Q.5	i.	Derive an expression ($\frac{\tau}{R} = \frac{C\theta}{L}$) for shear stress produced in a circular shaft subjected to torsion.	**4**
	ii.	A hollow shaft and a solid shaft constructed of the same material have the same length are subjected to same torque. The inner radius of the hollow shaft is 2/3 of its outer radius. Assuming that both shafts are subjected to the same maximum shear stresses. Compare the weights of both shafts.	**6**
OR	iii.	A hollow shaft is to transmit 300 kw at 80 rpm. If the shear stress is not to exceed 60MN/m^2 and internal diameter is 0.6 of the external diameter. Find the internal and external diameter assuming that the maximum torque is 1.4 times the mean.	**6**
Q.6	i.	Write down the expressions in tabular form for the crippling load in terms of actual length & effective length of column and also the relation between effective length & actual length for various end conditions of column.	**4**
	ii.	What are the assumptions made in the Euler's column theory? Derive an expression for crippling load when both the ends of the column are hinged.	**6**
OR	iii.	A hollow mild steel tube 6 m long, 4 cm internal diameter and 6mm thick is used as a strut with both ends hinged. Find the moment of inertia of section, crippling load & safe load taking factor of safety as 3. Take E = 2×10^5 N/mm^2.	**6**

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

Enrollment No.....

Faculty of Engineering

End Sem (Odd) Examination Dec-2019

AU3CO02/FT3CO02/ME3CO02 Strength of Materials

Programme: B.Tech. Branch/Specialisation: AU/FT/ME

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

Note: 1. 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.
2. All symbols have their usual meaning.

Q.1	i.	The ratio of change in volume to the original volume is called (a) Linear strain (b) Lateral strain (c) Volumetric strain (d) Poisson's ratio	**1**
	ii.	The unit of Young's modulus is same as that of stress. (a) Stress (b) Pressure (c) Both (a) and (b) (d) None of these	**1**
	iii.	The extremeties of any diameter on Mohr's circle represents (a) Principal stresses (b) Normal stresses on planes at 45° (c) Shear stresses on planes at 45° (d) Normal and shear stresses on a plane	**1**
	iv.	The resultant stress on an inclined plane which is inclined at an angle θ to the normal cross-section of a body which is subjected to a direct tensile stress (σ) in one plane, is (a) σ sin θ (b) σ cos θ (c) σ sin 2θ (d) σ cos 2θ	**1**
	v.	When a load on the free end of a cantilever beam is increased, failure will occur (a) At the free end (b) At the fixed end (c) In the middle of the beam (d) At a distance 2l/3 from free end	**1**
	vi.	In a beam where shear force changes sign, the bending moment will be (a) Zero (b) Minimum (c) Maximum (d) Infinity	**1**

P.T.O.

vii. In the torsion equation $T/J = \tau/r = G\theta/L$, the term J/R is called **1**
(a) Shear modulus (b) Section modulus
(c) Polar modulus (d) None of these

viii. For the same material, length and given torque, a hollow shaft weighs_____ a solid shaft. **1**
(a) Less than (b) More than (c) Equal to (d) None of these

ix. When both ends of a column are fixed, the effective length is **1**
(a) Its own length (b) Twice its length
(c) Half its length (d) $1/\sqrt{2} \times$ its length

x. The buckling load for a given material depends on **1**
(a) Slenderness ratio and area of cross-section
(b) Poisson's ratio and modulus of elasticity
(c) Slenderness ratio and modulus of elasticity
(d) Slenderness ratio, area of cross-section and modulus of elasticity

Q.2 i. Draw & explain the stress strain curve for ductile material. **4**

ii. A short post constructed from a hollow circular tube of aluminium supports a compressive load of 240 kN. The inner and outer diameters of the tube are 90 mm and 130 mm, respectively, and its length is 1 m. The shortening of the post due to the load is measured as 0.55 mm. Determine the compressive stress and strain in the post. **6**

OR iii. A steel pipe of length 1.2 m, outside diameter 150 mm, and inside diameter 110 mm is compressed by an axial force 620 kN. The material has modulus of elasticity 200 GPa and Poisson's ratio 0.30. Determine the following quantities for the pipe: **6**
(a) The shortening
(b) The lateral strain
(c) The increase in the outer diameter and the increase in the inner diameter
(d) The increase in the wall thickness.

