OR	iv.	A cantilever beam of length 3 m is subjected to a uniformly distributed load of 8 kN/m. The beam has a circular cross-section with a diameter of 100 mm. Find (a) The maximum bending stress in the beam & (b) The moment of inertia of the beam's cross-section.	7	3	2	3	2
Q.5	i.	What factors influence the deflection of a beam?	3	1	1	4	1
	ii.	Derive the expression of deflection for a cantilever beam with a point load at the free end.	7	3	2	4	1
OR	iii.	A simply supported beam of length L=6 m carries a point load P=500 N at its centre. The beam has a moment of inertia I=100×10⁻⁶ m⁴ and the Young's Modulus of the material is E=2×10¹¹ N/m². Calculate the deflection at the centre of the beam	7	3	3	4	1
Q.6	i.	What is torsion in shafts? What is the relationship between torque and the angle of twist?	3	2	3	5	1
	ii.	A solid circular shaft with a diameter of 40 mm is 2.5 m long and is subjected to a torque of 300 Nm. Calculate the maximum shear stress and angle of twist if the shear modulus G=75GPa.	7	3	3	5	1
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 Nm. Find (a) The polar moment of inertia J & (b) The angle of twist θ if the shear modulus G=80 GPa	7	3	2	5	2

In the cells above: $I = 100 \times 10^{-6}\ m^4$, $E = 2 \times 10^{11}\ N/m^2$.

******

Faculty of Engineering
End Sem Examination Dec 2024
AU3CO52 Mechanics of Materials

Programme: B.Tech.   Branch/Specialisation: AU

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.	Which of the following best defines strain?	1	1	1	01	1
		(a) Change in length per unit length					
		(b) Force per unit area					
		(c) Energy stored per unit volume					
		(d) Weight per unit volume					
	ii.	What is the principal stress?	1	1	1	01	1
		(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					
	iii.	What is the shear force at a section of a beam?	1	1	1	02	1
		(a) The force that causes bending					
		(b) The sum of vertical forces to the left or right of the section					
		(c) The total load applied to the beam					
		(d) The maximum load the beam can support					
	iv.	What is the relationship between shear force and bending moment along a beam?	1	2	1	02	2
		(a) Shear force is the derivative of bending moment with respect to distance					
		(b) Bending moment is the derivative of shear force with respect to distance					
		(c) Shear force equals bending moment					
		(d) Shear force and bending moment are independent of each other					

v. For a rectangular beam, what is the location of the neutral axis?
(a) At the top surface
(b) At the bottom surface
(c) At the centroid of the cross-section
(d) At the edge of the beam **1**   1   1   03   2

vi. What happens to bending stress in a beam if the moment of inertia increases?
(a) Bending stress increases
(b) Bending stress decreases
(c) Bending stress remains constant
(d) Bending stress becomes negative **1**   2   1   03   2

vii. What is deflection in the context of beam theory?
(a) The change in shape of a beam due to loads
(b) The maximum bending moment in a beam
(c) The vertical displacement of a point on a beam under loading
(d) The rotation of the beam at the supports **1**   2   1   04   1

viii. Which of the following factors primarily influences the deflection of a beam?
(a) Material density .
(b) Moment of inertia
(c) Length of the beam
(d) Both (b) and (c) **1**   2   1   04   2

ix. If the torque applied to a circular shaft is doubled, what happens to the shear stress in the shaft?
(a) Shear stress is halved
(b) Shear stress remains constant
(c) Shear stress is doubled
(d) Shear stress increases by a factor of four **1**   1   1   05   1

x. Which material property is most relevant when analyzing the torsion of circular shafts?
(a) Modulus of Elasticity
(b) Yield Strength
(c) Shear Modulus
(d) Tensile Strength **1**   1   1   05   1

Q.2 i. Define the following mechanical properties:
(a) Fatigue   (b) Creep   (c) Toughness **3**   1   2   1   1

ii. A reinforced concrete column 500 mm x 500 mm in section is reinforced with 4 steel bars of 25 mm diameter, one in each corner. The column is carrying a load of 1000 kN. Find the stresses in the concrete and steel bars. Take E for steel = 210 GPa and E for concrete = 14 GPa. **7**   3   2   1   1

