

I B.Tech Supplementary Examinations, Aug/Sep 2008
STRENGTH OF MATERIALS
(Chemical Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

1. (a) Draw a neat sketch of typical stress-strain curve obtain from direct tension test on a mild steel rod and explain the salient points.
 (b) Explain the terms ductility and malleability. Give examples.
 (c) Two vertical rods one of steel and another of brass and each fastened at the upper end at a distance of 1 m apart. Each rod is 1.2 m long and the diameter of steel rod is 25 mm and that of brass rod is 30mm. A horizontal rigid bar connects the lower ends of the bar and is placed a load of 5 kN so that the bar remains horizontal. Find the position of the load on the cross-bar and the stresses in each rod. Take $E_{steel} = 2.1 \times 10^5$ MPa and $E_{brass} = 1 \times 10^5$ MPa.
[4+4+8]
2. (a) Derive the relationship between the three elastic constants.
 (b) A bar of steel 25mm diameter is subjected to a tensile load of 30kN and the measured extension on a 200mm gauge length is 0.08 mm and the change in diameter is 2.32×10^{-3} mm. Calculate the Poisson's ratio and the values of three moduli.
[8+8]
3. Draw shear force and bending moment diagrams and mark the salient values. [16]
 {As shown in the Figure3}

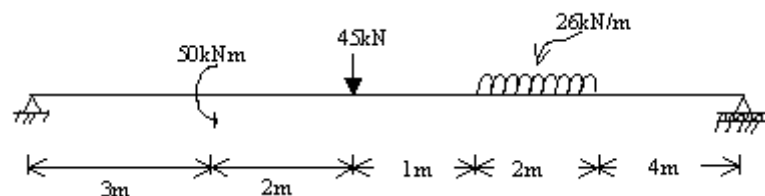


Figure 3

4. (a) List the assumption involved in the theory of simple bending.
 (b) Compare the weight of two beams of the same material and equal strength. One beam is of solid circular cross section, while the other beam is of hollow circular section, the internal diameter being 0.85 times the external diameter.
 (c) Find the section modulus for a rectangular cross section of 100mm $\times$ 300mm.
[4+6+6]
5. A beam of square section is used as a beam with one diagonal horizontal. The beam is subjected to a shear force F at a section. Find the maximum shear in the cross section of the beam and draw the shear distribution diagram for the section.
[16]

6. (a) Define a thick cylinder. What are the possible stresses in the thick cylinder, when subjected to internal pressure.
(b) State the expressions for stresses in thick cylindrical shells. State and derive the lame's expressions with the assumptions involved. [8+8]
7. At a point in a strained material, the principal tensile stresses across two perpendicular planes, are 80 N/mm^2 and 40 N/mm^2 . Determine normal stress, shear stress and the resultant stress on a plane inclined at 20° with the major principal plane. Determine also the obliquity. What will be the intensity of stress, which acting alone will produce the same maximum strain if Poisson's ratio = $\frac{1}{4}$. [16]
8. A solid circular shaft, which transmits 300 metric H.P. at 150 r.p.m, is to be replaced by a hollow shaft equal weight and of the same material, having the bore equal to half the external diameter. If the horse power transmitted is to remain unaltered, find the percentage change in the speed of the shaft. The maximum shear stress in the shaft is not to exceed 66.5 N/mm^2 . [16]

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1. (a) Explain the terms 'Ductility' and 'Malleability'. Give examples.
 (b) State Hooke's law and hence define modulus of elasticity
 (c) Two vertical rods, one of steel and the other of bronze are each fastened at the upper end at a distance of 500mm apart. Each rod is 1m long and 10mm in diameter. A horizontal rigid bar connects the lower ends of the bar and a load of 10kN is placed so that the bar remains horizontal. Find the position of the load on the cross bar and the stresses in each rod. Take modulus of elasticity of steel and brass as 200kN/mm² and 60kN/mm². [6+4+6]
2. (a) A circular rod 400mm long and 60 mm in diameter is subjected to an axial pull of 350kN. The increase in the length is 0.18mm and the decrease in diameter is 0.014mm. Calculate the values of Poisson's ratio, Modulus of elasticity, Bulk Modulus and Rigidity Modulus.
 (b) What do you mean by 'a bar of uniform strength'. Give the expression for it and explain the terms. [8+8]
3. (a) What is point of contra flexure.
 (b) Draw shear force and bending moment diagrams and mark the salient values. [4+12]
 {As shown in the Figure3b}

