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

[4062]-132

S.E. (Production & Production Sandwich)

(First Semester) EXAMINATION, 2011

STRENGTH ANALYSIS OF MACHINE ELEMENTS

(2008 PATTERN)

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

***N.B.* :—** (*i*) Attempt *one* question from each Unit of Section I and Section II.

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

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

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

(*v*) Use of non-programmable electronic pocket calculator is allowed.

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

SECTION I

UNIT I

1. (*a*) Prove that :

$$E = 3K(1 - 2\mu)$$

where,

E = Young's modulus,

K = Bulk modulus

μ = Poisson's ratio. [6]

(*b*) A steel tie bar of f 40 mm and 2 m long is subjected to a pull of 80 kN as shown in Fig. 1. To what length the bar should be bored centrally so that the total extension of the bar will increase by 20% under the same pull, the bore being 20 mm diameter. (Take E = 2×10^5 N/mm^2) [10]

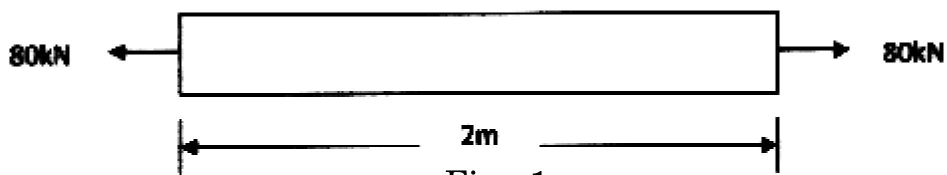

Fig. 1

Or

2. (*a*) In an experiment a bar of 30 mm is subjected to a pull of 60 kN. The measured extension length of 200 mm is 0.09 mm and the change in diameter is 0.0039 mm. Calculate the Poisson's ratio and the values of the three moduli. [6]

(*b*) Two steel rods and one copper rod each of 20 mm diameter together support a load of 50 kN as shown in Fig. 2. Find the stresses in each rod. Take E = 200 GPa for steel and E = 100 GPa for copper respectively. [10]

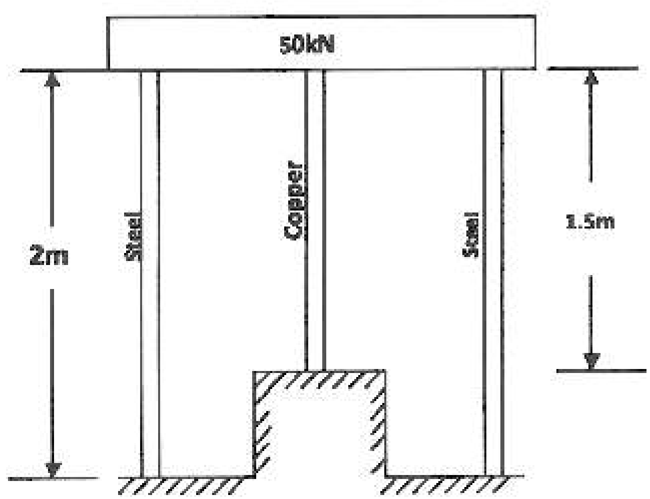

Fig. 2

UNIT II

3. (*a*) The two supports of a simply supported beam are 5 m apart. The beam is 8 m long with two overhangs of 2 m and 1 m on the left hand and the right hand sides respectively. The beam carries concentrated loads of 40 kN at the left hand end, 40 kN at 4 m, 20 kN at 6 m both from the left end and 20 kN at the right end of the beam. Draw shear force and bending moment diagrams for the beam. [8]

(*b*) A simply supported beam with over-hanging ends carries transverse loads as shown in Fig. 3. If W = 10 w, what is the overhanging length on each side, such that the bending moment at the middle of the beam, is zero ? Sketch the shear force and bending moment diagrams. [10]

