending and deflection of beams	Stresses in Beams: Pure Bending	L	3	U		R	L-1
		Flexure formula for beams, assumptions, and limitations	L	3	U		R	L-1
		Problems with a rectangular beam cross-section	L	3	U		R	L-1
		Problems	T	3	A		R	T-1
		Flexural stiffness determination using UTM.	L, P	3	U	M	R	L-1
		Deflection of Beams	L	3	U		R	L-1
		Moment-Curvature relation – assumptions and limitations	L	3	U		R	L-1
		Double integration method	L	3	U		R	L-1
		problems	L	3	A		R	L-1
		Problems	T	3	A		R	T-1
		Problems	T	3	A		R	T-1
		Macaulay’s Method	L	3	U		R	L-1
		problems	L	3	A		R	L-1
		problems	L	3	A		R	L-1
		Problems	T	3	A		R	T-1
		Stress on an inclined plane due to Uniaxial stress	L	4	U		R	L-1
4	Stresses on inclined plane and analysis of columns	Stress on an inclined plane due to Biaxial stress	L	4	U		R	L-1
		Stress on an inclined plane due to two Normal Stresses accompanied by Shear stresses	L	4	U		R	L-1
		problems	T	4	A		R	T-1
		principal planes and stresses	L	4	U		R	L-1
		Problems	L	4	A		R	L-1
		Mohr’s circle of stress	L	4	An		R	L-1
		Problems	T	4	A		R	T-1
		Thin Cylinder	L	4	U		R	L-1
		Problems	T	4	A		R	T-1
		Failure Theories	L,P	4	U	M	R	L-1
		Buckling and stability of long Columns	L	4	U		R	L-1
		Euler’s buckling/crippling load for columns with different end conditions	L	4	U		R	L-1
		Problems	T	4	A		R	T-1
		Euler equation derivation for both ends hinged only	L	4	U		R	L-1
		Rankine’s formula	L	4	U		R	L-1
		Problems	T	4	A		R	T-1

TABLE OF SPECIFICATIONS (ToS) (ESE Question Paper Design) (Use √)

Module	Module Title	Distribution of Marks (RBL)						Total Marks
		R	U	A	An	E	C	
1	Introduction to deformable bodies and axially loaded bars	√	√	√				
2	Torsion of shafts and SFD and BMD concept	√	√	√				

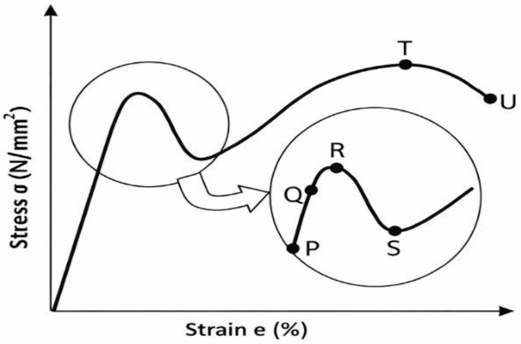
3	Pure bending and deflection of beams	√	√	√				
4	Stresses on inclined plane and analysis of columns	√	√	√				
This ToS shall be treated as a general guideline for students and teachers for distribution of marks.								

ASSESSMENT PATTERN		
Assessment		**Marks**
Continuous Internal Assessment		
1	Internal Examination	20
2	Learning Activity	15
3	Regularity	5
End Semester Examination - Theory		60
Total		**100**

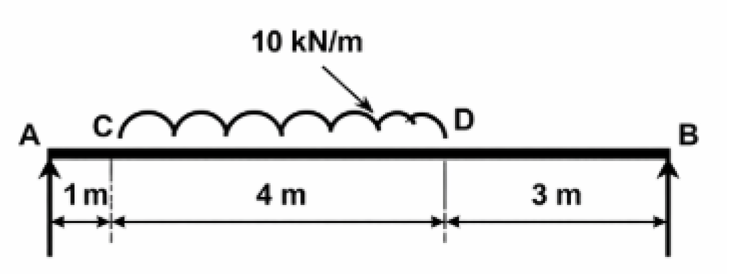
<table>
<tr><td colspan="4">THIRD SEMESTER B. TECH DEGREE (REGULAR) EXAMINATION, NOVEMBER 2026 (2025 SCHEME)</td></tr>
<tr><td>Course Code:</td><td colspan="3">B250002/ME310B</td></tr>
<tr><td>Course Name:</td><td colspan="3">Mechanics of Solids</td></tr>
<tr><td>Max. Marks</td><td>60</td><td>Duration:</td><td>2 hours 30 minutes</td></tr>
<tr><td colspan="4">For ME only</td></tr>
</table>

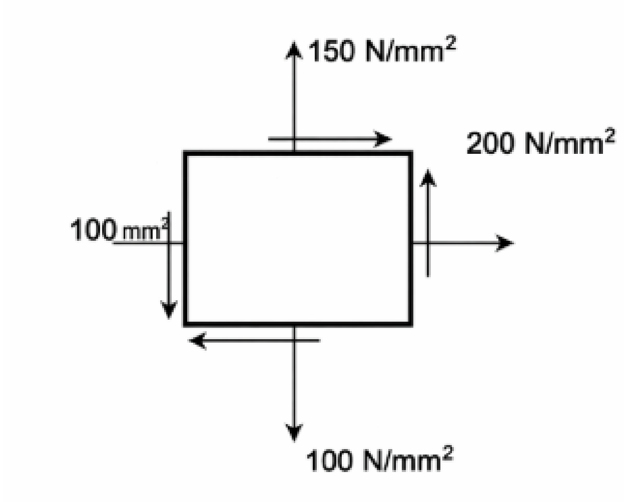
<table>
<tr><td colspan="4">PART A</td></tr>
<tr><td colspan="4">(Answer all questions. Each question carries 3 marks)</td></tr>
<tr><td>No.</td><td>Question</td><td>CO</td><td>Marks</td></tr>
<tr><td>1</td><td>a) The Poisson's ratio for a perfectly incompressible linear elastic material is________.

b) A steel rod of length L and diameter D, fixed at both ends, is uniformly heated to a temperature rise of ΔT. The Young's modulus is E and the coefficient of linear expansion is α. The thermal stress in the rod is given by the formula _________.
c) In terms of Poisson's ratio ν, the ratio of Young's Modulus E to Shear Modulus G of elastic materials is given _________.</td><td>CO1</td><td>(3)</td></tr>
<tr><td>2</td><td>The stress-strain curve for mild steel is shown in the figure given below. Choose the correct option based on both the figure and the table.



<table>
<tr><th>Point on the graph</th><th>Description of the point</th></tr>
<tr><td>P</td><td>1. Upper Yield Point</td></tr>
<tr><td>Q</td><td>2. Ultimate Tensile Strength</td></tr>
<tr><td>R</td><td>3. Proportionality Limit</td></tr>
<tr><td>S</td><td>4. Elastic Limit</td></tr>
<tr><td>T</td><td>5. Lower Yield Point</td></tr>
<tr><td>U</td><td>6. Failure</td></tr>
<tr><td>U</td><td>6. Failure</td></tr>
</table></td><td>CO1</td><td>(3)</td></tr>
<tr><td>3</td><td>(a) A concentrated load P acts on a simply supported beam of span L at a distance L/2 from the left support. The bending moment at the point of application of the load is given by _________.
(b) What is the unit of section modulus?
(c) What is the bending moment at the end supports of a simply supported beam?</td><td>CO2</td><td>(3)</td></tr>
<tr><td>4</td><td>(a) What is the unit of moment of inertia?
(b) State the point of contraflexure.
(c) Describe the importance of torsional rigidity.</td><td>CO2</td><td>(3)</td></tr>
<tr><td>5</td><td>(a) Slope in the beam at any point is measured in _______units.
(b) In a cantilever beam, the slope is _________ at fixed end.
(c) In simply supported beam, slope is maximum is at ___________ .</td><td>CO3</td><td>(3)</td></tr>
<tr><td>6</td><td>List out the assumptions made in flexural formula.</td><td>CO3</td><td>(3)</td></tr>
<tr><td>7</td><td>Write short notes on principal planes and principal stresses.</td><td>CO4</td><td>(3)</td></tr>
<tr><td>8</td><td>Differentiate between long and short columns.</td><td>CO4</td><td>(3)</td></tr>
</table>

PART B				
(Answer any one full question from each module, each question carries 9 marks)				
No.		Question	CO	Marks
MODULE I				
9		A steel rod of 20 mm diameter is enclosed in a copper tube of 40 mm external diameter and 25 mm internal diameter. The tube is enclosed at each end by rigid plates of negligible thickness. If the assembly is subjected to an axial load of 50 kN, find the stress developed in each material. Take the elastic modulus of copper and steel as: Ec=1.2×10^5 N/mm^2, Es=2×10^5 N/mm^2.	CO1	(9)
OR				
10		A bar of brass 20 mm diameter is enclosed in a steel tube of 40 mm external diameter and 20 mm internal diameter. The bar and the tube are initially 1.2 m long and are rigidly fastened at both ends using 20 mm diameter pins. If the temperature is raised by 60°C, find the stresses induced in the bar and the tube. Take Eb=1×10^5 N/mm^2, Es=2×10^5 N/mm^2, αs =11.6×10^−6/°C, αb=18.7×10^−6/°C.	CO1	(9)
MODULE II				
11	a)	Write down the assumptions in the theory of pure torsion.	CO2	(3)
	b)	Derive the torsion formula for a prismatic shaft with a circular cross-section.	CO2	(6)
OR				
12		Draw the shear force and bending moment diagram for a simply supported beam of length 8 m carrying a uniformly distributed load of 10 kN/m over a distance of 4 m, as shown in the figure.  	CO2	(9)
MODULE III				
13	a)	A cantilever beam is 3 m long and carries a point load of 20 kN at a distance of 2 m from the fixed end. Determine the slope and deflection at the free end of the cantilever. Take EI = 8*10^12 N/mm^2.	CO3	(4)
	b)	A rectangular beam 300 mm deep is simply supported over a span of 4 m. What uniformly distributed load may the beam carry, if the bending stress is not to exceed 120 MPa? Take I = 225×10^6 mm^4.	CO3	(5)
OR				
14		A horizontal beam of uniform section and 6 m long is simply supported at its ends. Two vertical concentrated loads of 48 kN and 40 kN act at 1 m and 3 m respectively from the left-hand support. Use Macaulay’s method to determine the deflection under each load, if E=2×10^5 N/mm^2 and I = 85*10^6 mm^4.	CO3	(9)
MODULE IV				
15		Find the Euler’s crippling load for a hollow cylindrical steel column of 38 mm external diameter and 2.5 mm thickness. Take the column length as 2.3 m and hinged at both ends. Take E = 205 GPa. Also, determine the crippling load by Rankine’s formula using constants of 335 MPa and 1/7500.	CO4	(9)
OR				

16	The state of stress at a point in a strained material is as shown in Fig. 1. Determine:(i) The direction of principal planes (ii) The magnitude of principal stresses (iii) The magnitude of maximum shear stress (iv) The plane of maximum shear stress  	CO4	(9)

COURSE DESCRIPTION							
REGULATION	**2025**	**L-T-J-P-S**	**3-1-0-0-4**	**VERSION**	**25/0**	**CREDITS**	**4**
(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)							

COURSE CODE	COURSE NAME	COURSE CATEGORY
B250002/ME300A	**FLUID MECHANICS & MACHINERY**	PCT
PRE-REQUISITE		
Engineering Physics, Differential Calculus		

PREAMBLE

- Introduces the fundamental concepts, properties, and governing laws of fluids.
- Covers fluid statics, dynamics, flow through pipes, and boundary layer theory.
- Provides the theoretical and mathematical foundation for analysing fluid flow behaviour.
- Develops understanding of the operation and performance of hydraulic machines.

RATIONALE

- Prepares students to solve real-world engineering problems using fluid mechanics principles.
- Applies concepts such as Bernoulli's equation and dimensional analysis to industrial systems.
- Integrates theoretical learning with practical laboratory experiments.
- Develops understanding of the design, operation, and efficiency of pumps and turbines. .

COMPETENCY STATEMENT/s

1. Apply the principles of fluid mechanics to analyze fluid properties, fluid flow, and energy losses in pipes and open channels for engineering applications.
2. Assess the performance and operational characteristics of hydraulic machines, including pumps and turbines, using fluid mechanics principles.

CO	CO Statement	Cognitive (C)	Psychomotor (P)	Affective (A)
CO1	Identify the fundamental fluid properties, their relationships and apply them to estimate the fluid pressure and hydrostatic forces on bodies.	**A**		
CO2	Apply continuity and momentum equations to evaluate different types of flow measurement devices.	**A**		
CO3	Analyse viscous flow through pipes and estimate the major and minor losses associated with piping network and understand the basic concept of dimensional analysis.	**A**		
CO4	Select suitable turbo machine for specific application by identifying the pertinent parameters	**A**		

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week					Hours / Semester	Credit	Examination Scheme						
							Theory			Practical			Total
L	T	J	P	S		C	CIA	ESE	Total	CIA	ESE	Total	
3	1	0	0	4	120	4	40	60	100	-	-	-	100

***L**: Lecture (One unit is of one-hour duration), **T**: Tutorial (One unit is of one-hour duration), **P**: Practical (One unit is of one-hour duration), **J**: Project (One unit is of one-hour duration), **S**: Self-Learning & Team Work (One unit is of one-hour duration), **CIA**: Continuous Internal Assessment, **ESE**: End Semester Examination*

SYLLABUS (Major Topics)

Module	Title	Major Topics	Hrs

1	Fluid Statics	Analysis of fluids at rest and evaluation of pressure distribution, hydrostatic forces, buoyancy, and stability of bodies.	16
2	Fluid Dynamics	Examination of fluids in motion using governing equations to determine velocity, pressure, and energy relationships.	12
3	Pipe Flow	Investigation of internal flow behaviour in pipes, including flow regimes, frictional losses, and energy variations.	16
4	Hydraulic Machines (Turbines and Pumps)	Exploration of the working principles and performance evaluation of machines that convert hydraulic energy to mechanical energy and vice versa.	16

Sl. No	**Self-learning / Team Work Description**
1	Explain the molecular basis of surface tension, highlighting why this phenomenon is confined to the free surface of a liquid. Additionally, derive the expression for capillary rise in a narrow tube, discuss the influence of surface tension, and contact angle on the height of rise.
2	Flow separation & Drag- Causes of flow separation, Skin friction and Pressure drag with real life application.
3	Hydraulic Gradient Line (HGL) & Energy Gradient Line (EGL)- Graphical representation, practical interpretation in pipelines.
4	Energy Loss Reduction Techniques in Pipes-Pipe material selection, Proper alignment and design, Minimizing fittings and disturbances
5	Boundary Layer Thickness & Displacement Thickness-Concept of different thickness definitions, Physical significance in flow behavior with practical applications.
6	Performance Characteristics of Turbines- Characteristic curves, Operating conditions.
7	Specific Speed of Turbines and Pumps- Concept and physical significance, How it helps in selecting suitable turbine/pump, Comparison between different machines.

SUGGESTED LEARNING RESOURCES

Text Book

Sl. No.	Title of Book	Author	Publication
1	Fluid Mechanics: Fundamentals and Application	Yunus A. Cengel & John M. Cimbala.	McGraw-hill
2	Fluid Mechanics	Frank M White	McGraw-Hill
3	A Textbook of Fluid Mechanics and Hydraulic Machines	Dr R K Bansal	Laxmi
4	Hydraulic Machines	Dr R K Rajput	S Chand

Reference

Sl. No.	Title of Book	Author	Publication
1	Introduction to Fluid Mechanics and Fluid Machines	Som S.K.	McGraw-hill
2	Engineering applications of Fluid dynamics	Fisher and Henly	Willford Press

Web Resource

1	https://nptel.ac.in/courses/112105269
2	https://nptel.ac.in/courses/112105171
3	https://nptel.ac.in/courses/105101082

DETAILED SYLLABUS								
Module	**Title**	**Topic**	**Mode of Delivery**	**CO**	**Learning Domain**			**Hrs**
					C	**P**	**A**	
1	Introduction on to Fluid Mechanics	**1.1 Properties of fluid** • Specific gravity, Specific Weight, Specific Volume, Dynamic and Kinematic Viscosity • Types of fluids, Newton's law of viscosity.	L	CO 1	3			4
		1.2 Pressure Measurement • Fluid pressure, Pressure head, and types of pressures. • Piezometer, Simple, differential Manometers	L		3			4
		1.3 Fluid statics • Pressure, density, height relationship. • Hydrostatic force and pressure on plane and inclined surfaces • Centre of pressure • Buoyancy Metacentre. • Stability of immersed and floating bodies.	L		3			8
2	Fluid Flow Analysis	**2.1 Fluid kinematics** • Types of flows • Material derivative velocity and acceleration. • Streamlines, path lines and streak lines • Stream function and velocity potential function, flow net	L	CO 2	3			3
		2.2 Fluid dynamics • Continuity equation. • Euler's, and Bernoulli's equations	L		3			3
		2.3 Measuring instruments • Pitot tube • Orificemeter • Venturimeter • Rectangular, Triangular Notches (with out problem)	L		3			6
3	Viscous Flow and Boundary Layer Theory	**3.1 Pipe flow** • Laminar and turbulent flows. • Significance of Reynolds number. • Shear stress and velocity distribution in a pipe flow.	L	CO 3	3			2
		3.2 Types of Losses • Hagen-Poiseullie equation • Darcy-Weisbach equation • Chezy's equation • Flow through an	L		3			2

		Orifice • Moody's chart for estimating frictional losses, • Major and minor energy losses • Hydraulic gradient line (HEL) and total energy line (TEL) • Navier-Stokes equation and explanation (without proof).						
		3.3 Dimensional analysis • Buckingham's π theorem	L		3			3
		3.4 Boundary layer theory • laminar and turbulent boundary layer. • Boundary layer separation with practical applications	L		3			2
4	Hydraulic Machines	**4.1 Impact of jets on**: • Fixed vertical • Moving vertical flat plates • Curved vanes – fixed and moving. • Velocity triangles	L	CO 4	3			3
		4.2 Classification of Turbines • Pelton, Francis and Kaplan Turbines • Principle and working, head, work done and efficiencies	L		3			5
		4.3 Classification of Pumps • Centrifugal Pumps: Principle and working, head, work required, efficiencies, Priming and cavitation • Reciprocating Pump: Principle and working – slip, negative slip, work required and efficiency.			2			8

TABLE OF SPECIFICATIONS (ToS) (ESE Question Paper Design) (Use √)								
Module	Module Title	Distribution of Marks (RBL)						Total Marks
		R	U	A	An	E	C	
1	Introduction to Fluid Mechanics	√	√	√				25
2	Fluid Flow Analysis	√	√	√				25
3	Viscous Flow and Boundary Layer Theory	√	√	√				25
4	Hydraulic Machines	√	√	√				25
This ToS shall be treated as a general guideline for students and teachers for distribution of marks.								

