Total No. of Questions—**12**] [Total No. of Printed Pages—**8+1**

Seat No.	

[4857]-119

S.E. (Mechanical/Mechanical-SW/Automobile) EXAMINATION, 2015

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*) Answer 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*) Assume suitable data, if necessary.

SECTION I

1. (*a*) A uniform rod of cross-sectional area 'A', length 'L' is held vertically and fixed at the top. Derive the expression for strain energy due to self weight. Assume Young's modulus of elasticity 'E' and mass density 'ρ'. [8]

(*b*) A steel rod 32 mm in diameter is fixed concentrically in a brass tube which has inside and outside diameters of 34 mm and 48 mm resp. Both the rod and tube are 400 mm long and their ends are in level. The compound rod is held between two stops which are exactly 400 mm apart and temp. of bar

P.T.O.

is then raised by 60°C. Find the stresses in rod and tube if the distance between stops :

(*i*) remains constant

(*ii*) is increased by 0.25 mm.

Also find the increase in distance between the stop if the force exerted between them is 80 kN.

Take E_{steel} = 200 GPa, $E_b = 0.9 \times 10^5$ MPa, $\alpha_{steel} = 1.2 \times 10^{-5}/°C$, $\alpha_b = 2.1 \times 10^{-5}/°C$. [8]

Or

2. (*a*) A steel rope lowers a load of 20 kN at the rate 2 m/sec. During the lowering of the load it is jammer. The unwound length of rope is 15 m. What will be instantaneous stress developed and maximum instantaneous elongation ? Assume diameter of rope 25 mm. Take E = 200 GPa. [8]

(*b*) A rectangular block 250 mm × 100 mm × 80 mm is subjected to axial loads as follow. 480 kN tensile in the direction of its length, 900 kN tensile on the 25 mm × 8 mm faces and 1000 kN compressive on the 250 mm × 100 mm faces assuming $\mu = 0.25$. Find in terms of modulus of elasticity E the material the strain in the direction of each force.

If $E = 2 \times 10^5$ N/mm^2, find values of Modulus of rigidity and Bulk Modulus for the material of the block, also calculate change in volume of the block due to the application of the loading specified above. [8]

3. (*a*) Derive expressions for slope and deflection at the free end of a cantilever beam of length L and subjected to u.d.l. 'W' over its entire length. [6]

(*b*) A beam ABCDE is loaded as shown in Fig. 1. Determine value of R and W. Draw SFD and BMD. Also find the point of contraflexure if any. [10]

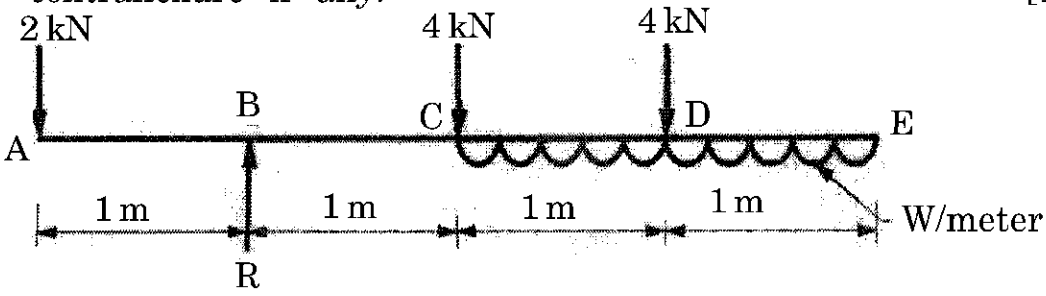

Fig. 1

Or

4. (*a*) Draw shear force and bending moment diagrams for the beam shown in Fig. 2. [8]

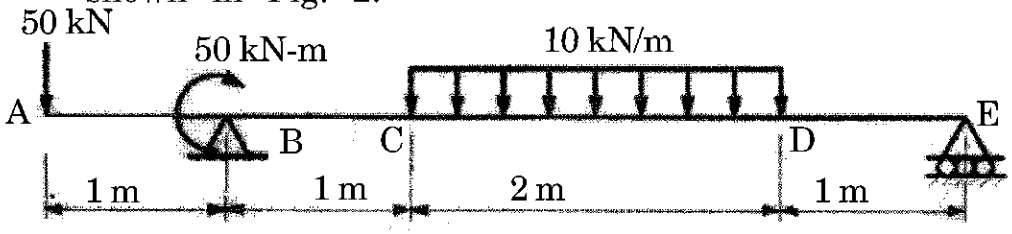

Fig. 2

(*b*) A beam ABCDEF, 7 m long is supported at point B and F as shown in Fig. 3. Beam carries UDL and concentrated load as shown. Determine slope and deflection at end A of the beam. [8]

