Total No. of Questions—12] [Total No. of Printed Pages—8+4

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S.E. (Mechanical & Mechanical Sandwich)

(Second Semester) EXAMINATION, 2010

(For Mechanical Branch Sem.-II and

For Mechanical Sandwich Sem.-I

STRENGTH OF MACHINE ELEMENTS

(2008 COURSE)

Time : Three Hours **Maximum Marks : 100**

N.B. :— (*i*) Answer *three* questions from Section I and *three* questions from Section II.

(*ii*) Answers to the two sections should be written in separate answer-books.

(*iii*) Neat diagrams must be drawn wherever necessary.

(*iv*) Figures to the right indicate full marks.

(*v*) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

(*vi*) Assume suitable data, if necessary.

SECTION I

UNIT I

1. (*a*) Derive the relation between Young's modulus and Bulk modulus. [4]

P.T.O.

(*b*) A wagon weighing 35 kN is attached to the wire rope and moving down an inclined plane at speed of 3.6 kmph. The wire rope diameter is 40 mm and its length is 60 m. When the rope jams and the wagon is suddenly brought to rest. Calculate the maximum instantaneous stress and maximum instantaneous elongation produced in it. Take modulus of elasticity E = 210 GPa. [6]

(*c*) A steel rod 40 mm in diameter is enclosed by a copper tube of external diameter 50 mm and internal diameter 40 mm. A pin 25 mm in diameter is fitted transverse to the assembly at each end as shown in Fig. 1 so as to secure the rod and the tube. If the temperature of the assembly is raised by 60°C, find :

(*i*) the stresses in steel rod and copper tube and

(*ii*) shear stress in the pin.

Take E_{st} = 200 GPa, E_{cu} = 100 GPa, $\alpha_{st} = 1.2 \times 10^{-5}$/°C, $\alpha_{cu} = 1.6 \times 10^{-5}$/°C. [8]

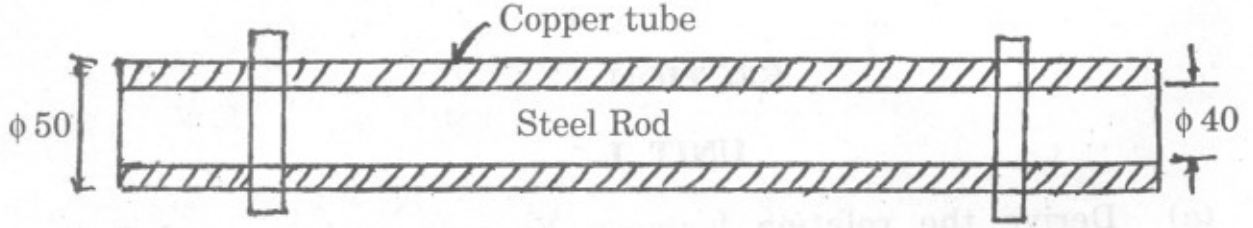

Fig. 1

Or

2. (*a*) Water under pressure 8 MPa is suddenly admitted on to a plunger of 80 mm diameter, attached to a rod of 25 mm diameter, 2.5 m long. Find the maximum instantaneous stress and deformation of the rod. Take E = 210 GPa. [6]

(*b*) Determine the elongation of a bar of tapering section having diameter d_1 and d_2 and length L and subjected to an axial force P. [4]

(*c*) The bulk modulus for the material is 50 GPa. A 12 mm diameter rod of the material was subjected to an axial pull of 14 kN and the change in diameter was observed to be 3.6×10^{-3} mm. Calculate Poisson's ratio and Modulus of elasticity. [8]

UNIT II

3. (*a*) Simply supported beam of span L carrying U.D.L. of W per unit run over the whole span. Derive the equation for maximum deflection and slope at each end. [6]

(*b*) A beam ABCDEF 12 m long and supported at A and E as shown in Fig. 2. Draw Shear Force and Bending Moment diagrams of the beam. Also find the position of point of contraflexure, if any. [10]