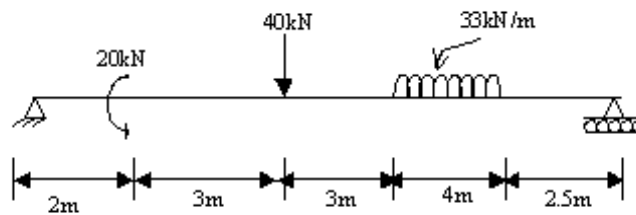


Figure 3b

4. (a) List the assumption involved in the theory of simple bending.
 (b) Compare the weight of two beams of the same material and equal strength. One beam is of solid circular cross section, while the other beam is of hollow circular section, the internal diameter being 0.85 times the external diameter.
 (c) Find the section modulus for a rectangular cross section of 100mm × 300mm. [4+6+6]

5. Find the ratio of maximum shear stress to the mean shear stress for a cross section in the figure 5. [16]

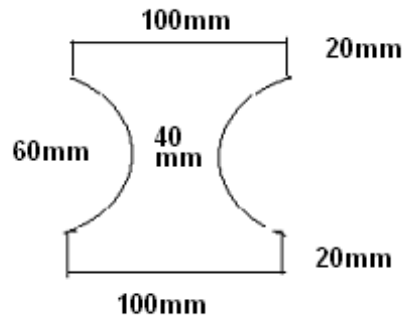


Figure 5

6. A copper tube of 32mm internal diameter and 34mm external diameter is closely wound with steel wire 1mm diameter. Estimate the tension at which the wire must have been wound if an internal gauge pressure of 2N/mm^2 . Produce a tensile circumferential stress of 8N/mm^2 in the copper tube. E for steel 1.65 for copper. [16]
7. At a certain point in a strained material the intensities of normal stresses on two planes at right angles to each other are 20 N/mm^2 and 10 N/mm^2 both tensile. They are accompanied by shear stress of 10 N/mm^2 . Find the principal planes and the principal stresses. Find also the maximum shear stress. [16]
8. Find the dimensions of a hollow shaft of internal diameter = $0.6 \times$ external diameter, to transmit 150 kW at 250 r.p.m. if the shearing stress is not to exceed 70 N/mm^2 . If a blending moment of 3000 Nm is now applied to the shaft find the speed at which it must be driven to transmit the same power for the same value of the maximum shearing stress. [16]

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1. (a) Explain the terms Elasticity and Plasticity. Give examples.
 (b) A steel plate of constant thickness of 10 mm is having a breadth of 120mm at one end and uniformly varies to a breadth of 50mm at the other end. It is subjected to an axial tensile force of 55kN at the ends. Take $E = 200 \text{ kN/mm}^2$. The length of the plate is 0.7m. Derive the expression involved from first principles and hence find the total extension. [8+8]
2. (a) Three vertical rods carry a tensile load of 150 kN. The cross-sectional area of each bar is 525 mm^2 . Their temperature is raised by 65°C and the load is now so adjusted that they extend equally. Determine the load shared by each rod. The outer two rods are of steel and the middle one is of brass.
 Take $E_{\text{steel}} = 2 E_{\text{brass}} = 200 \text{ GPa}$
 $\alpha_{\text{steel}} = 11 \times 10^{-6} \text{ per } ^\circ\text{C}$, $\alpha_{\text{brass}} = 18 \times 10^{-6} \text{ per } ^\circ\text{C}$.
 (b) Define the terms Bulk modulus and shear modulus. [10+6]
3. (a) What is 'point of contra flexure'.
 (b) Draw shear force and bending moment diagrams and mark the salient values. [4+12]
 {As shown in the Figure3b}

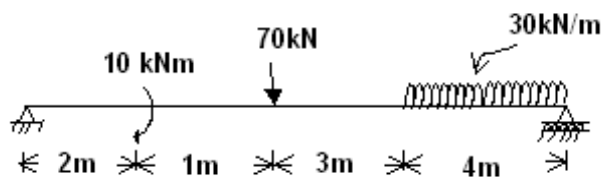


Figure 3b

4. (a) What is elastic section modulus?
 (b) Calculate the maximum stress induced in a cast iron pipe of external diameter 50mm, internal diameter 30mm and of length 4.5m. The pipe is supported at its ends and carries a point of 100N at its center.
 (c) A cantilever of length 2.5m fails when a load of 3 kN is applied at the free end. If the section of the beam is $45 \text{ mm} \times 75 \text{ mm}$, find the stress at failure. [4+6+6]
5. A steel section shown in figure 5 is subjected to a shear force of 80KN. Determine shear stress at the important points and sketch the shear distribution across the section. [16]

