Total No. of Questions—**12**] [Total No. of Printed Pages—**8+3**

Seat No.	

[4657]-18

S.E. (Mechanical/Automobile) (II Sem.) EXAMINATION, 2014

STRENGTH OF MACHINE ELEMENTS

(2008 PATTERN)

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

1. (*a*) Derive the expression for volumetric strain in a circular bar subjected axial tensile load. [6]

(*b*) A steel wire 2 m long and 3 mm in diameter is extended by 0.75 mm when a weight 'W' is suspended from the wire.

If the same weight is suspended from a brass wire, 2.5 m long, and 2 mm in diameter, it is elongated by 4.64 mm. Determine the modulus of elasticity of brass, if that of steel be 2.0×10^5 N/mm^2. [6]

(*c*) Three rods each of length 1 meter and cross-sectional area 200 mm^2 are connected to rigid plates at the ends as shown in Fig. 1. If the temp. of the assembly is raised by 25°C, determine stress in each rod. [Refer Fig. 1]. Given :

$E_s = 200$ GPa

$E_c = 120$ GPa

$\alpha_s = 12 \times 10^{-6}$ per °C

$\alpha_c = 18.5 \times 10^{-6}$ per °C. [6]

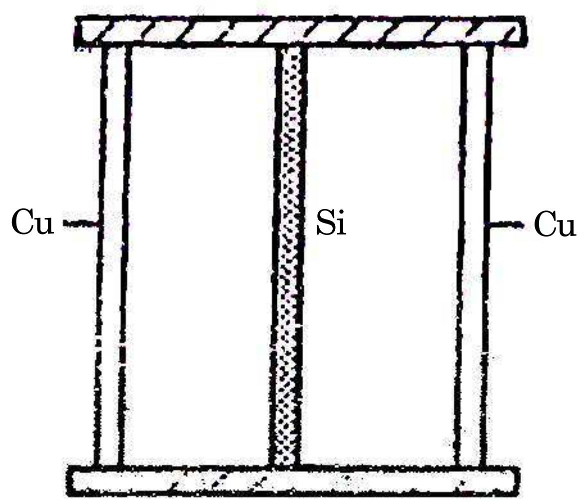

Fig. 1

Or

2. (*a*) Derive the expression for stress induced due to impact load falling from the height '*h*'. [6]

(*b*) Two cylindrical rods AC and CD, both of the same alloy (E = 70 GPa) are welded together at C and subjected to loading as shown in Fig. 2.

Determine :

(*i*) Total deformation of rod ACD

(*ii*) Displacement of point C. [6]

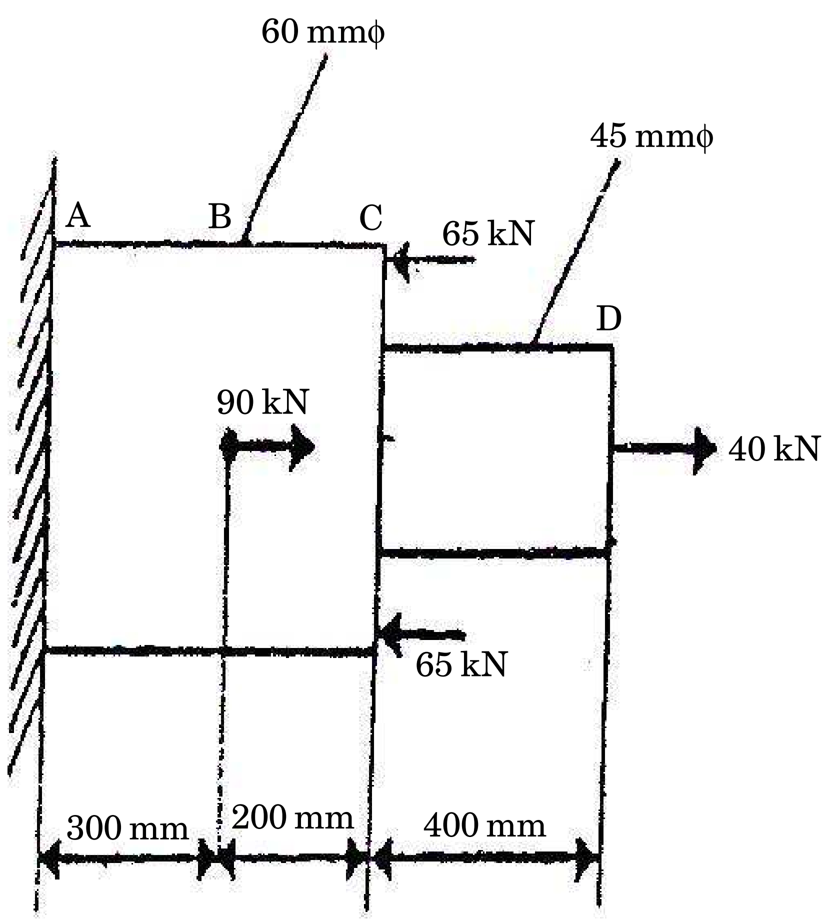

Fig. 2

(*c*) A metallic piece is subjected to forces, as shown in Fig. 3. Determine the change in volume, if E = 200 kN/mm^2 and Poisson's ratio = 0.25. [6]