ASSESSMENT PATTERN		
Assessment		**Marks**
Continuous Internal Assessment		40
1	Internal Examination	20
2	Learning Activity	15
3	Regularity	5
End Semester Examination - Theory		60
Total		**100**

Muthoot Institute of Technology and Science
Kochi
(Autonomous)

			Total Pages: 2
Register No.:	....	Name:	....

SECOND SEMESTER B. TECH DEGREE (REGULAR) EXAMINATION, MAY 2026 (2025 SCHEME)			
Course Code:	**B250002/ME300A**		
Course Name:	**Fluid Mechanics & Machinery**		
Max. Marks	**60**	**Duration:**	2 hours 30 minutes

PART A

MODULES 1-4

(Answer all questions. Each question carries 3 marks)

No.	*Question*	*CO*	*Mark s*
1	A vertical rectangular gate of width 3 m and height 4 m is hinged at the top and submerged in water such that its top edge coincides with the free surface. Find total force acting on the gate and position of centre of pressure.	CO1	(3)
2	A rectangular wooden block of dimensions 2 m × 1 m × 1 m is floating in water. It is observed that 70% of its volume is submerged. Calculate the buoyant force acting on the block. .	CO1	(3)
3	In a laboratory experiment, dye is injected into flowing water to study flow patterns. Smooth curves are observed in some regions, while irregular patterns appear in others. Based on these observations, define streamlines, pathlines, and streaklines**.**	CO2	(3)
4	A venturimeter is installed in a pipeline carrying water. The fluid enters the converging section, passes through the throat, and exits through the diverging section. Pressure difference between inlet and throat is measured. Choose the correct option with explanation Maximum velocity occurs at: A) Inlet B) Outlet C) Throat D) Diverging section	CO2	(3)
5	Water flows over a flat plate placed in a channel. Near the leading edge, flow is smooth, but further downstream it becomes turbulent. The thickness of the boundary layer increases along the length of the plate. Explain why boundary layer thickness increases along the plate	CO3	(3)
6	Engineers are designing a long pipeline to transport water over several kilometers. They must consider pipe diameter, roughness, velocity, and energy losses to ensure efficient flow. How does pipe diameter affect the velocity and head loss?	CO3	(3)
7	A flat plate moves in the same direction as a water jet. It is observed that the force exerted by the jet decreases as plate velocity increases. Why force decreases with increase in plate velocity.	CO4	(3)
8	In a turbine, water enters the runner at a certain angle and exits at another angle. Engineers use velocity triangles to analyze performance. Why are velocity triangles important in turbine analysis?	CO4	(3)

MODULES 1-4

(Answer any one full question from each module, each question carries 9 marks)

No.	*Question*	*CO*	*Mark s*
	MODULE I		

5	a)	An industrial pipeline carries oil of specific gravity 0.85. A differential U-tube manometer containing mercury is connected between two points A and B in the pipeline. The difference in mercury levels is observed to be 40 cm. The tapping points are at different elevations, with point A being 1 m above point B. 1) Draw a neat schematic diagram of the setup. 2) Calculate the pressure difference between points A and B. 3) Explain why mercury is preferred as a manometric fluid.	CO1	(6)
	b)	Oil flows through a long pipeline connecting two processing units. Engineers observe pressure losses and flow resistance. Explain how fluid properties like viscosity and density affect flow.	CO1	(3)
		OR		
6	a)	A lubrication system is designed for a machine where oil flows between two large parallel plates separated by a distance of 1.5 mm. The top plate moves at a velocity of 2 m/s while the bottom plate is stationary. The oil used has a density of 900 kg/m^3 and dynamic viscosity of 1.2 Ns/m^2. 1) Determine the velocity gradient within the oil film. 2) Calculate the shear stress developed in the fluid. 3) If the plate area is 0.8 m^2, determine the force required to maintain motion. 4) Calculate the kinematic viscosity of the oil. 5) Explain how temperature variation would affect the system performance.	CO1	(9)
		MODULE II		
7	a)	An aircraft uses a pitot tube to measure airspeed. The pressure difference between stagnation and static pressure is 1200 N/m^2. Density of air = 1.2 kg/m^3). Determine the aircraft speed. If aircraft flies at higher altitude (lower density), explain how the reading changes.	CO2	(5)
	b)	A fire hose nozzle reduces diameter from 100 mm to 40 mm to throw water to a long distance. Water enters the hose at velocity 2 m/s and pressure 300 kPa. Determine velocity and pressure at the nozzle exit.		(4)
		OR		
8	a)	A municipal system supplies water from a ground reservoir to the top of a building 18 m high through a pipe of diameter 200 mm. The velocity of water at the outlet is 4 m/s. 1) Determine the pressure required at the reservoir to ensure flow reaches the top. 2) Calculate discharge through the pipe. 3) If velocity is increased, explain how required pressure changes.	CO2	(9)
		MODULE III		
9	a)	A petroleum company transports crude oil from a storage terminal to a refinery through a long pipeline. Recently, the flow rate has decreased, increasing transportation time and cost. Engineers suspect that the issue is due to the **high viscosity of crude oil and possible laminar flow conditions**, leading to higher resistance. **System Details:** Pipe length = 600 m ,Diameter = 100 mm ,Pressure difference between ends = 80 kPa Oil properties: Density = 920 kg/m^3 ,Dynamic viscosity = 0.6 Ns/m^2 1) Calculate Reynolds number and determine flow type. 2) Verify whether Hagen–Poiseuille equation is applicable. 3) Calculate discharge through the pipeline. 3) Determine maximum and average velocity.	CO3	(9)
		OR		

10	a)	An engineer studies drag force on a spherical object using a small-scale model in a laboratory. The aim is to predict behavior of the full-scale prototype. **Variables involved:** • Drag force (F) • Diameter (D) • Velocity (V) • Density (ρ) • Viscosity (μ) 1) Apply Buckingham π theorem to derive dimensionless groups. 2) Identify Reynolds number from derived groups. 3) Establish relationship between model and prototype.	CO3	(9)
		MODULE IV		
11	a)	A small hydropower unit uses water stored at a height to generate power. Water flows through a nozzle and forms a jet that strikes a wheel fitted with curved vanes. Engineers observe that system efficiency depends on proper matching of jet velocity and vane speed. **Given:** • Head = 40 m • Coefficient of velocity (Cv) = 0.97 • Vane speed = 12 m/s • Mass flow rate = 35 kg/s • Jet deflection angle = 160° 1) Calculate velocity of jet at nozzle outlet. 2) Draw velocity triangles at inlet and outlet. 3) Determine force exerted on vanes in direction of motion. 4) Calculate power developed by the runner. 5) Determine efficiency of the system.	CO4	(9)
		OR		
12	a)	A reciprocating pump is used in a refinery for precise fluid delivery. Engineers notice variation between theoretical and actual discharge. **Given:** • Theoretical discharge = 0.032 m^3/s • Actual discharge = 0.029 m^3/s 1) Calculate slip of the pump. 2) Determine percentage slip. 3) If actual discharge increases to 0.034 m^3/s, calculate new slip. 4) Identify type of slip and explain reason.	CO4	(9)

****

COURSE DESCRIPTION							
REGULATION	**2025**	**L-T-J-P-S**	**2-1-1-0-4**	**VERSION**	**25/0**	**CREDITS**	**4**
(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)							

COURSE CODE	**COURSE NAME**	**COURSE CATEGORY**
B250002/ME320D	**MANUFACTURING PROCESS**	**PCB**
PRE-REQUISITE		
Basic knowledge of Material Science and fundamental analytical skills		

PREAMBLE

- Introduces the fundamental principles of manufacturing and material processing.
- Covers major manufacturing processes including casting, welding, metal forming, and powder metallurgy.
- Emphasizes process selection, quality control, and defect analysis in manufacturing.
- Provides insight into modern manufacturing technologies and their industrial applications.

RATIONALE

- Manufacturing is a fundamental competency for mechanical engineers, influencing product quality, cost, and performance.
- The course establishes the relationship between material behavior and manufacturing processes, enabling informed design and production decisions.
- Understanding process parameters help in defect reduction, quality improvement, and enhanced manufacturing efficiency.
- Knowledge of casting, welding, metal forming, and other manufacturing techniques supports effective process selection for industrial applications.
- Project-based learning promotes teamwork, problem-solving, creativity, and innovation skills.
- The course incorporates sustainable manufacturing practices and modern technological advancements to address contemporary engineering challenges.

COMPETENCY STATEMENT

Apply principles of metal extraction, solidification, deformation, and joining processes to improve material performance and manufacturing efficiency

CO	CO Statement	Cognitive (C)	Psychomotor (P)	Affective (A)
CO1	**Classify** and explain various manufacturing processes including casting, powder metallurgy, and their special techniques.	U		
CO2	**Analyse** the parameters and physics of different welding processes, including fusion, solid-state, resistance, and advanced welding methods.	A		
CO3	**Apply** the fundamentals of plastic deformation, rolling, and sheet metal operations to analyse process behaviour and defects.	A		
CO4	**Apply** the principles of forging, extrusion, drawing, and bending to evaluate process mechanics, defects, and industrial applications.	A		
CO5	**Design** and select appropriate manufacturing methods for industrial applications based on process capabilities and limitations.	E	Ar	V

TEACHING AND ASSESSMENT SCHEME													
Teaching Scheme / Week					**Hours / Semester**	**Credit**	**Examination Scheme**						
							Theory			**Practical**			**Total**
L	**T**	**J**	**P**	**S**	**120**	**C**	**CIA**	**ESE**	**Total**	**CIA**	**ESE**	**Total**	

2	1	1		4		4	60	40	100	-	-	-	100

L: *Lecture (One unit is of one-hour duration),* ***T***: *Tutorial (One unit is of one-hour duration),* ***P***: *Practical (One unit is of one-hour duration),* ***J***: *Project (One unit is of one-hour duration),* ***S***: *Self-Learning & Team Work (One unit is of one-hour duration),* ***CIA***: *Continuous Internal Assessment,* ***ESE***: *End Semester Examination*

SYLLABUS (Major Topics)

Module	Title	Major Topics	Hrs
1	Casting Processes and Powder Metallurgy	General Classification of Manufacturing Processes. **Casting**-Characteristics of sand, design of patterns, cores, chaplets, solidification of metals and Chvorinov's rule, elements of gating system, risers, chills, numerical problems, defects in castings. Special casting process- Shell moulding, precision investment, die casting, centrifugal casting, continuous casting and squeeze casting. **Powder Metallurgy**- Powder Production, powder characteristics, mixing, compaction methods, sintering	12
2	Welding and Joining Processes	**Welding**: Classification, Fusion and Solid-state welding processes Gas Welding - Oxyacetylene welding-chemistry, types of flame and its applications. Arc welding- applications, numerical problems, consumable and non-consumable arc welding. Thermit welding, friction welding, electro slag welding, ultrasonic welding, electron beam welding and laser beam welding. Resistance welding-applications, process parameters, numerical problems Heat Affected Zone, residual stresses and distortion, defects in welding **Brazing - soldering - adhesive bonding.**	12
3	Metal Forming and Rolling Processes	**Metal Forming**: Plastic deformation and yield criteria – hot and cold working processes **Rolling**- Flat-rolling process, types of rolling mills, rolling defects. **Sheet metal operations**- Press tool operations. Types of die-Progressive dies, Compound dies, and Combination dies.	11
4	Forging, Drawing, Bending and Extrusion	**Forging**-Forging load, numerical problems, Various methods, applications, defects in forging - **Wire, Rod, and tube drawing**, drawing defects – Deep drawing. **Bending** – Details of bending, Determination of workload, estimation of spring back, numerical problems. **Extrusion**- Metal flow, mechanics of extrusion, numerical problems, defects in extrusion, applications.	14

Sl. No	Self-learning / Team Work Description
1	Analyse how **casting simulation software** (e.g., AutoCAST or MAGMASOFT) predicts defects. Prepare a short report on defect reduction.
2	Investigate **eco-friendly mould materials** and **waste management** techniques used in industries and present key findings.
3	Compare **powder metallurgy** with **metal additive manufacturing** processes in terms of applications, advantages, and limitations.
4	Study the use of **robotic welding systems** (e.g., KUKA) and explain their advantages over manual welding.
5	Investigate **laser beam** and **electron beam welding** applications in **aerospace or medical industries.**
6	Explore how **sensors and automation** are used in **modern welding** for quality control.
7	Study how tools like **ANSYS** are used to analyse **metal forming processes**.
8	Investigate industrial **sheet metal** operations used in **automobile manufacturing**.
9	Study how **AI/ML techniques** are used to **optimize forging or extrusion** parameters.
10	Investigate the **forming of aluminium alloys** and advanced materials used in **EVs.**
11	Study methods used in industry to predict and reduce **spring back.**
12	Compare **hot and cold forging** processes based on **real industrial applications**.

SUGGESTED LEARNING RESOURCES

Text Book

Sl. No.	Title of Book	Author	Publication
1	Manufacturing Science	Amitabha Ghosh and Ashok Kumar Mallick	Affiliated East West Press Ltd, New Delhi, 2002

2	Manufacturing Engineering and Technology	S.Kalpakjian and Steven R Schimid	Pearson, 2001
3	Manufacturing Technology	S. Jose	Pentage educational services 2024

Reference			
Sl. No.	Title of Book	Author	Publication
1	Manufacturing Technology	RAO	Vol 2 3e, McGraw Hill Education India, 2013
2	Principles of Manufacturing Materials and Processes	Campbell J. S.	Tata McGraw Hill, 1999
3	Foundry Technology	P R Beeley	Elsevier, 2001
4	Materials and Processes in Manufacturing	Paul Degarma E and Ronald A. Kosher	Wiley,2011
5	Manufacturing Technology Foundry, Forming and Welding	P. N. Rao	Tata McGraw-Hill Education,2011
6	Principles of Metal Casting	Richard W. Heine, Carl R. Loper, Philip C. Rosenthal	Tata McGraw Hill Education, 2001

Web Resource	
1	https://nptel.ac.in/courses/112107219
2	https://nptel.ac.in/courses/112107215
3	https://nptel.ac.in/courses/112107089
4	https://nptel.ac.in/courses/112107144

DETAILED SYLLABUS

Module	**Title**	**Topic**	**Mode of Delivery**	**CO**	**Learning Domain**			**Hrs**
					C	**P**	**A**	
1	Casting Processes and Powder Metallurgy	Introduction to Manufacturing Processes.	L	CO1	U			1
		General Classification of Manufacturing Processes	L	CO1	U			1
		Introduction to casting process Characteristics of sand, design of patterns	L/T	CO1	A			1
		Sand casting Process cores, chaplets and solidification of metals	L	CO1	U			1
		Project		CO5	E	Ar	V	1
		Chvorinov's rule	T	CO1				1
		Elements of gating system, risers and chills	L	CO1	U			1
		Numerical problems	T	CO1	A			1
		Special casting process- Shell moulding	L	CO1	U			1
		Project		CO5	E	Ar	V	1
		Precision investment and Die casting.	L	CO1	U			1
		Centrifugal casting, squeeze casting and Continuous casting	L	CO1	U			1
		Introduction to Powder Metallurgy- Powder Production	L	CO1	U			1
		Powder characteristics and mixing	L	CO1	U			1
		Project		CO5	E	Ar	V	1
		Compaction and Sintering methods	L	CO1	U			1
	Welding and Joining Processes	Introduction to Welding	L	CO2	U			1
		Classification of welding -Fusion, Solid-state and Gas Welding	L	CO2	A			1

2		Oxyacetylene welding-chemistry, types of flame and its applications	L	CO2	A			1
		Arc welding- applications and numerical problems	T	CO2	An			1
		Project		CO5	E	Ar	V	1
		Consumable and non-consumable arc welding.	L	CO2	U			1
		Thermit welding and friction welding	L	CO2	U			1
		Electro slag welding and ultrasonic welding	L	CO2	U			1
		Electron beam welding and laser beam welding	L/T	CO2	A			1
		Project		CO5	E	Ar	V	1
		Resistance welding-applications, process parameters and numerical problems	T	CO2	An			1
		Heat Affected Zone, residual stresses and distortion.	L/T	CO2	A			1
		Defects in welding	L	CO2	U			1
		Brazing	L	CO2	U			1
		Project		CO5	E	Ar	V	1
		Soldering	L	CO2	U			1
		Adhesive bonding	L	CO2	U			1
3	Metal Forming and Rolling Processes	Plastic deformation and yield criteria	L	CO3	A			1
		Hot and cold working processes	L	CO3				1
		Project		CO5	E	Ar	V	1
		Flat-rolling process	T	CO3	A			1
		Types of rolling mills	L	CO3	U			1
		Sheet metal operations	L	CO3	A			1
		Press tool operations	L	CO3	A			1
		Project		CO5	E	Ar	V	1
		Types of die-Progressive dies	T	CO3	U			1
		Compound dies	L/T	CO3	A			1
		Combination dies	L/T	CO3	A			1
4	Forging, Drawing, Bending and Extrusion	Forging load	T	CO4	A			1
		Project		CO5	E	Ar	V	1
		Numerical problems	T	CO4				1
		Various methods and applications	L	CO4	An			1
		Defects in forging	L	CO4	U			1
		Wire, Rod and tube drawing	L	CO4	U			1
		Drawing defects	L	CO4	U			1
		Project		CO5	E	Ar	V	1
		Deep drawing	L	CO4	U			1
		Details of bending	L	CO4	U			1
		Determination of workload	T	CO4	A			1
		Estimation of spring back	T	CO4	A			1
		Project		CO5	E	Ar	V	1
		Numerical problems.	T	CO4	A			1
		Extrusion and Metal flow	L	CO4	U			1
		Mechanics of extrusion	L	CO4	A			1
		Numerical problems	T	CO4	A			1
		Project		CO5	E	Ar	V	1
		Defects in extrusion and Applications	L	CO4	A			1

SUGGESTIVE COURSE PROJECT				
Objective	**CO**	**Learning Domain**		
		C	P	A
Design and fabrication of a simple sand-casting Molds	CO1, CO5	E	Ar	V

Comparison of gating systems in casting	CO1, CO5	E	Ar	V
Study on casting defects with case examples	CO2, CO5	E	Ar	V
Comparative analysis of welding methods	CO2, CO5	E	Ar	V
Study on weld defects with case examples	CO2, CO5	E	Ar	V
Welding process parameter optimization	CO2, CO5	E	Ar	V
Temperature mapping in welding using thermocouples	CO2, CO5	E	Ar	V
Design and fabrication of a multipurpose manufacturing fixture	CO3, CO5	E	Ar	V
Process selection for manufacturing a common household product	CO3, CO4 CO5	E	Ar	V
Ergonomic tool redesign project	CO3, CO4, CO5	E	Ar	V

TABLE OF SPECIFICATIONS (ToS) (ESE Question Paper Design) (Use √)

Module	Module Title	Distribution of Marks (RBL)						Total Marks
		R	U	A	An	E	C	
1	Casting Processes and Powder Metallurgy		√	√	√			10
2	Welding and Joining Processes		√	√	√			10
3	Metal Forming and Rolling Processes		√	√	√			10
4	Forging, Drawing, Bending and Extrusion		√	√				10

