Code No: R2021031 **R20** SET - 1

II B. Tech I Semester Regular/Supplementary Examinations, December-2023
MECHANICS OF SOLIDS
(Com to ME, AME)

Time: 3 hours Max. Marks: 70

Answer any **FIVE** Questions each Question from each unit
All Questions carry **Equal** Marks
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UNIT-I

1 a) An axial pull of 40,000 N is acting on a bar consisting of three sections of length 30 cm, 25 cm, and 20 cm and of diameters 2 cm, 4 cm and 5 cm respectively. If the Young's Modulus is 2 x 10^5 N/mm^2, determine: (i) stress in each section and (ii) total extension of the bar. 7M

b) A bar of 30 mm diameter is subjected to a pull of 60 kN. The measured extension on gauge length of 200 mm is 0.1 mm and change in diameter is 0.004 mm. Calculate (i) Young's Modulus (ii) Bulk Modulus and (iii) Poison's Ratio. 7M

Or

2 a) A point is subjected to tensile stresses of 200 MPa and 150 MPa on two mutually perpendicular planes and an anticlockwise shear stress of 30 MPa. Determine the values of normal, shear stresses, maximum and minimum principal stresses on a plane inclined at 60^0 with the minor tensile stress. 7M

b) A steel rod of 28 mm diameter is 2.5 m long. Find the maximum instantaneous stress and work done at maximum elongation, when axial load of 50 kN is suddenly applied to it. Also calculate the maximum dynamic force in the rod. Take E = 200 GPa. 7M

UNIT-II

3 a) What are the different types of beams? Differentiate between a cantilever and a simply supported beam. 7M

b) A beam of span 12 m is simply supported at two-point 8 m apart with equal overhanging on either. The beam carries a uniformly distributed load of 2.5 kN/m run over the entire span. Construct the SFD and BMD. Locate also the point of contraflexure. 7M

Or

4 a) A cantilever of length 4 m carries a UDL of 1 kN/m run over the whole length and a point load of 2 kN at a distance of 1 m from the free end. Draw the S.F and B.M diagrams for the cantilever. 7M

b) Draw the shear force and bending moment diagram for a simply supported beam carrying a uniformly varying load from zero at each end to w per unit length at the centre. 7M

UNIT-III

5 a) Define the term 'bending stress' and explain the theory of simple bending. 7M

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b) A square beam 20 mm x 20 mm in section and 2 m long is supported at the ends. The beam fails when a point load of 400 N is applied at the centre of the beam. What uniformly distributed load per metre length will break a cantilever of the same material of 40 mm wide, 60 mm deep and 3 m long? 7M

Or

6 a) Show that for a rectangular section, the distribution of shearing stress is parabolic. 7M

b) A circular beam of 100 mm diameter is subjected to a shear force of 5 kN. Calculate: 7M

i. Average shear stress.
ii. Maximum shear stress
iii. Shear stress at a distance of 40 mm from neutral axis.

UNIT-IV

7 a) A simply supported beam AB of span *l* and stiffness *EI* carries a concentrated load *P* at its centre. Find the expression for slope of the beam at the support A and deflection of the beam at its centre. 7M

b) A beam 3 m long, simply supported at its ends, is carrying a point load at its centre. If the slope at the ends of the beam is not to exceed 1º, find the deflection at the centre of the beam. 7M

Or

8 a) Derive an expression for the shear stress produced in a circular shaft which is subjected to torsion. What are the assumptions made in the derivation? 7M

b) In a hollow circular shaft of outer and inner diameters of 20 cm and 10 cm respectively, the shear stress is not to exceed 40 N/mm^2. Find the maximum torque which the shaft can safely transmit. 7M

UNIT-V

9 a) Differentiate between Thin and Thick Cylinders. 7M

b) Calculate the change in diameter, change in length and change in volume of a thin cylindrical shell 100 cm diameter, 1 cm thick and 5 m long when subjected to internal pressure of 3 N/mm^2. Take the value of E = 2 x 10^5 N/mm^2 and Poisson's Ratio, $\mu = 0.3$. 7M

