25UMET301	STRENGTH OF MATERIALS	Category	L	T	P	R	Credit	Year of Introduction
		PCC	3	1	0	0	4	2025

Preamble: This course provides a comprehensive introduction to the mechanics of deformable solids, focusing on the analysis of stress, strain, and deformation under various loading conditions. It systematically develops the theoretical foundations of axial loading, torsion, bending, pressure vessels, and column stability, along with stress transformation and energy methods.

Prerequisite: EMS103 Engineering Mechanics

Course Outcomes: After the completion of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Apply fundamental concepts of stress and strain to determine stress–strain behavior of linearly elastic materials under simple loading conditions.	K3 Apply
CO2	Analyze axial deformation of prismatic and composite members including thermal effects and strain energy, and determine principal stresses.	K4 Analyze
CO3	Apply the theory of simple bending and torsion to determine bending stresses, torsional stresses, shear force and bending moment distributions in beams and circular shafts.	K3 Apply
CO4	Explain the concepts of beam deflection, column buckling, and classical theories of failure to interpret stability and failure behavior of structural members.	K2 Understand

Mapping of course outcomes with program outcomes and program specific outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	2	2
CO2	3	3	2	2	-	-	-	-	-	-	-	2	3
CO3	3	3	3	2	-	-	-	-	-	-	-	2	3
CO4	3	3	3	2	2	-	-	-	-	-	-	2	3
Avg	3	3	2.5	2	2	-	-	-	-	-	-	2	2.75

Mapping of course outcomes with Knowledge and Attitude Profile (WK)

	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	*	*	*	*	-	-	-	-	-
CO2	*	*	*	*	*	-	-	-	-
CO3	*	*	*	*	*	-	-	-	-
CO4	*	*	*	*	*	-	-	-	-

WKs Mapped with the course

WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
*	*	*	*	*	-	-	-	-

Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	**40**	**60**	**2.5 hrs**

Continuous Internal Evaluation Pattern:

Attendance : 5 marks
Continuous Assessment Test : 20 marks
Continuous Assessment Assignment : 15 marks

SYLLABUS

Module 1 (12 hrs)

Introduction to mechanics of deformable bodies and concept of continuum. Internal forces and stress at a point. Normal stress and shear stress. Concept of strain: normal strain and shear strain. Linear strain and lateral strain. Poisson's ratio. Volumetric strain.

Constitutive relations for linear elastic materials. Hooke's law in one dimension. Stress–strain diagram for ductile and brittle materials. Elastic constants: modulus of elasticity, modulus of rigidity and bulk modulus. Relationship among elastic constants. Saint-Venant's principle.

Module 2 (14 hrs)

Axial deformation of prismatic bars subjected to direct load. Deformation of members with varying cross section. Principle of superposition. Statically determinate composite bars under axial loading.

Thermal stresses in simple and composite members.

Strain energy due to axial loading. Gradually applied load, suddenly applied load and impact load. Generalized Hooke's law for isotropic materials (introductory form). Two-dimensional stress transformation equations. Principal stresses and principal planes. Mohr's circle for plane stress.

Module 3 (15 hrs)

Theory of simple bending and its assumptions. Flexural stress distribution in rectangular, circular and

I-sections. Section modulus.

Torsion of solid and hollow circular shafts. Assumptions of torsion theory. Derivation of torsion equation. Polar moment of inertia. Angle of twist. Torsional rigidity.

Beams- Types-Shear force and bending moment diagrams for cantilever, simply supported and overhanging beams subjected to concentrated loads and uniformly distributed loads.

Module 4 (15 hrs)

Load–deflection differential equation of beams. Determination of slope and deflection of simply supported and cantilever beams using Macaulay's method. Buckling of columns. Concept of crippling load. Euler's critical load for different end conditions. Effective length and slenderness ratio. Maximum principal stress theory (Rankine's theory), Maximum shear stress theory (Guest–Tresca theory), Maximum strain theory (Saint-Venant theory), Maximum strain energy theory, Maximum distortion energy theory (von Mises theory). Comparison and applicability to ductile and brittle materials.

