

Subject Name: Mechanics of Materials-I

Assignment-II

D.O.S: 1<sup>st</sup> Dec. 2010

1. An aluminum rod 30 mm diameter passes through a steel tube of 45 mm external diameter and 3 mm thick. The rod and tube are fixed at temperature  $150^{\circ}\text{C}$ . Find the stresses in the rod and tube when the temperature falls to  $30^{\circ}\text{C}$ .

Take:  $E_s = 210 \text{ KN/mm}^2$ ,  $\alpha_s = 12.1 \times 10^{-6} / ^{\circ}\text{C}$ ,  $E_a = 70 \text{ KN/mm}^2$  and  $\alpha_a = 23.11 \times 10^{-6} / ^{\circ}\text{C}$

2. The aluminium and steel rods as shown in the Figure-1 are held between two supports. The rods are stress-free at temperature of  $40^{\circ}\text{C}$ . What will be stresses in the two rods when the temperature is  $10^{\circ}\text{C}$  if (i) the supports are non-yielding, and (ii) the supports come nearer to each other by 0.1 mm.

Take:  $E_s = 200 \text{ GPa}$ ,  $\alpha_s = 11.7 \times 10^{-6} / ^{\circ}\text{C}$ ,  $E_a = 70 \text{ GPa}$ ,  $\alpha_a = 23 \times 10^{-6} / ^{\circ}\text{C}$

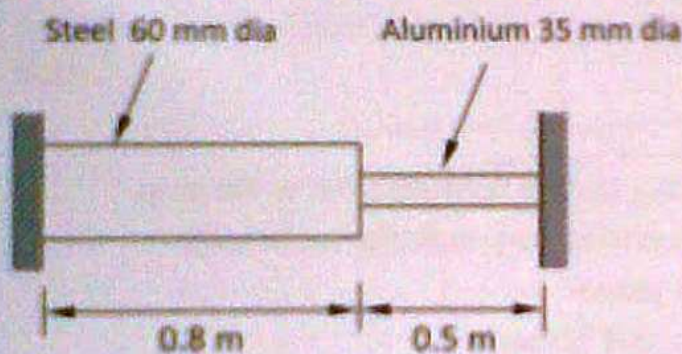
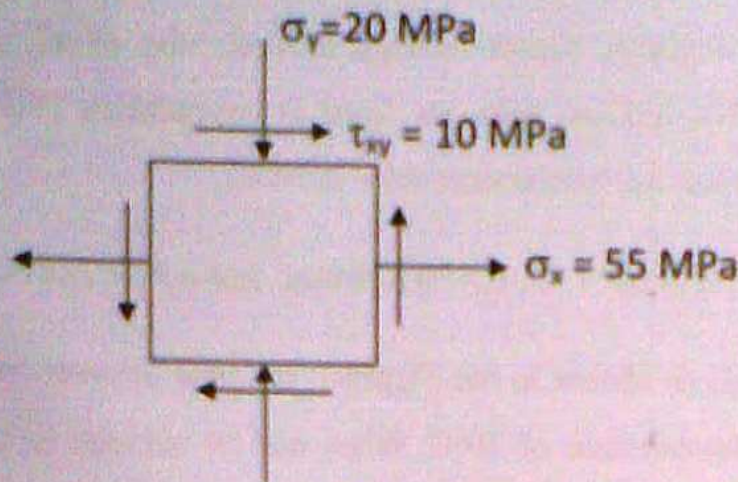


Fig-2

3. At a certain point in a strained material, the stress acting is 40MPa tensile in X- direction, 30 MPa compressive in Y- direction and 20MPa shear. Determine the principal stresses and their locations. Find also the maximum shear stress and the stresses on a plane inclined at  $35^{\circ}$  to the plane carrying the stress of 40MPa.
4. At a point on the surface of a machine component the stresses acting on the x face of a stress element are  $\sigma_x = 55 \text{ MPa}$  (tensile),  $\sigma_y = 20 \text{ MPa}$  (compressive) and  $\tau_{xy} = 10$



MPa as shown in the Figure-2. Find the principal stresses and maximum shear stress by constructing Mohr's stress circle. Show the direction of the principal planes on the element.