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN

Assessment		**Marks**
Continuous Internal Assessment		**60**
1	Internal Examination	20
2	Learning Activity	5
3	Regularity	5
4	Course Project	30
End Semester Examination - Theory		**40**
Total		**100**

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(Autonomous)

			Total Pages: …….
Register No.:	……………	Name:	…………………………………………

THIRD SEMESTER B. TECH DEGREE (REGULAR) EXAMINATION, DECEMBER 2025 (2025 SCHEME)			
Course Code:	**B250002/ME320D**		
Course Name:	**MANUFACTURING PROCESSES**		
Max. Marks	**40**	**Duration:**	2 hours 30 minutes

PART - A

(Answer all questions. Each question carries 2 marks)

No.	***Question***	***CO***	***Marks***
1	Compare sand casting and die casting process	CO1	(2)
2	Analyse the benefits of powder metallurgy and state any two advantages it offers over conventional manufacturing methods	CO1	(2)
3	Identify the various functions of electrode coatings in arc welding and analyse how they contribute to weld quality and stability	CO2	(2)
4	Explain residual stresses and distortion in welding and suggest methods to prevent them.	CO2	(2)
5	Illustrate the flat rolling process using neat sketches and present the equation for rolling load.	CO3	(2)
6	What are the different types of rolling mills? Explain any one with applications.	CO3	(2)
7	A metal with strength coefficient K=1000 MPa and strain hardening exponent n=0.2 is subjected to an engineering strain of 0.15. Determine the average flow stress.	CO4	(2)
8	Define spring back as observed in sheet metal forming operation.	CO4	(2)

PART – B

(Answer any one full question from each module, each question carries 6 marks)

No.		***Question***	***CO***	***Marks***
		MODULE I		
5	a)	A company needs to produce a component with intricate shapes and tight tolerances. Propose the use of investment casting and describe the step-by-step process involved, highlighting its benefits	CO1	(3)
	b)	With sketches discuss the various types of defects generated during the casting process	CO1	(3)
		OR		
6	a)	A company wants to manufacture self-lubricating bearings using powder metallurgy. Outline the sequence of primary operations involved in the process and explain the relevance of each step in ensuring performance.	CO1	(3)
	b)	Which of the following casting shapes would have the least solidification time? (a) Sphere of diameter, D = 35 mm (b) Cylinder of diameter d = height, h = 35 mm	CO1	(3)
		MODULE II		
7	a)	Outline the Tungsten Inert Gas (TIG) welding process supported by a neat schematic. Furthermore, depict the three welding current polarities used in arc welding with diagrams. For each, state one typical application and summarize its effect on arc characteristics and penetration.	CO2	(3)
	b)	The arc length characteristic of a DC welding arc is given by V = 24 + 1.5 L, where L is the arc length and V is voltage. Determine the heat input to a low carbon steel plate for the following data: Open circuit voltage of power source, V_{oc} = 65 V Short circuit current, I_{sc} = 140 A Arc length, L = 5 mm Efficiency of heat input, η = 86%	CO2	(3)
		OR		
8	a)	Explain the principle of resistance welding. Describe its working and list the major types of resistance welding with their applications.	CO2	(3)

	b)	Two steel sheets of 2 mm thickness are resistance welded in a lap joint with a current of 10000 A for 0.15 second. The effective resistance of the joint can be taken as 150 µΩ. The joint can be considered as a cylinder of 5 mm diameter and 2 mm height. Heat required for melting steel can be taken as 10 J/mm^3. Determine the amount of heat generated and lost during the welding.	CO2	(3)
		MODULE III		
9	a)	A 400 mm wide strip of 30 mm thickness is fed through a rolling mill with two powered rolls each of radius 300 mm. The work thickness is to be reduced to 25 mm in one pass at a roll speed of 50 rev/min. The work material has a flow curve defined by K = 275 MPa and n = 0.15. The coefficient of friction between rolls and work is assumed to be 0.12. Determine the roll force.	CO3	(3)
	b)	A kitchen appliance industry is manufacturing sheet metal parts for a mixer grinder. The process involves: • Cutting the outer profile • Producing circular and rectangular holes • Removing extra edges • Cutting small portions from the sides **Question** 1. Identify the four different shearing operations suitable for these requirements. 2. Explain any two operations with neat, labelled sketches	CO3	(3)
		OR		
10	a)	Determine the die and punch dimensions for blanking a circular disc of 20 mm diameter from a C20 steel sheet of thickness 2.5 mm. Shear strength of C20 steel is 300 MPa. Also determine the punching force. What will be the dimensions of die and punch, if it were a piercing process.	CO3	(3)
	b)	State the difference between blanking and punching	CO3	(3)
		MODULE IV		
11	a)	A manufacturing firm is evaluating extrusion methods to improve efficiency. Compare direct and indirect extrusion based on working principles and mention one advantage and one limitation of each.	CO4	(3)
	b)	A sheet metal component shows dimensional errors after bending. Define bend allowance and bend deduction and explain how they help in achieving accurate dimensions.	CO4	(3)
		OR		
12	a)	An automotive company produces cup-shaped components but faces defects during forming. Explain the deep drawing process and mention one common defect with its cause.	CO4	(3)
	b)	A manufacturer needs to select forging methods for different production requirements. Differentiate open die forging and closed die forging (any two points) and suggest one suitable application for each.	CO4	(3)

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COURSE DESCRIPTION							
REGULATION	**2025**	**L-T-J-P-S**	**3-0-0-0-5**	**VERSION**	**25/0**	**CREDITS**	**4**
(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)							

COURSE CODE	COURSE NAME	COURSE CATEGORY
B250002/ME300E	**AI FOR MECHANICAL ENGINEERING**	EST
PRE-REQUISITE		
B250903/CN110E - Programming in Python		

PREAMBLE

This course bridges the gap between traditional mechanical engineering and modern artificial intelligence. By integrating Python programming, machine learning, and data analytics, students are equipped to transition from conventional design paradigms to the data-driven methodologies required for autonomous systems and Industry 4.0.

RATIONALE

- Adapting to Industry 4.0: Prepares students for a manufacturing landscape that is being fundamentally transformed by digital technology.
- Bridging Physical and Digital: Equips mechanical engineers with the ability to seamlessly integrate traditional physical systems with modern digital intelligence.
- Building Foundational Skills: Provides essential, practical expertise in data analysis and artificial intelligence.
- Driving Future Innovation: Gives graduates the necessary tools to design the smart, sustainable, and autonomous systems of the future.

COMPETENCY STATEMENT/s

Integrate emerging technologies such as automation, AI, and IoT to develop socially responsible industrial solutions that improve working conditions, ensure economic viability, and contribute to global sustainability goals

CO	CO Statement	Cognitive (C)	Psychomotor (P)	Affective (A)
CO 1	**Explain** the concepts of Artificial Intelligence, Machine Learning paradigms, and core task types, and implement data handling workflows using Python libraries — NumPy, Pandas, Matplotlib, and Seaborn	U	-	-
CO 2	**Apply** supervised learning algorithms — linear regression, K-Nearest Neighbors, and Naive Bayes — and unsupervised clustering using K-Means to solve engineering problems through hand calculations, and evaluate model performance using RMSE, R-squared, precision, and recall	A	-	-
CO 3	**Analyse** the architecture and computational mechanics of Artificial Neural Networks and Convolutional Neural Networks, and apply dimensionality reduction using Principal Component Analysis to interpret high-dimensional engineering data	A	-	-
CO 4	**Describe** the role of AI in robotics, digital twins, and smart manufacturing within the Industry 4.0 framework	U	-	-

<table>
<tr><th colspan="14">TEACHING AND ASSESSMENT SCHEME</th></tr>
<tr><th colspan="5" rowspan="2">Teaching Scheme / Week</th><th rowspan="2">Hours / Semester</th><th rowspan="2">Credit</th><th colspan="7">Examination Scheme</th></tr>
<tr><th colspan="3">Theory</th><th colspan="3">Practical</th><th rowspan="2">Total</th></tr>
<tr><th>L</th><th>T</th><th>J</th><th>P</th><th>S</th><th rowspan="2">120</th><th>C</th><th>CIA</th><th>ESE</th><th>Total</th><th>CIA</th><th>ESE</th><th>Total</th></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>5</td><td>4</td><td>60</td><td>40</td><td>100</td><td></td><td></td><td></td><td></td></tr>
</table>

__L__: Lecture (One unit is of one-hour duration), __T__: Tutorial (One unit is of one-hour duration), __P__: Practical (One unit is of one-hour duration), __J__: Project (One unit is of one-hour duration), __S__: Self-Learning & Team Work (One unit is of one-hour duration), __CIA__: Continuous Internal Assessment, __ESE__: End Semester Examination

SYLLABUS (Major Topics)

Module	Title	Major Topics	Hrs
1	**Foundations of AI/ML and Python for Data Handling**	Introduction to Artificial Intelligence and Machine Learning: concept of AI as a discipline and ML as its subset, motivating example of the self-driving car. Paradigms of machine learning: supervised learning, unsupervised learning, and reinforcement learning. Core ML task types: classification, regression, and clustering, all treated at an intuitive level without mathematical formalism. Python for data handling: numerical computation using NumPy, structured data manipulation using Pandas, and data visualisation using Matplotlib and Seaborn.	10
2	**ML Algorithms, and Model Evaluation**	Supervised learning algorithms — simple linear regression, multiple linear regression, K-Nearest Neighbors, and Naive Bayes classifier, including mathematical formulation and hand-calculation problems. Unsupervised learning — K-Means clustering algorithm, centroid initialisation, iterative assignment, convergence, and the elbow method for selecting the number of clusters. Model evaluation and performance metrics — Root Mean Square Error (RMSE), R-squared for regression models, confusion matrix, precision, recall, and F1-score for classification models.	12
3	**Dimensionality Reduction, Deep Learning**	Dimensionality reduction — Principal Component Analysis (PCA), covariance matrix, eigenvalues and eigenvectors, extraction of principal components, and explained variance ratio. Artificial Neural Networks — perceptron model, multi-layer perceptrons, activation functions (Sigmoid, Tanh, ReLU, Softmax), forward and backward pass concepts. Convolutional Neural Networks — digital image representation, convolutional filters and feature maps, padding, stride, max pooling, and the layered CNN architecture.	13
4	**AI in Robotics and Autonomous Systems**	Reinforcement learning basics: agent, environment, state, action and reward; Path planning and adaptive control: concepts and engineering relevance; AI in Digital Twins: virtual models for monitoring and prediction; Smart manufacturing and Industry 4.0: AI-driven quality control and automation; Future trends in AI for mechanical systems: digital manufacturing and smart factories	10

Sl. No	**Self-learning / Team Work Description**
1	Students will independently explore the concept of AI and ML by studying real-world applications — with particular focus on the self-driving car example — and map the three learning paradigms (supervised, unsupervised, reinforcement) to at least five mechanical engineering problems of their choice, justifying the paradigm selection for each. Individually, students will set up their Python environment, practise NumPy array operations, and perform basic statistical computations on a small numerical dataset. In teams, students will source an open-source mechanical or manufacturing dataset — such as bearing vibration logs, material test records, or process sensor data — load it using Pandas, perform data cleaning and exploratory analysis, and present annotated Matplotlib and Seaborn visualisations highlighting key patterns, distributions, and variable relationships observed in the data.
2	Individually, solve hand-calculation problems on linear regression, KNN, Naive Bayes, and K-Means for small numerical datasets. In teams, implement all algorithms on the Module 1 dataset using Scikit-learn, compute evaluation metrics, and present a comparative report justifying the best-fit model for the chosen engineering problem.
3	Individually, apply PCA by hand on a small dataset and trace a forward pass through a simple MLP using assumed weights. In teams, implement PCA and a Keras/PyTorch ANN on the team dataset, experiment with activation functions and layer configurations, and present a comparative analysis of model performance.
4	As team, research and summarise one real-world application each of AI in robotics, digital twins, and smart manufacturing from technical literature. In teams, analyse a documented Industry 4.0 implementation, prepare a system architecture diagram, and present findings with a critical reflection on societal and SDG implications.

SUGGESTED LEARNING RESOURCES

Text Book			
Sl. No.	Title of Book	Author	Publication
1	Artificial Intelligence and Machine Learning	Lyla B Das	Techsar Publications
2	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow	Aurélien Géron	Shroff Publishers & Distributors
3	Introduction to Industrial Internet of Things and Industry 4.0	Sudip Misra, Chandana Roy, and Anandarup Mukherjee	CRC Press

Reference			
Sl. No.	Title of Book	Author	Publication
1	Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter	Wes McKinney	Shroff Publishers & Distributors
2	Industry 4.0: The Industrial Internet of Things	Alasdair Gilchrist	Apress (Springer Nature)

Web Resource	
1	Python for Data Science - https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2	Industry 4.0: Managing the Digital Transformation - https://onlinecourses.nptel.ac.in/noc26_ge04/preview

DETAILED SYLLABUS								
Module	**Title**	**Topic**	**Mode of Delivery**	**CO**	**Learning Domain**			**Hrs**
					C	**P**	**A**	
1	**Foundations of AI/ML and Python for Data Handling**	The AI Landscape: AI as a discipline vs. ML as a subset. Evolution of AI.	L	1	U			1
		Case Study: The Self-Driving Car (Perception, Planning, and Control).	L	1	U			1
		ML Paradigms: Supervised, Unsupervised, and Reinforcement Learning.	L	1	U			1
		Core Tasks: Intuition of Classification, Regression, and Clustering.	L	1	U			1
		NumPy I: Array creation, indexing, and vectorization	L	1	A			1
		NumPy II: Numerical computation and linear algebra basics for ML.	L	1	A			1
		Pandas I: Series and DataFrames; importing CSV/Excel data.	L	1	A			1
		Pandas II: Data cleaning, filtering, and handling missing values.	L	1	A			1
		Matplotlib: Creating basic plots (Line, Scatter, Bar) for data exploration.	L	1	A			1
		Seaborn: Advanced statistical visualization and heatmaps.	L	1	A			1
2	**ML Algorithms, and Model Evaluation**	Simple Linear Regression: The least squares method and formulation.	L	2	A			1
		Multiple Linear Regression: Handling multiple features and coefficients.	L	2	A			1
		Solved Problems: Hand-calculating regression slopes and intercepts.	L	2	A			1
		K-Nearest Neighbors (KNN): Distance metrics and the "K" factor.	L	2	A			1
		Naive Bayes: Bayes' Theorem and probabilistic classification.	L	2	A			1
		Unsupervised Learning: K-Means Clustering logic and centroids.	L	2	A			1

	Dimensionality Reduction, Deep Learning	K-Means Mechanics: Iterative assignment, convergence, and local optima.	L	2	A			1
		Hyperparameters: Selecting K via the Elbow Method.	L	2	A			1
		Regression Metrics: Calculating and interpreting RMSE and R^2.	L	2	A			1
		Classification Metrics: Confusion Matrix, Precision, Recall, and F1-Score.	L	2	A			1
3		Intro to PCA: The curse of dimensionality and why we reduce it.	L	3	A			1
		PCA Math I: Covariance matrices, Eigenvalues, and Eigenvectors.	L	3	A			1
		PCA Math II: Principal components and Explained Variance Ratio.	L	3	A			1
		The Perceptron: The biological inspiration and the mathematical unit.	L	3	A			1
		Multi-Layer Perceptrons (MLP): Input, Hidden, and Output layers.	L	3	A			1
		Activation Functions: Comparing Sigmoid, Tanh, ReLU, and Softmax.	L	3	A			1
		The Learning Process: Forward pass and the concept of Backpropagation.	L	3	A			1
		Intro to CNNs: Digital image representation (pixels and channels).	L	3	A			1
		CNN Operations: Filters (Kernels), Padding, Stride, and Feature Maps.	L	3	A			1
		CNN Architecture: Max Pooling layers and Flattening for classification.	L	3	A			1
4	**AI in Robotics and Autonomous Systems**	Role of AI in robotics: perception, decision and control layers – overview	L	4	U			1
		Reinforcement learning basics: agent, environment, state, action and reward	L	4	U			2
		Path planning and adaptive control: concepts and engineering relevance	L	4	U			2
		AI in Digital Twins: virtual models for monitoring and prediction	L	4	U			1
		Smart manufacturing and Industry 4.0: AI-driven quality control and automation	L	4	U			1
		Future trends in AI for mechanical systems: digital manufacturing and smart factories	L	4	U			1
		Hands-on: digital twin case study walkthrough – data-driven maintenance prediction	L	4	A			2

TABLE OF SPECIFICATIONS (ToS) (ESE Question Paper Design) (Use √)

Module	Module Title	Distribution of Marks (RBL)						Total Marks
		R	U	A	An	E	C	
1	Foundations of AI/ML and Python for Data Handling		√					15
2	ML Algorithms, and Model Evaluation		√	√				15
3	Dimensionality Reduction, Deep Learning		√	√				15
4	AI in Robotics and Autonomous Systems		√					15

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN

Assessment		**Marks**
Continuous Internal Assessment		**60**
1	Internal Examination	20
2	Learning Activity	15
3	Regularity	5
4	Experiential Learning Activity	20
End Semester Examination - Theory		**40**
Total		**100**

CONTINUOUS INTERNAL ASSESSMENT DETAILED

Assessment		**Marks**
1	Internal Exams	20
2	Learning Activity 1 – Quiz from Module 1,2	7.5
3	Learning Activity 2 – Quiz from Module 3,4	7.5
4	Experiential Learning Activity 1 – Mini project in teams. The project will be continuous incorporating learnings from Module 1, 2 and 3	15
5	Experiential Learning Activity 2 – Flipped Classroom Activity from Module 4	5
6	Regularity	5
Total		**60**

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			Total Pages: …….
Register No.:	……………	Name:	…………………………………………

(AN AUTONOMOUS COLLEGE AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANATHAPURAM)

FOURTH SEMESTER B. TECH DEGREE (REGULAR) EXAMINATION, MAY 2026 (2025 SCHEME)			
Course Code:	**B250002/ME300E**		
Course Name:	**AI FOR MECHANICAL ENGINEERS**		
Max. Marks	**60**	**Duration:**	2 hours 30 minutes

PART - A

(Answer all questions. Each question carries 3 marks)

