Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem Examination Dec-2023

AU3CO43 / ME3CO43 Mechanics of Materials

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

Q.1 i. A rod, 120 cm long and of diameter 3.0 cm is subjected to an axial pull of 18 kN. The stress in N/mm^2 is- **1**

(a) 22.57 (b) 23.47 (c) 24.57 (d) 25.47

ii. When a wire is stretched to double in length, the longitudinal strain produced in it is- **1**

(a) 0.5 (b) 1 (c) 1.5 (d) 2

iii. Minor principal stress has minimum _____. **1**

(a) Value of shear stress acting on the plane

(b) Intensity of direct stress

(c) Both (a) and (b)

(d) None of these

iv. If the principal stresses in a plane stress problem are σ_1 = 100 MPa, σ_2 = 40MPa, the magnitude of the maximum shear stress (in MPa) will be- **1**

(a) 60 (b) 50 (c) 30 (d) 20

v. The neutral axis of the cross-section a beam is that axis at which the bending stress is- **1**

(a) Zero (b) Minimum (c) Maximum (d) Infinity

vi. The point where shear force changes its sign, the bending moment at that point will be- **1**

(a) Maximum (b) Minimum (c) Zero (d) None of these

vii. A hollow shaft of same cross-section area as compared to a solid shaft transmit- **1**

(a) 1/16 (b) 1/8 (c) 1/4 (d) 15/16

viii. A bicycle is pedalled with a constant torque of 100 N-m with the wheel revolving at 20 rpm. The power developed is- **1**

(a) 210 W (b) 0.2 HP (c) 2.1 kW (d) 2 HP

P.T.O.

ix. Euler's formula is applicable to a- **1**

(a) Short column (b) Medium column

(c) Long column (d) All of these

x. The slenderness ratio is the ratio of- **1**

(a) Area of column to least radius of gyration

(b) Length of column to least radius of gyration

(c) Least radius of gyration to area of column

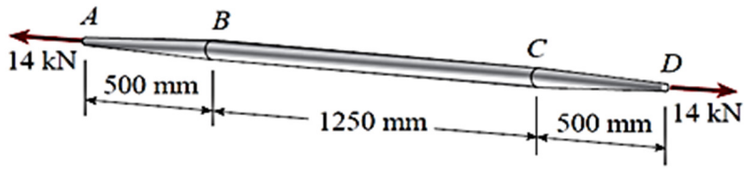
(d) Least radius of gyration to length of column

Q.2 i. A circular bar is subjected to an axial pull of 100 kN. If the maximum intensity of shear stress on any oblique plane is not to exceed 60 MPa, determine the diameter of the bar. **2**

ii. Define the following terms: **8**

(a) Plasticity (b) Creep (c) Resilience (d) Modulus of rigidity

OR iii. Calculate the elongation of a copper bar of solid circular cross section with tapered ends when it is stretched by axial loads of magnitude 14 kN as shown in figure. The length of the end segments is 500 mm and the length of the prismatic middle segment is 1250 mm. Also, the diameters at cross sections A, B, C, and D are 12, 24, 24 and 12 mm, respectively, and the modulus of elasticity is 120 GPa. **8**



Q.3 i. The tensile stresses at a point across two mutually perpendicular planes are 120 MPa and 60 MPa. Determine the normal, tangential and resultant stresses on a plane inclined at 30° to the axis of the minor stress. **3**

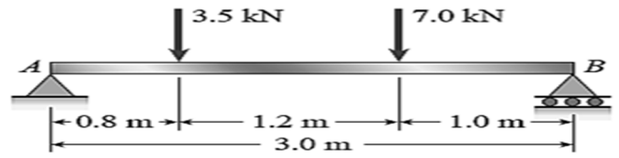
ii. The principal tensile stress at a point across two perpendicular planes is 120 MPa and 60 MPa. Find the normal and tangential stress and the resultant stress and its obliquity on a plane at 20° with the major principal plane. Also find the intensity of stress which acting alone can produce the same maximum strain. **7**

Take Poisson's ratio = 0.25.

