Q.5	i.	Can you explain the difference between a solid shaft and a hollow shaft in terms of torsion?	**3**	1	1	4	1
	ii.	A solid circular shaft of diameter 50 mm and length 2 m is subjected to a torque of 400 Nm. Calculate the angle of twist and the maximum shear stress.	**7**	3	2	4	2
OR	iii.	A hollow shaft has an outer diameter of 80 mm and an inner diameter of 50 mm. It is 3 m long and subjected to a torque of 600 N-m. Find (a) The polar moment of inertia J & (b) The angle of twist θ if the shear modulus G=80 GPa.	**7**	3	3	4	1
Q.6	i.	What is the difference between a column and a strut?	**2**	1	1	5	1
	ii.	A steel column is 5 meters long and has a cross-sectional area $A=2\times10^{-3}\ m^2$ and a moment of inertia $I=8\times10^{-6}\ m^4$. Calculate the slenderness ratio of the column.	**3**	3	3	5	2
	iii.	A column with a length of L=3 m is made of steel with a Young's Modulus $E=2.1\times10^{11}\ N/m^2$ and a moment of inertia $I=500\times10^{-6}\ m^4$. The column is fixed at both ends. Calculate the critical buckling load for this column.	**5**	3	3	5	1
OR	iv.	A steel column has a length L=5 m, a moment of inertia $I=600\times10^{-6}\ m^4$ and is made of steel with a Young's Modulus $E=2\times10^{11}\ N/m^2$. The column is pinned at both ends. Calculate the critical buckling load for the column.	**5**	3	3	5	2

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Total No. of Questions: 6 *Total No. of Printed Pages:4*

Enrollment No.....

Faculty of Engineering
End Sem Examination Dec 2024
ME3CO43 Mechanics of Materials

Programme: B.Tech. Branch/Specialisation: ME

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

			Marks	BL	PO	CO	PSO
Q.1	i.	In tensile testing, what is the point at which a material begins to deform plastically called? (a) Yield point (b) Ultimate point (c) Breaking point (d) Elastic limit	**1**	1	1	1	1
	ii.	What is the relationship between stress and strain in the elastic region of a material's deformation? (a) Inversely proportional (b) No relationship (c) Directly proportional (d) Exponentially proportional	**1**	1	1	1	2
	iii.	In a compound stress system, if the normal stress is positive, what does this indicate? (a) Compression (b) Tension (c) Shear (d) No stress	**1**	1	1	2	1
	iv.	What is the principal stress? (a) The maximum normal stress on a plane (b) The stress due to axial loading only (c) The average of all stresses in a material (d) The stress acting perpendicular to a surface	**1**	1	1	2	1
	v.	How is the bending moment at a section of a beam defined? (a) The product of shear force and distance (b) The sum of moments about the section (c) The maximum load applied to the beam (d) The deflection of the beam at that section	**1**	2	1	3	1

vi.	For a simply supported beam with a central point load, the bending moment at the centre is: (a) Zero (b) Maximum (c) Equal to the applied load (d) Equal to the shear force	**1**	1	1	3	1
vii.	What is the primary failure mode of a circular shaft under torsion? (a) Bending failure (b) Shear failure (c) Buckling failure (d) Fatigue failure	**1**	1	1	4	2
viii.	What is torsion in the context of circular shafts? (a) The bending of a shaft under axial loads (b) The twisting of a shaft due to applied torque (c) The compression of a shaft under vertical loads (d) The deflection of a beam under lateral loads	**1**	2	1	4	1
ix.	What is meant by the term "slenderness ratio" of a column? (a) The ratio of the length of the column to its cross-sectional area (b) The ratio of the length of the column to its radius of gyration (c) The ratio of the cross-sectional area to its moment of inertia (d) The ratio of the length of the column to its height	**1**	1	1	5	1
x.	For a slender column, which of the following statements is true regarding buckling? (a) Buckling occurs due to shear stress (b) Buckling occurs due to axial load exceeding the critical load (c) Buckling is not a concern for short columns (d) Buckling occurs at the material's yield point	**1**	1	1	5	1
Q.2 i.	A load of 5 kN is to be raised with the help of a steel wire. Find the minimum diameter of the steel wire, if the stress is not to exceed 100 MPa.	**2**	1	1	1	1
ii.	Obtain a relation for the elongation of a uniformly circular tapering section?	**8**	2	1	1	1