No.	**Question**	**CO**	**Marks**
1	A mechanical engineer has collected operational data from a fleet of machines but has no labels indicating which machines failed. He wants to identify unusual operating patterns. Which ML paradigm is appropriate here and why? What changes if failure labels become available?	CO1	(3)
2	A team loads a sensor dataset and finds that temperature readings have 15% missing values, motor speed is in RPM while vibration is in mm/s, and the defect column has 95% normal and 5% defective entries. What data handling concerns must be addressed before any ML model is applied, and which Python libraries would you use for each?	CO1	(3)
3	A student trains a KNN classifier with K=1 to predict bearing failure and achieves 99% training accuracy but poor test accuracy. Another student uses Naive Bayes on the same data and gets moderate but consistent accuracy on both sets. Explain what is happening in each case and which model you would recommend for deployment.	CO2	(3)
4	A regression model predicting surface roughness gives R-squared = 0.91 but RMSE = 4.7 microns, which exceeds the acceptable tolerance of 2 microns. The classification model for defect detection gives precision = 0.95 but recall = 0.60. Interpret both results and explain which problem is more critical to address first and why.	CO2	(3)
5	A dataset from a CNC machining centre has 50 sensor variables, many of which are correlated. A student applies KNN directly and gets poor results. Another applies PCA first, retains 6 components explaining 92% variance, and then applies KNN with significantly better results. Explain why PCA improved performance in this case.	CO3	(3)
6	A CNN trained on 10,000 surface defect images achieves high training accuracy but fails on images taken under different lighting conditions on the shop floor. Identify the problem and explain how the convolutional layers, pooling, and training strategy contribute to or could mitigate this issue.	CO3	(3)
7	A plant engineer claims that a digital twin of their extrusion line is just a 3D CAD model updated periodically with inspection reports. A consultant disagrees. Justify the consultant's position by explaining what a true AI-integrated digital twin should be capable of that the engineer's description lacks.	CO4	(3)
8	A factory installs an AI-driven vision inspection system that achieves 98% defect detection accuracy in trials but performs poorly after three months of production. Suggest at least three possible reasons rooted in smart manufacturing and IIoT concepts that could explain this degradation in performance.	CO4	(3)

PART – B

(Answer any one full question from each module, each question carries 9 marks)

No.	**Question**	**CO**	**Marks**

<table>
<tr><th colspan="5">MODULE I</th></tr>
<tr><td rowspan="2">5</td><td>a)</td><td>A CSV file contains columns: timestamp, load_kN, temperature_C, vibration_mm_s with 500 rows of sensor data. Write Python code using Pandas and Matplotlib to: (a) load and describe the dataset, (b) identify and handle missing values, and (c) plot a scatter graph of load_kN vs vibration_mm_s.</td><td>CO1</td><td>(5)</td></tr>
<tr><td>b)</td><td>Explain the concept of data normalization. Given a feature with values [20, 50, 80, 110, 140], apply (a) min-max normalization and (b) z-score standardization. State which method you would prefer for a neural network input layer and justify your answer.</td><td>CO1</td><td>(4)</td></tr>
<tr><th colspan="5">OR</th></tr>
<tr><td rowspan="2">6</td><td>a)</td><td>Explain how linear regression works. A dataset of machine operating hours vs maintenance cost (in INR) is given. Describe the steps to build, train, and evaluate a linear regression model in Python using Scikit-learn, and state two metrics you would use to evaluate its performance.</td><td>CO1</td><td>(5)</td></tr>
<tr><td>b)</td><td>A polynomial regression model of degree 2 is fitted to a stress–strain dataset. Compared to a linear model, the training RMSE drops from 12.4 to 3.1, but the test RMSE rises from 13.0 to 28.7.^{3} (a) Identify whether the model is underfitting or overfitting. (b) Suggest two remedies. (c) Define the bias-variance tradeoff in the context of this problem.</td><td>CO1</td><td>(4)</td></tr>
<tr><th colspan="5">MODULE II</th></tr>
<tr><td rowspan="2">7</td><td>a)</td><td>The following dataset records cutting speed (X1), feed rate (X2), and resulting surface roughness (Y) for a milling operation. Using the normal equation for multiple linear regression, set up the matrix formulation and compute the predicted surface roughness for a new observation where X1 = 3 and X2 = 2. Interpret the regression coefficients and explain what they indicate about the influence of each cutting parameter on surface roughness.
<table>
<tr><th>Obs</th><th>X1(m/min)</th><th>X2 (mm/rev)</th><th>Y(mm)</th></tr>
<tr><td>1</td><td>2</td><td>1</td><td>4.2</td></tr>
<tr><td>2</td><td>3</td><td>2</td><td>5.8</td></tr>
<tr><td>3</td><td>4</td><td>1</td><td>6.1</td></tr>
<tr><td>4</td><td>2</td><td>3</td><td>5.0</td></tr>
<tr><td>5</td><td>5</td><td>2</td><td>7.3</td></tr>
</table></td><td>CO2</td><td>(5)</td></tr>
<tr><td>b)</td><td>A bearing fault detection model produces the following confusion matrix from 100 test samples. Compute precision, recall, and F1-score for the defective class. The plant engineer states that the model is good enough because overall accuracy is 91%. Critically evaluate this claim with reference to the computed metrics and the consequences of missed fault detections in a mechanical system
<table>
<tr><th></th><th>Predicted Normal</th><th>Predicted Defective</th></tr>
<tr><td>Actual Normal</td><td>83</td><td>2</td></tr>
<tr><td>Actual Defective</td><td>7</td><td>8</td></tr>
</table></td><td>CO2</td><td>(4)</td></tr>
<tr><th colspan="5">OR</th></tr>
<tr><td>8</td><td>a)</td><td>A quality control engineer collects the following dataset of tool wear measurements and classifies each as acceptable (0) or defective (1). Apply the K-Nearest Neighbors algorithm with K = 3 using Euclidean distance to classify the query point Q = (4.5, 3.2). Show all distance calculations, identify the three nearest neighbors, and state the predicted class. Repeat for K = 5 and comment on whether the classification changes and what this implies about the choice of K.
<table>
<tr><th>Point</th><th>Feature 1</th><th>Feature 2</th><th>Class</th></tr>
<tr><td>A</td><td>2</td><td>3</td><td>0</td></tr>
<tr><td>B</td><td>3</td><td>4.5</td><td>0</td></tr>
<tr><td>C</td><td>4</td><td>2.5</td><td>1</td></tr>
<tr><td>D</td><td>5</td><td>3.5</td><td>1</td></tr>
<tr><td>E</td><td>6</td><td>5.0</td><td>1</td></tr>
<tr><td>F</td><td>3.5</td><td>2.0</td><td>0</td></tr>
<tr><td>G</td><td>5.5</td><td>4.0</td><td>1</td></tr>
</table></td><td>CO2</td><td>(5)</td></tr>
</table>

<table>
<tr><td></td><td></td><td><table><tr><td>H</td><td>2.5</td><td>4.0</td><td>0</td></tr></table></td><td></td><td></td></tr>
<tr><td></td><td>b)</td><td>A K-Means algorithm is initialised with two centroids C1 = (2, 3) and C2 = (6, 5) on the following dataset. Perform two complete iterations — assignment and centroid update — and show the cluster assignments and new centroid positions after each iteration. Comment on whether the algorithm has converged after two iterations and what convergence means in the context of this problem.
<table><tr><th>Point</th><th>X1</th><th>X2</th></tr><tr><td>P1</td><td>1</td><td>2</td></tr><tr><td>P2</td><td>2</td><td>4</td></tr><tr><td>P3</td><td>3</td><td>3</td></tr><tr><td>P4</td><td>5</td><td>4</td></tr><tr><td>P5</td><td>6</td><td>6</td></tr><tr><td>P6</td><td>7</td><td>5</td></tr></table></td><td>CO2</td><td>(4)</td></tr>
<tr><td colspan="5">MODULE III</td></tr>
<tr><td rowspan="2">9</td><td>a)</td><td>A manufacturing plant collects data from 12 sensors monitoring a milling machine. The dataset has 500 observations. A student standardises the data and computes the covariance matrix. The first three principal components explain 48%, 27%, and 13% of the variance respectively.

How many principal components would you retain and why? The student argues that since the original data has 12 sensors, at least 6 components must be retained to preserve enough information. Critically evaluate this argument. If the retained components are used as inputs to a downstream classifier, what advantage does this offer over using the original 12 sensor readings directly?</td><td>CO3</td><td>(5)</td></tr>
<tr><td>b)</td><td>In the context of the scenario in previous question, design a neural network for predicting a suitable output. Provide logic for selection of activation function.</td><td>CO3</td><td>(4)</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td rowspan="2">10</td><td>a)</td><td>a) A dataset with 6 observations and 3 variables is given below. The data has been mean-centred. Compute the covariance matrix, identify the direction of maximum variance, and explain how this relates to the first principal component. If the eigenvalues obtained are λ1 = 4.5, λ2 = 1.8, λ3 = 0.7, determine the number of components to retain for 90% explained variance and justify your answer.
<table><tr><th>Obs</th><th>X1</th><th>X2</th><th>X3</th></tr><tr><td>1</td><td>2</td><td>1</td><td>0</td></tr><tr><td>2</td><td>-1</td><td>-2</td><td>1</td></tr><tr><td>3</td><td>3</td><td>2</td><td>-1</td></tr><tr><td>4</td><td>-2</td><td>-1</td><td>0</td></tr><tr><td>5</td><td>1</td><td>3</td><td>2</td></tr><tr><td>6</td><td>-3</td><td>-3</td><td>-2</td></tr></table></td><td>CO3</td><td>(5)</td></tr>
<tr><td>b)</td><td>A simple neural network has 2 input neurons, a hidden layer with 2 neurons (ReLU activation), and 1 output neuron (Sigmoid activation). Using the weights and input given below, perform a complete forward pass and compute the final output. Show all intermediate steps.

Input: X = [0.6, 0.4]

Hidden layer weights: W1 = [[0.5, 0.4], [0.3, 0.7]], bias b1 = [0.1, 0.1]

Output layer weights: W2 = [0.6, 0.9], bias b2 = 0.05</td><td>CO3</td><td>(4)</td></tr>
<tr><td colspan="5">MODULE IV</td></tr>
<tr><td rowspan="2">11</td><td>a)</td><td>Explain reinforcement learning in detail. Compare it with supervised learning in terms of (a) data requirement, (b) feedback mechanism, and (c) suitability for robotic control tasks.</td><td>CO3</td><td>(5)</td></tr>
<tr><td>b)</td><td>Describe the architecture of an autonomous mobile robot used in a warehouse. Explain how AI contributes to each layer: (a) perception, (b) decision-making and (c) control. Mention one specific algorithm used in each layer.</td><td>CO3</td><td>(4)</td></tr>
</table>

		OR		
12	a)	Discuss the role of AI and machine learning in advancing Industry 4.0. How do technologies such as digital twins, intelligent robots, and AI-driven quality control systems change the role of a mechanical engineer? Support your answer with two real-world examples.	CO3	(5)
	b)	A company wants to build an AI-based visual inspection system to detect surface defects on machined parts. Describe (a) the type of AI model suitable for this task, (b) the data collection and labeling process, (c) model training steps, and (d) how the system would be integrated into the production line.	CO3	(4)

COURSE DESCRIPTION							
REGULATION	**2025**	**L-T-J-P-S**	**3-0-0-0-1**	**VERSION**	**25/0**	**CREDITS**	**2**
(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)							

COURSE CODE	COURSE NAME	COURSE CATEGORY
B250908/HU900F	**ENGINEERING ECONOMICS**	HMT
	PRE-REQUISITE	
	There are no prerequisites for taking this course.	

PREAMBLE

This course uses an active, experiential learning approach, combining lectures, case analysis, projects, and debates to build managerial and economic competencies like leadership, financial literacy, and strategic thinking. Its assessment design emphasizes real-world application, with learning activities as the primary component to evaluate students through analysis, creation, and practical problem-solving. The course emphasizes experiential learning through diverse activities to develop key economic and managerial skills. Assessments focus on practical application, enabling students to demonstrate higher-order thinking skills through real-world tasks. Engineering economics fundamentals like time value of money, depreciation, and break-even analysis remain essential, but today's engineers must also engage with expanded concepts such as sustainability, carbon pricing, lifecycle assessment, and digital cost modelling. This course blends classical methods with these contemporary dimensions to prepare graduates for real-world economic decision-making in modern industries.

RATIONALE

Economic decision-making is central to all engineering projects, encompassing investments, infrastructure, energy, procurement, and pricing - making it essential that engineers can make financially sound decisions independently.

India's landmark initiatives such as the National Infrastructure Pipeline, Smart Cities Mission, National Hydrogen Mission, and PLI schemes demand engineers capable of evaluating project viability, PPP economics, and capital allocation, directly supporting goals like Make in India and Atmanirbhar Bharat.

Sustainability is now an economic imperative, requiring engineers to assess lifecycle costs, carbon pricing, and green investments to deliver solutions that are both environmentally responsible and economically viable.

Engineering entrepreneurs need competencies in unit economics, cost analysis, pricing strategies, break-even analysis, and valuation to build sustainable business models.This course equips students with the quantitative and decision-making tools necessary to address these real-world engineering and economic challenges.

COMPETENCY STATEMENT/s

Learners will be able to develop the ability to apply engineering economics principles to evaluate investments, analyse project viability, integrate sustainability considerations, and make technically sound and economically informed decisions in engineering, and entrepreneurial contexts.

CO	CO Statement	Cognitive (C)	Psychomotor (P)	Affective (A)
1	Explain fundamental economic principles such as opportunity cost, demand and supply, and market structures and their relevance to engineering resource allocation and pricing decisions .	Understand	-	Receiving
2	Apply the concepts of cost and revenue, break-even techniques, learning curves, and equipment replacement methods to support engineering production decisions.	Apply	-	Valuing
3	Apply capital budgeting techniques - including non-discounted methods and discounted methods to determine project viability.	Apply	-	Valuing
4	Apply project analysis and lifecycle costing techniques to assess engineering projects from economic and sustainability perspectives.	Apply	-	Valuing

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week					Hours / Semester	Credit	Examination Scheme						
							Theory			Practical			Total
L	**T**	**J**	**P**	**S**		**C**	**CIA**	**ESE**	**Total**	**CIA**	**ESE**	**Total**	
3				1	**30**	2	60	40	100	-	-	-	100

***L**: Lecture (One unit is of one-hour duration), **T**: Tutorial (One unit is of one-hour duration), **P**: Practical (One unit is of one-hour duration), **J**: Project (One unit is of one-hour duration), **S**: Self-Learning & Team Work (One unit is of one-hour duration), **CIA**: Continuous Internal Assessment, **ESE**: End Semester Examination*

SYLLABUS (Major Topics)

Module	Title	Major Topics	Hrs
1	Economic Foundations for Engineering Decision-Making	Introduction to Economics, Demand and Supply Analysis, Elasticity of Demand, Market Structures **Relevant topics from Text 1,2 & 3**	9
2	Production Economics	Cost and Revenue Analysis, Break Even and Decision Analysis, Equipment Replacement Analysis **Relevant topics from Text 4,5 & 6**	9
3	Investment Decision Techniques	Introduction to Capital Budgeting, Non-Discounted Techniques, Discounted Techniques - Evaluation Methods and Economic Comparison Methods **Relevant topics from Text 7 & 8**	9
4	Project Economics, Sustainability & Contemporary Engineering Decisions	Project Economic Analysis & Public Sector Decisions, Life Cycle Cost Analysis **Relevant topics from Text 6,7, 9 & 10.**	9

SUGGESTED LEARNING RESOURCES

Text Book

Sl. No.	Title of Book	Author	Publication
1	Macro-Economic Theory and Policy	D. N. Dwivedi	McGraw Hill
2	Principles of Macroeconomics	N. Gregory Mankiw	Cengage
3	Principles of Economics	N. Gregory Mankiw	Cengage
4	Managerial Economics	D. N. Dwivedi	Vikas Publishing House
5	Engineering Economics	R. Panneerselvam	PHI Learning
6	Engineering Economy	William G. Sullivan, Elin M. Wicks & C. Patrick Koelling	Pearson
7	Engineering Economy	Leland Blank & Anthony Tarquin	McGraw Hill
8	Financial Management	Prasanna Chandra	Tata McGraw Hill
9	Macroeconomic Theory	M. L. Jhingan	Vrinda Publications
10	Sustainable Engineering: Concepts, Design and Case Studies	David T. Allen & David R. Shonnard	Pearson-Prentice Hall

Reference

Sl. No.	Title of Book	Author	Publication
1	Contemporary Engineering Economics	Chan S. Park	Pearson-Prentice Hall
2	Principles of Engineering Economy	Eugene L. Grant,W.Grant Ireson & Richard S. Leavenworth	Wiley
3	Economic Analysis of Investment Projects	World Bank Group	World Bank Publications
4	LCOE and Renewable Energy Economics in India	NITI Aayog or MNRE	NITI Aayog or MNRE Publications

Web Resource

1	Engineering Economic Analysis - Prof.Pradeep K. Jha - IIT Roorkee (NPTEL)

DETAILED SYLLABUS								
Module	**Title**	**Topic**	**Mode of Delivery**	**CO**	**Learning Domain**			**Hrs**
					C	**P**	**A**	
1	**Economic Foundations for Engineering Decision-Making (9 hours)**	**1.1 Introduction to Economics**						
		Definition of economics, Engineering and economics Scarcity, choice, and trade-offs	Lecture	CO1	U		Re	1
		Production Possibility Curve (PPC)	Lecture	CO1	U		Re	1
		1.2 Demand and Supply Analysis						
		Determinants of demand and supply Law of Demand and the Law of Supply.	Lecture	CO1	U		Re	1
		Determination of market equilibrium	Lecture	CO1	U		Re	1
		1.3 Elasticity of Demand						
		Price elasticity, Income elasticity and Cross elasticity	Lecture	CO1	U		Re	2
		1.4 Market Structures						
		Perfect competition, Monopolistic competition, Monopoly, and Oligopoly with key features and engineering relevance	Lecture	CO1	U		Re	3
		HOTS Activity 1: Demand and Supply Dynamics of an Engineering Product						
		HOTS Activity 2: Market Structures and the Life Cycle of an Engineering Product: The Influence of Market Structure on Product Evolution						
2	**Production Economics (9 hours)**	**2.1 Cost and Revenue Analysis**						
		Key cost and revenue concepts, the interrelationship between cost, revenue, and profit	Lecture	CO2	U		Re	1
		Break-even analysis	Lecture	CO2	Ap		V	2
		Make-or-buy decisions Learning curve effects	Lecture	CO2	Ap		V	2
		2.2 Equipment Replacement Analysis						
		Factors influencing replacement decisions and determination of the economic life of an asset.	Lecture	CO2	Ap		V	2
		Evaluation of replacement versus retention alternatives	Lecture	CO2	Ap		V	2
		HOTS Activity 1: Unit Economics and Viability Analysis of an Engineering Start-Up Idea						
		HOTS Activity 2: Defender–Challenger Replacement Analysis of an Industrial Power System						
3	**Investment Decision Techniques (9 hours)**	**3.1 Introduction to Capital Budgeting**						
		Meaning and Importance, Time Value of Money, Types of Interest, Discounted versus Non-Discounted Methods	Lecture	CO3	U		Re	1
		3.2 Non-Discounted Techniques						
		Average Rate of Return (ARR) and Payback Period	Lecture	CO3	Ap		V	2
		3.3 Discounted Techniques						
		Net Present Value (NPV) and Internal Rate of Return (IRR),	Lecture	CO3	Ap		V	2
		Cost Benefit Analysis		CO3	Ap		V	2