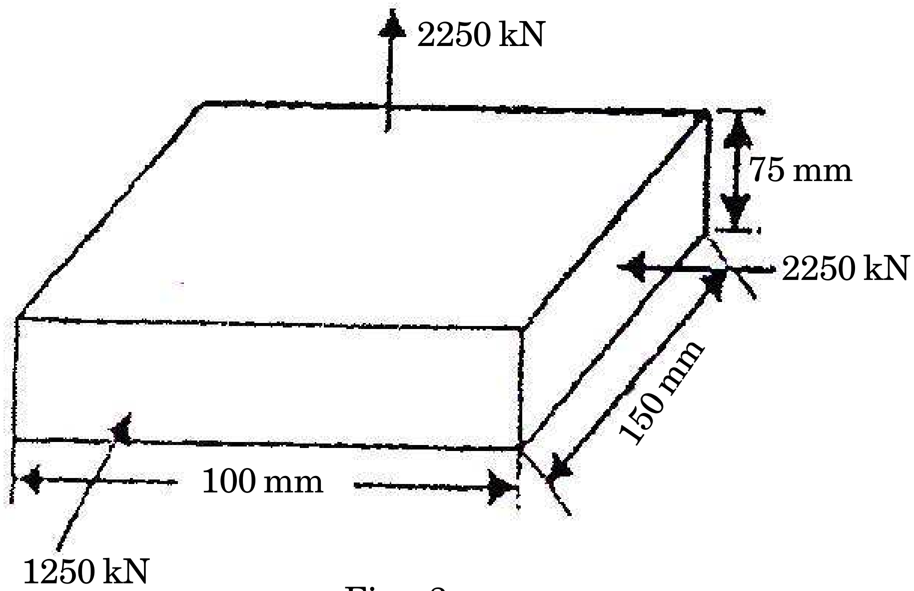

Fig. 3

3. (*a*) Derive the equation for maximum deflection and slope at each end of simply supported beam of span length '*l*' carrying uniformly distributed load of '*w*' per unit run over the whole span. [6]

(*b*) Determine the deflections at points C, D and E in the beam shown in Fig. 4. Take E = 200 kN/mm^2 and I = 60 × 10^6 mm^4. Use Macaulay's method. [10]

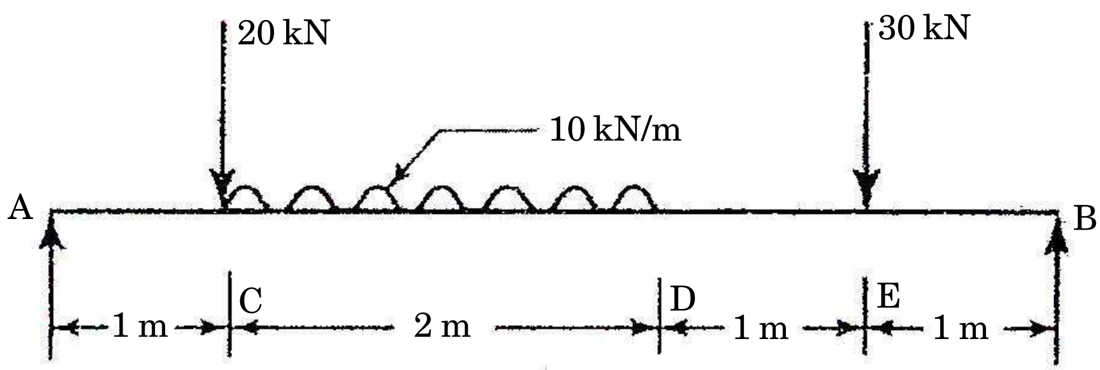

Fig. 4

Or

4. (*a*) A horizontal beam is simply supported at the ends and carries a uniformly distributed load 10 kN per meter between the supports 10 m apart. Counterclockwise moments of 60 kNm and 40 kNm are applied to the left and right hand support respectively.