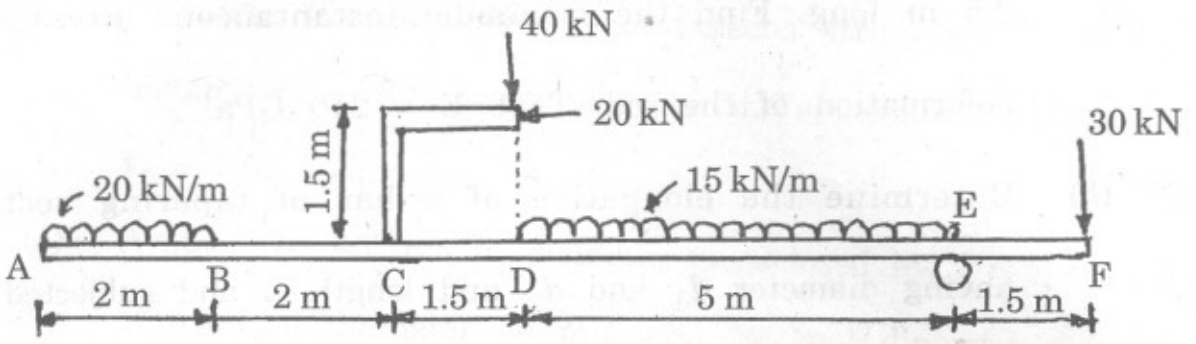

Fig. 2

Or

4. (*a*) Determine slope and deflection at point B and maximum deflection for the beam as shown in Fig. 3. Take E = 200 GPa, Moment of Inertia I = 20×10^{-5}. [8]

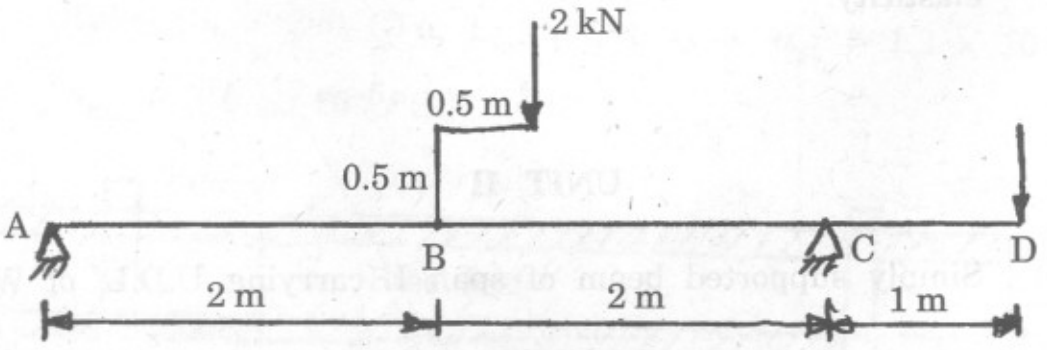

Fig. 3

(*b*) Fig. 4 shows the Shear Force diagram for a beam which rests on two supports one of them is at left end. Draw the Loading diagram and Bending moment diagram and also find the position of second support. [8]