Or

10 a) What are the assumptions for solving the problems on thick cylindrical shells? What do you understand by the term 'Lame Theorem'? 7M

b) A thick spherical shell of 400 mm inside diameter is subjected to an internal pressure of 1.5 N/mm^2. Determine the necessary thickness of the shell, if the permissible stress in the shell material is 3 N/mm^2. 7M

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UNIT-I

1 a) The following observations were made during a tensile test on a mild steel specimen 40 mm in diameter and 200 mm long. Elongation with 40 kN load, δl = 0.0304 mm, yield load = 161 kN, maximum load = 242 kN and length of specimen at fracture = 249 mm. Determine: (i) Young's modulus of elasticity (ii) Yield point stress (iii) Ultimate stress (iv) Percentage elongation. 7M

b) A steel tube of internal diameter 100 mm and external diameter 125 mm is surrounded by a brass tube of 150 mm diameter. The composite bar is subjected to an axial pull of 10 kN. Find the load carried by each tube and the stresses and strains developed in them. If E_s = 200 GPa and E_b = 100 GPa. 7M

Or

2 a) A bar 30 mm in diameter was subjected to tensile load of 54 kN and the measured extension on 300 mm gauge length was 0.112 mm and change in diameter was 0.00366 mm. Determine the Poisson's ratio and value of three moduli. 7M

b) A steel bar 3 m long and 2500 mm^2 in area hangs vertically, which is securely fixed on a collar at its lower end. If a weight of 15 kN falls on the collar from a height of 10 mm, determine the stress developed in the bar. What will be the strain energy stored in the bar? Take E as 200 GPa. 7M

UNIT-II

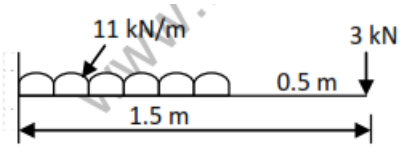
3 a) What is a beam? Classify and Explain types of beams. 7M

b) A beam 6 m long rests on two supports 5 m apart. The right end is overhanging by 1 m. The beam carries a uniformly distributed load of 1.5 kN/m over the entire length of the beam. Draw shear force and bending moment and find the amount and position of maximum bending moment. 7M

Or

4 a) What do you mean by point of contra flexure? Is the point of contra flexure and point of infection different. 7M

b) Draw the shear force and bending moment diagrams for the cantilever loaded as shown in figure below. 7M



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UNIT-III

5 a) State the assumptions made in the theory of simple bending. 7M

b) A timber beam of rectangular section of length 8 m is simply supported. The beam carries a U.D.L of 12 kN/m run over the entire length and a point load of 10 kN at 3 metre from the left support. If the depth is two times the width and the stress in the timber is not to exceed 8 N/mm^2, find the suitable dimensions of the section. 7M

Or

6 a) Derive an expression for the shear stress at any point in a circular section of a beam, which is subjected to the shear force F. 7M

b) A rectangular beam 100 mm wide and 250 mm deep is subjected to a maximum shear force of 50 kN. Determine: 7M

i. Average shear stress.
ii. Maximum shear stress
iii. Shear stress at a distance of 25 mm above the neutral axis.

