Code No: R2021012 **R20** SET - 1

II B. Tech I Semester Regular/Supplementary Examinations, January, 2023
STRENGTH OF MATERIALS - I
(Civil Engineering)

Time: 3 hours Max. Marks: 70

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

1 a) A steel plate of constant thickness 14 mm is having a breadth of 120 mm at one end and uniformly varies to a breadth of 80 mm at the other end. Find the total extension due to an axial pull of 100kN at the ends. Take E = 206 kN/mm^2 and length of the plate as 900 mm. Derive the formula involved from first principles. [7 M]

b) Write expressions for the relation between i) Modulus of Elasticity and Shear Modulus, ii) Modulus of Elasticity and Bulk Modulus, and hence derive the relation among the three elastic constants. [7 M]

OR

2 a) Find the minimum diameter of a steel wire with which a load of 50 kN can be raised so that the stress may not exceed 125 MPa. Find the diameter chosen and also find the extension of wire if it is 4.5 m long. Take E = 2.1× 10^5 N/mm^2. [7 M]

b) A copper rod 8 mm in diameter when subjected to a pull of 800N extends by 0.15 mm over a gauge length of 450 mm. Find the modulus elasticity of copper. [7 M]

UNIT-II

3 Draw shear force and bending moment diagrams for the beam shown in fig.1 [14 M]

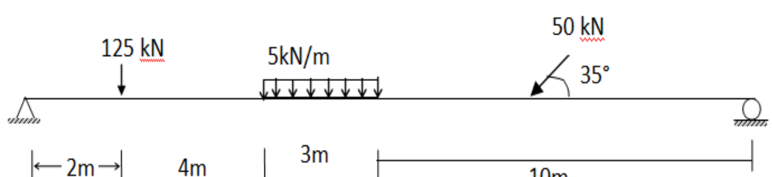

Fig.1

OR

4 Draw shear force and bending moment diagrams for the beam shown in fig.2. [14 M]

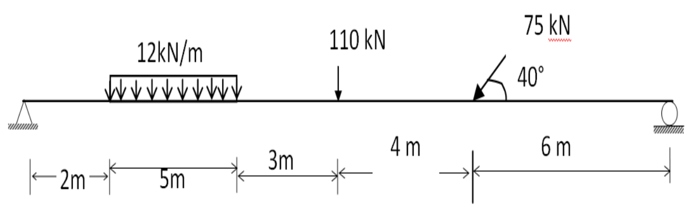

Fig.2

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UNIT-III

5 a) A simply supported beam of span 5m has a cross section 250 mm × 450 mm. If the permissible stress is 7 MPa, find the maximum concentrated load that can be applied at 3 m from left end. [7 M]

b) A rolled steel joist of symmetric I section has top and bottom flanges 260 mm × 25 mm and web of size 300 mm × 20 mm. It is used as a simply supported beam over a span of 6m to carry an u.d.l of 70 kN/m over its entire span. Draw bending stress across a section at $(1/3)^{rd}$ the span. [7 M]

OR

6 a) From first principles show that the shear stress is not maximum at the neutral axis in case of an isosceles triangular section. [7 M]

b) A beam is of T-section has flange of 230mm × 25mm and web 20mm ×200 mm. If it is subjected to a shear force of 40 kN, find the maximum intensity of shear stress and sketch the distribution of shear stress across the section. [7 M]

UNIT-IV

7 A steel girder of uniform cross-section is 14m long and is simply supported at the ends. It carries concentrated loads of 145kN and 90kN at 4m and 9m respectively from the left end. Calculate the deflection under point loads and the maximum deflection in the girder. Use Double Integration Method.
Take $I = 67 \times 10^{-4}\ m^4$ and $E = 210\ kN/mm^2$. [14 M]

OR

8 A cantilever beam of length 5m, carries two point loads of 12 kN and 10 kN at a distance of 2 m and 4m respectively from the fixed end. The moment of inertia of the beam is 1.6I for a distance of 2 m from the fixed end and for the remaining length of beam it is 1.2I. Find the deflection and slope under the point load and at the free end using Moment-Area method. Take $E = 2.2\times10^5$ MPa and $I = 89 \times 10^6\ mm^4$. [14 M]

