Total No. of Questions—**12**] [Total No. of Printed Pages—**8+2**

[3762]-120

S.E. (Mech.) (II Sem.) EXAMINATION, 2010

STRENGTH OF MACHINE ELEMENTS

(2008 COURSE)

Time : Four 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 1

1. (*a*) Draw typical stress-strain diagram for ductile material indicating all salient features. [4]

(*b*) A steel circular bar PQRS fixed rigidly at P and S bar is subjected to axial loads of 60 kN and 120 kN at Q and R as shown in Fig. 1. Find the loads shared by each part of

P.T.O.

the bar and the displacement of the points Q and R. Take E for steel 207 kN/mm^2. [6]

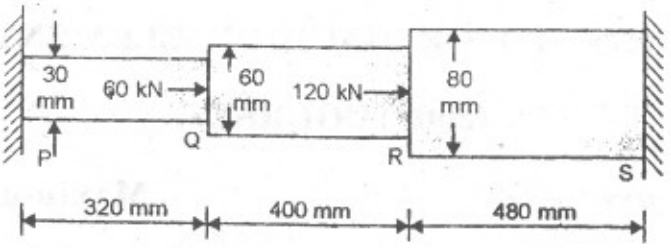

Fig. 1

(*c*) A rod 12.5 mm in diameter is stretched by 3.20 mm under a steady load of 10,000 N. What stress would be produced in the bar by a weight of 700 N falling through 75 mm before commencing to stretch the rod if it is initially unstressed. The value of E may be taken as 2.1×10^5 N/mm^2. [6]

2. (*a*) Define and explain :

(1) Factor of safety.

(2) Margin of safety. [4]

(*b*) A bar of steel is 40 mm × 40 mm in section and is 120 mm long. It is subjected to a tensile load of 200 kN along the longitudinal axis and tensile loads of 500 kN and 400 kN on the lateral faces.

(1) Find the change in dimensions of the bar and change in volume.

(2) Find also what axial longitudinal tensile load acting along can produce the same longitudinal strain as in (1). [6]

(c) A steel bar is square in cross-section having side 40 mm, 4 m long is heated through 75°C with its ends clamp before heating. Calculate the thrust exerted by the bar on clamps :

(i) If the clamps do not yield

(ii) If the clamps yield by 0.75 mm

Take E = 200 GPa and $\alpha = 11.5 \times 10^{-6}$/°C. [6]

UNIT 2

3. (a) Show that for a simply supported beam of length l subjected to a central concentrated load W, deflection at mid span is given by :

$$y = \frac{Wl^3}{48EI}$$

Use Macaulay's method. [6]

(b) Explain the point of contraflexure in brief. [2]

(c) Draw shear force and bending moment diagrams for the cantilever shown in Fig. 2 [10]

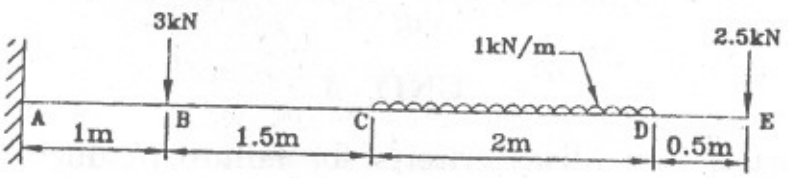

Fig. 2

Or

4. (*a*) For the simply supported beam shown in Fig. 3, find :

(*i*) Slope at each end

(*ii*) Deflections at C & D

Take E = 200 kN/mm^2 and I = 6.50 × 10^8 mm^4. [10]

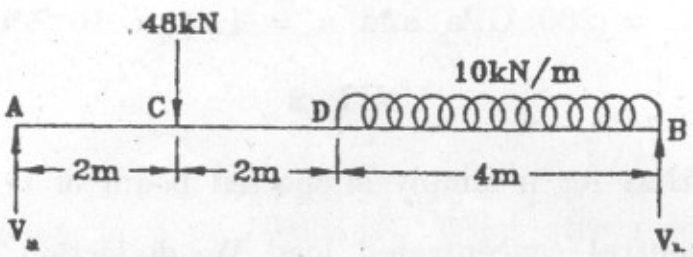

Fig. 3

(*b*) Draw shear force and bending moment diagram for the beam shown in Fig. 4. [8]