UNIT-IV

7 A horizontal beam of uniform section and 6 m long is simply supported at its ends. Two vertical concentrated loads of 48 kN and 40 kN act at 1 m and 3 m respectively from the left-hand support. Determine the position and magnitude of the maximum deflection. If E = 200 GPa and EI = 85 x 10^6 mm^4. 14M

Or

8 a) Define the terms: Torsion, Torsional Rigidity and Polar Moment of Inertia. 7M

b) Two shafts of the same material and of same lengths are subjected to the same torque, if the first shaft is of a solid circular section and the second shaft is of hollow circular section, whose internal diameter is 2/3 of the outside diameter and the maximum shear stress developed in each shaft is the same, compare the weights of the shafts. 7M

UNIT-V

9 a) Find an expression for the change in volume of a thin cylinder shell subjected to internal fluid pressure. 7M

b) A cylindrical pipe of diameter 1.5 m and thickness 1.5 cm is subjected to an internal fluid pressure of 1.2 N/mm^2. Determine: Longitudinal stress developed in the pipe and Circumferential stress developed in the pipe. 7M

Or

10 A cast iron pipe of 400 mm internal diameter and 100 mm thickness carries water under a pressure of 8 N/mm^2. Determine the maximum and minimum intensities of hoop stress across the section. Also sketch the radial pressure distribution and hoop stress distribution across the section. 14M

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UNIT-I

1 a) The ultimate stress for a hollow steel column which carries an axial load of 2MN is 500 N/mm^2. If the external diameter of the column is 250 mm, determine the internal diameter. Take the factor of safety as 4.0. 7M

b) Find an expression for the total elongation of a uniformly tapering rectangular when it is subjected to an axial load P. 7M

Or

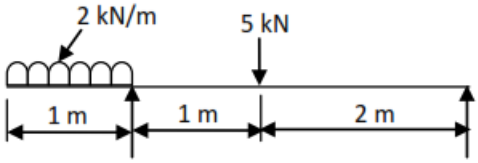
2 a) At a point in a strained material, the principal stresses are 100 MPa and 50 MPa both tensile. Find the normal and shear stresses at a section inclined at 60^0 with the axis of the major principal stresses. Also evaluate the resultant stress, angle of obliquity and Maximum shear stress. 7M

b) Define strain energy and explain how it is stored in a body. 7M

UNIT-II

3 a) Define and explain the following terms: Shear Force, Bending Moment, Shear Force Diagram and Bending Moment Diagram. 7M

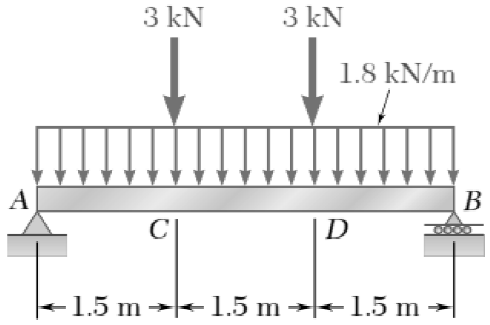
b) Draw the SFD and BMD for the overhanging beam loaded as shown in figure below. And also locate the point of contra-flexure. 7M



Or

4 a) Derive the relations among loading, shear force and bending moment in a beam. 7M

b) For the beam and loading shown below draw the Shear Force and Bending Moment Diagram. Also evaluate the maximum bending moment 7M



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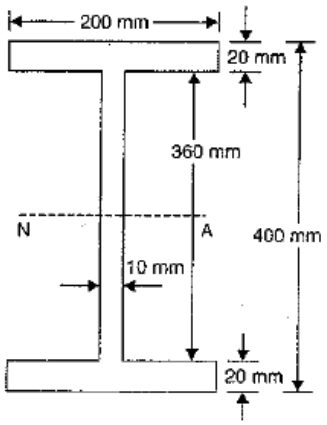
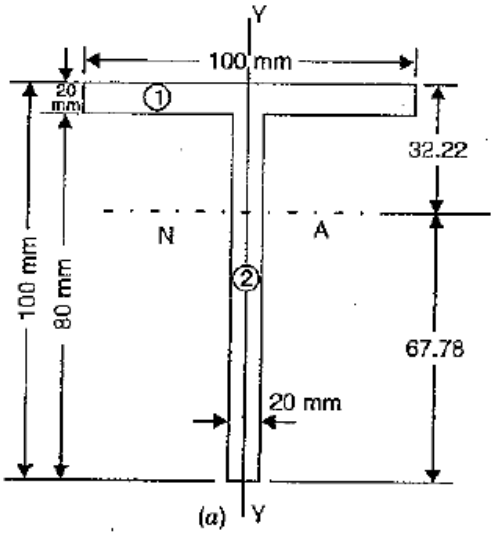
UNIT-III

