

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE MODULE: MECHANICS OF MATERIALS

Course Coordinator: Mr. Hemanth B R				Academic Year: 2026-27	
Department: Mechanical Engineering					
Course Code	Course Title	Core/Elective	Prerequisite	Contact Hours	Total Hrs/ Sessions
				L:T: P:S	
1BME304	Mechanics of Materials	Core	-	3:0:0:0	42

Course Learning Objective:

The course will enable the students to:

1. Understand the fundamental principles of engineering mechanics and equilibrium of particles and rigid bodies.
2. Understand the concepts of stress, strain, and deformation in axially loaded members.
3. Understand the principles governing torsion and the torsional behavior of circular shafts.
4. Understand the concepts of bending, beam stresses, and deformation of beams under various loading conditions.
5. Understand complex stress systems and the fundamental principles involved in the analysis of pressure vessels.

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching learning process and facilitate the achievement of course outcomes.

1. Flipped Classroom
2. Problem-Based Learning (PBL)
3. Simulation and Virtual Labs
4. ICT-Enabled Teaching

Module-1

Equilibrium of a Particle: Condition for the Equilibrium of a Particle, The Free-Body Diagram, Coplanar Force Systems. (Numerical)

Force System Resultants: Moment of a Force—Scalar Formulation, Principle of Moments, Moment of a Couple, Reduction of a Simple Distributed Loading. (Numerical)

Equilibrium of a Rigid Body: Conditions for Rigid-Body Equilibrium, Free-Body Diagrams, Equations of Equilibrium, Two- and Three-Force Members, Constraints and Statical Determinacy. (Numerical)

TLP: Power Point Presentation, Video demonstration or simulations, Chalk and Talk

Module-2

Introduction: Normal Stress and Strain; Mechanical Properties of Materials; Elasticity, Plasticity, and Creep; Linear Elasticity, Hooke's Law, and Poisson's Ratio; Shear Stress and Strain; Allowable Stresses and Allowable Loads. (Numericals)

Axially Loaded Members: Changes in Lengths of Axially Loaded Members; Changes in Lengths under Nonuniform Conditions; Statically Indeterminate Structures; Thermal Effects, Misfits, and Pre-strains; Stresses on Inclined Sections; Strain Energy; Stress Concentrations. (Numericals).

TLP: Power Point Presentation, Video demonstration or simulations, Chalk and Talk

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Module-3

Torsion: Introduction; Torsional Deformations of a Circular Bar; Circular Bars of Linearly Elastic Materials, Nonuniform Torsion, Stresses and Strains in Pure Shear, Relationship Between Moduli of Elasticity E and G , Transmission of Power by Circular Shafts, Statically Indeterminate Torsional Members, Strain Energy in Torsion and Pure Shear. (Numerical).

TLP: Power Point Presentation, Video demonstration or simulations, Chalk and Talk.

Module-4

Stresses in Beams: Pure Bending and Nonuniform Bending; Curvature of a Beam; Longitudinal Strains in Beams; Normal Stresses in Beams; Design of Beams for Bending Stresses; Nonprismatic Beams; Shear Stresses in Beams of Rectangular Cross Section; Shear Stresses in Beams of Circular Cross Section; Shear Stresses in the Webs of Beams with Flanges; Beams with Axial Loads; Stress Concentrations in Bending. (Numerical)

Shear Forces and Bending Moments: Introduction; Types of Beams, Loads, and Reactions; Shear Forces and Bending Moments; Relationships Among Loads, Shear Forces, and Bending Moments; Shear-Force and Bending-Moment Diagrams. (Numerical).

TLP: Power Point Presentation, Video demonstration or simulations, Chalk and Talk.

Module-5

Analysis of Stress and Strain: Introduction; Plane Stress; Principal Stresses and Maximum Shear Stresses; Mohr's Circle for Plane Stress; Hooke's Law for Plane Stress; Triaxial Stress; Plane Strain. (Numerical).

Pressure Vessels, Beams, and Combined Loadings: Spherical Pressure Vessels; Cylindrical Pressure Vessels; Combined Loadings (Numericals).

TLP: Power Point Presentation, Video demonstration or simulations, Chalk and Talk.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Analyse equilibrium of particles and rigid bodies (**L2, L3**)

CO2: Determine stresses and strains in axially loaded members (**L2, L3**)

CO3: Analyze torsional behavior of circular shafts (**L3**)

CO4: Analyze stresses and deformations in beams (**L3**)

CO5: Evaluate complex stress systems and pressure vessels (**L3, L4**)

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.