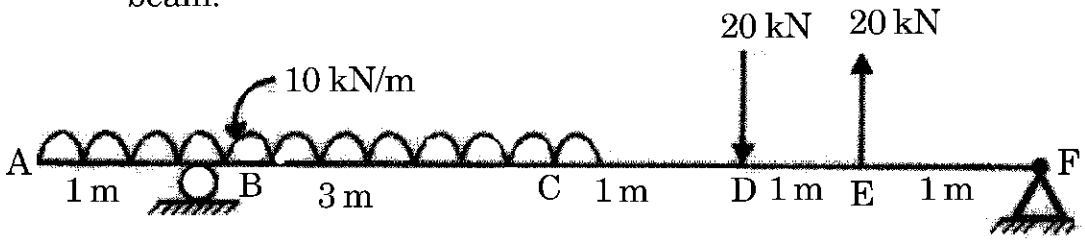

Fig. 3

5. (*a*) 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 : [8]

(*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.

(*b*) At a point in a strained material, stress pattern is as shown in Fig. 4. Determine : [10]

(*i*) Normal and shear stresses on the planes the normal of which are inclined at 30° with *x*-axis.

(*ii*) Magnitude and nature of principal stresses.

(*iii*) Orientation of principal planes.

(*iv*) Maximum shear stress and orientation of planes having maximum shear stress.

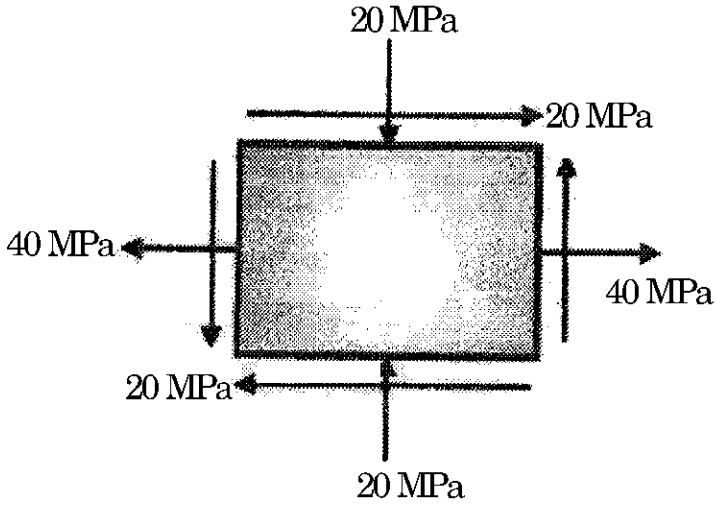

Fig. 4

Or

6. (*a*) A rectangular block of material is subjected to stresses on perpendicular planes as shown in Fig. 5. Using Mohr's circle method (Graphical method), find : [8]

(*i*) The normal and shear stresses on plane for which $\theta = 20°$

(*ii*) The magnitude of principal stresses and

(*iii*) Inclination of the planes on which principal stresses acts.

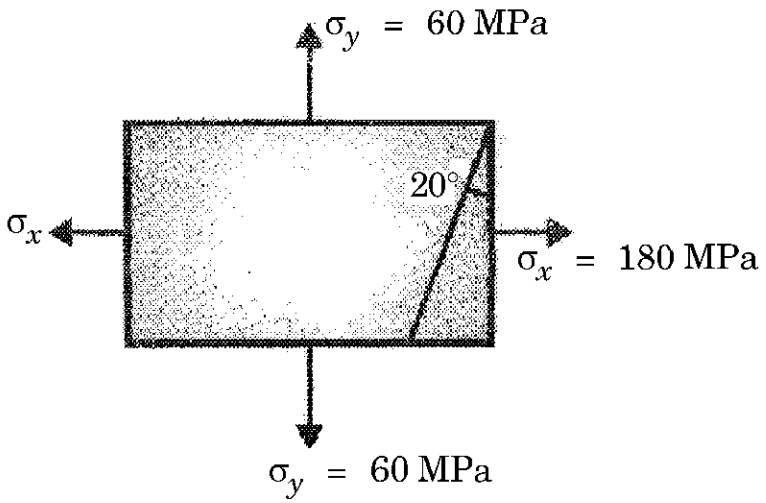

Fig. 5

(*b*) Define principal planes and principal stresses. Explain : [10]

(*i*) Maximum strain energy theory

(*ii*) Shear strain energy theory.