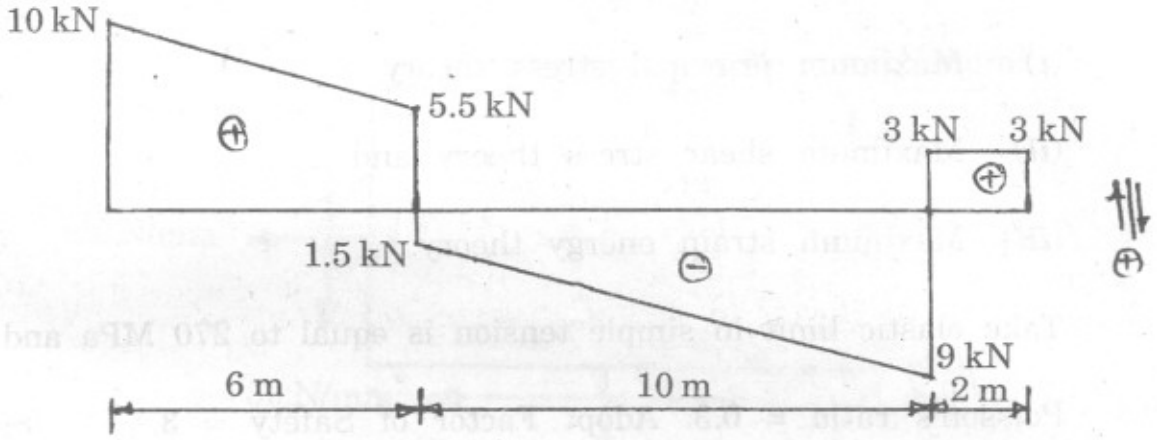

Fig. 4

UNIT III

5. (*a*) Derive the equations for normal and shear (tangential) stresses on an inclined plane BE when it is subjected to two mutually perpendicular tensile stresses σ_x and σ_y as shown in Fig. 5. [8]

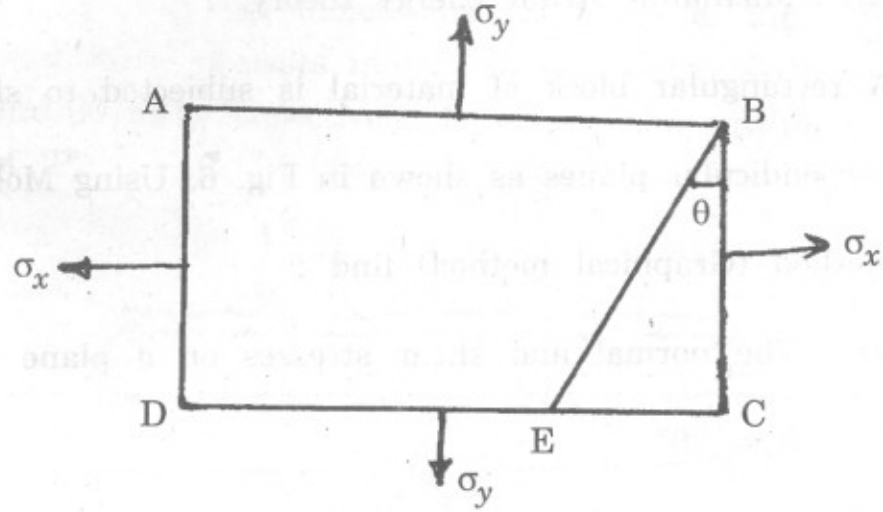

Fig. 5

(*b*) A bolt is subjected to an axial pull of 8 kN and a transverse shear force of 3 kN. Determine the diameter of the bolt required based on :

(*i*) Maximum principal stress theory

(*ii*) Maximum shear stress theory and

(*iii*) Maximum strain energy theory.

Take elastic limit in simple tension is equal to 270 MPa and Poisson's ratio = 0.3. Adopt Factor of Safety = 3. [8]

Or

6. (*a*) What are various theories of failures ? Explain in detail :

(*i*) Maximum Principal stress theory and

(*ii*) Maximum strain energy theory. [8]

(*b*) A rectangular block of material is subjected to stresses on perpendicular planes as shown in Fig. 6. Using Mohr's Circle method (Graphical method) find :

(*i*) The normal and shear stresses on a plane for which $\theta = 30°$

(*ii*) The magnitude of principal stresses and

(*iii*) inclination of the planes on which principal stresses acts. [8]