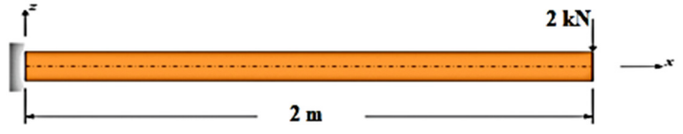
OR iii. Obtain an expression for the major and minor principal stress on a plane, when body is subjected to direct stress in two mutually perpendicular directions. **7**

Q.4 Attempt any two:

i. Draw the shear force and bending moment diagram for the beam shown in figure: **5**



ii. A cantilever of length 2 m fails when a load of 2 kN is applied at the free end as shown in figure. If the section of the beam is 40 mm x 60 mm, find the stress a failure? **5**



iii. A beam of length 6 m is simply supported at its ends and carries two-point loads of 48 kN and 40 kN at a distance of 1 m and 3 m respectively from the left support. Find the deflection under each load. **5**

Take E = 200 GPa & I = 85 x 10^6 mm^4

Q.5 i Write the assumptions of Torsion equation. **2**

ii A hollow shaft of external diameter 120 mm transmits 300 kW power at 200 rpm. Determine the maximum internal diameter if the maximum stress in the shaft is not to exceed 60 MPa. **8**

OR iii Determine the diameter of solid shaft which will transmit 300 kW at 250 rpm. The maximum shear stress not to exceed 30 MPa and twist should not be more than 1° in a shaft length of 2 m. Take modulus of rigidity for the material of the shaft as 100 GPa. **8**

Q.6 i Why Rankine theory of column's preferred over Euler's theory? **2**

ii Find the expression with proper assumptions for crippling load P at which a column of length l with both the ends of the column is hinged. **8**

OR iii A column of timber section 15 cm x 20 cm is 6 m long both ends being fixed. If the Young's modulus for timber = 17.5 kN/mm^2, determine: **8**

(a) Crippling load (b) Safe load for column if factor of safety is 3.

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Marking Scheme

AU3C043 /ME3C043

Mechanics of Materials

Q.1	i	(d) 25.47	**1**
	ii	(d) 2	**1**
	iii	(b) intensity of direct stress	**1**
	iv	(c) 30	**1**
	v	(a) Zero	**1**
	vi	(a) Maximum	**1**
	vii	(d) 15/16	**1**
	viii	(a) 210 W	**1**
	ix	(c) Long column	**1**
	x	(b) length of column to least radius of gyration	**1**
Q.2	i	D = 46.06 mm	**2**
	ii	2 Marks for each definition	**8**
OR	iii	Δl = 0.837 mm	**8**
Q.3	i	1 Mark Each Normal Stress = 105 MPa Tangential Stress = 25.98 MPa Resultant stresses = 108.16 MPa	**3**
	ii	2 Marks for normal stress = 112.98 MPa 2 Marks for tangential stress = 19.28 MPa 2 Marks for resultant stress = 114.6 MPa 1 Mark for obliquity = 9.4^o 1 Marks for intensity of stress = 105 MPa	**8**
OR	iii	4 Marks for Major principal stress expression 4 Marks for Minor principal stress expression	**8**
Q.4	i	2.5 Mark for SFD 2.5 Mark for BMD	**5**
	ii	σ= 166.67 MPa	**5**
OR	iii	1 Mark for creating deflection equation 2 Mark for deflection at C = -9.019 mm 2 Mark for deflection at D = - 16.7 mm	**5**
Q.5	i	2 Marks for assumptions	**2**
	ii	2 Mark for Torque calculation = 14323900 N-mm 6 Marks for internal dia = 88.5 mm	**8**
OR	iii	1 Mark for calculating Torque T = 11459000 N-mm 1.5 Mark for D based on strength = 124.5 mm 1.5 Mark for D based on Rigidity = 107.5 mm 1 Mark for selection of diameter = 124.5 mm	**8**
Q.6	i	2 Marks for prper explanation	**2**
	ii	2 Mark for assumption 6 marrks for expression	**8**
OR	iii	2 Marks for calculating Ixx = 10^8 mm^4 2 Marks for calculating Iyy= 5625 x 10^4 mm^4 2 Marks for calculating P = 1079.48 kN 2 Marks for Safe load = 360 kN	**8**