		Present Worth (PW), Future Worth (FW) and Annual Worth (AW)	Lecture	CO3	Ap		V	2
		HOTS Activity 1: Investment Appraisal of a Renewable Energy Project Using Non-Discounted and Discounted Cash Flow Techniques						
		HOTS Activity 2: Evaluation of Public Infrastructure Project Using Benefit–Cost Analysis						
4	**Project Economics, Sustainability & Contemporary Engineering Decisions (9 hours)**	**4.1 Project Economic Analysis & Public Sector Decisions**						
		Project economic analysis, Social Discount Rate, Economic Internal Rate of Return (EIRR) vs Financial Internal Rate of Return (FIRR)	Lecture	CO4	U		Re	2
		Carbon pricing and approaches, Public Private Partnership (PPP) economics.	Lecture	CO4	U		Re	2
		4.2 Life Cycle Cost Analysis						
		Concept and methodology of life cycle costing, whole-life costing and first-cost decision-making	Lecture	CO4	Ap		V	2
		Economic aspects of Life Cycle Assessment (LCA) and principles of the circular economy	Lecture	CO4	Ap		V	3
		HOTS Activity 1: Economic and Technical Evaluation of a Public–Private Partnership (PPP) Project.						
		HOTS Activity 2: A Life Cycle Cost Analysis of an Engineering Asset						

HOTS-BASED LEARNING ACTIVITIES

2 Activities per Module | 8 Total Activities | Best 5 of 8 counted | 5 Marks Each
Total: 25 Marks

Sample Activities	Module	Cognitive	Affective	Mode	Marks	CO
M1-A1: Demand and Supply Dynamics of an Engineering Product	M1	Apply	Valuing	Individual	5	CO1
M1-A2: Market Structures and the Life Cycle of an Engineering Product: The Influence of Market Structure on Product Evolution	M1	Apply	Valuing	Group	5	CO1
M2-A1: Unit Economics and Viability Analysis of an Engineering Start-Up Idea	M2	Apply	Valuing	Group	5	CO2
M2-A2: Defender - Challenger Replacement Analysis of an Industrial Power System	M2	Apply	Valuing	Individual	5	CO2
M3-A1:Investment Appraisal of a Renewable Energy Project Using Non-Discounted and Discounted Cash Flow Techniques	M3	Apply	Valuing	Group	5	CO3
M3-A2:Evaluation of Public Infrastructure Project Using Benefit–Cost Analysis	M3	Apply	Valuing	Individual	5	CO3
M4-A1: Economic and Technical Evaluation of a Public–Private Partnership (PPP) Project.	M4	Apply	Valuing	Group	5	CO4

M4-A2: Life Cycle Cost Analysis of an Engineering Asset	M4	Apply	Valuing	Individual	5	CO4

Sample Learning Activities

Module 1
M1-A1: Demand and Supply Dynamics of an Engineering Product
[Individual Assignment - 5 Marks- Bloom's Level: Apply -CO1]
Activity Description:
Each student selects an engineering product of their choice and conducts a comprehensive market analysis by identifying and analysing the key determinants of demand and supply, supported by relevant real-world data. The activity also requires a critical evaluation of a significant real-world shock - such as a technological advancement, government policy, global disruption, or shift in consumer preferences - on price and output behaviour of the chosen product. Based on this analysis, the student recommends one data-driven, market-informed decision that an engineer or product manager should undertake.
HOTS Tasks:

- Select an engineering product and identify the major determinants of demand and supply
- Analyse the product's price and output behaviour using a demand-supply framework, supported by real-world data or trends
- Identify and critically evaluate a significant real-world shock that has disrupted this market and assess the direction and magnitude of its impact on price and output
- Based on your analysis, recommend one specific, data-driven decision with clear justification

Deliverable: A single-page interactive dashboard (Canva/Tableau Public/PowerPoint) with 4-Quadrant Layout: Demand Drivers, Supply Constraints, Shock Impact, Decision Matrix

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
Demand and Supply Analysis	All key determinants identified; shock correctly identified	Covers most determinants; shock identified	Basic determinants listed; shock named without depth	Superficial identification of determinants; shock absent or misidentified;
Recommendation	Specific evidence-backed recommendation with strong rationale	Good recommendation mostly justified with data	Recommendation present but vaguely reasoned	Recommendation absent or not grounded in analysis
Dashboard Design	All four quadrants clearly structured, visually professional, and analytically substantive	All four quadrants present; mostly clear and analytical	Quadrants present but content shallow or layout unclear	Less than four quadrants; poor layout and missing content

M1-A2 - Market Structures and the Life Cycle of an Engineering Product: The Influence of Market Structure on Product Evolution
[Group Project -5 Marks-Bloom's Level: Apply-CO1]
Activity Description:
Student groups select an engineering product or system of their choice and use market structure theory to explain its economic behaviour across its life cycle. The activity requires identification of the relevant market structure and a critical evaluation of how that structure influences competition, pricing power, and engineering decision-making. Groups must further examine how the product's market position has evolved across different industry life cycle stages - from emergence and growth to maturity.
HOTS Tasks:

- Identify the market structure in which the chosen product operates; justify the classification with evidence
- Critically evaluate how this structure influences competition intensity, risks, demand and supply dynamics, and the firm's pricing power
- Analyse how the market structure shapes engineering and product development decisions at each life cycle stage - emergence, growth, maturity, decline, or disruption
- Identify one strategic inflection point in the product's history

Deliverable: A 5-slide executive market analysis presentation

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
Market Structure Diagnosis and Life Cycle Mapping	Structure correctly identified and justified with strong evidence; all life stages mapped with evidence-backed assessment	Structure Structure correctly identified with good justification; life cycle stages adequately covered	Structure identified with limited justification; basic life cycle coverage and inadequate	Structure misidentified or absent; life cycle absent or superficial
Inflection Point	Inflection point identified and well-explained	Inflection point identified and vaguely explained	Inflection point identified and not explained	No inflection point
Presentation Quality	Professionally structured 5-slide deck; analytically substantive; confident Q&A	Good presentation; most slides analytical; handles most Q&A	Adequate slides; some analytical gaps; struggles with Q&A	Weak structure; unable to defend choices

Module 2
M2-A1- Unit Economics and Viability Analysis of an Engineering Start-Up Idea
[Group Project - 5 Marks- Bloom's Level: Apply -CO2]
Activity Description:
Each student identifies a start-up idea for an engineering product or service and constructs its unit economics model to assess whether the venture is economically viable and scalable. The analysis must address four interconnected areas: defining the product and target customer, building the unit economics model, performing a break-even and decision analysis, and applying the learning curve effect to project how costs and profitability will change as the venture grows.
HOTS Tasks:

- Define the product or service and target customer, and state the problem being solved and the value proposition clearly.
- Classify and calculate fixed costs, variable costs, total cost, average cost, and marginal cost per unit; identify total revenue, average revenue, and marginal revenue
- Determine the break-even point in both units and in sales value; perform a decision analysis to assess viability
- Apply the learning curve effect to estimate how repetition and accumulated experience will reduce per-unit costs over time
- Pitch the venture in 3 minutes, presenting your unit economics model and financial projections

Deliverable: One-page unit economics model + financial projection + 3-minute pitch

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
Problem Statement and Unit Economics	Problem and value proposition is unique and clear; all cost and revenue components correctly classified and calculated with explicit, well-justified assumptions	Good problem statement and value proposition ; most components correct with partially justified assumptions	Problem and value proposition generic; some components correct with limited justification	Vague or absent problem definition; components and assumptions unstated or unjustified
Break-Even Analysis	Break-even correctly computed in units and sales; learning curve effects rigorously applied with projections	Break-even correct; learning curve partially applied	Break-even computed; limited learning curve analysis	Break-even absent or incorrect; no learning curve analysis
Pitch Clarity	Compelling and structured 3-minute pitch	Good pitch and economic points	Adequate pitch and delivery	Weak or incomplete pitch

M2- A2 - Defender–Challenger Replacement Analysis of an Industrial Power System

[Individual Assignment - 5 Marks-Bloom's Level: Apply -CO2]

Activity Description:

Groups are provided with a detailed real-world scenario involving a 7-year-old diesel generator used in a mid-sized manufacturing facility, which is experiencing rising fuel consumption, frequent breakdowns, and declining reliability. Two replacement alternatives are available: a new conventional diesel generator of similar capacity and a smart hybrid generator equipped with IoT-based load monitoring and predictive maintenance capabilities. Students must apply the defender-challenger replacement analysis framework to determine the optimal course of action.

HOTS Tasks:

- Identify and explain the possible reasons why the existing generator is a candidate for replacement
- Compute the Equivalent Uniform Annual Cost (EUAC) for each remaining year of the defender's life using year-by-year data and determine the year at which EUAC is minimised.
- Present the results in a clearly structured EUAC table and identify the optimal replacement year
- Apply the one-year principle to evaluate whether it is economically justified to retain the defender for one additional year
- Estimate the Total Cost of Ownership (TCO) for each replacement alternative over an 8-year period
- Provide a clear, evidence-based recommendation: retain the existing generator, replace with the conventional option, or upgrade to the smart hybrid system

Deliverable: Replacement Decision Dashboard with clearly defined panels: Reasons for replacement, EUAC Table, TCO Comparison

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
Replacement Justification and EUAC Computation	All relevant replacement drivers identified with technical and economic reasoning; EUAC correctly computed with optimal replacement year fully justified	Most drivers identified with sound reasoning; mostly correct EUAC with optimal year identified with minor gaps	Basic reasons stated with limited depth; EUAC partially computed with optimal year identified without full reasoning	Superficial or incomplete justification; significant computation errors; optimal year absent or incorrect
One Year Principle and TCO	One year principle correctly applied; TCO computed accurately for both alternatives over 8 years	One year principle correctly applied; TCO mostly accurate	One year principle attempted; TCO partially computed	One year principle not applied; TCO absent or incorrect
Recommendation and Dashboard	Evidence based , specific recommendation; dashboard professionally structured with all three panels	Good recommendation; dashboard mostly complete	Recommendation present; dashboard partially structured	Absent or unsupported; dashboard incomplete

Module 3

M3- A1: Investment Appraisal of a Renewable Energy Project

[Group Project - 5 Marks-Bloom's Level: Apply -CO3]

Activity Description:

Each group is provided with a realistic dataset for a proposed solar power plant in Kerala. Using investment decision techniques, students evaluate the economic viability of the project and recommend whether to invest. The activity integrates both non-discounted and discounted cash flow techniques, scenario analysis, and sensitivity testing through a tornado diagram to identify the most critical risk drivers.

HOTS Tasks:

- Compute the Net Present Value (NPV) at a 10% discount rate and the Internal Rate of Return (IRR) for the proposed solar power project

- Compute the Payback Period (PBP) and Accounting Rate of Return (ARR) as non-discounted assessment benchmarks
- Construct a tornado diagram ranking the sensitivity of project viability to key variables; identify the two most critical risk drivers
- Set up a three-scenario analysis (pessimistic, base case, optimistic) and compute the expected NPV under each scenario
- Integrate the findings into a coherent investment appraisal report with a clear, justified recommendation

Deliverable: Investment Appraisal Report + Scenario Table

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
NPV, IRR and Tornado Diagram	NPV and IRR correctly computed with precise interpretation; tornado diagram correctly constructed with two critical risk drivers identified and justified with specific numerical sensitivity	Mostly correct computation with mostly accurate interpretation; diagram mostly correct with risk drivers partially justified	Computation partially correct with limited interpretation; basic diagram with risk drivers named without depth	Significant errors with no meaningful interpretation; diagram absent or incorrect; risk drivers not identified
Scenario Analysis	All three scenarios clearly defined with distinct, justified assumptions; expected NPV computed correctly for each	Three scenarios present; mostly justified; NPV mostly correct	Scenarios present; assumptions vaguely stated; NPV partially computed	Scenarios absent or only one; NPV not computed
Investment Recommend-ation	Clear, evidence-integrated recommendation drawing on all techniques; risk acknowledgement is specific and insightful	Good recommendation; mostly evidence-based; risk mentioned	Recommendation present; limited evidence integration	Absent or unsupported recommendation

M3-A2- Evaluation of Public Infrastructure Project Using Benefit–Cost Analysis

[Individual Assignment - 5 Marks-Bloom's Level: Apply -CO3]

Activity Description:

Each student selects a real Indian public infrastructure project (such as a flyover, metro line, water treatment plant, or highway) with publicly available cost and benefit data, and conducts a comprehensive benefit-cost analysis to evaluate whether the project is economically justified. Students are expected to critically engage with how costs and benefits are identified, quantified, and monetised.

HOTS Tasks:

- Identify and categorise all project costs and benefits using reliable published sources
- Perform a benefit-cost analysis and examine how the choice of discount rate influences the project's economic justification
- Critically evaluate whether any significant benefits are excluded or undervalued and whether any costs are ignored in the official analysis
- Assess the project through an ESG (Environmental, Social, and Governance) lens by analysing its impact on equity, environmental sustainability, and overall societal outcomes
- Provide a reasoned recommendation from a decision-maker's perspective, acknowledging limitations in the available data

Deliverable: A structured 100-word evaluative commentary + supporting computations

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
Cost and Benefit Identification and Analysis	All major costs and benefits correctly identified and categorised with reliable source citations; BCA correctly computed with	Most costs and benefits identified with adequate sources; BCA mostly correct with discount	Basic identification with some omissions and limited sourcing; BCA computed	Significant gaps in identification with unreliable or absent sources; BCA absent or

	discount rate choice rigorously analysed	rate impact partially analysed	with discount rate effect noted without depth	incorrect with no discount rate analysis
Critical Evaluation of Gaps	Specific excluded or undervalued benefits and ignored costs identified and substantiated with evidence	Key gaps identified with partial substantiation	Gaps mentioned but not substantiated	No critical evaluation of gaps
ESG Assessment and Recommendation	ESG dimensions critically evaluated with specific evidence; recommendation is well-reasoned and acknowledges data limitations	Good ESG coverage; recommendation mostly justified	ESG mentioned; recommendation present but vague	ESG absent; recommendation unsupported

Module 4

M4-A1 -Economic and Technical Evaluation of a Public–Private Partnership (PPP) Project.

[Group Project -5 Marks-Bloom's Level: Apply - CO4]

Activity Description:

Students will individually analyze a real-world Public–Private Partnership (PPP) project. The activity requires students to critically evaluate the economic structure, risk-sharing mechanism, financial sustainability, and technical effectiveness of the selected PPP project using engineering economics concepts.

HOTS Tasks:

- Identify and classify the selected project based on the PPP model adopted (BOT, BOOT, DBFO, Hybrid Annuity, Joint Venture/SPV, etc.) and explain the roles of the public and private stakeholders
- Critically evaluate the project using engineering economics principles by examining: cost-benefit aspects, allocation of risks between stakeholders, and long-term economic sustainability
- Examine whether the PPP approach was appropriate for the selected project and defend the conclusion using financial reasoning, efficiency considerations, and public value assessment

Deliverable: One-page critical evaluation sheet (500 words)

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
PPP Model Identification	Correct PPP model and stakeholder roles clearly explained	Correct model with minor gaps	Partial identification/ explanation	Incorrect or missing
Economic Evaluation	Clear cost-benefit, risk allocation, and sustainability analysis using economic reasoning	Good analysis with minor gaps	Basic analysis with limited reasoning	Weak or absent analysis
PPP Suitability	Strong, evidence-based justification on PPP suitability	Reasonable justification	Limited justification	Unsupported or absent argument

M4-A2 Life Cycle Cost Analysis of an Engineering Asset

[Individual Assignment - 5 Marks-Bloom's Level: Apply - CO4]

Activity Description:

A structured data sheet for a long-lived engineering asset will be provided with all necessary figures already filled in for both alternatives. Students must conduct a life cycle cost analysis across four tasks: applying LCCA methodology to quantify all cost components and compute NPV; comparing two alternatives to identify the crossover point where the cheaper first-cost option becomes costlier over time; and delivering a justified recommendation that acknowledges a real-world constraint and proposes a practical strategy to overcome it.

HOTS Tasks:

- Apply the LCCA methodology to quantify all cost components from acquisition to disposal for both alternatives; compute the Net Present Value of total life cycle costs for each
- Compare the two alternatives across their full cost profiles; identify the crossover point where the cheaper first-cost option becomes more expensive over ti
- Deliver a justified recommendation that acknowledges one real-world constraint (budget, regulatory, technical, or social) and proposes a practical strategy to overcome it

Deliverable: Life Cycle Cost Analysis Dashboard with clearly defined panels: LCCA Cost Breakdown, NPV Comparison, Crossover Analysis, Recommendation

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
LCCA Methodology, NPV and Crossover Analysis	All cost components correctly classified and quantified; NPV computed accurately for both alternatives; crossover point precisely identified and presented	Most components correct; NPV mostly accurate with minor omissions; crossover identified and mostly well-presented and interpreted	Basic cost components covered; NPV partially computed; crossover identified but presentation or interpretation limited	Significant omissions; NPV absent or incorrect; crossover absent or incorrectly identified
Recommend-ation and Constraint	Specific, evidence-backed recommendation; real-world constraint clearly identified with a credible, practical mitigation strategy	Good recommendation; constraint identified; mitigation mostly credible	Recommendation present; constraint mentioned; mitigation vague	Absent or unsupported recommendation; no constraint identified
Dashboard	All panels clearly structured, visually professional, and analytically substantive	All relevant panels present; mostly clear and analytical	All panels present but content shallow or layout unclear	Poor panel layout; missing content

Assessment Pattern			
Component	Method	Marks	Remarks
Internal Examination I (CIA-I)	Written Test Modules 1 & 2	15	Duration: 1.5 hrs
Internal Examination II (CIA-II)	Written Test Modules 3 & 4	15	Duration: 1.5 hrs
Learning Activities (HOTS)	2 HOTS Activities per Module	25	8 activities; best 5 of 8 counted; 5 marks each
Regularity & Engagement	Attendance + Participation	5	
CONTINUOUS INTERNAL ASSESSMENT (CIA)		60	
End Semester Examination (ESE)	Written Exam All 4 Modules	40	Duration: 2.5 hrs; All modules
TOTAL (CIA+ESE)		100	

Internal Examination Blueprint (50 Marks Each)			
Q	Description	Coverage	Marks
1	Numerical problems	Either module	5 * 2 marks=10
2	Short answer - application based questions		5* 2 marks = 10
3	Short-answer - conceptual questions		5* 5 marks =25
4	Case-based HOT questions - evaluate a real or simulated engineering decision scenario		1*5marks = 5
TOTAL			50

End Semester Examination Blueprint (40 Marks)

Part	Description	Coverage	Marks
A	8 short-answer questions- concepts, definitions, short numericals (Answer all)	All modules	8 × 2 marks=16
B	4 either-or questions - numerical problems with interpretation and application based questions		4×4 marks=16
C	2 questions and answer any 1 - HOT case study based question	Any module	1×8 marks =8
TOTAL			40

THIRD SEMESTER B. TECH DEGREE (REGULAR) EXAMINATION, NOVEMBER 2026 (2025 SCHEME)			
Course Code:	**B250908/HU900F**		
Course Name:	**ENGINEERING ECONOMICS**		
Max. Marks	**40**	**Duration**:	**2.5 hours**