5 A rolled steel joint of I section has the dimensions as shown in fig. This beam of I section carries a U.D.L of 40 kN/m run on a span of 10 m, calculate the maximum stress produced due to bending. 14M



Or

6 The shear force acting on a section of a beam is 50 kN. The section of the beam is T – shaped of dimensions 100 mm x 100 mm x 20 mm as shown in fig. The moment of inertia about the horizontal neutral axis is 314.221 x 10^4 mm^4. Calculate the shear stress at the neutral axis and at the junction of the web and the flange. 14M



UNIT-IV

7 a) Derive an expression for the slope and deflection of a cantilever of length *l*, carrying a point load W at the free end by double integration method. 7M

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b) A cantilever of length 2m carries a point load of 20kN at the free end and another load of 20kN at its centre. If E = 10^5 N/mm^2 and I = 10^8 mm^4 for the cantilever then determine by moment area method, the slope and deflection of the cantilever at the free end. 7M

Or

8 a) Derive the relation for a circular shaft when subjected to torsion as given below 7M

$$\frac{T}{J} = \frac{\tau}{R} = \frac{C\theta}{J}$$

b) Determine the diameter of a solid steel shaft which will transmit 90 kW at 160 rpm. Also determine the length of the shaft if the twist must not exceed 1° over the entire length. The maximum shear stress is limited to 60 N/mm^2. Take the value of modulus of rigidity = 8 x 10^4 N/mm^2. 7M

UNIT-V

9 a) Show that in thin cylindrical shells subjected to internal fluid pressure, the circumferential stress is twice the longitudinal stress. 7M

b) A thin cylindrical shell with following dimensions is filled with a liquid at atmospheric pressure: Length = 1.2 m, external diameter = 20 cm, thickness of metal = 8 mm. Find the value of the pressure exerted by the liquid on the liquid on the walls of the cylinder and the hoop stress induced if an additional volume of 25 cm^3 of liquid is pumped into the cylinder. Take E = 2.1 x 10^5 N/mm^2 and Poisson's Ratio = 0.33. 7M

Or

10 a) What do you mean by Lame's equations? How will you derive these equations? 7M

b) Find the thickness of metal necessary for a cylindrical shell of internal diameter 160 mm to with stand an internal pressure of 8 N/mm^2. The maximum hoop stress in the section is not to exceed 35 N/mm^2. 7M

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UNIT-I

1 a) A steel rod of 3 cm diameter and 5 m long is connected to two grips and the rod is maintained at a temperature of 95ºC. Determine the stress and pull exerted when the temperature falls to 30ºC, if
i. The ends do not yield and
ii. The ends yield by 0.12 cm. 7M

b) Define composite bar. How will you find the stresses and load carried by each member of a composite bar. 7M

Or

2 a) The stresses at a point in a bar are 200 N/mm^2 (tensile) and 100 N/mm^2 (compressive). Determine the resultant stress in magnitude and direction on a plane inclined at 60^0 to the axis of the major stress. Also determine the maximum intensity of shear stress in the material at the point. 7M

b) A copper bar of 12 mm diameter gets stretched by 1 mm under a steady load of 4 kN. What stress would be produced in the bar by a weight 500 N, the weight falls through 80 mm before striking the collar rigidly fixed to the lower end of the bar? Take young's modulus for the bar material as 100 GPa. 7M