OR	iii.	A reinforced concrete circular section of 50,000 mm^2 cross sectional area carries 6 reinforcing bars whose total area is 500 mm^2. Find the safe load which the column can carry, if the stress in steel and the concrete are not to exceed 120 MPa and 5 MPa respectively. Take modulus of elasticity of steel as 18 times that of concrete.	**8**	3	1	1	2
Q.3	i.	What is the principal plane?	**1**	1	1	2	1
	ii.	What is the significance of principal stresses?	**2**	1	1	2	1
	iii.	At a point in a stressed body the principal stresses are 100 MPa (tensile) and 60 MPa (compressive). Determine the normal stress and the shear stress on a plane inclined at 50^o to the axis of major principal stress. Also calculate the maximum shear stress at the point.	**7**	3	2	2	1
OR	iv.	A point is subjected to perpendicular stresses of 50 MPa and 30 MPa, both tensile. Calculate the normal, tangential stress and resultant stress and its obliquity on a plane making an angle of 30^o with the axis of second stress.	**7**	3	2	2	2
Q.4	i.	How do you calculate the shear force at a section of a beam?	**2**	1	1	3	1
	ii.	Why is it important to calculate deflection in beams?	**2**	2	1	3	1
	iii.	A cantilever beam of length 4 m carries a uniform load of 3 kN/m over its entire length. Find (a) The reactions at the fixed support & (b) The shear force and bending moment at the free end. Draw also the SFD & BMD for the beam.	**6**	3	2	3	2
OR	iv.	A simply supported beam of length 6 m has two-point loads: 15 kN at 2 m from the left end and 10 kN at 4 m from the left end. The beam has a rectangular cross-section of 150 mm by 300 mm. Find: (a) The maximum bending moment in the beam & (b) The maximum bending stress.	**6**	3	2	3	1

Marking Scheme

ME3CO43 (T) Mechanics of Materials (T)

Q.1	i)	a) Yield Point	**1**
	ii)	c) Directly proportional	**1**
	iii)	b) Tension	**1**
	iv)	a) The maximum normal stress on a plane	**1**
	v)	b) The sum of moments about the section	**1**
	vi)	b) Maximum	**1**
	vii)	b) Shear failure	**1**
	viii)	b) The twisting of a shaft due to applied torque	**1**
	ix)	b) The ratio of the length of the column to its radius of gyration	**1**
	x)	b) Buckling occurs due to axial load exceeding the critical load.	**1**

Q.2	i.	D = 8 mm 2 Marks			**2**
	ii.	8 Marks for Derivation			**8**
OR	iii.	A_s = 500 mm^2	A_c = 49500 mm^2	2 Marks	**8**
		σ_c = 3.5 MPa	σ_s = 63 MPa	2 Marks	
		P = 204.75 kN		4 Marks	

Q.3	i.	2 Marks for significance	**2**
	ii.	1 Mark for definition	**1**
	iii.	Normal stress = 35 MPa	**7**
		Tangential stress = 8.66 MPa	
		Resultant stress = 36.05 MPa	
		Obliquity = 13^o.54’	
		Maximum Shear stress = 80 MPa	
OR	iv.	Normal stress = 6.1 MPa	**7**
		Tangential stress = 78.78 MPa	
		Maximum Shear stress = 80 MPa	

Q.4	i.	2 Marks for Explanation	**2**
	ii.	2 Marks for Explanation	**2**
	iii.	1 Mark for Reaction at the fixed end = 12 kN upward	**6**
		1 Mark for Shear force at Free end = -12 kN (downward)	
		1 Mark for BM at Midpoint = 48 kN-m	
		3 Marks for SF & BM Diagram	
	iv.	2 Marks for Reaction at supports = RA & RB = 13.33 kN & 11.67 kN	**6**
		2 Marks for Max BM = 23670 N-m	
		2 Marks for Bending Stress = 76 MPa	

Q.5	i.	3 Marks for Explanation	**3**
	ii.	2 Marks for polar moment of inertia = 3.07 x 10^{-9} m^4	**7**
		2 Marks for Angle of twist = 0.5 degree	
		3 Marks for Maximum shear stress = 32.5 MPa	
OR	iii.	3 Marks for polar moment of inertia = 2.36 x 10^{-6} m^4	**7**
		4 Marks for Angle of twist = 5.4 degree	

Q.6

	i.	2 Marks for difference	**2**
	ii.	Slenderness Ratio (L/k) = 79	**3**
	iii.	P_{cr} = 3.66 x 10^7	**5**
	iv.	P_{cr} = 1.58 x 10^7	**5**

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P.T.O.