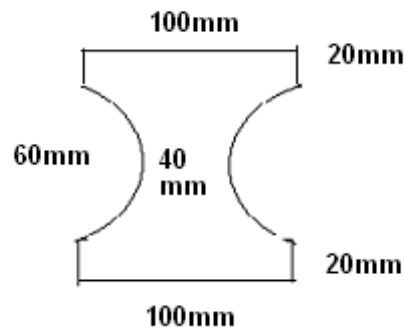


Figure 5

6. (a) Define a thick cylinder. What are the possible stresses in the thick cylinder, when subjected to internal pressure.
 (b) State the expressions for stresses in thick cylindrical shells. State and derive the lame's expressions with the assumptions involved. [8+8]
7. A rectangular block of material is subjected to a tensile stress of 100 N/mm^2 on one plane and a tensile of 50 N/mm^2 on a plane at right angles, together with shear stresses of 60 N/mm^2 on the same planes. Find:
 - (a) The direction of the principal planes
 - (b) The magnitude of the principal stresses.
 - (c) The magnitude of the greatest shear stress. [6+4+6]
8. A hollow shaft 450 mm external diameter and 250mm internal diameter is subjected to a torque of 400 kNm. Find the shear stresses at the outer and the inner surfaces of the shaft. Draw the shear stress distribution for the wall of the shaft. Find also the twist in a length of 2.50 m of the shaft. Take $C = 8 \times 10^4 \text{ N/mm}^2$. [16]

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1. (a) What is a homogeneous and isotropic material?
 (b) Define the terms stress and strain. State their units.
 (c) A steel rod having circular cross section tapers uniformly from 50mm diameter at one end to 35mm diameter at the other end in a length of 0.7m. Take $E = 210 \text{ kN/mm}^2$. It is subjected to an axial compression of 55kN at the ends. Find the deformation of the bar by deriving the expression involved, from first principles. [4+4+8]

2. A steel rod of 20mm diameter passes centrally through a brass tube of 40mm external diameter and 30mm internal diameter. The tube is closed at each end by rigid plates of negligible thickness. The nuts are tightened lightly home on the projected parts of the rod. If the temperature of the assemble is raised by 80°C , calculate the stresses developed in brass and steel.
 Take $E_{\text{steel}} = 210 \text{ GPa}$, $E_{\text{brass}} = 100 \text{ GPa}$
 $\alpha_{\text{steel}} = 11.8 \times 10^{-6} \text{ per } ^\circ\text{C}$, $\alpha_{\text{brass}} = 19 \times 10^{-6} \text{ per } ^\circ\text{C}$. [16]

3. (a) What do you mean by point of contra flexure.
 (b) Draw shear force and Bending Moment diagrams for the beam shown in (figure3b). [8+8]

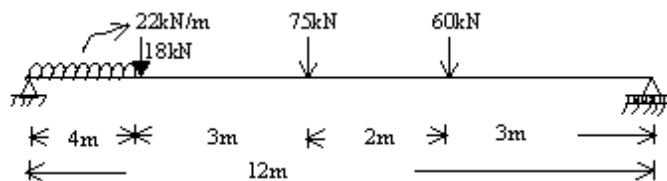


Figure 3b

4. (a) List the assumption involved in the theory of simple bending.
 (b) Compare the weight of two beams of the same material and equal strength. One beam is of solid circular cross section, while the other beam is of hollow circular section, the internal diameter being 0.8 times the external diameter.
 (c) Find the section modulus for a rectangular cross section of $200\text{mm} \times 350\text{mm}$. [4+8+4]

5. A hollow rectangular (box) section having 350×250 outer dimensions and 300×200 inner dimensions is subjected to a linear change in bending moment of 8KNm per meter length along the length of member. Determine the shear stress distribution across the depth of section and maximum shear stress. [16]

6. Calculate

- (a) the change in diameter,
- (b) change in length and
- (c) change in volume of a thin cylindrical shell 100cm diameter, 1cm thick and 5m long when subjected to internal pressure of 3N/mm^2 ;
Take the value of $E = 2 \times 10^5 \text{N/mm}^2$ and poisson's ratio=0.3; [4+4+8]

7. A rectangular rosette strain gauge records the following values for linear strain at a point in two dimensional stress system: $e_x = 500 \times 10^{-6}$, $e_y = -125 \times 10^{-6}$ and $e_{45} = 250 \times 10^{-6}$ the latter being at 45° to the X and Y axes. Determine the principal strains and stresses. Take $E = 2.1 \times 10^6 \text{ N/mm}^2$ and $\mu = 0.3$. [16]

8. A hollow shaft of diameter ratio $3/8$ is to transmit 375 kW at 100 rpm, the maximum torque being 20% greater than the mean; the shear stress is not to exceed 60 N/mm^2 and the twist in a length of 4 metre is not to exceed 2 degrees. Calculate its external and internal diameters, which would satisfy both the above conditions. Take $C = 8 \times 10^4 \text{ N/mm}^2$. [16]
