Code No: RR10802 **Set No. 1**

I B.Tech Supplementary Examinations, November/December 2005
STRENGTH OF MATERIALS
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Define stress, strain and Modulus of elasticity of a material.
   (b) What is ductility of a material? Is ductility a desirable property of a material? What is working stress of a material?
   (c) A steel rod ABCD is loaded as shown in Figure1. Estimate the total deformation and stresses. Take E= 210 kN/mm^2.

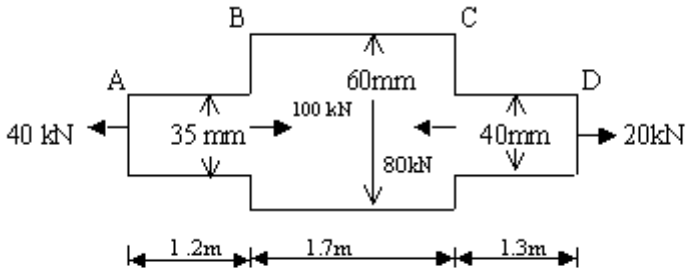

Figure 1:

[6+4+6]

2. A steel rod of 20mm diameter passes centrally through a copper tube 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 assembly is raised by 70^0C, calculate the stresses developed in copper and steel.
   Take $E_{steel} = 210$ GPa, $E_{copper} = 100$ GPa and
   $\alpha_{steel} = 12 \times 10^{-6}$ per ^{0}C,
   $\alpha_{copper} = 18 \times 10^{-6}$ per ^{0}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 (figure2). [8+8]

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.

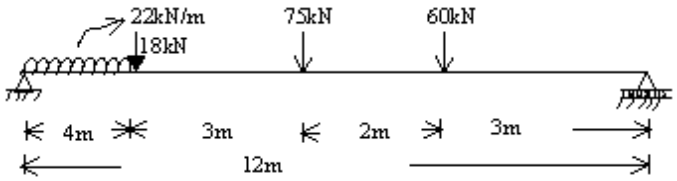

Figure 2:

(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 45mm × 75mm, find the stress at failure. [4+6+6]

5. A cast iron bracket subjected to bending has a cross section of unsymmetrical I-section with a 300mm x 80mm web, 300mm x 100mm top flange and 200mm x 100mm bottom flange. If the cross section is subjected to a shear force of 150KN, draw the shear stress distribution over the depth of the section and also calculate the maximum shear stress. [16]

6. (a) Derive the expression for change in dimensions of thin cylindrical shells.

   (b) Explain and derive the volumetric strain that occur in thin cylinders. [8+8]

7. Construct Mohr's circle for an element in pure shear q.

   (a) From the circle, derive the following stress transformation equations:
   $$P_n = q \sin 2\theta;\ P_t = q \cos 2\theta.$$

   (b) Obtain from the circle the principal stresses and show them on a sketch of properly oriented element.

   (c) Show from the circle that the maximum and minimum shear stresses are ± q.

   [8+4+4]

8. (a) A solid shaft of diameter 80mm is subjected to a twisting moment of 8 M N mm and a blending moment of 5 M N mm at a point. Determine:

      i. Principal stresses and

      ii. Position of the plane on which they act.

   (b) A steel shaft transmits 105 kW at 160 r.p.m.If the shaft is 100mm in diameter, find the torque on the shaft and the maximum shearing stress induced. Find also the twist of the shaft in a length of 6m. Take C = 8 * 10^4 N/mm^2.[8+8]

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Code No: RR10802 **Set No. 2**

I B.Tech Supplementary Examinations, November/December 2005
STRENGTH OF MATERIALS
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain the hardness and toughness of a material.
   (b) Describe the various types of stress.
   (c) Find the total deformation and stresses in the steel bar shown in Figure1 Below [4+4+8]

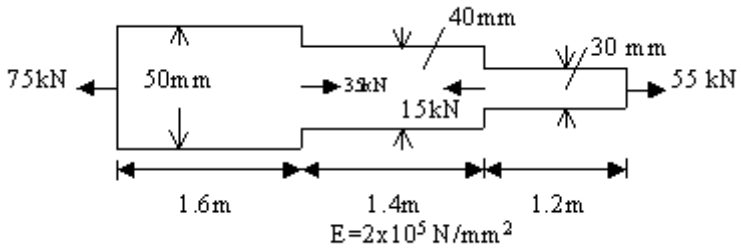

Figure 1:

2. A bar of steel is 50mm × 50mm in section and is 140mm long. It is subjected to a tensile load of 270 kN along the longitudinal axis and tensile loads of 500 kN, 420 kN on the lateral faces.
   (a) Find the charge in dimensions of the bar and the change in volume.
   (b) Also find what axial longitudinal tensile load acting alone can produce the same longitudinal strain as in(a) . [8+8]