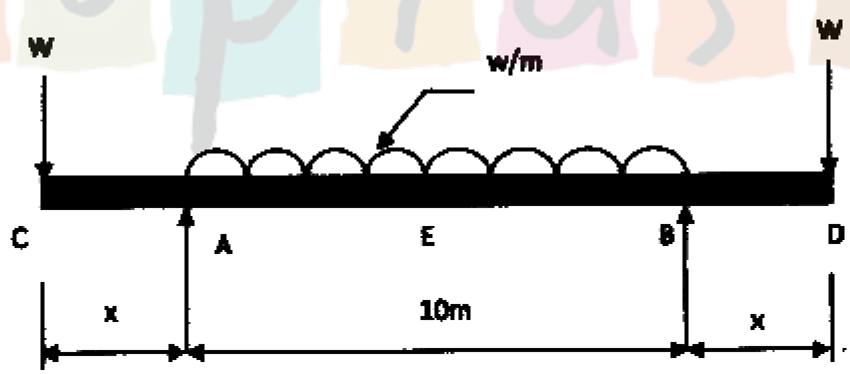

Fig. 3

Or

4. (*a*) A cantilever PQ of 1.5 m is fixed at point P and carrying a concentrated load of 2 kN at the free end Q. It also carries a uniform distributed load (UDL) of 1 kN/m over a span of 1 m from the fixed end. Draw the S.F. and B.M. diagrams for this beam. [8]

(*b*) Shear force diagram for a loaded beam is shown in Fig. 4. Determine the loading on the beam and hence draw bending moment diagram. Locate the point of contraflexure, if any. [10]

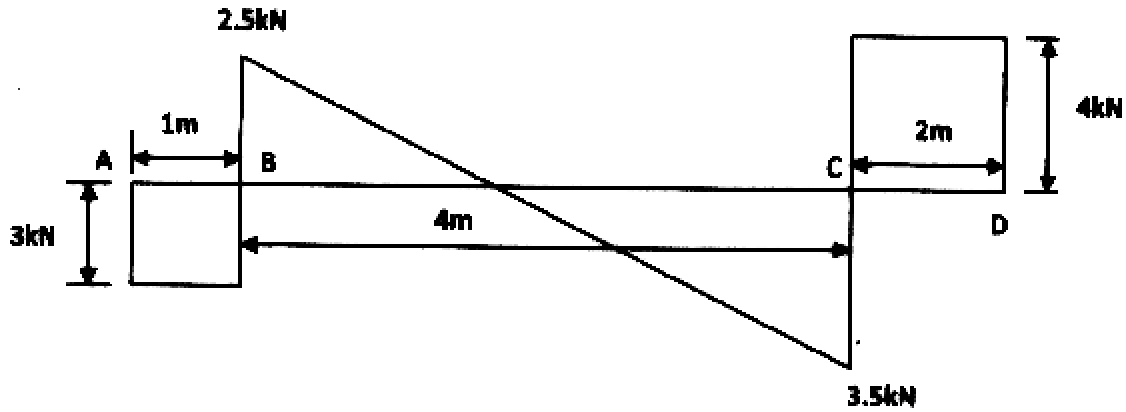

Fig. 4

UNIT III

5. (*a*) Prove the relations :

where,

M = Total moment of resistance offered by the beam section in N-mm

I = Moment of Inertia of the section about the neutral axis in mm^4

s = Stress intensity in the fiber N/mm^2

y = Distance of the fiber from the neutral axis in mm

E = Modulus of Elasticity in N/mm^2

R = Radius of Neutral surface in mm. [6]

(*b*) A cast iron bracket as shown in Fig. 5 is subjected to bending and has cross-section of I-form with unequal flanges. The total depth of the section is 280 mm and the metal is 40 mm thick throughout. The top flange is 200 mm wide. Find the position of neutral axis and the moment of inertia of the section about the neutral axis and determine the maximum bending moment that should be imposed on this section if the tensile stress in the top flange is not to exceed 20 N/mm^2. What is the value of the compressive stress in the bottom flange ? [10]