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- Notwithstanding the above, a student is considered to have **passed the course**, provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Internal Assessment Test (IA) + Continuous Comprehensive Assessments (CCA) = Continuous Internal Evaluation CIE [25+25=50 marks]

- A minimum of **two Internal Assessment Tests (IA)** shall be conducted, carrying a total of **25 marks**.
- In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	To analyse and solve engineering problems involving any three or more of the following topics: equilibrium of particles and rigid bodies, stress analysis, axially loaded members, torsion, bending and shear in beams, pressure vessels, and combined loading, and interpret the results from an engineering perspective.. – Technical Report	15
2.	Structural Analysis of Engineering Components - Case Study Presentation	10

Continuous Internal Evaluation (CIE)

- The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
- Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
- The remaining 25 marks shall be assigned for Continuous Comprehensive Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
- A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

- For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
- For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
- If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Suggested Learning Resources:

Books

- Hibbeler R C, "Engineering Mechanics: Statics", 14th Ed., Pearson. ISBN: 978-0133918922, 2016
- Goodno B J & Gere J M, "Mechanics of Materials", Enhanced Edition, 9th SI Ed., Cengage Learning. ISBN: 978-0357377857, 2020.

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Reference Books

1. Ferdinand P Beer, E. Russell Johnston, David Mazurek, Phillip J Cornwell and Brian Self, "Vector Mechanics for Engineers: Statics and Dynamics, 12th Ed., McGraw Hill, 2024.
2. Hibbeler R C, "Mechanics of Materials", 11th Ed., Pearson Education, 2024.
3. Meriam J L and Kraige L G, "Engineering Mechanics: Statics", 9th Ed., John Wiley & Sons, 2020.
4. Ferdinand P Beer, E Russell Johnston, John T DeWolf, David F Mazurek and Sanjeev Sanghi, "Mechanics of Materials", 8th Ed., McGraw Hill Education, 2020.
5. James M Gere and Barry J Goodno, "Mechanics of Materials", 9th Ed., Cengage Learning, 2018.
6. Timoshenko S P and Young D H, "Elements of Strength of Materials", 5th Ed., McGraw Hill Education, 2017 (Reprint).
7. Arthur P Boresi and Richard J Schmidt, "Advanced Mechanics of Materials", 6th Ed., John Wiley & Sons, 2003.

Rubrics for Learning Activity 1:

To analyse and solve engineering problems involving any three or more of the following topics: equilibrium of particles and rigid bodies, stress analysis, axially loaded members, torsion, bending and shear in beams, pressure vessels, and combined loading, with appropriate engineering interpretation of the results. - Technical Report

Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Problem Formulation (P01, P02)	Correctly identifies engineering problem, assumptions and develops appropriate Free Body Diagrams/models.	Minor omissions in assumptions or modelling.	Adequate understanding with limited justification.	Incorrect assumptions or incomplete formulation.	Unable to formulate the problem.
Analytical Solution (P01, P02, P03)	Accurate calculations with correct application of engineering principles and equations.	Minor computational errors.	Correct approach with moderate calculation errors.	Frequent conceptual and computational errors.	Unable to solve the problem.
Engineering Interpretation (P02, P04)	Critically analyses results, validates assumptions and provides meaningful engineering conclusions.	Good interpretation with minor omissions.	Basic interpretation of results.	Limited interpretation and discussion.	No meaningful interpretation.
Technical Documentation (P09)	Well-organized, neat, complete and professionally documented.	Good documentation with minor deficiencies.	Acceptable documentation.	Poor organization and incomplete documentation.	Inadequate submission.

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Rubrics for Learning Activity 2:					
Structural Analysis of Engineering Components - Case Study Presentation					
Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Problem Identification (PO1, PO2)	Clearly identifies the engineering problem with complete justification.	Correctly identifies the problem with minor omissions in assumptions.	Identifies the problem with minor errors	Incomplete or incorrect problem formulation	Unable to identify or formulate the engineering problem.
Application of Mechanics Principles (PO1, PO2, PO3)	Correctly applies three or more mechanics concepts (equilibrium, stress analysis, torsion, bending, pressure vessels, combined loading, etc.) and sound engineering reasoning.	Applies the relevant concepts with minor conceptual errors.	Applies basic concepts with moderate errors.	Limited application of mechanics principles; frequent errors.	Unable to apply the relevant mechanics concepts.
Analysis, Interpretation and Design Recommendations (PO2, PO4)	Critically analyses results, validates assumptions, identifies failure/safety concerns, and proposes feasible engineering recommendations with justification.	Provides appropriate analysis and recommendations with minor omissions.	Performs basic analysis and provides limited recommendations.	Interpretation is incomplete or lacks engineering justification.	No meaningful analysis or recommendations.
Presentation and Technical Communication (PO9)	Presentation is well-organized, technically sound, visually effective, and delivered confidently with accurate responses to questions.	Good organization and communication with minor deficiencies.	Adequate presentation and communication.	Poor organization or ineffective communication.	Unable to communicate technical content effectively.

The Correlation of Course Outcomes (CO's) and Program Outcomes (PO's)

Subject Code: 1BME304				TITLE: Mechanics of Materials						Faculty: HEMANTH B R	
List of Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO-1	3	3	-	-	-	-	-	-	2	-	2
CO-2	3	3	2	-	-	-	-	-	2	-	2
CO-3	3	3	2	-	-	-	-	-	2	-	2
CO-4	3	3	2	2	-	-	-	2	3	-	2
CO-5	3	3	2	2	-	-	-	2	3	-	2

Note: 3 = Strong Contribution 2 = Average Contribution 1 = Weak Contribution - = No Contribution