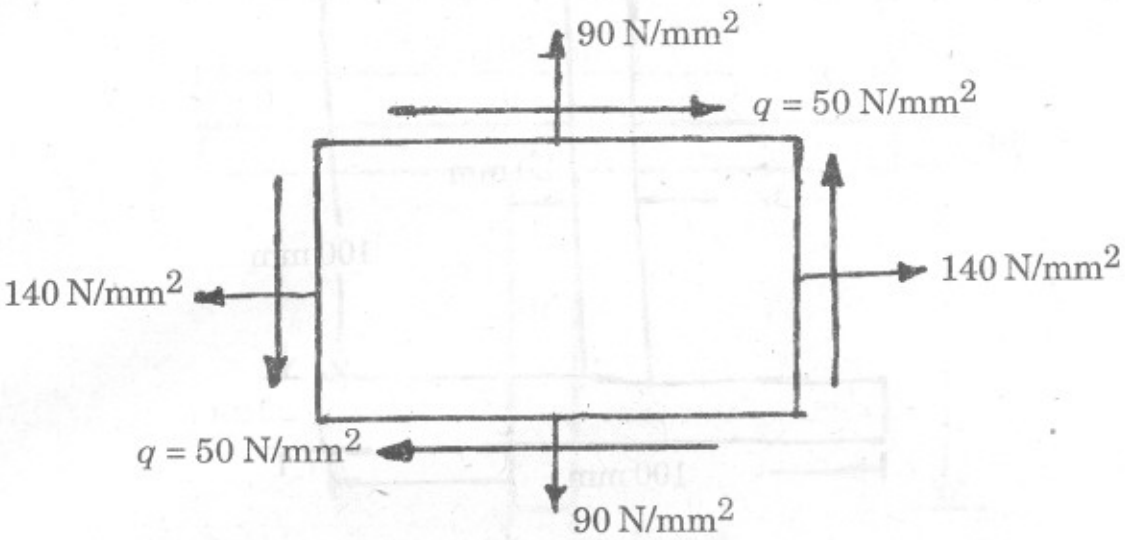

Fig. 6

SECTION II
UNIT IV

7. (*a*) A simply supported beam of 4 m span carries a load 'P' acting vertically downward as shown in Fig. 7 (*a*). The cross-section is I section the dimensions are given in Fig. 7 (*b*). If the permissible stresses in tension and compression are 40 MPa and 30 MPa respectively. Determine the maximum safe value of 'P'. [8]

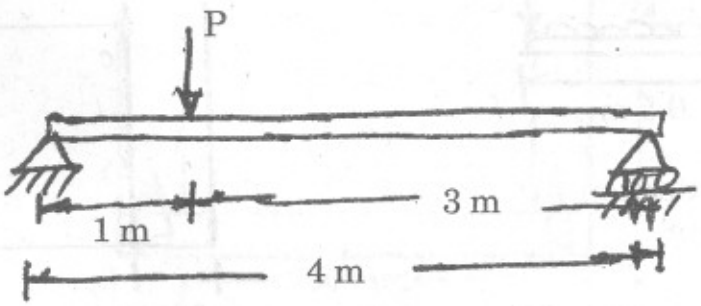

Fig. 7 (*a*)

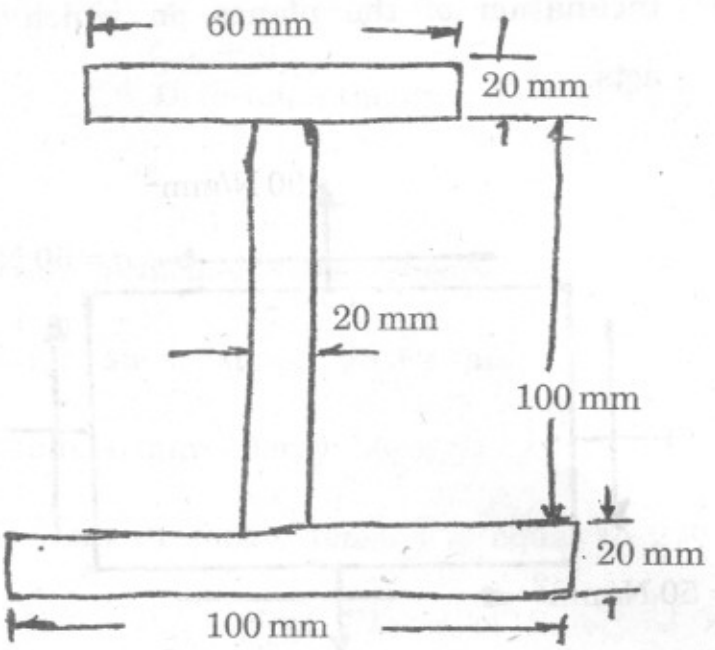

Fig. 7 (*b*)

(*b*) A cantilever beam of negligible self-weight carries uniform distributed load 40 kN/m over entire span of 1 m and also has a concentrated load 80 kN at free end, find shear stresses along horizontal planes passing through points *a*, *b* and *c*. Section of beam and the points are shown in Fig. 8. [8]