UNIT-V

9 A cylindrical shell 5m long, 1.4m in diameter is subjected to an internal pressure of 1.8 MPa. If the thickness of the shell is 12mm, find the circumferential and longitudinal stresses. Find also maximum shear stress and the changes in the dimensions of the shell. Take $E = 206\ kN/mm^2$ and Poisson's ratio = 0.29. [14 M]

OR

10 a) What is meant by thick cylinder? What is the important assumption made in the analysis of thick cylinders? [4 M]

b) A thick cylindrical pipe of outside diameter 360 mm and internal diameter of 240 mm is subjected to an internal fluid pressure of 32 MPa and external fluid pressure of 9 MPa. Determine the hoop stress developed and draw the variation of hoop stress and radial stress across the thickness. [10 M]

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UNIT-I

1 a) A steel tube 45 mm internal diameter, 2.5 mm thick and 5 m long is covered throughout with copper tube 5 mm thick. The tubes are firmly united at their ends. This compound tube is subjected to tension and the stress produced in steel is 90 MPa. Determine i) elongation of the tube ii) stress in the copper tube and iii) load carried by the combined tube. [9M]
Take E_{steel} = 210 kN/mm^2 and E_{copper} = 110 kN/mm^2.

b) A copper rod 8 mm in diameter when subjected to a pull of 960 N extends by 0.16 mm over a gauge length of 450 mm. Find the modulus elasticity of copper. [5M]

OR

2 A composite bar of length 900 mm is made up of an aluminum bar of length 450 mm and the steel bar of length 400 mm. The cross-sectional areas of aluminum and steel bars are 120 mm × 120 mm and 80 mm × 80 mm respectively. Assuming that the bars are prevented from buckling sideways, calculate the compressive force P to be applied to the composite bar that will cause the total length of the bar to decrease by 0.4 mm. Assume the modulus of elasticity of aluminum and steel as 72 kN/mm^2 and 200 kN/mm^2 respectively. [14 M]

UNIT-II

3 Draw shear force and bending moment diagrams for the beam shown in Fig.1. [14 M]

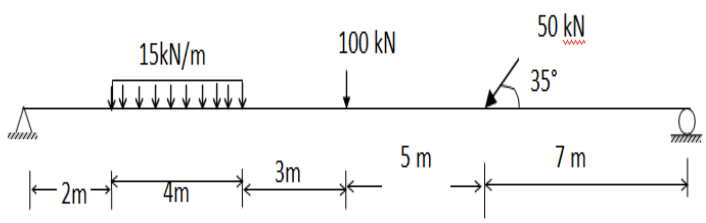

Fig.1

OR

4 Draw shear force and bending moment diagrams for the beam shown in Fig.2. Find the distances of 'point of contra-flexure' from either of the supports. [14 M]

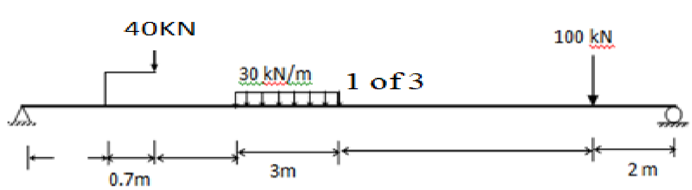

Fig.2

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UNIT-III

5 a) A simply supported beam of span 6.3m has a cross section 230 mm × 360 mm. If the permissible stress is 7 MPa, find the maximum concentrated load that can be applied at 2.5 m from left end. [7 M]

b) A rolled steel joist of symmetric I section has top and bottom flanges 230 mm × 25 mm and web of size 300 mm × 20 mm. It is used as a simply supported beam over a span of 6.5m to carry an u.d.l of 70 kN/m over its entire span. Draw bending stress across a section at $(1/5)^{th}$ the span. [7 M]

OR

6 a) Find ratio of maximum shear stress to average shear stress in a rectangular cross-section, when it is subjected to a transverse shear force F. Sketch the variation of shear stress and sketch the distribution of shear stress across the section. [7 M]

b) A T-beam has the following dimensions: Flange = 250 mm wide and 20 mm thick. Web = 350 mm deep and 25 mm thick.
Draw shear stress distribution across the depth marking values at salient points. [7 M]