Draw shear force and bending moment diagrams for the beam. [Refer Fig. 5] [12]

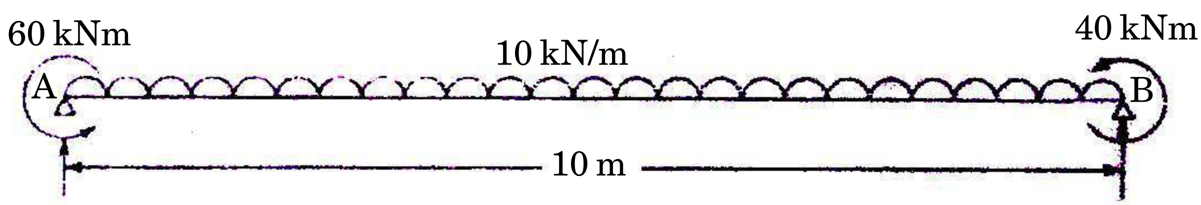

Fig. 5

(*b*) Explain :

(*i*) Point of contraflexure

(*ii*) Flexural Rigidity. [4]

5. (*a*) Derive the following equations for normal and shear stresses on an inclined plane, when it is subjected to biaxial stresses σ_1 and σ_2 :

$$\sigma_\theta = \left(\frac{\sigma_1 + \sigma_2}{2}\right) + \left(\frac{\sigma_1 - \sigma_2}{2}\right) \cdot \cos 2\theta$$

$$\tau_\theta = \left(\frac{\sigma_1 - \sigma_2}{2}\right) \cdot \sin 2\theta.$$ [8]

(*b*) Draw the Mohr's stress circle for direct stresses of 65 MN/m^2, tensile and 35 MN/m^2, compressive, and estimate the magnitude and direction of the resultant stresses on planes making angles 20° and 65° with the plane of first principal stress. Find also the normal and tangential stresses on these planes. [8]

Or

6. (*a*) A mild steel shaft 120 mm diameter is subjected to a maximum torque 20 kNm and a maximum bending moment of 12 kNm at a particular section.

Find the factor of safety according to the maximum shear stress theory, if the elastic limit in simple tension is 220 MN/m^2. Give justification for the theory used. [8]

(*b*) A prismatic bar carrying an axial tensile stress σ_x is cut by an oblique section LM, as shown in Fig. 6. If the normal and shear stresses on this section are 90 MN/m^2 and 30 MN/m^2 respectively, find the value of σ_x and the angle θ defining the aspect of section LM. [8]

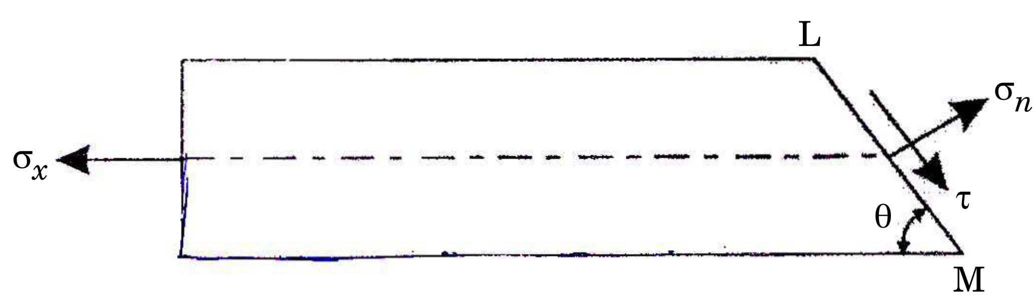

Fig. 6

SECTION II

7. (*a*) A cast iron test beam 20 mm × 20 mm in section and 1 metre long and supported at ends fails when a central load of 640 N is applied. What UDL will break a cantilever of same material 50 mm wide, 100 mm deep and 2 metres long ? [8]

(*b*) A beam section shown in Fig. 7 is subjected to shear force 300 kN. Draw the shear stress distribution diagram for the beam section. [8]

