2021

STRENGTH OF MATERIALS

Full Marks: 100

Time: Three hours

The figures in the margin indicate full marks for the questions.

Answer question 1 and any four questions from the rest.

1. a) In workshop and factories, a turning force is always applied to transmit energy by _____. **1**

   b) The angle that the line of action of the resultant stress makes with the normal to the plane is called _____. **1**

   c) What is polar moment of inertia? **2**

   d) Give the practical application of bending equation. **3**

   e) "The amount by which a layer increases or decreases in length, depends upon the position of the layer with respect to the neutral axis". Justify the above statement. **5**

   f) Derive the expression for bending stress, $\frac{y}{R} = \frac{f}{E}$ **8**

2. a) What are the assumptions made in the theory of pure torsion? **4**

   b) Derive the relationship to find the maximum torque which a shaft of radius R can transmit. **6**

   c) Find the angle of twist per meter length of a hollow shaft of 100mm external diameter and 60 mm internal diameter, if the shear stress is not to exceed 40 MPa. **10**

Given C = 85 GPa.

3. a) A steel rod 5 m long and 30 mm in diameter is subjected to an axial tensile load of 50 kN. Determine,   10

        (i) Longitudinal strain,

        (ii)   Lateral strain,

        (iii)   Change in length of the rod,

        (iv)   Change in diameter of the rod,

        (v)   Change in volume of the rod.

    Given, $E = 2 \times 10^5$ N/mm^2 and Poisson's ratio = 0.25

b) A steel cube of block 50 mm side as shown in fig.1 is subjected to a force of 6 kN (tension), 8 kN (compression) and 4 kN (tension) along x, y and z direction respectively. Determine the change in volume of the block. Given E = 200 GPa and m = 10/3.   10
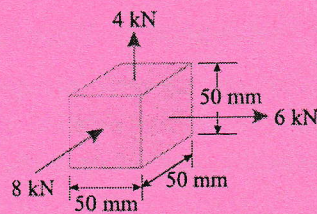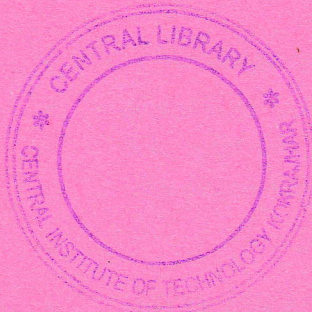
Fig.1

4. a) Draw Mohr's circle for principal stresses of 80 N/mm^2 tensile and 50 N/mm^2 compressive and find the resultant stresses on planes making 22^0 and 64^0 with the major principal plane. Find also the normal and tangential stresses on these planes.   10

b) A rectangular block of material is subjected to a tensile   10

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stress of 110 N/mm^2 on one plane and 47 N/mm^2 on other with a shear stress of 63 N/mm^2 on the same planes. Find

(i) The direction of the principal planes.

(ii) The magnitude of the principal stress.

(iii) The magnitude of the greatest shear stress.

Use analytical method.

5. a) What are the assumptions made in the theory of simple bending?   4

b) A steel plate of width 125 mm and of thickness 25 mm is bent into a circular arch of radius 12 m. Determine,   10

     (i) Moment of inertia,

     (ii) Y_{max},

     (iii) The maximum stress induced,

     (iv) The bending moment which will produce the maximum stress.

Given, E = 2 x 10^5 N/mm^2.

c) A cantilever of length 3m fails when a load of 3 kN is applied at the free end. If the section of the beam is 35 mm x 55 mm. find the stress at the failure.   6

6. Calculate and draw the shear force and bending moment diagrams for the given beam in fig 2. Also find the point of contraflexure.   20
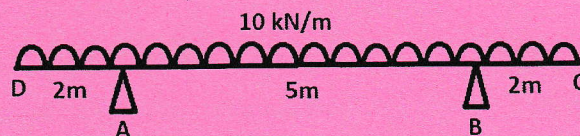
10 kN/m

D 2m   5m   2m C

     A   B

Fig.2

7.   Draw shear force and bending moment diagrams for   20
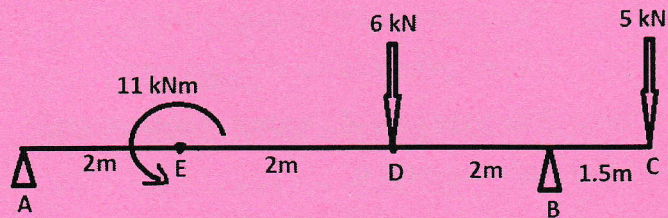   the beam shown in fig 3.

Fig.3