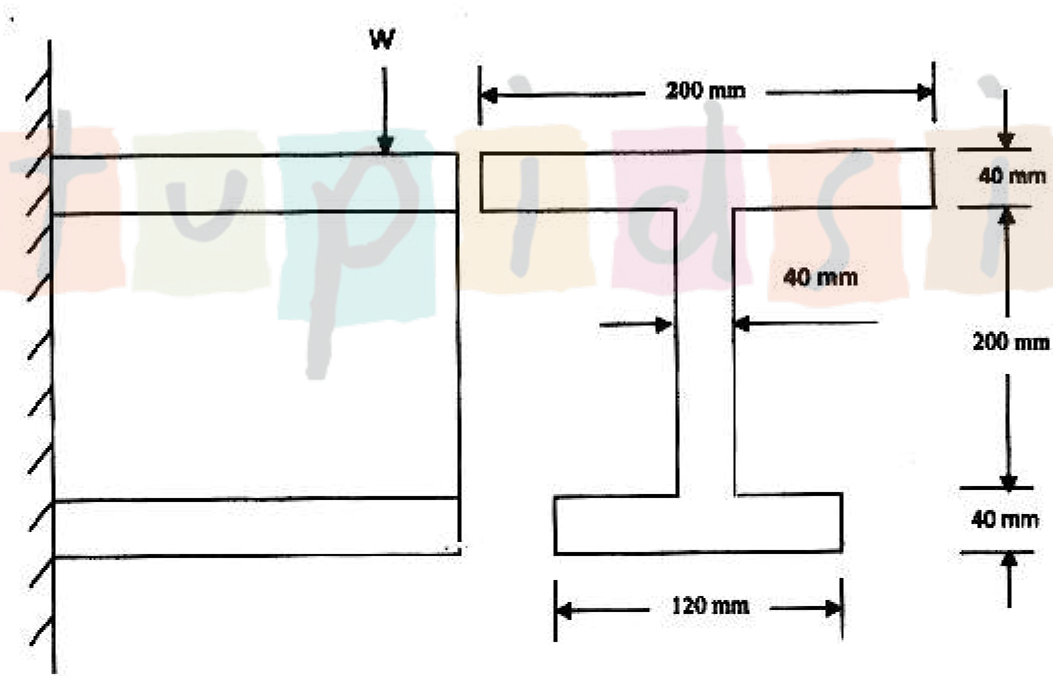

Fig. 5

Or

6. (*a*) Define the term 'bending stress' and explain clearly the theory of simply bending. [6]

(*b*) Draw shear stress distribution on a 'T' section with flange 150 mm × 15 mm deep and flange 200 mm × 20 mm wide. The section is symmetric about vertical axis. The shear force applied is 110 kN. [10]

SECTION II

UNIT IV

7. (*a*) Deduce expressions for stresses on an inclined plane in a body subjected to a biaxial stress condition. [8]

(*b*) Draw Mohr's stress circle for a biaxial stress system having two direct stresses of 30 MPa (tensile) and 20 MPa (compressive). Determine the magnitude and the direction of the resultant stresses on planes which make angles of :

(*i*) 25º,

(*ii*) 70° with the 30 MPa stress.

Also find the normal and shear stresses on these planes. [8]

Or

8. (*a*) What is strain energy of a material ? Derive the expressions for the same in different forms. [8]

(*b*) Two bars each of length *l* and of the same material are each subjected to the same axial tensile force P. The first bar has a uniform diameter 2*d*. The second bar has a diameter *d* for length *l*/3 and a diameter 2*d* for the remaining length. Compare the strain energies of the two bars. [8]

UNIT V

9. (*a*) Deduce the torsion equation stating the assumptions made. Deduce the expressions for maximum stresses in solid and hollow shafts. [8]

(*b*) Determine the diameter of a solid shaft which will transmit 90 kW at 160 rpm if the shear stress in the shaft is limited to 60 N/mm^2. Find also the length of the shaft, if the twist must not exceed 1° over the entire length. Take $C = 8 \times 10^4$ N/mm^2. [10]

Or

10. (*a*) Compare the weight of a solid shaft with that of a hollow one to transmit a given power at a given speed with a given maximum shearing stress, the outside diameter of the hollow shaft being 1.5 times the internal diameter. [10]

(*b*) A hollow shaft with diameter ratio 3/5 is required to transmit 450 kW at 120 rpm with a uniform twisting moment. The shearing stress in the shaft must not exceed 60 N/mm^2 and the twist in a length of 2.5 m must not exceed 1°. Calculate the minimum external diameter of the shaft satisfying these conditions. Take the modulus of the rigidity, $C = 8 \times 10^4$ N/mm^2. [8]

UNIT VI

11. (*a*) An 80 mm wide and 180 mm deep cantilever is of 3 m span. It carries a uniformly distributed load of intensity 6 kN/m on a 2 m length of span starting from the free end. Determine the slope and the deflection at the free end. E = 205 GPa. [8]

(*b*) Establish the governing differential equation of beams. What are its limitations ? [8]

Or

12. (*a*) What is meant by equivalent length of columns ? What are its values for different end conditions of columns ? [6]

(*b*) A steel bar of rectangular section 30 mm × 40 mm pinned at each end is subjected to axial compression. The bar is 1.75 m long. Determine the buckling load and the corresponding axial stress using Euler's formula. Determine the minimum length for which Euler's equation may be used to determine the buckling load, if the proportional limit of the material is 200 N/mm^2. Take $E = 2 \times 10^5$ N/mm^2. [10]