<table>
<tr><th colspan="4"><i>PART A</i></th></tr>
<tr><th colspan="4"><i>(Answer all questions. Each question carries 2 marks)</i></th></tr>
<tr><th><i>No.</i></th><th><i>Question</i></th><th><i>CO</i></th><th><i>Marks</i></th></tr>
<tr><td>1</td><td>The price of a product rises from ₹100 to ₹120. Demand falls from 200 units to 160 units. Find price elasticity of demand.</td><td>CO1</td><td>(2)</td></tr>
<tr><td>2</td><td>Fill in the Blanks
A. In monopoly, there is a ______ seller.
B. In perfect competition, firms are ______ takers</td><td>CO1</td><td>(2)</td></tr>
<tr><td>3</td><td>Match the following cost concepts with their definition.
<table>
<tr><th>Column A</th><th>Column B</th></tr>
<tr><td>1) Opportunity Cost</td><td>A.Cost already incurred and cannot be recovered</td></tr>
<tr><td>2)Sunk Cost</td><td>B.Additional cost of producing one more unit</td></tr>
<tr><td>3)Incremental Cost</td><td>C.Total cost divided by number of units produced</td></tr>
<tr><td>4)Average Cost</td><td>D.Value of the next best alternative foregone</td></tr>
</table></td><td>CO2</td><td>(2)</td></tr>
<tr><td>4</td><td>How does the learning curve effect lead to a continuous decline in average cost as cumulative output increases?</td><td>CO2</td><td>(2)</td></tr>
<tr><td>5</td><td>An engineering company is evaluating two investment projects using ARR and NPV methods. Why do companies generally prefer the NPV method over the ARR method for making long-term investment decisions?</td><td>CO3</td><td>(2)</td></tr>
<tr><td>6</td><td>A bank offers two investment options to an engineer, one based on simple interest and another based on compound interest. Differentiate between them based on the method of interest calculation and growth of investment over time</td><td>CO3</td><td>(2)</td></tr>
<tr><td>7</td><td>Identify which of the following two scenarios represents a carbon tax and which represents a cap-and-trade system.
Scenario 1: The government sets a fixed price of ₹2,500 per tonne of CO_2 emitted. Firms must pay this amount for every tonne they emit.
Scenario 2: The government sets a legal limit of 50 million tonnes of CO_2 for the entire economy in a year and issues tradable permits equal to that amount.</td><td>CO4</td><td>(2)</td></tr>
<tr><td>8.</td><td>Distinguish the key conceptual and methodological differences between Financial Internal Rate of Return (FIRR) and Economic Internal Rate of Return (EIRR).</td><td>CO4</td><td>(2)</td></tr>
</table>

PART B			
(Answer any one full question from each module. Each question carries 4 marks)			
No.	***Question***	***CO***	***Marks***
MODULE I			
9	A robotics manufacturing company has limited resources and can produce the following combinations of robots and drones. Using the below data: A. Draw and explain the Production Possibility Curve (PPC). B. Analyse how scarcity of resources leads to opportunity cost in the production process.	CO1	(4)

C. Distinguish between efficient, inefficient, and unattainable production points using the data given.
D. Evaluate whether the company can produce 90 robots and 50 drones simultaneously under existing resources and technology.

Robots	Drones
100	0
80	20
50	40
0	70

OR

10

A solar panel manufacturing company operates in a market where only a few major firms dominate the industry. The company continuously invests in advanced technology, product innovation, and marketing strategies to remain competitive. Based on this scenario:

A. Identify the market structure and justify your answer.
B. Explain the major characteristics of this market structure with reference to the solar panel industry.
C. Analyze the advantages and disadvantages faced by consumers in such a market.
D. Evaluate the role of innovation and technological advancement in improving competitiveness and market growth.

CO1

(4)

MODULE II

11

The following cost data is available for the current fiscal year of a company that manufactures aluminium parts (mounting brackets) for other companies (industrial equipment assemblers):

Fixed Cost		**Variable Cost Per Unit**	
Cost	**Amount (Rs)**	**Cost**	**Amount (Rs)**
Factory lease and electricity	4,20,000	Raw aluminium stock	18
CNC machine depreciation	1,20,000	Machining labour	10
Permanent employee salary	96,000	Cutting tool wear and consumables	5
Quality inspection and testing	48,000	Variable quality control	2

Selling cost per unit is Rs.55 and sales forecast is 45,000 units. Calculate the Break-Even Point (BEP) in units and in sales revenue. Also, determine the Margin of Safety (MOS) in units and in sales revenue.

CO 2

(4)

OR

12

A firm has acquired a CNC machining centre at a purchase cost of Rs. 20,000. The Asset Management team must determine the optimal economic service life of this asset - the number of years it should be kept in service. The projected year-end costs and salvage values are given below:

End of Year (n)	**Operation Cost at n (Rs.)**	**Maintenance Cost at n (Rs.)**	**Salvage Value at n (Rs.)**
1	3,000	300	9,000
2	4,000	400	8,000
3	5,000	500	7,000
4	6,000	600	6,000

CO2

(4)

5	7,000	700	5,000
6	8,000	800	4,000

Assume interest rate (i) is 15%

[Hint: Compute the present worth of each year's operating and maintenance costs, account for the declining salvage value, and find the year where the Equivalent Annual Cost (EAC) at 15% interest stops decreasing.]

MODULE III

13 An engineering project requires an initial investment of ₹10,00,000. The expected annual profits over a period of 5 years are given in the table below. Calculate the Accounting Rate of Return.

Year	**Expected profit (Rs.)**
1	1,00,000
2	1,50,000
3	2,00,000
4	2,50,000
5	3,00,000

[Hint: ARR is the ratio of average cash inflow and average investment]

CO 3 (4)

OR

14 A project requires an initial investment of ₹5,00,000 and is expected to generate uniform annual cash inflows of ₹2,00,000 over a period of 3 years. Given a discount rate of 10%, calculate the Net Present Value (NPV) of the project and comment on its financial viability.

CO3 (4)

MODULE IV

15 The National Highways Authority of India (NHAI) has awarded a contract to InfraConnect Ltd., a private conglomerate, to construct a four-lane expressway connecting two major industrial cities spanning 120 km. Under the agreement, InfraConnect Ltd. finances and constructs the expressway at a total project cost of Rs. 850 crore.The company is permitted to collect toll charges from users for a period of 25 years.After 25 years, the expressway is transferred back to NHAI at no additional cost.The government bears no construction or operational cost throughout the contract period. Answer the following questions:

A. Identify the PPP model used in the scenario and expand the full form of the model identified.
B. State any 3 key features of the model

CO 4 (4))

OR

16 A piece of industrial equipment was purchased at a first cost of Rs. 30,000, with an annual operating and maintenance cost of Rs. 12,000, and an estimated salvage value of Rs. 4,000 at the end of its 6-year useful life. Due to an unexpected project cancellation, the equipment must be decommissioned after only 2 years of service and sold on the used-equipment market.

A. At an interest rate of 10% per year, determine the minimum market value the 2-year-old equipment must fetch so that its annual worth (AW) over the shortened 2-year period equals the AW calculated over the full 6-year design life.
B. Compare the required market value from (A) with the original first cost and the expected salvage value after the full 6-year life. Is the required market value economically reasonable?

[Hint: Find the AW over the full 6-year life first, then find what salvage value at year 2 would produce that same AW.]

CO4 (4)

PART C

(Answer any one full question.Each question carries 8 marks)

17 An automobile manufacturing company experiences a sudden shortage of semiconductors due to global supply chain disruptions. Since semiconductors are essential for modern vehicle production, the company faces production delays, rising costs, reduced output, and uncertainty in delivery schedules. Management is considering options such as reducing production, increasing vehicle prices, sourcing chips from alternative suppliers, and redesigning vehicles with fewer electronic components.

CO 1 (8)

<table>
<tr><td></td><td>A. Analyze the effect of the semiconductor shortage on the supply of automobiles.
B. Explain how market equilibrium price and quantity may change.
C. Evaluate the company’s possible short-run and long-run responses.
D. Critically examine whether reducing production or seeking alternative suppliers represents a more economically rational decision under conditions of supply chain disruption and market uncertainty.</td><td></td><td></td></tr>
<tr><td colspan="4">OR</td></tr>
<tr><td>18</td><td>NexusGrid Technologies plans to expand its cloud data centre and fibre-optic network to Tier-II cities in Karnataka and Tamil Nadu under a 5-year initiative, Project AXIS. The project requires an upfront investment of Rs. 50,00,000 (Year 0), covering servers, fibre-laying, civil infrastructure, and licensing. At the end of Year 5, assets will be salvaged for Rs. 3,00,000*. The required rate of return is 12% per annum. Net cash inflows rise progressively as the client base scales.
<table>
<tr><th>Year</th><th>Net cash inflow (₹)</th></tr>
<tr><td>0</td><td>(50,00,000)</td></tr>
<tr><td>1</td><td>9,00,000</td></tr>
<tr><td>2</td><td>11,00,000</td></tr>
<tr><td>3</td><td>13,00,000</td></tr>
<tr><td>4</td><td>15,00,000</td></tr>
<tr><td>5</td><td>17,00,000 + 3,00,000*</td></tr>
</table>
Evaluate Project AXIS by answering the following questions.
A. How quickly will NexusGrid get its ₹50,00,000 back?
B. Find out the NPV and tell us whether the project actually creates wealth.
C. Calculate rate of return generated independently by the project.
D. After assessing the three angles ,give a decision summary in 100 words.</td><td>CO 3</td><td>(8)</td></tr>
</table>

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COURSE DESCRIPTION							
REGULATION	**2025**	**L-T-J-P-S**	**3-0-0-0-1**	**VERSION**	**25/0**	**CREDITS**	**2**
(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)							

COURSE CODE	**COURSE NAME**	**COURSE CATEGORY**
B250908/CN900F	**MANAGEMENT FOR ENGINEERS**	**HMT**
PRE-REQUISITE		
NIL		

PREAMBLE

Engineering education has traditionally focused on producing technically proficient graduates capable of solving well-defined problems. However, the modern engineering landscape now demands professionals who can work collaboratively in dynamic, cross-functional, and globally distributed environments. Reports such as the World Economic Forum's Future of Jobs emphasize the growing importance of leadership, communication, decision-making, and critical thinking alongside technical skills. Industry feedback in India highlights a persistent gap, where graduates possess strong domain knowledge but lack preparedness in managing projects, people, and organizational challenges. This course designed to bridge this gap by developing essential managerial competencies tailored to real-world engineering practice.

RATIONALE

This course integrates classical management theories with contemporary practices, treating them as complementary frameworks that help students understand both foundational principles and modern organizational approaches. It emphasizes continuous evaluation of how new methods such as Agile, OKRs, and Design Thinking extend or challenge traditional ideas. All learning is contextualized within engineering environments through real-world case studies, industrial scenario, and activities relevant to engineering sectors. The pedagogy focuses on Higher Order Thinking Skills through curated activities designed to engage learners in solving real problems, critiquing strategies, and developing actionable solutions. Despite being a 2-credit course, it ensures depth by concentrating on four key domains -Foundations, People & Leadership, Finance & Analytics, and Operations & Strategy.

COMPETENCY STATEMENT

Demonstrate the ability to integrate management concepts to analyse organizational challenges and make effective, ethical, and innovative decisions in dynamic business environments.

CO	CO Statement	Cognitive (C)	Psychomotor (P)	Affective (A)
1	Explain and apply classical and contemporary management principles to engineering organisational contexts	Apply (L3)	-	Valuing (L3)
2	Analyse human behaviour, leadership styles, and organisational dynamics using traditional and modern frameworks	Apply (L3)	-	Valuing (L3)
3	Apply quantitative decision-making tools to interpret data-driven management insights	Analyse (L4)	-	Organising (L4)
4	Create management strategies, innovation plans, integrating operations, sustainability, and digital transformation	Analyse (L4)	-	Organising (L4)

<table>
<tr><th colspan="11">TEACHING AND ASSESSMENT SCHEME</th></tr>
<tr><th colspan="5" rowspan="2">Teaching Scheme / Week</th><th rowspan="2">Hours / Semester</th><th rowspan="2">Credit</th><th colspan="4">Examination Scheme</th></tr>
<tr><th colspan="3">Theory</th><th rowspan="2">Total</th></tr>
<tr><th>L</th><th>T</th><th>J</th><th>P</th><th>S</th><th rowspan="2">30</th><th>C</th><th>CIA</th><th>ESE</th><th>Total</th></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>1</td><td>2</td><td>60</td><td>40</td><td>100</td><td>100</td></tr>
<tr><td colspan="11"><i>L: Lecture (One unit is of one-hour duration), T: Tutorial (One unit is of one-hour duration), P: Practical (One unit is of one-hour duration), J: Project (One unit is of one-hour duration), S: Self-Learning & Team Work (One unit is of one-hour duration), CIA: Continuous Internal Assessment, ESE: End Semester Examination</i></td></tr>
</table>

SYLLABUS

Module	Title	Major Topics	Hrs
1	Foundations of Management & Contemporary Thinking	Evolution & Functions of Management, Planning, Organising, Controlling, Contemporary Strategy	11

2	Human Resource Management, Leadership & Organisational Behaviour	Human Resource Management, Motivation, Leadership, Organisational Behaviour, Change Management	9
3	Decisions – Making	Quantitative Techniques for Decisions, Network Diagrams – CPM, PERT	9
4	Operations, Strategy & Entrepreneurship	Operations and Quality Management, Project Management and Agile Methods	7

SUGGESTED LEARNING RESOURCES

Text Books

Sl. No.	Title of Book	Author	Publication
1	Essentials of Management	Koontz, H. & Weihrich, H	McGraw Hill, 11th Edition
2	Management	Robbins, S.P. & Coulter, M	Pearson Education, 14th Edition
3	Financial Management: Theory and Practice	Prasanna Chandra	McGraw Hill, 11th Edition

Reference

Sl. No.	Title of Book	Author	Publication
1	Blue Ocean Strategy	Kim, W.C. & Mauborgne, R.	Harvard Business Review Press, 2004
2	The Lean Start-up	Ries, E.	Crown Business, 2011
3	Change by Design	Brown, T.	Harper Business, 2019

Web Resource

NPTEL	Principles of Management - Prof. Susmita Muhopadhyay, Prof. S. Srinivasan - IIT Kharagpur
	Organisation of Engineering Systems and Human Resources Management - Prof. Vinayshil Gautam, IIT Delhi

Detailed Lesson Plan

Hr	Session	Topic / Content	Teaching Method	Cognitive (Bloom's)	Affective	CO
MODULE 1 - Foundations of Management & Contemporary Thinking | 11 Hours | CO1 | Cognitive: Apply (L3) | Affective: Valuing (L3)						
1.1 - Evolution & Functions of Management						
1	S1.1	Definition, nature, and significance of management Management vs Administration Functions: Planning, Organising, Staffing, Directing, Controlling	Lecture + PPT	Remember (L1)	Receiving (L1)	**CO1**
2,3	S1.2	Classical theories: Taylor's Scientific Management, Fayol's 14 Principles, Weber's Bureaucracy: Behavioural school: Hawthorne studies, McGregor's Theory X & Y	Lecture + PPT + Discussion	Understand (L2)	Responding (L2)	**CO1**
4	S1.3	Levels and roles of managers Engineer-to-manager transition Management 3.0: Purpose-driven leadership	Lecture + Discussion	Understand (L3)	Valuing (L3)	**CO1**
1.2 - Planning & Organising						
5	S1.4	Planning process: Vision, Mission, Goals, Objectives, Policies, Procedures Types of plans: Strategic, Tactical, Operational	Lecture + PPT	Understand (L2)	Responding (L2)	**CO1**

6	S1.5	SWOT analysis; Environmental scanning; Management by Objectives	Lecture + PPT	Understand (L2)	Responding (L2)	**CO1**
7	S1.6	Organising structures: Line, Line & Staff, Matrix, Functional Delegation & Decentralisation, Flat organisations, Holacracy, Remote and hybrid work models	Lecture + Case Study	Understand (L3)	Valuing (L3)	**CO1**
1.3 - Controlling & Contemporary Strategy						
8	S1.7	Control process: Standards, measuring performance, corrective action	Lecture + PPT	Understand (L3)	Valuing (L3)	**CO1**
9	S1.8	Blue Ocean Strategy and Value Innovation, ESG integration	Lecture + PPT	Understand (L3)	Valuing (L3)	**CO1**
10	M1-A1	**HOTS Activity 1**	Group	Apply (L3)	Valuing (L3)	**CO1**
11	M1-A2	**HOTS Activity 2**	Group	Apply (L3)	Valuing (L3)	**CO1**
MODULE 2 - Human Resource Management, Leadership & Organisational Behaviour | 9 Hours | CO2 | Cognitive: Analyse (L4) | Affective: Valuing (L3)						
2.1 - Human Resource Management						
12	S2.1	HRM: Concept, scope, functions; HRM vs Personnel Management Recruitment, Selection, Induction	Lecture + Discussion	Understand (L2)	Responding (L2)	**CO2**
13	S2.2	Training & Development: Methods, on-job vs off-job. Performance Appraisal: 360°feedback, rating scales, Compensation management	Lecture + Role Play	Apply (L3)	Valuing (L3)	**CO2**
14	S2.3	HR Analytics: talent management, attrition prediction. Future of Work: Gig workforce, hybrid HR practices	Lecture + Case Study	Apply (L3)	Valuing (L3)	**CO2**
2.2 - Motivation & Leadership						
15	S2.4	Motivation theories: Maslow, Herzberg, McClelland Leadership styles: Autocratic, Democratic, Situational	Lecture + Theory Comparison Chart	Apply (L3)	Valuing (L3)	**CO2**
16	S2.5	Transformational vs Transactional leadership Authentic & Adaptive Leadership Psychological safety; Cross-cultural leadership	Lecture + Case Analysis	Apply (L3)	Valuing (L3)	**CO2**
17	M2-A1	**HOTS Activity 3**	Group	Apply (L3)	Valuing (L3)	**CO2**
2.3 - Organisational Behaviour & Change Management						
18	S2.6	Perception, attitude, values, personality in organisations Group dynamics, teamwork, conflict management (Thomas-Kilmann)	Lecture + Group Exercise	Apply (L3)	Valuing (L3)	**CO2**