SECTION II

7. (*a*) With usual notations, derive flexural formula : [6]

$$\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}.$$

(*b*) Fig. 6 shows cross-section of beam is subjected to shear force of 10 kN. Draw shear force diagram and determine also the

ratio of maximum shear stress and mean shear stress. [6]

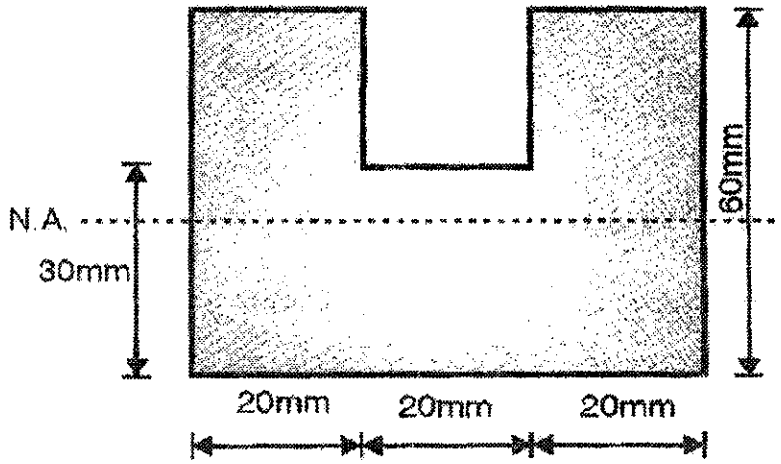

Fig. 6

(*c*) Two 50 mm × 150 mm rectangular timber section is connected together as shown in Fig. 7. If sagging B.M. of 4 kN-m is applied to this beam about the horizontal axis :

(*i*) Locate the neutral axis

(*ii*) Find the stresses at extreme fiber

(*iii*) Plot bending stress distribution diagram. [6]

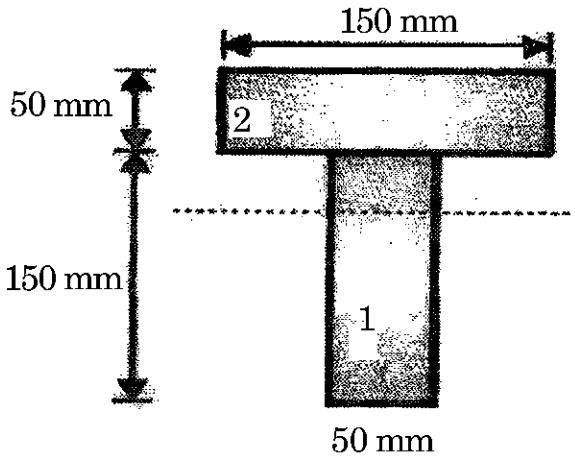

Fig. 7

Or

8. (*a*) A simply supported beam with overhang is loaded with point load as shown in Fig. 8. The cross-section of beam is I-section. The allowable bending stresses in tension and compression are 150 Mpa and 100 Mpa. Find the safe load '*w*' on the overhang. [10]