Q.3 i. Derive an expression for Strain energy due to gradually applied loads. **4**

ii. A plane-stress condition exists at a point on the surface of a loaded structure, where the stresses have the magnitudes and directions shown on the stress element of Fig. 1. Determine the normal & tangential stresses acting on an element that is oriented at a clockwise angle of 15° with respect to the original element. **6**

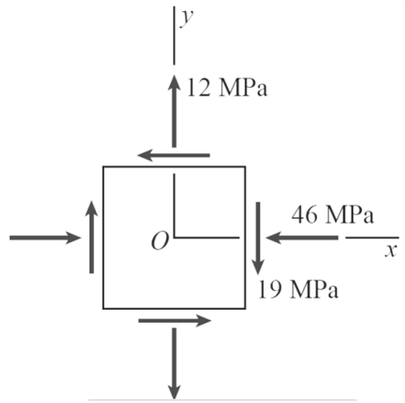

Fig 1

OR iii. An element in plane stress at the surface of a large machine is subjected to major stress 100 MPa, minor stress 34 MPa, and shear stress 28 MPa. Using Mohr's circle, determine the following quantities: **6**
(a) The stresses acting on an element inclined at an angle 40°
(b) The principal stresses
(c) The maximum shear stresses.

Q.4 i. Explain the various types of beams & various types of loads with suitable diagram. **4**

ii. Derive an expression $(\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R})$ for bending stresses in beams. **6**

OR iii. Draw the S.F.D. & B.M.D. for an overhanging beam of length 6m carrying uniformly distributed load of 2kN/m over the entire length. The two supports are at a distance of 4m. A point load of 2kN is also acting on any of the free end. Also locate the point of contraflexure. **6**

P.T.O.

Marking Scheme

AU3CO02/FT3CO02/ME3CO02 Strength of Materials

Q.1	i.	The ratio of change in volume to the original volume is called (c) Volumetric strain	**1**
	ii.	The unit of Young's modulus is same as that of stress. (c) Both (a) and (b)	**1**
	iii.	The extremeties of any diameter on Mohr's circle represents (a) Principal stresses	**1**
	iv.	The resultant stress on an inclined plane which is inclined at an angle θ to the normal cross-section of a body which is subjected to a direct tensile stress (σ) in one plane, is (b) σ cos θ	**1**
	v.	When a load on the free end of a cantilever beam is increased, failure will occur (b) At the fixed end	**1**
	vi.	In a beam where shear force changes sign, the bending moment will be (c) Maximum	**1**
	vii.	In the torsion equation T/J = τ/r = Gθ/ L, the term J/R is called (c) Polar modulus	**1**
	viii.	For the same material, length and given torque, a hollow shaft weighs_____ a solid shaft. (a) Less than	**1**
	ix.	When both ends of a column are fixed, the effective length is (c) Half its length	**1**
	x.	The buckling load for a given material depends on (c) Slenderness ratio and modulus of elasticity	**1**

Q.2	i.	Stress strain curve for ductile material		**4**
		Diagram	2 marks	
		Explanation	2 marks	
	ii.	Compressive stress	3 marks	**6**
		Strain in the post	3 marks	
OR	iii.	Determine the following quantities for the pipe:		**6**
		(a) The shortening	1.5 marks	
		(b) The lateral strain	1.5 marks	
		(c) The increase in the outer diameter and the increase in the inner diameter	1.5 marks	
		(d) The increase in the wall thickness.	1.5 marks	

Q.3	i.	Derivation for Strain energy due to gradually applied loads		**4**
			3 marks	
		Diagram	1 mark	
	ii.	Determine the normal stresses	3 marks	**6**
		Tangential stresses	3 marks	
OR	iii.	Mohr's circle diagram	3 marks	**6**
		(a) The stresses acting on an element inclined at an angle 40°	1 mark	
		(b) The principal stresses	1 mark	
		(c) The maximum shear stresses.	1 mark	

Q.4	i.	Types of beams with diagram	2 marks	**4**
		Types of loads with diagram	2 marks	
	ii.	$(\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R})$ for bending stresses in beams		**6**
		Diagram	2 marks	
		Derivation	4 marks	
OR	iii.	Beam diagram / Load diagram	1 mark	**6**
		S.F.D.	2 marks	
		B.M.D.	2 marks	
		Point of contraflexure	1 mark	

Q.5	i.	$(\frac{\tau}{R} = \frac{C\theta}{L})$ for shear stress produced in a circular shaft subjected to torsion.		**4**
		Diagram	1 mark	
		Derivation	3 marks	
	ii.	Relation between outer diameters of the shafts	3 marks	**6**
		Weights of hollow shaft and a solid shaft	3 marks	
OR	iii.	Formula	1 mark	**6**
		Torque	1 mark	
		T_{mean}	1 mark	
		Internal diameter	1.5 marks	
		External diameter	1.5 marks	

Q.6	i.	Each condition 1 mark	(1 mark * 4)	**4**
	ii.	Assumptions made in the Euler's column theory	2 marks	**6**
		Diagram	1 mark	
		Derivation	3 marks	
OR	iii.	Find the moment of inertia	2 marks	**6**
		Crippling load	2 marks	
		Safe load	2 marks	

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