		Organisational culture: Schein's model				
19	S2.7	Change management: Kotter's 8-step process, Resistance to change; Change fatigue in technical organisations Organisational resilience post-disruption	Lecture + Change Case Study	Apply (L3)	Organisation (L4)	**CO2**
20	M2-A2	**HOTS Activity 4**	*Individual*	Apply (L3)	Valuing (L3)	**CO2**
MODULE 3 - Decision-Making | 9 Hours | CO3 | Cognitive: Analyse (L4) | Affective: Organisation (L4)						
3.1 - Quantitative Techniques for Decisions (Hours 16–19)						
21	S3.5	Linear programming: Problem formulation and graphical solution	Lecture + Numerical Problem	Apply (L3)	Valuing (L3)	**CO3**
22,23	S3.7	Network analysis: PERT and CPM, project scheduling, critical path, crashing	Network Drawing Exercise	Apply (L3)	Valuing (L3)	**CO3**
24,25	S3.8	Decision theory: Decision trees Decision under certainty, risk, and uncertainty	Lecture + Case Decision Tree	Apply (L4)	Organisation (L4)	**CO3**
26,27	S3.9	Decision-making models: Rational, Bounded rationality, Data-driven decision-making: Objectives and Key Results (OKRs), KPIs	Lecture + Group Problem-Solving	Apply (L3)	Valuing (L3)	**CO3**
28	M3-A1	**HOTS Activity 5**	*Individual*	Apply (L3)	Valuing (L3)	**CO3**
29	M3-A2	**HOTS Activity 6**	*Individual*	Apply (L3)	Valuing (L3)	**CO3**
MODULE 4 – Operations, Quality and Project Management | 7 Hours | CO4 | Cognitive: Apply (L3) | Affective: Organisation (L4)						
4.1 - Operations & Quality Management						
30,31	S4.1	Operations management: Scope and significance in engineering firms, Production planning and control - Inventory management: Concepts of EOQ, ABC analysis, JIT	Lecture + Manufacturing Case Study	Understand (L2)	Responding (L2)	**CO4**
32	S4.2	TQM; ISO 9001:2015; Six Sigma (DMAIC overview), Supply chain management: Concepts, tiers, procurement	Lecture	Apply (L3)	Valuing (L3)	**CO4**
33	S4.3	Industry 4.0: IoT, Cyber-Physical Systems, Digital Twins, Lean 4.0	Lecture	Apply (L3)	Organisation (L4)	**CO4**
4.2 - Project Management & Agile Methods						
34	S4.4	Project lifecycle: Initiation, Planning, Execution, Monitoring, Closure, Work Breakdown Structure: Resource allocation; Risk management	Lecture	Apply (L3)	Valuing (L3)	**CO4**

35	S4.5	Agile Project Management: Scrum (sprints, backlog, retrospective), Kanban Hybrid project management: Waterfall + Agile	Lecture	Apply (L3)	Organisation (L4)	**CO4**
36	M4-A2	**HOTS Activity 7 and 8**	*Group*	Apply (L3)	Valuing (L3)	**CO4**
HOTS Activity: *Design Thinking Sprint + Lean Start-up Pitch (Individual)* - Analyse (L4)						

SAAMPLE HOTS-Based Learning Activities

2 Activities per Module | 8 Total Activities | Best 5 of 8 counted | 5 Marks Each |

Activity	Module	Cognitive	Affective	Mode	Marks	CO
M1-A1: Strategic Planning & Organisational redesign	M1	Apply	Valuing	Group	5	CO1
M1-A2: Management Principles Debate	M1	Apply	Valuing	Individual	5	CO1
M2-A1: Leadership & EI Field Study	M2	Apply	Valuing	Group	5	CO2
M2-A2: HRM vs Personnel Management	M2	Apply	Valuing	Individual	5	CO2
M3-A1: Crashing the network	M3	Apply	Organising	Individual	5	CO3
M3-A2: Decision Tree analysis	M3	Apply	Organising	Individual	5	CO3
M4-A1: Industry 4.0 Transformation Plan	M4	Apply	Organising	Group	5	CO4
M4-A2: Design Thinking + Start-up Pitch	M4	Apply	Organising	Group	5	CO4
	TOTAL (Best 5 of 8 counted)				25	CO1-CO4

M1-A1 Strategic Planning & Organisational redesign [*Group Project | 5 Marks*]
| CO1 | Learning Domain – [Cognitive - Apply (3) | Affective – Valuing (3)] |

Activity Description:

Groups of 4-5 select a real Indian engineering company and conduct a full strategic and organisational analysis. They must go beyond describing the company - they must critique its current strategy, propose goals for one business unit, and redesign one aspect of its structure using modern principles.

HOTS Tasks:

- Conduct SWOT analysis using the company's annual report and recent news (not Wikipedia)
- Map the company's current strategy to Porter's Generic Strategies; evaluate whether it aligns with its stated mission
- Evaluate the current org structure; propose one structural change (e.g., move to matrix or flat) with full justification
- Boardroom pitch: 3 minutes

Deliverable: 3-slide presentation

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
Strategic Analysis Depth	Rigorous SWOT with evidence; sharp strategic critique	Covers all frameworks; minor gaps	Partial coverage; limited evidence	Superficial or incomplete analysis
Organisational Redesign	Theoretically sound redesign;	Good redesign	Adequate	Unclear
Presentation	Presentation is exceptionally well-organized logical flow, and strong conclusion.	Presentation is organized with minor lapses in flow or transitions.	Organization is somewhat clear but lacks smooth flow or coherence.	Presentation lacks structure and is difficult to follow.

M1-A2 Management Principles Debate *[In-Class Activity | 5 Marks]*
| CO1 | Learning Domain – [Cognitive - Apply (3) | Affective – Valuing (3)] |

Activity Description:

A structured Oxford-style debate on a contemporary management dilemma. Teams of 3 are assigned positions and must argue using management theory and real-world examples. Two rounds are conducted per session; students are randomly assigned positions to prevent preparation bias.

Sample Debate Propositions:

- 'In the age of AI and analytics, data-driven decision-making is always superior to managerial intuition.'
- 'Flat organisational structures are more effective than hierarchical ones for engineering companies.'

HOTS Tasks:

- Build an argument using at least two management theories or verified real-world examples (2-minute opening)
- Rebut the opposing team's argument with specific counter-evidence (1-minute rebuttal)
- What was the strongest argument against your position, and how would you refine your stance?

Deliverable: Live debate (team)

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
Argument Quality	Sophisticated, evidence-based argument using 2+ theories	Good argument; one strong theory	Argument present; theory use weak	Argument poorly constructed
Rebuttal Effectiveness	Sharp, precise rebuttal with specific counter-evidence	Good rebuttal; mostly specific	Rebuttal present; lacks precision	Absent or irrelevant rebuttal
Post-Debate Reflection	Insightful, self-critical reflection; identifies strongest counter-argument precisely	Good reflection; mostly insightful	Adequate reflection; somewhat descriptive	Minimal or absent reflection
Communication Clarity	Articulate, confident, well-structured delivery	Clear; minor delivery issues	Adequate; some clarity issues	Unclear or poorly structured

Module 2 - HOTS Learning Activities

M2-A1 Leadership Style & EI Field Study *[Group Project | 5 Marks]*

| CO2 | Learning Domain – [Cognitive - Apply (3) | Affective – Valuing (3)] |

Activity Description:

Student groups design and conduct a structured interview with a working engineering professional (manager, project lead, or entrepreneur). They analyse the leader's style and Emotional Intelligence, connect findings to motivation theory, and make development recommendations using evidence.

HOTS Tasks:

- Design a 10-question open-ended interview protocol targeting leadership style, motivation philosophy, and Emotional Intelligence competencies - avoid leading questions
- Analyse the interviewee's dominant leadership style using at least two frameworks (e.g., Situational + Transformational)
- Map the leader's motivational approach to Maslow or Herzberg; identify which needs are being activated
- Evaluate: Does the leader demonstrate psychological safety behaviours? Justify with specific quotes (paraphrased)
- Recommend two targeted leadership development actions with rationale; connect to a modern leadership framework

Deliverable: 5-minute video summary

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
Leadership Theory Application	Two+ frameworks applied accurately with specific evidence from interview	Two frameworks; mostly accurate	One framework; adequate application	Theories mentioned but not applied
EQ Assessment Depth	All domains assessed with evidence and interpretation	4+ domains assessed; mostly precise	Partial EQ assessment	Absent or superficial EQ analysis
Recommendations Quality	Specific, actionable, theory-backed development plan	Mostly specific recommendations ;	Generic recommendations	Vague or absent recommendations

M2-A2 HRM vs Personnel Management *[Individual Assignment | 5 Marks]*

| CO2 | Learning Domain – [Cognitive - Apply (3) | Affective – Valuing (3)] |

Activity Description:

A growing e-commerce company plans to expand from 50 to 300 employees in 18 months. *Develop* a comprehensive Human Resource plan covering: (a) recruitment strategy, (b) induction and training, (c) a performance appraisal system, and (d) a compensation structure. Justify every decision in terms of organisational goals and employee well-being.

HOTS Tasks:

- Prepare a comprehensive HR plan
- Justify each decision - visualise with appropriate charts

Deliverable: 1-page HR plan with justification (100 words max) + reflection note

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
Depth of HR Plan	The HR Plan covering all required HR elements	Most of the HR elements covered	Some HR elements covered	Minimal HR elements covered
Justification	Each decision supported with proper justification and validation	Most of the justification and validation are good	Justification and validation are not fully substantiated	Vague justification and validation

Module 3 - HOTS Learning Activities

M2-A1 Project Management *[Group Project | 5 Marks]*

| CO3 | Learning Domain – [Cognitive – Analyse (4) | Affective – Organising (4)] |

Activity Description:

Develop a network for the given project to identify the probability of completion of the project in a specified time.

Deliverable: Problem solution

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
Network diagram	Well-structured network	Structured network	Network having minor mistakes	Network is not correct
Solution	The best solution	Minor mistake	Procedure correct but solution is not correct	No logical conclusion

M3-A2 Decision Tree analysis [*Individual Assignment | 5 Marks]*

| CO3 | Learning Domain – [Cognitive – Analyse (4) | Affective – Organising (4)] |

Activity Description:

Strategic Decision-Making for Business Expansion Using Data Analytics - Students will critically evaluate managerial decision-making models and apply data-driven techniques using OKRs and KPIs to recommend strategic business decisions in a realistic organisational scenario.

HOTS Tasks:

- analyse human and organisational constraints in real-world decision-making
- justify whether purely rational decisions are practical in dynamic business environments.
- evaluate the role and limitations of data in managerial decision-making
- Two Organisational OKRs
- create measurable and strategically aligned performance indicators

Deliverable: Executive briefing (3 decks) submission

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
Understanding of Decision Models	Deep conceptual clarity and application	Minor gaps	Basic understanding	Limited understanding
OKR & KPI Design	Highly relevant and measurable indicators	Mostly relevant	Partially measurable	Poorly designed
Executive Briefing	Jargon-free, precise briefing	Good briefing	Adequate briefing	Absent or unclear deliverables

Module 4 - HOTS Learning Activities

M4-A1 Industry 4.0 Transformation Plan *[Group Project | 5 Marks]*

| CO4 | Learning Domain – [Cognitive – Analyse (4) | Affective – Organising (4)] |

Activity Description:

Student groups act as management consultants hired by a traditional engineering manufacturing company to design a phased Industry 4.0 transformation roadmap. They must critically evaluate current operations, identify digital intervention opportunities, and build a 12-month implementation plan with realistic constraints.

HOTS Tasks:

- Assess the company's current operational maturity using an Industry 4.0 readiness framework - score each dimension (Connectivity, Intelligence, Flexible Automation, Digital Services)
- Identify 3 specific pain points addressable by IoT sensors, Digital Twins, or AI-based quality monitoring - quantify the expected improvement

- Design a phased 12-month transformation roadmap: Phase 1 (Quick wins, 0-3 months), Phase 2 (Core digitisation, 3-9 months), Phase 3 (Integration, 9-12 months) - with milestones and KPIs
- Apply Lean 4.0: Map one key process using a digital value stream; identify where technology replaces manual steps
- Critically evaluate 3 risks: cybersecurity exposure, workforce skill gap, and change resistance - propose specific mitigation for each
- Evaluate sustainability impact: How does the transformation reduce carbon footprint or material waste? Link to circular economy principles

Deliverable: Roadmap visual as 7-slide pitch deck + Q&A

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
Readiness Assessment	Rigorous, evidence-based maturity scoring with clear dimension analysis	Good assessment; mostly evidence-based	Adequate; limited evidence	Superficial or template-based
Transformation Roadmap	Phased, milestone-driven, realistic plan with measurable KPIs	Good plan; mostly realistic	Partial plan; some logic gaps	Vague or unfeasible roadmap
Lean 4.0 & Risk Analysis	Lean 4.0 integration demonstrated; all 3 risks with specific mitigations	Good integration; 2 risks with mitigations	Partial; risks listed without mitigations	Absent or surface-level
Sustainability Connection	Circular economy link quantified; specific waste/carbon reduction estimated	Good link; mostly quantified	Link mentioned; not quantified	Absent or incorrect

M4-A1 Design Thinking Sprint + Lean Start-up Pitch *[Individual Assignment | 5 Marks]* | CO4 | Learning Domain – [Cognitive – Analyse (4) | Affective – Organising (4)] |

Activity Description:

Each student identifies a real engineering or manufacturing problem they have observed (in an internship, project, lab, or news), applies the Design Thinking process to generate a solution concept, and pitches it as a Lean Start-up using the Lean Canvas. The activity combines structured creativity with entrepreneurial framing.

HOTS Tasks:

- Empathise & Define: Identify a real problem; create an empathy map for the primary user; write a sharp Point-of-View (POV) statement: [User] needs [need] because [surprising insight]
- Ideate: Generate 15 ideas in 10 minutes (brain writing); select top 2 using a 2x2 Feasibility-Impact matrix; justify the final choice
- Prototype: Create a low-fidelity prototype (process diagram, storyboard, or rough mock-up) of your solution
- Complete a Lean Canvas: Problem, Customer Segments, Unique Value Proposition, Solution, Revenue Streams, Cost Structure, Key Metrics, Unfair Advantage
- Define MVP: What is the minimum version of your product/service that tests your riskiest assumption?
- Pitch (3 minutes): Present the problem, solution, and MVP to the class; field 2 questions
- Reflect: Which Indian government scheme (Start-up India, PLI, Atal Innovation Mission, MSME scheme) is most relevant to your start up, and why?

Deliverable: Empathy map + POV statement + Lean Canvas (1 page) + prototype sketch + 3-minute pitch + reflection

Criterion	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (1-2)
Problem Identification & POV	Sharp, validated problem; empathy map reveals genuine insight; POV is crisp	Good problem; POV mostly sharp	Adequate problem; POV partially formed	Vague problem; POV absent or unclear
Lean Canvas Completeness	All 9 blocks complete, internally consistent, and commercially plausible	8 blocks complete; mostly consistent	6-7 blocks; some inconsistency	5 or fewer blocks; major gaps
MVP Definition	MVP precisely targets riskiest assumption; build-measure-learn loop clear	Good MVP; BML loop mostly clear	MVP defined; BML loop vague	MVP absent or not connected to assumption
Pitch & Reflection	Compelling pitch; scheme choice justified with specific eligibility reasoning	Good pitch; scheme named and explained	Adequate pitch; scheme vaguely referenced	Weak pitch; reflection absent

Assessment Pattern

Component	Method	Marks	Remarks
Internal Examination I (CIA-I)	Written Test - Modules 1 & 2	15	Duration: 1.5 hrs
Internal Examination II (CIA-II)	Written Test - Modules 3 & 4	15	Duration: 1.5 hrs
Learning Activities (HOTS)	2 HOTS Activities/ Module	25	8 activities
Regularity & Engagement	Attendance + Participation	5	
CONTINUOUS INTERNAL ASSESSMENT (CIA)		60	
End Semester Examination (ESE)	Written Exam - All 4 Modules	40	Duration: 2.5hrs; All modules
TOTAL (CIA+ESE)		100	

5.1 Internal Examination Blueprint (50 Marks Each)

No.	Description	Coverage	Marks	Cognitive
1	Numerical problem	Either module	2*4=8	L2 / L3
2	Short-answer - conceptual		6*3=18	L2
3	Short answer - application		4*5=20	L3
4	Case-based HOTS - evaluate a real or simulated engineering decision scenario		1*4=4	L4
TOTAL			50	

5.2 End Semester Examination Blueprint (40 Marks)

Part	Description	Coverage	Marks	Cognitive
A	8 short-answer questions (answer all) - concepts, definitions, short numerical with interpretation	All modules	8×2=16	L2 /L3
B	4 Either Or questions- numerical problems with interpretation		4×4=16	L3
C	2 questions, answer 1 - comprehensive HOTS case study: multi-criteria decision with real engineering context	Any module	1×8=8	L4
TOTAL			40	

<table>
<tr><td colspan="4">THIRD SEMESTER B. TECH DEGREE (REGULAR) EXAMINATION, DECEMBER 2026 (2025 SCHEME)</td></tr>
<tr><td>Course Code:</td><td colspan="3">B250908/CN900F</td></tr>
<tr><td>Course Name:</td><td colspan="3">MANAGEMENT FOR ENGINEERS</td></tr>
<tr><td>Max. Marks</td><td>40</td><td>Duration:</td><td>2 hours 30 minutes</td></tr>
<tr><td colspan="4">Common to CE, EEE, ECE</td></tr>
</table>

<table>
<tr><th colspan="4">PART A</th></tr>
<tr><th colspan="4"><i>(Answer all questions. Each question carries 3 marks)</i></th></tr>
<tr><th><i>No.</i></th><th><i>Question</i></th><th><i>CO</i></th><th><i>Marks</i></th></tr>
<tr><td>1</td><td>A manufacturing firm has a clearly defined hierarchy, detailed written rules, and standardized procedures for every task. Which classical management concept is dominant in this organisation? Mention one advantage and one limitation of this approach.</td><td>CO 1</td><td>(2)</td></tr>
<tr><td>2</td><td>A production supervisor set a target of reducing machine downtime by 15% within three months. Weekly reviews were conducted and corrective actions were taken whenever deviations occurred. Which management function is primarily illustrated here? Explain the sequence involved.</td><td>CO 1</td><td>(2)</td></tr>
<tr><td>3</td><td>A team leader observes that operators strictly follow instructions only when supervisors are present. When unsupervised, productivity drops sharply. Which motivation theory best explains this behaviour? Justify briefly.</td><td>CO 2</td><td>(2)</td></tr>
<tr><td>4</td><td>A plant manager conducts a short technical training directly on the shop floor using live machines rather than classroom simulations. Classify the training method and state one benefit and one limitation of this approach.</td><td>CO 2</td><td>(2)</td></tr>
<tr><td>5</td><td>A project network shows three different time estimates for each activity: optimistic, most likely, and pessimistic. Identify the scheduling technique and explain the purpose of using three estimates.</td><td>CO 3</td><td>(2)</td></tr>
<tr><td>6</td><td>A small manufacturing company produces two products: Product A and Product B. Each product requires processing in two departments: Assembly and Finishing. Develop the objective function and the constraints. The resource requirements and profit details are given below:
<table>
<tr><th>Product</th><th>Assembly Time (hrs)</th><th>Finishing Time (hrs)</th><th>Profit per Unit</th></tr>
<tr><td>Product A</td><td>2</td><td>1</td><td>40</td></tr>
<tr><td>Product B</td><td>1</td><td>2</td><td>50</td></tr>
</table></td><td>CO 3</td><td>(2)</td></tr>
<tr><td>7</td><td>An engineering firm observed that only 15% of inventory items contribute nearly 70% of inventory value. Identify the inventory classification approach suitable here and explain how management attention should differ among item categories.</td><td>CO 4</td><td>(2)</td></tr>
<tr><td>8</td><td>A manufacturing company noticed that defects mainly originated during machine setup operations. In the DMAIC approach of Six Sigma, explain which phase should focus on identifying root causes and why.</td><td>CO 4</td><td>(2)</td></tr>
</table>