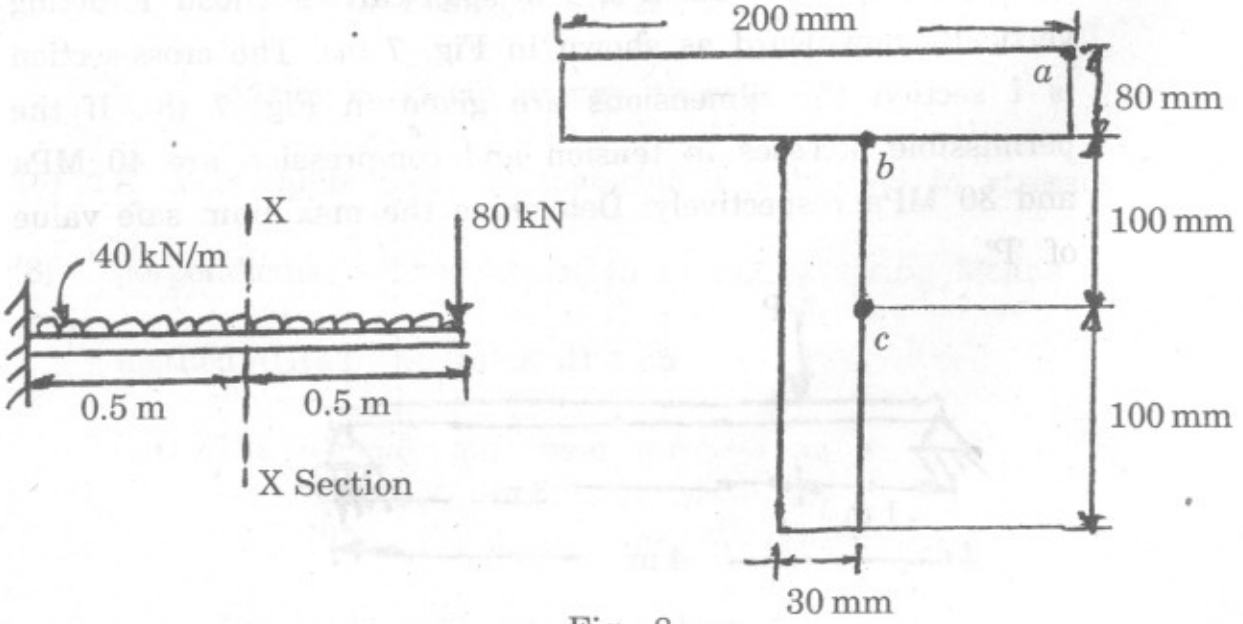

Fig. 8

Or

8. (*a*) A cantilever beam has 'T' shaped cross-section. It is acted upon by a clockwise couple 'M' at free end. Determine 'M' if allowable stresses in bending in tension and compression are 40 MPa and 105 MPa respectively. Fig. 9 shows the dimensions. [8]

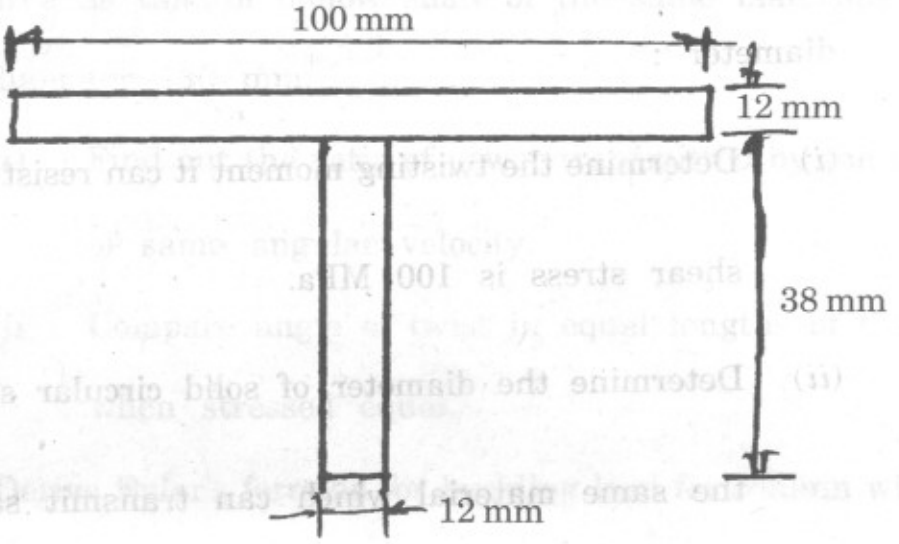

Fig. 9

(*b*) A timber box beam having cross-section as shown in Fig. 10. The beam is simply supported and carries a vertical load 'P' at mid span. Length of beam is 2 m; allowable working stress in bending is 8 MPa. Each screw can transmit a shear force of 3000 N. Find the spacing of screws. [8]