(Figure-2)

5. A shaft 8cm diameter is subjected to a bending moment of 300 kN-m and a torque of 250kN-m.

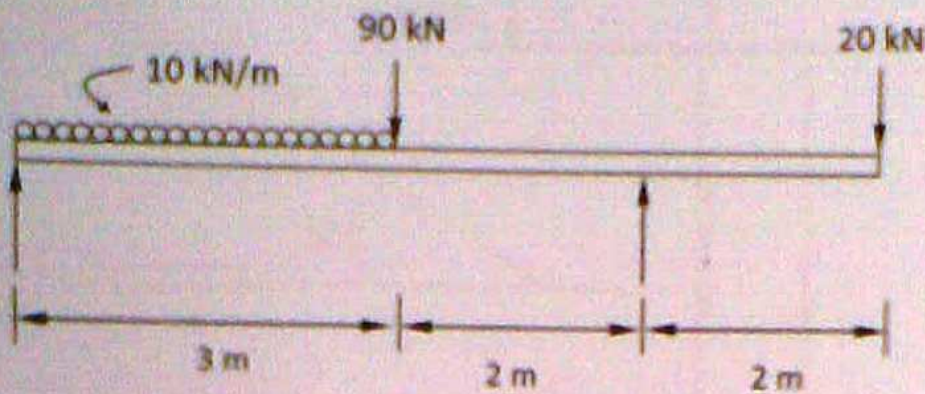
Determine the following:

- the maximum normal bending stress on a section perpendicular to the axis.
  - the maximum normal shear stress on a section perpendicular to the axis.
  - the principal stresses and the principal planes.
  - the maximum shear stress and the principal planes.
6. The propeller shaft of a steam ship has to transmit 900 kW at 380 rpm. The shaft has an internal diameter of 160 mm. Calculate the minimum external diameter if the shearing stress in shaft is limited to  $190 \text{ N/mm}^2$ .
7. A shaft is required for an engine which indicates 750 kW at 80 r.p.m, the maximum twisting moment on the shaft is 1.8 times the mean torque. The main bearings are 5m apart and the shaft carries a flywheel midway between bearings weighing 400kN. The B.M due to this weight is additional to that due to the steam pressure which is 0.8 times the mean twisting moment. Find the diameter of the shaft to satisfy the condition that the maximum tensile stress in the material is 56MPa.
8. A cantilever ABCD, 8m long is fixed at A, such that AB= BC= 3m and CD= 2m. It carries loads 20kN, 10kN and 5 kN at B, C and , respectively, in addition to U.D.L. of



10kN/m run between A and B and 20kN/m between C and D. Draw S.F.D and B.M.D and salient values.

9. Draw the shear force and bending moment diagrams for the beam shown below.



(Figure-3)

10. A simply supported beam having hollow rectangular cross section as shown in the Figure 4. The beam resists B.M about the horizontal neutral axis. The permissible stresses in tension and compression are to be 29 and 78 Mpa, respectively. Calculate the moment of resistance of the section about the horizontal neutral axis for both positive and negative B.M.

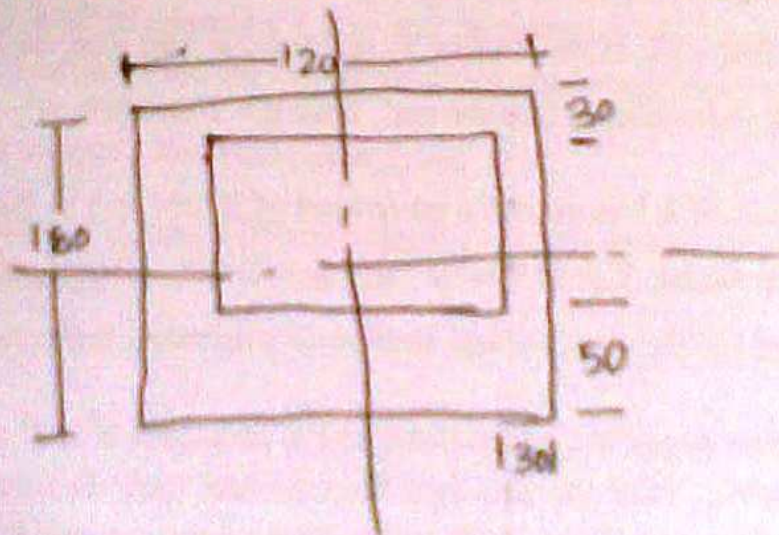


Figure-4

11. A T-beam of cross section 120×130×20 mm (Figure-5) is simply supported at its ends over a span of 3 m, the flange of 120 mm being horizontal. What concentrated load can



be applied at mid-span if the maximum tensile stress is not to exceed 150 Mpa? Show the bending stress distribution in the section.