3. Draw shear force and bending moment diagrams and mark the salient values. {As shown in the Figure2} [16]

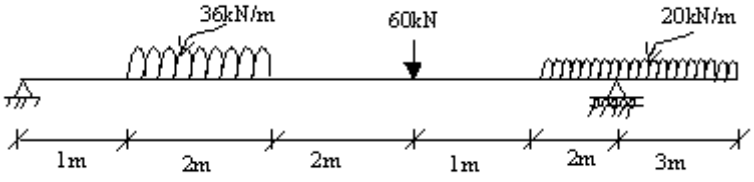

Figure 2:

4. (a) A beam resting freely on supports 5.6m apart, carries a u.d.l of 11 kN/m and also a point load of 10kN at 2m from the left support. If the permissible stress in timber is 6MPa, design a suitable section by making the depth equal to 1.8 times the width.

   (b) What is elastic section modulus. [12+4]

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) Derive the expression for change in dimensions of thin cylindrical shells.

   (b) Explain and derive the volumetric strain that occur in thin cylinders. [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 20^0 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 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 * 10^4 N/mm^2. [16]

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Code No: RR10802 **Set No. 3**

I B.Tech Supplementary Examinations, November/December 2005
STRENGTH OF MATERIALS
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Draw a neat sketch of a typical stresses-strain curve obtained from a direct tension test on a mild steel rod and explain the salient points.
   (b) Define stress and strain.
   (c) A rigid bar ABC hinged at 'A' and supported at two points 'B' and 'C' by the steel and Aluminum bars whose c/s area is 500 mm^2 and 450 mm^2 respectively. A 30 kN load is acting mid-way between B and C. Determine the load taken by the two rods. Take E$_s$ = 2x10^5 MPa, E$_{Aluminium}$ = 0.7x10^5 MPa. {as shown in the figure1} [4+4+8]

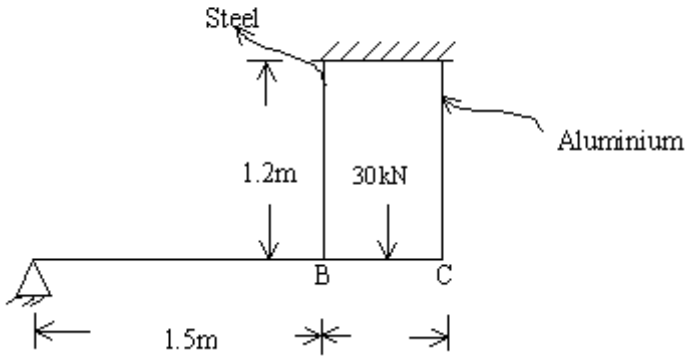

Figure 1:

2. A bar of brass 30mm diameter enclosed in a steel tube of 60mm external diameter and 30mm internal diameter. The bar and the tube are rigidly fastened at both ends and are both initially 1.2 m long. Determine the stresses in the material when the temperature raises by 110^{0}C. If the composite bar is then subjected to an axial tensile load of 70 kN, find the resulting stresses. Take E$_{steel}$ = 2 × 10^5 MPa, E$_{brass}$ = 1 × 10^5 MPa and the coefficients of the expansion α_{steel} =11.6 × 10^{-6} per ^{0}C, α_{brass} = 18.7 × 10^{-6} per ^{0}C. [16]

3. Draw shear force and bending moment diagrams and mark the salient values. {As shown in the Figure2} [16]

4. (a) A water main 100mm internal diameter is made of mild steel plate 12mm thick and is running full. If it is freely supported at the ends find the maximum

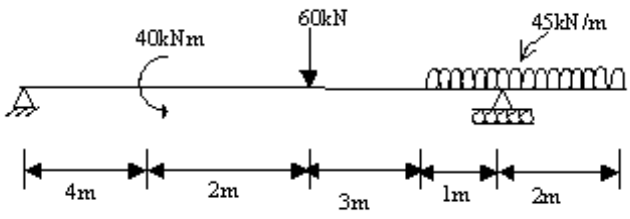

Figure 2:

permissible span if the bending stress is not to exceed 4 MPa. Unit weight of steel = 78 kN/m^3, Unit weight of water = 9.81 kN/m^3.