OR iii. A steel bar ABCD 4 m long is subjected to forces as shown in fig. 1. Find the elongation of the bar. Take E for the steel as 200 GPa. **7**   3   2   1   1
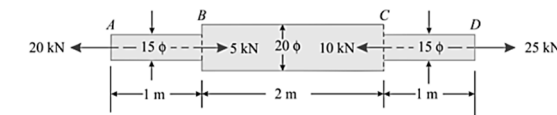

Figure 1

Q.3 i. What is shear force in a beam & bending moment in a beam? **2**   1   1   2   1

ii. What is the significance of the point of contraflexure? **2**   1   1   2   2

iii. A simply supported beam of length 6 m has a point load of 10 kN applied at the midpoint (3 m from either end). Find (a) The reactions at the supports & (b) The shear force and bending moment at the midpoint.
Draw also the SFD & BMD for the beam. **6**   3   3   2   2

OR iv. A simply supported beam of length 10 m carries a uniform distributed load of 2 kN/m over its entire length. Find (a) The reactions at the supports & (b) The shear force and bending moment at the midpoint.
Draw also the SFD & BMD for the beam. **6**   3   3   2   2

Q.4 i. What is the neutral axis? **1**   1   1   3   2

ii. How is bending stress calculated? **2**   1   1   3   1

iii. A simply supported beam of length 5 m is subjected to a point load of 10 kN at its midpoint. The beam has a rectangular cross-section with a width of 200 mm and a height of 300 mm. Find (a) The maximum bending stress in the beam & (b) The moment of inertia of the beam's cross-section. **7**   3   2   3   2

Marking Scheme
AU3CO52 (T) Mechanics of Materials (T)

Q.1   i)   a) Change in length per unit length   1
      ii)   a) The maximum normal stress on a plane   1
      iii)   b) The sum of vertical forces to the left or right of the section   1
      iv)   a) Shear force is the derivative of bending moment with respect to   1
             distance
      v)   c) At the centroid of the cross-section   1
      vi)   b) Bending stress decreases   1
      vii)   c) The vertical displacement of a point on a beam under loading   1
      viii) d) Both B and C   1
      ix)   c) Shear stress is doubled   1
      x)   c) Shear Modulus   1

Q.2   i.   1 Mark for each definition   3
      ii. A_s = 1963 mm^2 A_c = 248037 mm^2 3 Marks   7
             σ_c = 3.6 MPa σ_s = 54 MPa   4 Marks

OR   iii.   Change in length = 1.85 mm   7 Marks   7

Q.3   i.   2 Marks for both definition   2
      ii.   2 Marks for significance   2
OR   iii.   1 Mark for Reaction at the supports = 5 kN   6
             1 Mark for Shear force at Mid points = -5kN
             1 Mark for BM at Mid point = 15 kN-m
             3 Marks for SF & BM Diagram
      iv.   1 Mark for Reaction at the supports = 10 kN   6
             1 Mark for Shear force at Mid points = 0 kN
             1 Mark for BM at Mid point = 25 kN-m
             3 Marks for SF & BM Diagram

Q.4   i.   2 Marks for Explanation   2
      ii.   1 Mark for Definition   1
      iii.   2 Marks for Maximum BM = 12500 N-m   7
             1 Mark for the distance from outer most fibre = 0.15 m
             2 Marks for Moment of Inertia = 0.00045 m^4
             2 Marks for Maximum bending stress = 4.17 MPa

OR   iv.   1 Marks for Moment of Inertia = 4.91 x 10^{-6} m^4 7
             1 Mark for Total Load = 24000 N
             2 Marks for Maximum BM = 36000 N-m
             1 Mark for the distance from outer most fibre = 0.05 m
             2 Marks for Maximum bending stress = 366 MPa

Q.5   i.   3 Marks for Explanation   3
      ii.   7 Marks for Derivation   7
OR   iii.   Deflection = 11.25 mm   7

Q.6
      i.   3 Marks for Explanation   3
      ii.   2 Marks for polar moment of inertia = 1.57 x 10^{-8} m^4 7
             2 Marks for Angle of twist = 2.93 degree
             3 Marks for Maximum shear stress = 3.81 MPa
      iii.   4 Marks for polar moment of inertia = 2.36 x 10^{-6} m^4 7
             3 Marks for Angle of twist = 5.44 degree

*****