UNIT-IV

7 A cantilever beam of length 7m, carries a point load of 15 kN at a distance of 5 m from the fixed end. The moment of inertia of the beam is 1.8I for a distance of 5 m from the fixed end and for the remaining length of beam the moment of inertia is I. Find the deflection and slope under the point load and at the free end using Moment-Area method. Take $E = 2.2\times10^5$ MPa and $I = 89 \times 10^6$ mm^4. [14 M]

OR

8 Find the deflection at the points C and D for the beam shown in the Fig.3. Also find slopes at the supports A and B. Use Double Integration method. EI = 18,000 kNm^2. [14 M]

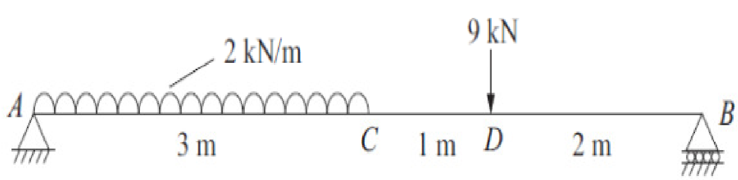

Fig.3

UNIT-V

9 A cylindrical shell 4 m long, 1.5 m in diameter is subjected to an internal pressure of 1.4 MPa. If the thickness of the shell is 12 mm, find the circumferential and longitudinal stresses. Find also maximum shear stress and the changes in the dimensions of the shell.
Take E = 205 kN/mm^2 and Poisson's ratio = 0.3. [14 M]

OR

10 a) State the assumptions involved in the analysis of thick cylinders. [4 M]

b) A compound cylinder is made by shrinking a jacket onto a cylinder. The internal diameter is 120 mm, the outside diameter 230 mm and the diameter at the junction 100 mm. The cylinder is subjected to an internal pressure of 50 MPa. If the pressure at the common junction is 18 MPa before the fluid pressure is applied, find the final stresses at different sections. [10 M]

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UNIT-I

1 A steel plate of constant thickness 12 mm is having a breadth of 120 mm at one end and uniformly varies to a breadth of 70 mm at the other end. Find the total extension due to an axial pull of 80 kN at the ends. Take E = 206 kN/mm^2 and length of the plate as 900mm. Derive the formula involved from first principles. [14M]

OR

2 a) A composite bar of length 850 mm is made up of an aluminum bar of length 450 mm and steel bar of length 400 mm. The cross-sectional areas of aluminum and steel bars are 120 mm × 120 mm and 80 mm × 80 mm respectively. Assuming that the bars are prevented from buckling sideways, calculate the compressive force P to be applied to the composite bar that will cause the total length of the bar to decrease by 0.3 mm. Assume the modulus of elasticity of aluminum and steel as 72 kN/mm^2 and 210 kN/mm^2 respectively. [9M]

b) For an elastic material, express Poisson's ratio in terms of Bulk modulus and shear modulus. Derive the expression from first principles. [5M]