(b) Define the term elastic section modulus. [12+4]

5. A steel section shown in figure3 is subjected to a shear force of 80KN. Determine shear stress at the important points and sketch the shear distribution across the section. [16]

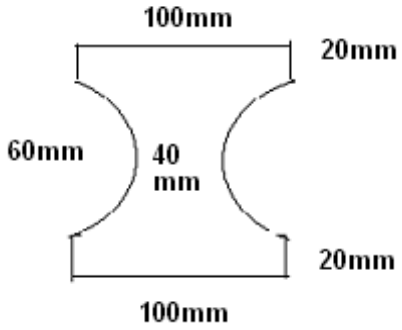

Figure 3:

6. (a) Define a thin cylinder.

(b) Describe the types of possible failures in a thin cylinder subjected to uniform internal pressure.

(c) Derive the equation for circumferential stress in the thin cylinder subjected to internal pressure. [4+4+8]

7. The intensity of the resultant stress on a plane AB at a point in a material under stress is 80 N/mm^2 and is inclined at 30° to the normal to that plane. The normal component of stress on another plane BC, at right angles to the plane AB is 60 N/mm^2. Determine the following. (figure shown below 4)

(a) The resultant stress on the plane BC

(b) The principal stresses and their directions

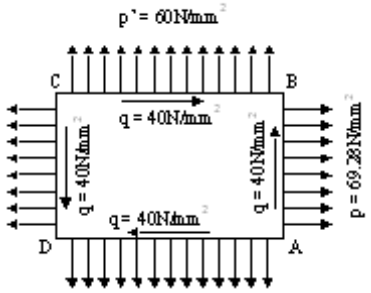

Figure 4:

The maximum shear stresses and their planes.

[4+4+8]

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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Code No: RR10802 **Set No. 4**

I B.Tech Supplementary Examinations, November/December 2005
STRENGTH OF MATERIALS
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Draw a typical stress-strain curve obtained from a direct tension test on a mild steel rod and explain the salient points.
   (b) Explain the terms 'toughness', and 'hardness' of a material.
   (c) A composite bar of length 700mm is made up of an aluminum bar of length 400mm and steel bar of length 300mm. The cross-sectional areas of aluminum and steel bars are of 100mm × 100mm and 50mm × 50mm respectively. Assuming that the bars are prevented from buckling sideways, calculate the compressive force P to be applied to the composite bars that will cause the total length of the bar to decease by 0.25mm. Take modulus of elasticity of aluminum and steel as 70 kN/mm^2 and 200kN/mm^2 respectively. [6+4+6]

2. (a) Define the elastic constants and Poisson's ratio. State their units.
   (b) A compound mild steel rod ABC of circular section transmits on axial pull. The total length of the bar is 1.5 m, the part AB is 0.85m long the BC 0.65m long. AB is 25mm diameter, and BC is 20mm diameter. If the total change in length is 0.9mm, determine for separate parts AB and BC the changes in length, diameter and volume. Take Poisson's ratio=0.3. [8+8]

3. Draw shear force and bending moment diagrams and mark the salient values. [16] (figure1) shown in below.

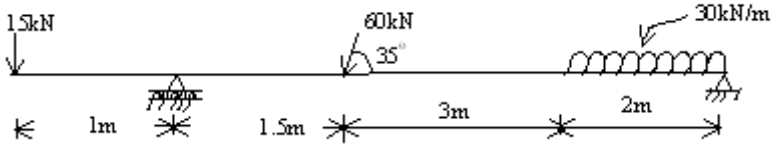

Figure 1:

4. Derive the bending equation from first principles. State the assumptions involved. [16]

5. A hollow rectangular (box) section having 350 x 250 outer dimensions and 300 x 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. A cast iron pipe of 220mm internal diameter and 15mm metal thickness is closely wound with a layer of 5mm diameter steel wire with a tensile stress of 42N/mm^2.

Calculate the stresses induced in pipe and the steel wire if the internal fluid pressure in the pipe is $32 N/mm^2$.
$E = 1 \times 10^5$ N/mm^2 for C.I.
$E_s = 2 \times 10^5$ N/mm^2 1/m=0.3. [16]

7. At a point in a strained material subjected to plane strain, $e_x = 510 * 10^{-6}$, $e_y = 165 * 10^{-6}$ and $\varphi_{xy} = 270 * 10^{-6}$. Determine the following:

   (a) Strains for an element rotated through an angle $\theta = 30^0$

   (b) Principal strains, and principal strains axes

   (c) Maximum shearing strain.
   Solve the problem analytically.

   [4+4+8]

8. A shaft transmits 300 kW power at 120 r.p.m. Determine

   (a) The necessary diameter of diameter of solid circular shaft

   (b) The necessary diameter of hollow circular section, the inside diameter being 2/3 of the external diameter. The allowable shear stress is 70 N/mm^2. Taking the density of material is 77 kN/m^3 , calculate the % saving in the material if hollow shaft is used. [8+8]

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