UNIT-II

3 a) A cantilever AB 1.8 m long carries a point load of 2.5 kN at its free end and a uniformly distributed load of 1 kN/m from A to B. Draw the shear force and the bending moment diagrams for the beam. 7M

b) A beam of length *'l'* carries a uniformly distributed load of *'w'* per unit length. The beam is supported on two supports at equal distances from the two ends. Determine the position of the supports, if the B.M., to which the beam is subjected to, is as small as possible. Draw the S.F. and B.M. diagrams for the beam. 7M

Or

4 a) What is an overhanging beam? What do you mean by point of Contraflexure? 7M

b) A simply supported beam of 3 m span carries two loads of 5 kN each at 1 m and 2 m from the left-hand support. Draw the shear force and bending moment diagrams for the beam. 7M

UNIT-III

5 a) What do you mean by section modulus? Find an expression for section modulus for rectangular, circular and hollow circular sections. 7M
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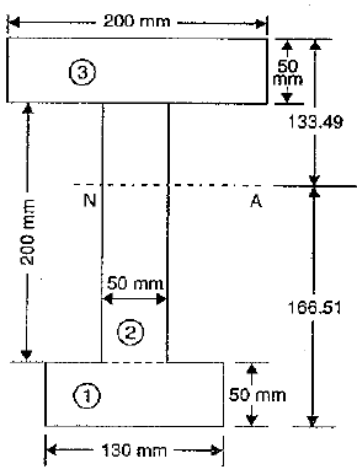
b) A rectangular beam 200 mm deep is simply supported over a beam of span 2 m. Find the uniformly distributed load, the beam can carry if the bending stress is not to exceed 30 MPa. Take I for the beam as 8 x 10^6 mm^4. 7M

Or

6 a) The shear force acting on a beam at an I – section with unequal flanges is 50 kN. The section is shown in fig. The moment of inertia of the section about neutral axis is 2.849 x 10^4 mm^4. Calculate the shear stress at the neutral axis and also draw the shear stress distribution over the depth of the section. 14M



UNIT-IV

7 a) A cantilever of length 3 m is carrying a point load 25 kN at the free end. If the moment of inertia of the beam = 10^8 mm^4 and value of E = 2.1 x 10^5 N/mm^2, find slope of the cantilever at the free end and deflection at the free end. 7M

b) Find an expression for the slope and deflection of a simply supported beam of length *l* and carrying a uniformly distributed load of *w* per unit length over the entire length. 7M

Or

8 a) Determine the diameter of a solid shaft which will transmit 300 kW at 250 rpm. The maximum shear stress should not exceed 30 N/mm^2 and twist should not be more than 1° in a shaft length of 2 m. Take modulus of rigidity = 1 x 10^5 N/mm^2. 7M

b) Two solid shafts AB and BC of aluminium and steel respectively are rigidly fastened together at B and attached to two rigid supports at A and C. Shaft AB is 7.5 cm in diameter and 2 m in length. Shaft BC is 5.5 cm in diameter and 1 m in length. A torque of 2000 N-cm is applied at the junction B. Compute the maximum shearing stress in each material. What is the angle of twist at the junction? Take modulus of rigidity of the material as C_{Al} = 0.3 x 10^5 N/mm^2 and C_{St} = 0.9 x 10^5 N/mm^2. 7M

UNIT-V

9	a)	Derive an expression for circumferential stress and longitudinal stress for a thin shell subjected to an internal pressure.	7M
	b)	A thin cylinder of internal diameter 1.25 m contains a fluid at an internal pressure of 2 N/mm^2. Determine the maximum thickness of the cylinder if: i) The longitudinal stress is not to exceed 30 N/mm^2. ii) The circumferential stress is not to exceed 45 N/mm^2.	7M

Or

10	a)	Differentiate between a thin cylinder and thick cylinder. Find an expression for the radial pressure and hoop stress at any point in case of a thick cylinder.	7M
	b)	What do you mean by a thick compound cylinder? How will you determine hoop stresses in a thick compound cylinder?	7M