UNIT-II

3 Draw shear force and bending moment diagrams for the beam shown in Fig.1. [14 M]

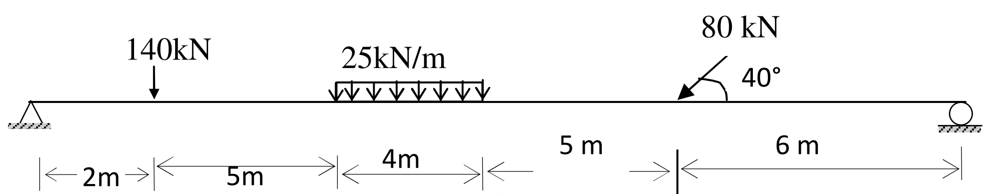

Fig.1

OR

4 Draw shear force and bending moment diagrams for the beam shown in Fig.2. [14 M]

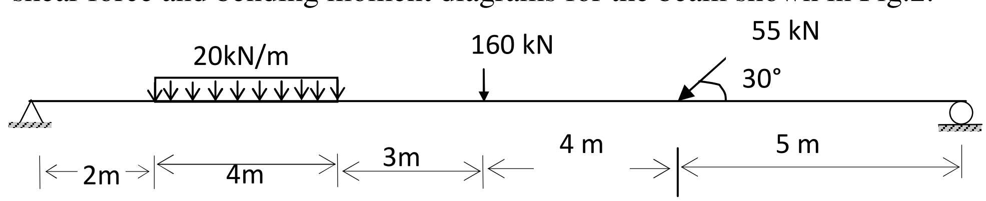

Fig.2

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UNIT-III

5 a A simply supported beam of span 3m having a cross-section 230 mm wide and 400 mm deep carries a concentrated load W at the centre. The allowable bending and shear stresses are 9 MPa and 3 Mpa respectively. What is the safe load W? [7 M]

b Find the dimensions of the strongest rectangular beam that can be cut out of a log of wood 2.6 m diameter. [7 M]

OR

6 a) A beam of square cross-section is used as a beam with one diagonal horizontal. Obtain the magnitude and location of maximum shear stress in the beam. Draw the variation of shear stress across the section. [7 M]

b) A beam is of T-section has flange of 200mm × 20mm and web 25mm × 180mm. If it is subjected to a shear force of 45 kN, find the maximum intensity of shear stress and sketch the distribution of shear stress across the section. [7 M]

UNIT-IV

7 A steel girder of uniform cross-section is 18m long and is simply supported at the ends. It carries concentrated loads of 135 kN and 95 kN at 4 m and 10 m from the left end. Calculate the deflection under point loads and the maximum deflection in the girder. Take $I = 70 \times 10^{-4}$ m^4 and $E = 206$ kN/mm^2. Use Double Integration method. [14 M]

OR

8 Find the slope and deflection at the free end for the beam shown in Fig.3 using Moment-Area method. Take $E = 2\times10^5$ MPa and $I = 96 \times 10^6$ mm^4. [14 M]

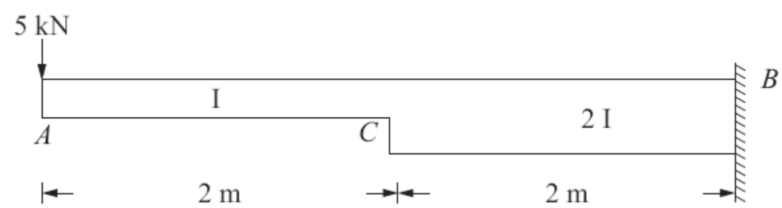

Fig.3

UNIT-V

9 a) What are the important assumption made in the analysis of thick cylinders? [4 M]

b) A thick cylindrical pipe of outside diameter 380 mm and internal diameter of 240 mm is subjected to an internal fluid pressure of 30 MPa and external fluid pressure of 10 MPa. Determine the hoop stress developed and draw the variation of hoop stress and radial stress across the thickness. [10 M]

OR

10 a) Obtain the expressions, from first principles, for Hoop stress and Longitudinal stress when a thin cylindrical shell is subjected to internal fluid pressure "p". Also obtain the expression for 'Maximum Shear Stress'. [7 M]

b) A thin cylindrical shell 1.7 m diameter and 6 m long is having 12 mm metal thickness. If the shell is subjected to an internal fluid pressure of 8 MPa, determine changes in diameter and length. [7 M]

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UNIT-I

1 A load of 450 kN is supported by a square reinforced concrete (RC) column of size 300 × 300 mm. The column is reinforced with 4 reinforcing bars of 20 mm diameter. If the modulus of elasticity of steel is 16 times that of concrete, find (i) the stresses in steel and concrete (ii) If the stress in concrete is limited to 5 MPa, what is the cross-sectional area of steel required to carry an axial load of 500kN. [14M]

OR

2 A composite bar of length 900 mm is made up of an aluminum bar of length 460 mm and steel bar of length 440 mm. The cross-sectional areas of aluminum and steel bars are 120mm × 120mm and 80mm × 80mm respectively. Assuming that the bars are prevented from buckling sideways, calculate the compressive force P to be applied to the composite bar that will cause the total length of the bar to decrease by 0.4 mm. Assume the Modulus of elasticity of aluminum and steel as 72 kN/mm^2 and 210 kN/mm^2 respectively. [14M]