<table>
<tr><th colspan="5">PART B</th></tr>
<tr><th colspan="5"><i>(Answer any one full question from each module, each question carries 4 marks)</i></th></tr>
<tr><th colspan="2"><i>No.</i></th><th><i>Question</i></th><th><i>CO</i></th><th><i>Marks</i></th></tr>
<tr><th colspan="5">MODULE I</th></tr>
<tr><td>9</td><td>a)</td><td>A company manufacturing industrial valves conducted a SWOT analysis before launching a smart IoT-enabled product. The observations were:
● Strong R&D team
● Rising global demand for smart monitoring systems
● High initial investment cost
● Entry of multinational competitors
Classify each observation under SWOT categories and explain how management can convert one weakness into a strategic advantage.</td><td>CO 1</td><td>(4)</td></tr>
<tr><th colspan="5">OR</th></tr>
<tr><td>10</td><td>a)</td><td>A manufacturing unit shifted from a traditional line structure to a matrix structure for handling multiple automation projects simultaneously. Compare the two structures based on:
● Flexibility
● Communication flow
● Resource utilisation
● Employee reporting relationships</td><td>CO 1</td><td>(4)</td></tr>
</table>

<table>
<tr><td></td><td></td><td>Conclude whether the shift is justified for project-based engineering environments.</td><td></td><td></td></tr>
<tr><td colspan="5">MODULE II</td></tr>
<tr><td>11</td><td>a)</td><td>A project manager uses the following leadership approaches in different situations:
Gives strict instructions during machine breakdowns
Encourages team voting during product redesign
Delegates authority completely to an expert R&D team
Identify the leadership styles used in each case and justify why situational leadership is important in engineering environments.</td><td>CO 2</td><td>(4)</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>12</td><td>a)</td><td>A production unit experiences repeated conflicts between maintenance engineers and production supervisors regarding machine shutdown schedules. Using the Thomas–Kilmann conflict framework:
Identify any two possible conflict-handling styles suitable here
Compare their likely outcomes
Recommend the most effective approach with justification</td><td>CO 2</td><td>(4)</td></tr>
<tr><td colspan="5">MODULE III</td></tr>
<tr><td>13</td><td>a)</td><td>A construction project consists of the following activities:
<table>
<tr><th>Activity</th><th>Immediate Predecessor</th><th>Duration (Days)</th></tr>
<tr><td>A</td><td>—</td><td>3</td></tr>
<tr><td>B</td><td>A</td><td>4</td></tr>
<tr><td>C</td><td>A</td><td>5</td></tr>
<tr><td>D</td><td>B</td><td>6</td></tr>
<tr><td>E</td><td>B</td><td>2</td></tr>
<tr><td>F</td><td>C</td><td>4</td></tr>
<tr><td>G</td><td>D, E</td><td>3</td></tr>
<tr><td>H</td><td>F, G</td><td>5</td></tr>
</table>
Draw the network diagram for the project., Identify the critical path., Find the total project completion time.</td><td>CO 3</td><td>(4)</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>14</td><td>a)</td><td>A production dashboard shows the following monthly KPIs:
<table>
<tr><th>KPI</th><th>Target</th><th>Actual</th></tr>
<tr><td>Machine Utilization</td><td>90%</td><td>72%</td></tr>
<tr><td>Defect Rate</td><td>2%</td><td>5%</td></tr>
<tr><td>Delivery Performance</td><td>95%</td><td>88%</td></tr>
</table>
Interpret the dashboard results and suggest managerial actions.</td><td>CO 3</td><td>(4)</td></tr>
<tr><td colspan="5">MODULE IV</td></tr>
<tr><td>15</td><td>a)</td><td>A fabrication workshop consumes 24,000 units of a component annually. Ordering cost per order is ₹500 and holding cost per unit per year is ₹20.
Determine the Economic Order Quantity (EOQ).
Interpret how EOQ helps improve operational efficiency in inventory management.</td><td>CO 4</td><td>(4)</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>16</td><td>a)</td><td>A manufacturing start-up plans to implement Industry 4.0 technologies for predictive maintenance. The management is considering IoT sensors, Digital Twins, and Collaborative Robots.
Explain how Digital Twins can improve maintenance decisions.
Discuss one operational advantage and one implementation challenge of Collaborative Robots.
Analyse how Lean 4.0 combines traditional lean concepts with digital technologies.</td><td>CO 4</td><td>(4)</td></tr>
<tr><td colspan="5">PART C</td></tr>
<tr><td colspan="5"><i>(Answer any one full question, each question carries 8 marks)</i></td></tr>
<tr><td>17</td><td>a)</td><td>A construction company XYZ Ltd is executing a large smart-city infrastructure project for a municipal corporation. The project involves multiple teams including design, procurement, construction, quality inspection, and IT support.
Recently, the company experienced:
Poor coordination among departments.
Delays in procurement and project execution.
Frequent conflicts between supervisors and workers.
Lack of clarity in decision-making authority.
Increasing project costs and resource wastage.
Difficulty in monitoring project progress.</td><td>CO 1,2,3,4</td><td>(8)</td></tr>
</table>

- Low employee morale due to long working hours.
- Resistance from senior employees toward adopting Agile project tracking software.

The CEO wants the management team to redesign the organisational and project management practices to complete the project successfully.

Questions

1. Explain how management principles and functions apply to this situation.
2. Identify the major organisational behaviour issues in the case.
3. Suggest leadership styles suitable for handling project teams and labour conflicts.
4. Discuss the importance of controlling in reducing project delays and cost overruns.
5. Recommend Human Resource Management practices to improve employee morale and teamwork.
6. Explain how quantitative techniques can support managerial decision-making in project scheduling and resource allocation.
7. Suggest operations and quality management practices for improving project efficiency.
8. Explain how Agile methods and change management strategies can support successful project execution and technology adoption.

OR

18 a)

is a fast-growing packaged food startup that began as a small family business. Due to increasing customer demand, the company expanded its operations to three cities within two years. However, rapid growth created several managerial challenges.

The Managing Director noticed that:

- Employees were unclear about their responsibilities.
- Production delays were becoming frequent.
- Customer complaints regarding product quality increased.
- Team leaders followed different leadership styles, causing confusion among workers.
- Employee motivation reduced because performance rewards were inconsistent.
- The company introduced new digital inventory software, but many employees resisted the change.
- Project deadlines for launching a new product line were repeatedly missed.
- Management wants to adopt Agile methods to improve coordination and faster product launches.

The company collected the following monthly operational data:

Parameter	Before Expansion	After Expansion
Average Production per Day	1,200 units	2,800 units
Product Defect Rate	2%	8%
Employee Turnover	5%	18%
Customer Complaints per Month	20	95

Questions

1. Explain how the basic functions of management are relevant in this case.
2. Identify planning and organising issues faced by the company.
3. Suggest suitable motivation and leadership approaches to improve employee performance.
4. Explain the role of Human Resource Management in reducing turnover and improving productivity.
5. Analyse employee resistance to technological change and suggest change management strategies.
6. Using quantitative thinking, identify two operational problems that require immediate managerial attention.
7. Explain how Agile methods can help the company manage product launch projects more effectively.
8. Suggest quality management measures to reduce product defects and customer complaints.

CO 1,2,3,4

(8)

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COURSE DESCRIPTION							
REGULATION	**2025**	**L-T-J-P-S**	**0-0-0-2-0**	**VERSION**	**25/0**	**CREDITS**	**2**
(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)							

COURSE CODE	COURSE NAME	COURSE CATEGORY
B250002/ME330T	Materials Testing Lab	PCL
PRE-REQUISITE		
Engineering, Mechanics, Mechanics of solids		

PREAMBLE

This laboratory course provides hands-on exposure to experimental techniques used to evaluate the mechanical behaviour and performance of engineering materials. It integrates testing, measurement, and microstructural analysis to build a practical understanding of material response under various loading and service conditions.

RATIONALE

This laboratory syllabus is designed to determine the mechanical properties and behavior of materials under different loading conditions through hands-on experimentation. It also enables students to apply the relationship between material structure, failure mechanisms, and engineering performance in practical scenarios.

COMPETENCY STATEMENT/s

1. Determine the mechanical behavior of materials under various loading conditions.
2. Apply the relationship between material properties and microstructure to engineering applications.

CO	CO Statement	Cognitive (C)	Psychomotor (P)	Affective (A)
1	Evaluate the mechanical properties of different materials under various loading conditions.	A	M	Res
2	Relate material microstructure to its mechanical behaviour.	A	M	Res
3	Analyse the effect of design features on the performance of mechanical components.	A	M	Res
4	Apply experimental techniques to determine material properties.	A	M	Res
5	Apply fundamental engineering principles to analyse the behaviour of structures under load.	A	M	Res

<table>
<tr><th colspan="14">TEACHING AND ASSESSMENT SCHEME</th></tr>
<tr><th colspan="5" rowspan="2">Teaching Scheme / Week</th><th rowspan="3">Hours / Semester</th><th rowspan="2">Credit</th><th colspan="7">Examination Scheme</th></tr>
<tr><th colspan="3">Theory</th><th colspan="3">Practical</th><th rowspan="2">Total</th></tr>
<tr><th>L</th><th>T</th><th>J</th><th>P</th><th>S</th><th>C</th><th>CIA</th><th>ESE</th><th>Total</th><th>CIA</th><th>ESE</th><th>Total</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>60</td><td>40</td><td>100</td><td>100</td></tr>
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</table>

Experiment No.	Major Topics (10 experiments are mandatory)	Hrs
1	Evaluate the tensile properties of a ductile material (mild steel, high-strength steel, or torsteel) using a Universal Testing Machine (UTM) equipped with an extensometer.	3

2	Conduct compressions test on a ductile material (mild steel, tor-steel, or high-strength steel) using a Universal Testing Machine (UTM) equipped with an extensometer.	3
3	Determine the tensile properties of cast iron (a brittle material) using a Universal Testing Machine (UTM) equipped with an extensometer.	3
4	Determine the shear strength of a mild steel rod using a shear test.	3
5	Perform Brinell/Vickers/Rockwell hardness tests on a given material	3
6	Determine the torsional rigidity of mild steel/copper/brass rods.	3
7	Evaluate the flexural stiffness (flexural rigidity) of mild steel/copper/brass specimens using a three-point bend test on a Universal Testing Machine (UTM)	3
8	Determine the notch toughness of the material at room temperature using Izod and Charpy impact testing.	3
9	Investigate the effect of coil type (close-coiled vs. open-coiled) and arrangement (series vs. parallel) on spring stiffness.	3
10	Microstructure of mild steel/copper/ brass/aluminium using optical microscope, double disc polishing machine, emery papers and etchant.	3
11	Analyse the fracture surface morphology of a ductile or brittle material using an optical microscope for fractographic characterisation.	3
12	Evaluate the fracture toughness of a material with a Universal Testing Machine (UTM)	3
13	To study the procedure for plotting S-N curve using Fatigue testing machine	3
14	Perform stress analysis using photoelasticity.	3
15	Measure the deformation (strain) of an object using strain gauges.	3
16	Perform a bending test on a wooden beam to assess its load-carrying capacity.	3

SUGGESTED LEARNING RESOURCES

Text Book

Sl. No.	Title of Book	Author	Publication
1	Callister's Materials Science and Engineering	D. Wayne Callister and David G. Rethwisch	Wiley
2	Mechanical Testing and Evaluation	Howard Kuhn; Dana Medlin	ASM International

Reference

Sl. No.	Title of Book	Author	Publication
1	Mechanics of Materials	James M. Gere and Barry J. Goodno	Cengage Learning
2	Introduction to Materials Science for Engineers	James F. Shackelford	Pearson

Web Resource / Virtual Lab

	https://onlinecourses.nptel.ac.in/noc23_mm38/preview
	https://archive.nptel.ac.in/courses/112/107/112107146/
	https://archive.nptel.ac.in/courses/112/106/112106293/

LAB COMPONENT DESIGN

Objective	**CO**	**Learning Domain**		
		C	P	A
Determine the mechanical properties of materials under different loading conditions such as tension, compression, shear, torsion, bending, and impact.	1	A	M	Res

Apply standard experimental methods to evaluate hardness, toughness, fatigue behaviour, and fracture characteristics of engineering materials.	1,4	A	M	Res
Determine the relationship between material behaviour and failure modes through testing and fractographic examination.	1,2,3	A	M	Res
Develop practical skills in handling laboratory equipment such as UTM, hardness testers, impact testing machines, and strain measurement devices.	4	A	M	Res
Interpret experimental data to assess material performance and suitability for engineering applications.	1,2,3	A	M	Res
Correlate microstructure with mechanical properties using metallographic techniques and microscopic analysis.	2	A	M	R

ASSESSMENT PATTERN		
Assessment		**Marks**
Continuous Internal Assessment		
1	Continuous Lab Assessment	50
2	Regularity	10
End Semester Examination - Lab		40
Total		**100**

COURSE DESCRIPTION							
REGULATION	**2025**	**L-T-J-P-S**	**0-0-0-3-0**	**VERSION**	**25/0**	**CREDITS**	**2**
(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)							

COURSE CODE	COURSE NAME	COURSE CATEGORY
B250002/ME330U	Fluid Mechanics & Hydraulic Machines Lab	PCL
PRE-REQUISITE		
Basic knowledge of fluid mechanics principles, hydraulic machines, flow measurement techniques		

PREAMBLE

- Provides practical understanding of fluid mechanics and hydraulic machines.
- Helps students verify theoretical concepts through experiments.
- Develops skills in flow measurement, performance testing, and data analysis.
- Enhances laboratory practices, observation, and technical reporting skills.
- Gives hands-on experience with pumps, turbines, and flow measuring devices.

RATIONALE

- Bridges the gap between theory and practical engineering applications.
- Enables experimental study of fluid flow, head losses, and stability concepts.
- Develops competency in using laboratory instruments and equipment.
- Improves analytical, problem solving, and interpretation skills.
- Prepares students for industrial and real-world hydraulic engineering applications.

COMPETENCY STATEMENT/s

- Perform, analyze, and interpret fluid mechanics and hydraulic machinery experiments by applying theoretical concepts to practical engineering systems and preparing technical laboratory reports

CO	CO Statement	Cognitive (C)	Psychomotor (P)	Affective (A)
1	Conduct fluid mechanics experiments and measure various flow parameters using standard laboratory equipment.	A	P	V
2	Analyze fluid flow characteristics, stability conditions, and head losses in hydraulic systems.	A	P	V
3	Evaluate the performance and efficiency of pumps and hydraulic turbines through experimental methods.	A	P	V
4	Interpret experimental observations and prepare technical reports by correlating practical results with theoretical concepts.	A	P	V

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week					Hours / Semester	Credit	Examination Scheme		
							Practical		
L	**T**	**J**	**P**	**S**		**C**	**CIA**	**ESE**	**Total**
-	-	-	3	-		2	60	40	100

***L**: Lecture (One unit is of one-hour duration), **T**: Tutorial (One unit is of one-hour duration), **P**: Practical (One unit is of one-hour duration), **J**: Project (One unit is of one-hour duration), **S**: Self-Learning & Team Work (One unit is of one-hour duration), **CIA**: Continuous Internal Assessment, **ESE**: End Semester Examination*

SUGGESTED LEARNING RESOURCES

Web Resource / Virtual Lab	
1	https://fm-iitk.vlabs.ac.in
2	https://eerc03-iiith.vlabs.ac.in
3	https://ce-iitb.vlabs.ac.in/

LAB COMPONENT DESIGN

Objective	CO	Learning Domain		
		C	P	A
1) Laboratory Orientation and Safety Guidelines				
2) Metacentre/Stability • determine the metacentric height (GM) of the floating body • evaluate the stability of the floating body (stable, unstable, or neutral equilibrium) • measure the angle of tilt for a given displacement of weight • calculate the radius of gyration (k) of the body	1,2,4	A	P	V
3) Triangular/Rectangular Notches • measure the head of water (H) over the notch • determine the actual discharge (Q_a) • calculate the theoretical discharge (Q_t) • determine the coefficient of discharge (Cd) • plot a calibration curve between discharge and head over the notch	1,2,4	A	P	V
4) Orificemeter Apparatus • measure the discharge (Q) through the orifice meter • determine the pressure (head) difference across the orifice plate • calculate the theoretical discharge using flow equations • determine the actual discharge experimentally • calculate the coefficient of discharge (Cd)	1,2,4	A	P	V
5) Venturimenter Apparatus • measure the discharge (Q) through the Venturi meter • determine the pressure difference (head difference) between inlet and throat • calculate the theoretical discharge using Bernoulli's equation • determine the actual discharge experimentally • calculate the coefficient of discharge (Cd)	1,2,4	A	P	V
6) Orifice apparatus • measure the actual discharge (Q_a) through the orifice and mouthpiece • calculate the theoretical discharge (Q_t) • determine the coefficient of discharge (Cd) • determine the coefficient of velocity (Cv)	1,2,4	A	P	V
7) Major Loss in a Pipe • measure the discharge (Q) through the pipe • determine the head loss due to friction in the pipe • calculate the velocity of flow in the pipe • determine Chezy's constant (C) • determine Darcy's friction factor (f)	1,2,4	A	P	V
8) Performance test on Centrifugal pumps and determination of operating characteristics. • measure the discharge (Q) of the pump • determine the head developed (H) by the pump • calculate the input power and output power • evaluate the efficiency of the pump	3,4	A	P	V
9) Performance test on Reciprocating pump and determination of operating characteristics. • measure the discharge (Q) of the pump • determine the head developed (H) by the pump • calculate the input power and output power • evaluate the efficiency, slip of the pump	3,4	A	P	V
10) Performance test on Pelton turbine and determination of operating characteristics. • measure the discharge (Q) supplied to the turbine • determine the head (H) acting on the turbine • measure the speed of the turbine • calculate the input power (water power) • calculate the output power (shaft power) • determine the efficiency of the turbine	3,4	A	P	V

11) Performance test on Francis Turbine and determination of operating characteristics. • measure the discharge (Q) flowing through the turbine • determine the net head (H) acting on the turbine • measure the speed of the turbine runner • calculate the input power (water power) • calculate the output power (shaft power) • determine the overall efficiency of the turbine	3,4	A	P	V
12) Performance test on Kaplan Turbines and determination of operating characteristics • measure the discharge (Q) flowing through the turbine • determine the net head (H) acting on the turbine • measure the speed of the turbine runner • calculate the input power (water power) • calculate the output power (shaft power) • determine the overall efficiency of the turbine	3,4	A	P	V

ASSESSMENT PATTERN		
Assessment		**Marks**
Continuous Internal Assessment		60
1	Continuous Lab Assessment	
2	Regularity	
End Semester Examination - Lab		40
Total		**100**