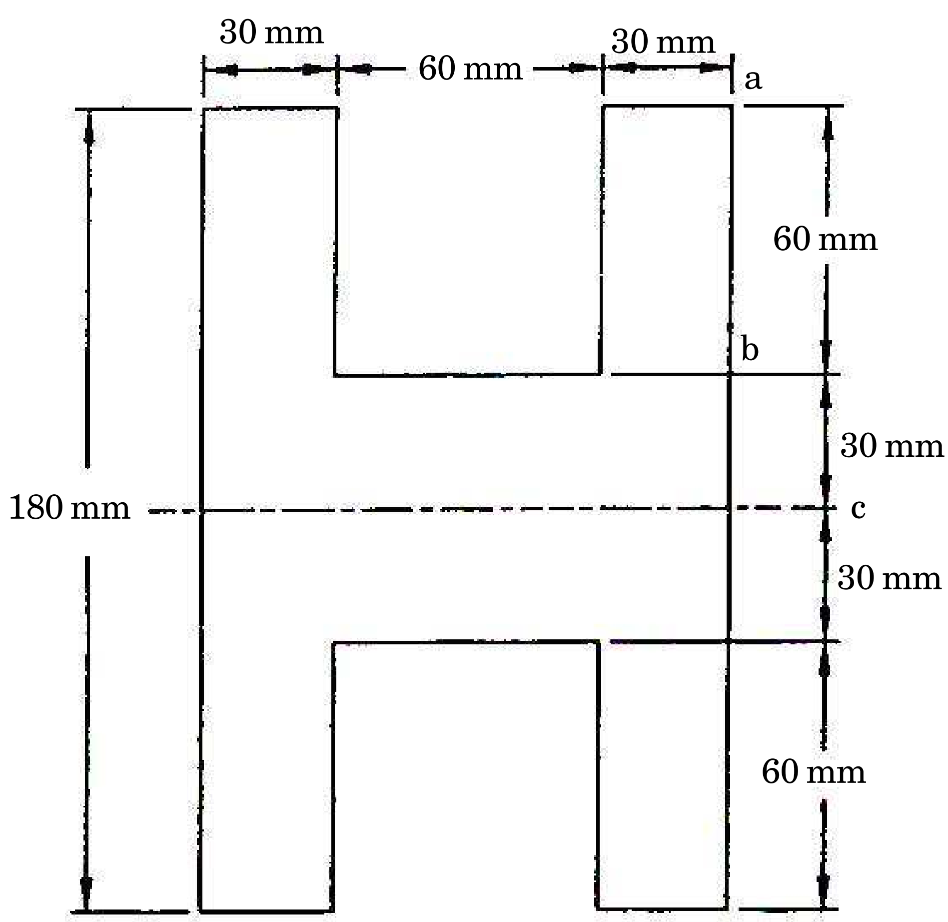

Fig. 7

Or

8. (*a*) A beam of T section 6 metre long supports the load system shown in Fig. 8 which shows also the bending moment diagram for the beam. The beam has flange width of 100 mm and overall depth of 120 mm. The flange and web are 20 mm thick. The section is placed with the flange at the bottom. Find the safe value of 'W' is the stresses in compression and tension shall not exceed 90 N/mm^2 and 50 N/mm^2. [8]

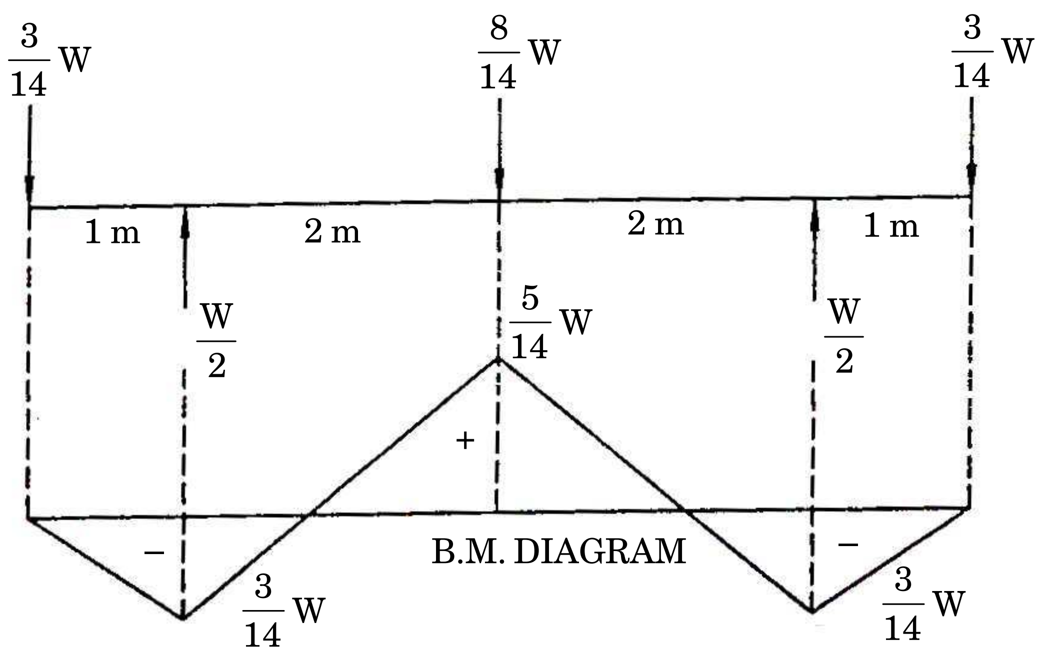

Fig. 8

(*b*) For a section shown in Fig. 9, determine the shearing stresses at A, B, C for a shearing force of 200 kN. [8]