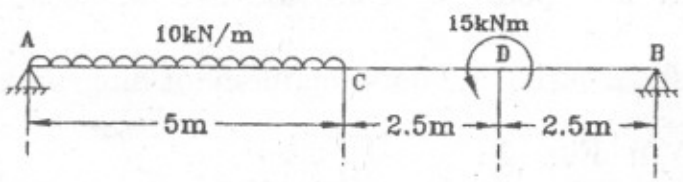

Fig. 4

UNIT 3

5. (*a*) Discuss Von Mises criteria for failure in ductile materials. [6]

(*b*) Two planes AB and BC which are at right angles carry shear stresses of intensity 17.5 N/mm^2 while these planes also carry a tensile stress of 70 N/mm^2 and a compressive stress of

35 N/mm^2 respectively. Refer Fig. 5

Determine the principal planes and the principal stresses. Also determine the maximum shear stress and the planes on which it acts. [10]

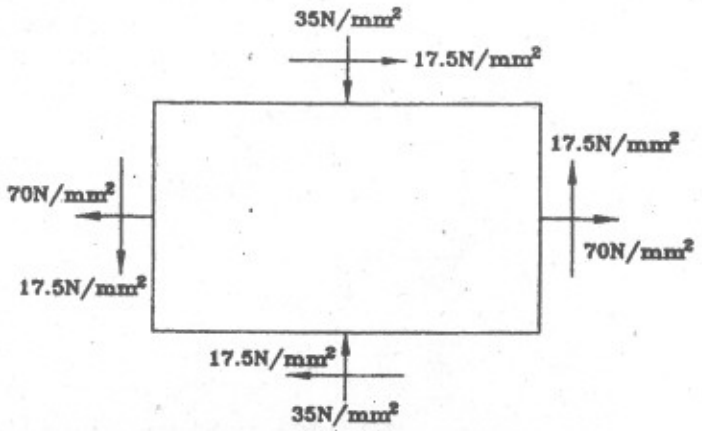

Fig. 5

Or

6. (*a*) A solid circular shaft subjected to a bending moment of 60 kN.m and a torque of 15 kN.m. Design the diameter of shaft by using :

(1) Maximum principal stress theory

(2) Maximum shear stress theory

(3) Maximum strain energy theory.

Take $\mu = 0.28$, yield strength of shaft is 225 MPa and factor of safety = 2.5. [8]

(*b*) At a point in a strained material, the principal stresses are 200 MPa (compressive) and 350 MPa (tensile). Determine the intensity of normal tangential and resultant stresses on a plane inclined at 38° to the plane carrying 200 MPa stress. Solve by Mohr's circle method. (Ref. Fig. 6) 8

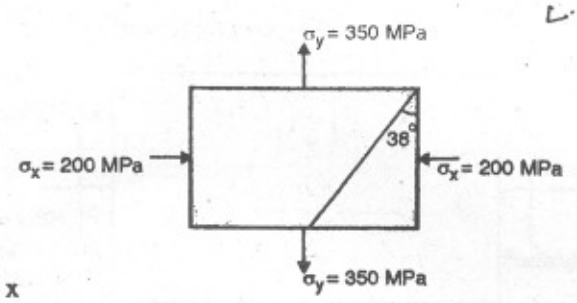

Fig. 6

SECTION II

UNIT 4

7. (*a*) Consider the beam subjected to pure bending by bending moment M and radius of curvature of neutral layer R, M.I. is I and modulus of elasticity E. Derive an equation for magnitude of bending moment M in terms of E.I.R. [6]

(*b*) A steel beam of I section is 600 mm deep. Each flange is 250 mm wide and 25 mm thick. The beam section is subjected to a shear force of 500 kN. Determine shear stress distribution

for the beam section when the web is horizontal. (Ref. Fig. 7) [10]