UNIT-II

3 Draw shear force and bending moment diagrams for the beam shown in Fig.1. [14M]

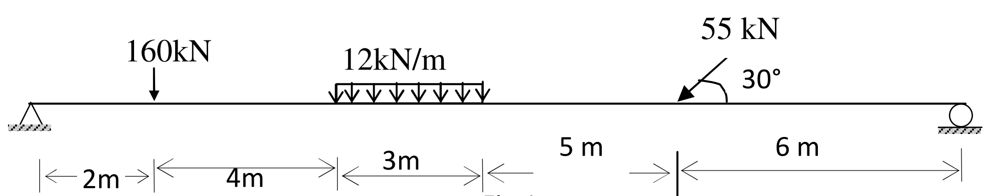

Fig.1

OR

4 Draw shear force and bending moment diagrams for the beam shown in Fig.2. Find the distances of 'point of contra-flexure' from either of the supports. [14M]

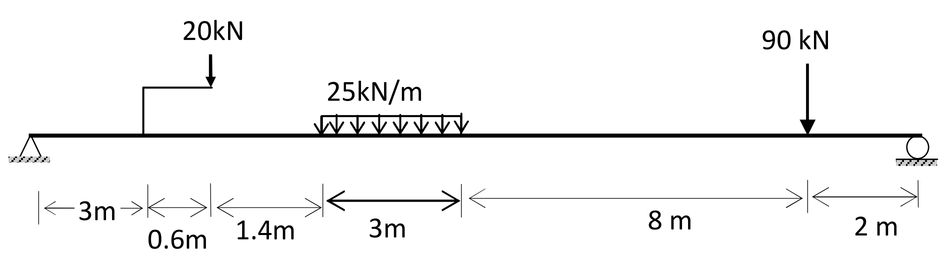

Fig.2
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UNIT-III

5 a) Find the dimensions of the strongest rectangular beam that can be cut out of a log of wood 2.2 m diameter. [6 M]

b) A T-beam having flange 220mm × 20 mm and web 25 mm × 150 mm is simply supported over a span of 8 m. It carries a u.d.l of 6 kN/m including self weight over its entire span, together with a load of 40 kN at mid-span. Find the maximum tensile and compressive stresses occurring in the beam section. [8 M]

OR

6 a) From first principles prove that the maximum shear stress in a circular section of a beam is (4/3) times the average stress. Sketch the shear stress variation. [6 M]

b) A simply supported beam of span 3.2 m having a cross-section 200 mm wide and 350 mm deep carries a point load W at the centre. The permissible stresses are 6 MPa in bending and 2 MPa in shear. Calculate the safe load W. [8 M]

UNIT-IV

7 A cantilever beam of length 6m, carries an udl of 12 kN/m for a distance of 4 m from the fixed end. Find the deflection and slope at a distance of 4 m from the fixed support and at the free end using Moment Area method. Assume constant Moment of Inertia throughout the beam. [14M]
Take $E = 2.1\times10^5$ MPa and $I = 89 \times 10^6\ mm^4$.

OR

8 A steel girder of uniform cross-section is 16m long and is simply supported at the ends. It carries a concentrated load of 125 kN at 6 m from the left end. It also carries an udl of 15kN/m from a distance, 12m to 16m from left support. Calculate the deflection under the point load and the maximum deflection in the girder. Take $I = 70 \times 10^{-4}\ m^4$ and $E = 206\ kN/mm^2$. Use Double Integration method. [14M]

UNIT-V

9 a) Derive the expressions for changes in diameter, length and volume if a thin cylinder is subjected to an internal fluid pressure, from first principles. [7 M]

b) A thin cylindrical shell 1.5 m diameter and 5 m long is having 10 mm metal thickness. If the shell is subjected to an internal fluid pressure of 6 MPa, determine changes in diameter and length. [7 M]

OR

10 A thick cylindrical pipe of outside diameter 360 mm and internal diameter of 250 mm is subjected to an internal fluid pressure of 27 MPa and external fluid pressure of 9 MPa. Determine the hoop stress developed and draw the variation of hoop stress and radial stress across the thickness. [14M]