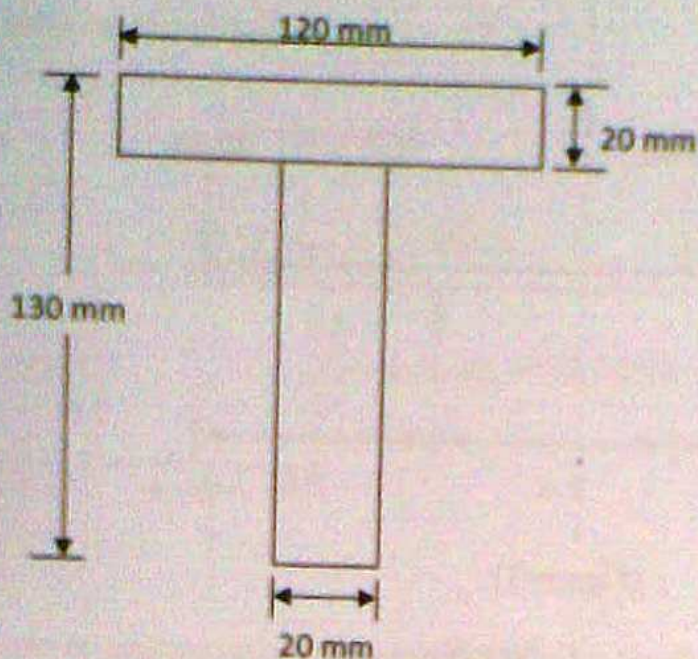


Figure-5

12. A cantilever of length 4m carries a u.d.l. of 1500 N/m on its full length and a point load of 1000N at the free end. If the section is rectangular 160 mm wide and 280 mm deep, find the slope and deflection at free the end. Take  $E = 20000 \text{ N/mm}^2$ .
13. A beam with a span of 4.5 m carries a point load of 30 kN at 3 m from the left support. If the section of the beam,  $I_{xx} = 54.97 \times 10^{-6} \text{ m}^4$  and  $E = 200 \text{ GN/m}^2$ , find (i) the deflection under the load and (ii) the position and amount of maximum deflection.
14. For a  $60^\circ$  rosette, the respective strain measured at an angles  $0^\circ$ ,  $60^\circ$  and  $120^\circ$  are  $+0.0003$ ,  $+0.0003$  and  $-0.0002$ . Find the principal stresses and their directions. Take  $E = 210 \text{ GPa}$  and  $\nu = 0.25$ . The stress condition is 2D in the plane of measurement.
15. On the surface of a structural component in a space vehicle, the strains are monitored by means of three strain gages arranged as shown in the Figure-6. During a certain maneuver, the following strains were recorded:  $\epsilon_a = 1200 \times 10^{-6}$ ,  $\epsilon_b = 300 \times 10^{-6}$  and  $\epsilon_c = 400 \times 10^{-6}$ . Determine the principal strains and principal stresses in the material for which  $E = 210 \text{ GPa}$  and  $\nu = 0.30$ .



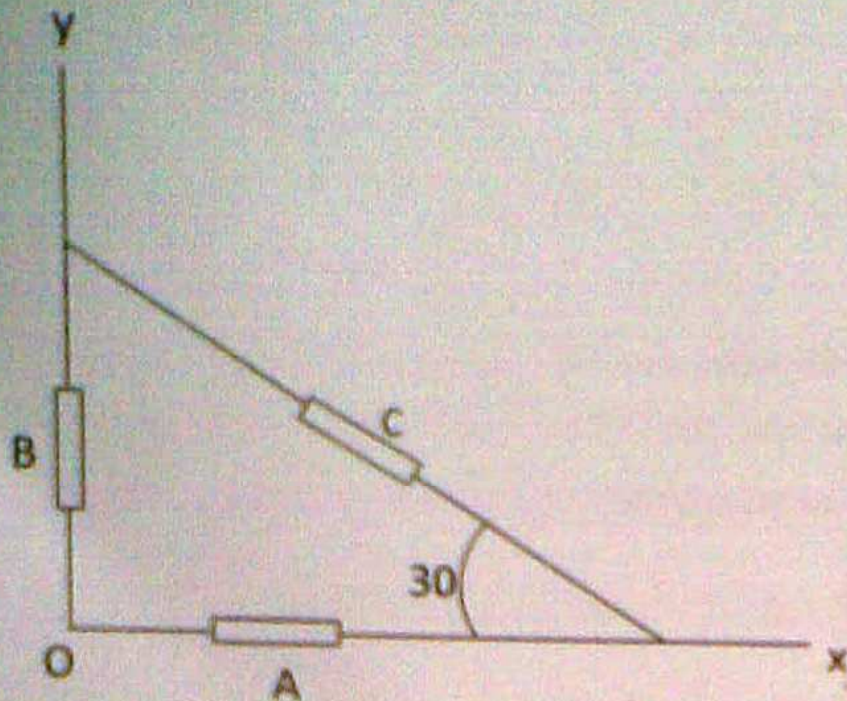


Fig.6

16. A steel bar of solid circular cross section is 50 mm in diameter. The bar is pinned at both ends and subjected axial compression. If the limit of proportionality of the material is 210 Mpa and  $E = 200$  Gpa, determine the minimum length for which Euler's formulae is valid. Also determine the value of Euler buckling load if the column has minimum length.
17. The cylindrical shell of diameter 1.2 m and thickness is 15 mm is subjected to an internal pressure of  $20 \text{ N/mm}^2$ . Find the circumferential and longitudinal stresses.
18.
  - a) Fatigue strength and Endurance Limit
  - b) Definition of spring. Different types of spring and deduce relation for closed coil helical spring.