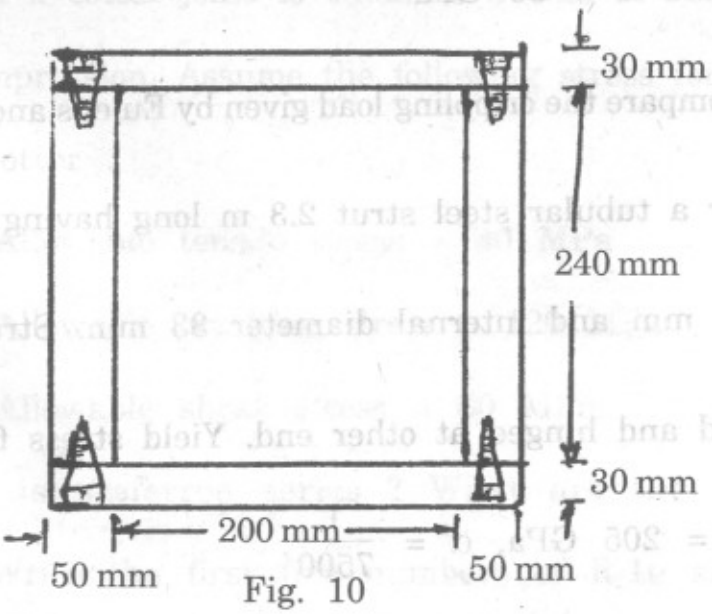

Fig. 10

UNIT V

9. (*a*) A hollow shaft has 60 mm external diameter and 50 mm internal diameter :

(*i*) Determine the twisting moment it can resist if permissible shear stress is 100 MPa.

(*ii*) Determine the diameter of solid circular shaft made of the same material which can transmit same twisting moment.

(*iii*) Compare their weights per meter length.

Take G = 80 GPa. [8]

(*b*) Compare the crippling load given by Euler's and Rankine's formula for a tubular steel strut 2.3 m long having external diameter 38 mm and internal diameter 33 mm. Strut is fixed at one end and hinged at other end. Yield stress for steel 335 MPa, E = 205 GPa, $\alpha = \frac{1}{7500}$. [8]

Or

10. (*a*) A solid shaft of 180 mm diameter has the same cross-sectional area as that of hollow shaft of the same materials of inside diameter 130 mm.

(*i*) Find out the ratio of power transmitted by the two shafts of same angular velocity.

(*ii*) Compare angle of twist in equal lengths of these shafts when stressed equal. [8]

(*b*) Derive Euler's formula for buckling load for column with hinged ends. Also state the limitations of Euler's formula. [8]

UNIT VI

11. (*a*) Design a cotter joint to transmit a load of 90 kN in tension or compression. Assume the following stress for socket, spigot and cotter :

Allowable tensile stress = 90 MPa

Allowable crushing stress = 120 MPa

Allowable shear stress = 60 MPa. [12]

(*b*) What is preferred series ? What are the advantages of it ? Write the first five numbers of R-10 series. [6]

Or

12. (*a*) A knuckle joint is subjected to an axial load of 100 kN. Determine the diameter of knuckle pin considering the load to be uniformly distributed over the pin in the eye and uniformly varying over the portion of pin in forks :

Allowable tensile and compressive stress for pin = 600 N/mm^2

Allowable shear stress for pin = 300 N/mm^2

Allowable bearing pressure for pin = 200 N/mm^2

Thickness of eye = 1.5 × pin diameter

Total fork thickness = eye thickness.

Draw a neat sketch of the joint. [12]

(*b*) Write a short note on Design for environment. [6]