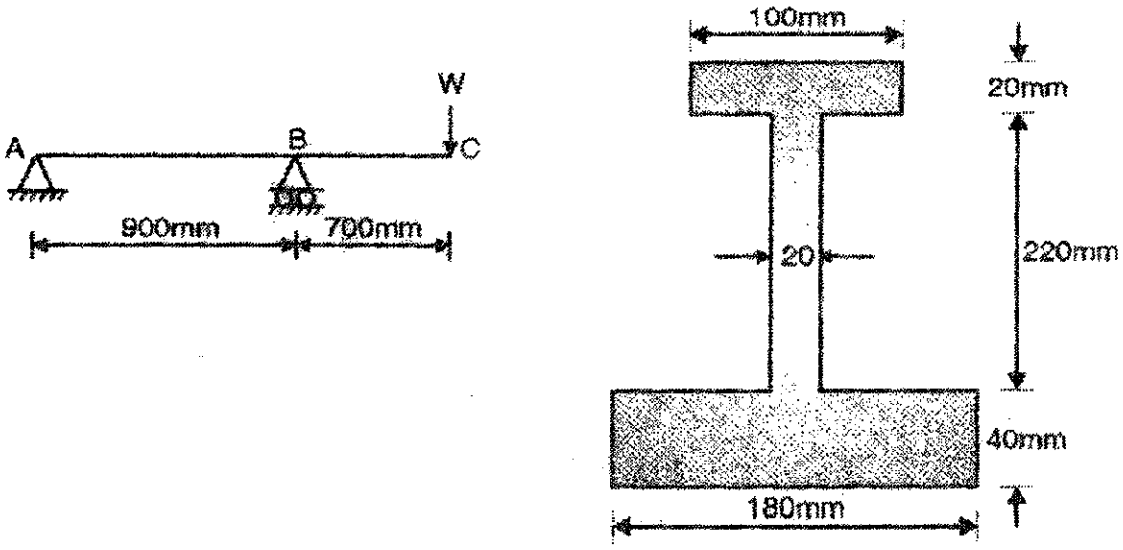

Fig. 8

(*b*) A symmetrical beam of I-section is 200 mm × 400 mm in size, the thickness of flange 20 mm and web is 15 mm. The beam carrying UDL of 20 kN/m over entire length of 4 m. Draw the shear stress distribution diagram over depth of section. [8]

9. (*a*) Derive Euler's formula for buckling load for column with one end fixed and other end hinged. [8]

(*b*) A composite shaft consists of Cu rod of 30 mm diameter enclosed in a steel tube of external diameter 50 mm and 10 mm thick. The shaft is required to transmit a torque 1200 N-m. Determine the shear stresses develop in Cu and steel, if both the shaft has equal length and welded to a plate at each end, so that their twist are equal. Take $G_{steel} = 2\ G_{Cu}$. [8]

Or

10. (*a*) Find Euler's critical load for a hollow cylindrical cast iron column 200 mm external diameter and 25 mm thick, if it is 6 m long and hinged at both ends. Take $E = 8 \times 10^4$ N/mm^2. Compare Euler's critical load with Rankine's formula. Take $\alpha = 1/1600$, and $\sigma_c = 550$ N/mm^2. For what length of column would critical load by Euler's and Rankine's formula be equal ? [8]

(*b*) A hollow shaft of diameter ratio 3/8 is required to transmit 600 kW at 110 rpm. The maximum torque being 20% greater than the mean. Shear stress is not to exceed 63 N/mm^2 and the twist in a length of 3 m not to exceed 1.4 degrees. Calculate external diameter of shaft which would satisfy these conditions. G = 84 GPa. [8]

11. (*a*) Explain the term 'Product Life Cycle'. [4]

(*b*) Explain briefly the consideration of energy requirements. [6]

(*c*) A C-frame subjected to a force of 8 kN is shown in Fig. 9. It is made of gray cast iron FG 300. If factor of safety is 5, determine the dimensions of the cross-section of frame. [6]

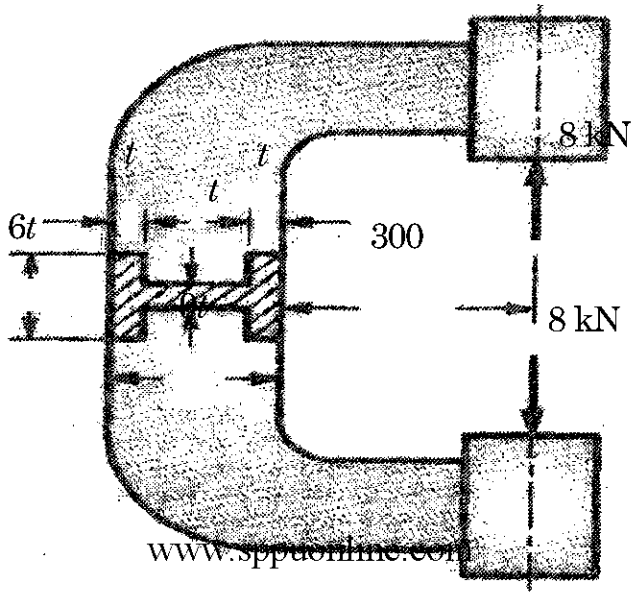

Fig. 9

Or

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

(*b*) Design a cotter joint to transmit a load of 90 kN in tension or compression. Assume the following stress for socket, spigot and cotter : [10]

Allowable tensile stress = 90 MPa

Allowable crushing stress = 120 MPa

Allowable shear stress = 60 MPa.