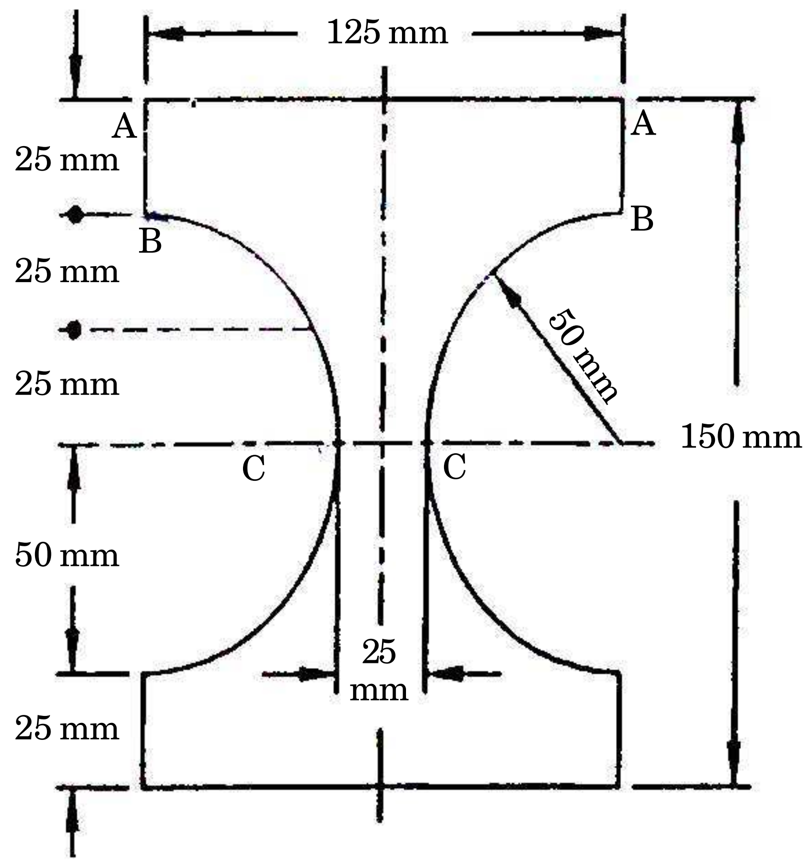

Fig. 9

9. (*a*) From first principle, derive the equation for Euler load 'P_E' for the column with both ends hinged. State assumptions in Euler's theory. [8]

(*b*) A solid shaft transmits 250 kW at 100 rpm. If the shear stresses is not to exceed 75 N/mm^2, what should be the diameter of the shaft ? If this shaft is to be replaced by a hollow one whose internal diameter is 0.6 times outer diameter, determine the size of hollow shaft and percentage saving in weight, the maximum shearing stress being the same. [8]

Or

10. (*a*) A hollow cast iron column 5 m long is fixed at both ends and has an external diameter of 300 mm. The column supports an axial load of 1200 kN. Find the internal diameter of the column, adopting factor of safety '5'. Take $\sigma_c = 550$ N/mm^2 and $a = \frac{1}{1600}$. [8]

(*b*) A composite shaft consists of a steel rod 60 mm diameter surrounded by closely fitting tube of brass fixed to it. Find the outside diameter of brass tube, so that when a torque is applied to the composite shaft, it will be shared equally by the two materials. Take c for steel $= 8.4 \times 10^4$ N/mm^2 and c for brass $= 4.2 \times 10^4$ N/mm^2. [8]

11. (*a*) Write short notes on :

(*i*) Preferred series in design

(*ii*) Design of component subjected to eccentric loading. [8]

(*b*) Design a cotter joint to resist a load of 40 kN, which acts along the axes of the ends connected by the cotter. The material of the rod and cotter is same and has the following properties :

$\sigma_t = 200$ MPa, $\sigma_c = 420$ MPa, $\tau = 160$ MPa.

Assuming factor of safety 4, design the dimensions of the cotter joint. [10]

Or

12. (*a*) Why is factor of safety necessary in the design of mechanical component ?

Discuss the important factors influencing the selection of factor of safety. [6]

(*b*) Explain creativity in design. [6]

(*c*) Explain design for environment. [6]