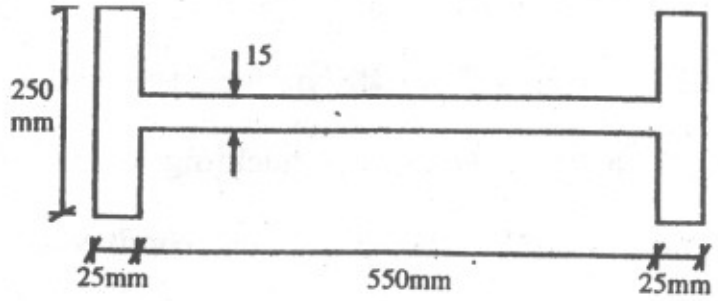

Fig. 7

Or

8. (*a*) For a hollow circular section whose external dia. is twice the internal diameter, find the ratio of maximum shear stress to average shear stress. [6]

(*b*) A horizontal beam of section is 3 m long and is simply supported at the ends. Find the maximum udl it can carry if the compressive and tensile stress must not exceed 55 N/mm^2 and 30 N/mm^2 respectively. Draw a diagram showing the variation of stress over mid span section of beam. (Ref. Fig. 8) [10]

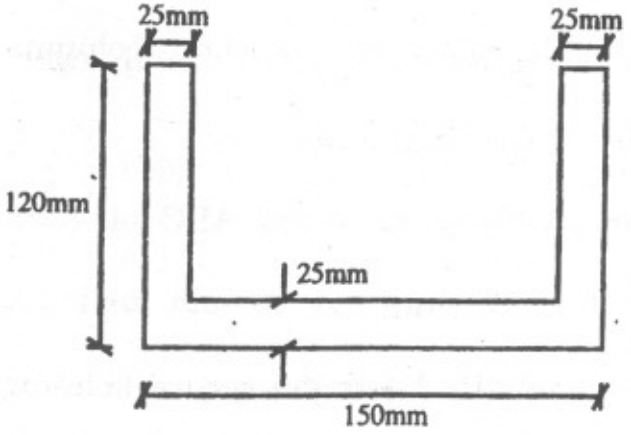

Fig. 8

UNIT 5

9. (*a*) A bar of length 4 m is used as simply supported beam and subjected to u.d.l. of 30 kN/m over the whole span, deflects 15 mm at centre. Determine buckling loads when it is used as column with the following end conditions :

(*i*) Both ends are pin jointed

(*ii*) One end fixed and other end hinged

(*iii*) Both ends fixed. [8]

(*b*) Compare the weights of equal lengths of hollow and solid shaft to resist same torsional moment for same maximum shear stress. Assume internal diameter 0.8 times the external diameter for hollow shaft. [8]

Or

10. (*a*) State the limitations of Euler's formula. Hence derive Rankine formula for long as well as short columns to overcome the limitations. [8]

(*b*) A 70 mm diameter steel rod ABC of 4 m length has brass sleeve of I.D. 70 mm and 10 mm wall thickness for portion AB of 2 m length. Assuming secure bonding between rod and sleeve, find torques T that can be applied at the ends in

opposite sense such that :

(*i*) Shear stress in steel is not exceeded 110 MPa

(*ii*) Angle of twist between the ends of shaft is limited to eight degrees. [8]

UNIT 6

11. (*a*) Explain various steps in the process of designing a machine components. [6]

(*b*) Explain the term design synthesis. [4]

(*c*) A beam of circular cross-section of dia. 10 mm has its centre line curved to radius 50 mm. Find the intensity of maximum stress in the beam, when it subjected to a moment of 5000 Nmm. [8]

Or

12. (*a*) Explain any *three* of the following terms in short for design of simple machine parts :

(*i*) Creativity in design

(*ii*) Product life cycle

(*iii*) Selection of f.o.s.

(*iv*) Service factor. [6]

(*b*) Design a knuckle joint for a tie rod of circular section for a maximum pull of 70 kN. The ultimate strength of material against tearing is 420 N/mm^2. The shearing strength of material is 396 N/mm^2. Take f.o.s. = 6. [8]

(*c*) Write a short note on design of component subjected to eccentric loading. (Mention design steps). [4]