Text Books:

1. Hibbeler, R. C., *Mechanics of materials* (10th ed.). Pearson Education, 2017.
2. Beer, F. P., Johnston, E. R., Jr., DeWolf, J. T., & Mazurek, D. F., *Mechanics of materials* (7th ed.). McGraw Hill Education, 2014.
3. Bhavikatti, S. S., *Strength of materials* (3rd ed.). V. G. Gadag & Co., 2010.
4. Bansal, R. K., *Strength of materials* (6th ed.). Laxmi Publications, 2010.

Reference Books:

1. Popov, E. P., *Engineering mechanics of solids* (2nd ed.). Prentice Hall of India, 2002.
2. Gere, J. M., & Goodno, B. J., *Mechanics of materials* (8th ed.). Cengage Learning, 2012.
3. Timoshenko, S. P., & Young, D. H., *Elements of strength of materials* (5th ed.). CBS Publishers, 2011.
4. Srinath, L. S., *Advanced mechanics of solids* (1st ed.). Tata McGraw Hill Education, 2010.

END SEMESTER EXAMINATION – MODEL QUESTION PAPER

Course Code	**25UMET301**
Course Name	**Strength of Materials**
Max. Marks: 60	**Duration: 2.5 Hours**

Part A

(Answer all questions. Each question carries 3 marks)

Qn No.	Question	Marks	CO	BL
1	Explain the significance of Poisson's ratio and derive the expression for volumetric strain in terms of linear strain.	3	1	L2
2	Describe Saint-Venant's principle and discuss its importance in stress analysis.	3	1	L2

3	Explain the principle of superposition and state the conditions under which it is applicable in axial deformation problems.	3	2	L2
4	Define principal stresses and principal planes. Explain their engineering significance.	3	2	L2
5	State the assumptions of simple bending theory and explain the concept of section modulus.	3	3	L2
6	Explain the assumptions made in the theory of torsion of circular shafts.	3	3	L2
7	Define crippling load, effective length, and slenderness ratio for columns.	3	4	L2
8	Compare Maximum Principal Stress Theory and Maximum Shear Stress Theory of failure.	3	4	L2
Part B (*Answer any one full question from each Module. Each carry 9 marks*)				
Module I				
Qn No.	**Question**	**Marks**	**CO**	**BL**
9	A steel rod of 30 mm diameter and 2 m length is subjected to a tensile load of 120 kN. Determine the stress, strain and elongation if E = 200 GPa. Also calculate the lateral contraction assuming Poisson's ratio = 0.3.	9	1	L3
OR				
10	A cylindrical specimen is subjected to a tensile force of 90 kN. Given its original diameter is 25 mm and gauge length is 300 mm, determine the stress, strain and extension if E = 210 GPa. Verify the applicability of Hooke's law for the given loading condition.	9	1	L3
Module II				
Qn No.	**Question**	**Marks**	**CO**	**BL**
11	A composite bar consisting of steel and aluminium sections is subjected to an axial load of 120 kN. Determine the stresses developed in each material and the total deformation. Analyse the effect of compatibility of deformation in obtaining the solution.	9	2	L4
OR				
12	At a point in a stressed member, $\sigma_x = 80MPa$ (tensile), $\sigma_y = -20MPa$ (compressive), and τxy = 40 MPa. Analyse the state of stress by determining the principal stresses, principal planes and maximum shear stress using Mohr's circle.	9	2	L4
Module III				
Qn No.	**Question**	**Marks**	**CO**	**BL**
13.	A simply supported beam of span 6 m carries a point load of 20 kN at its centre. Draw the shear force and bending moment diagrams and determine the maximum bending moment.	5	3	L3
OR				

14.	A hollow circular shaft transmits 250 kW at 150 rpm. The outside diameter is 200 mm and the inside diameter is 120 mm. Determine the maximum shear stress and angle of twist over a length of 4 m if G = 80 GPa.	5	3	L3
Module IV				
Qn No.	**Question**	**Marks**	**CO**	**BL**
15.	Explain Euler's theory of column buckling and discuss the effect of different end conditions on the critical load.	6	4	L2
OR				
16.	Explain the Maximum Distortion Energy Theory (von Mises theory) and compare it with the Maximum Principal Stress Theory with suitable applications to ductile and brittle materials.	6	4	L2

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