

# 17304

11819

**3 Hours / 100 Marks**

Seat No.

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- Instructions* –
- (1) All Questions are *Compulsory*.
  - (2) Answer each next main Question on a new page.
  - (3) Illustrate your answers with neat sketches wherever necessary.
  - (4) Figures to the right indicate full marks.
  - (5) Assume suitable data, if necessary.
  - (6) Use of Non-programmable Electronic Pocket Calculator is permissible.
  - (7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

**Marks**

1. a) **Attempt any SIX of the following:**

**12**

- (i) Define following properties of material -
  - (1) Elasticity
  - (2) Malleability
- (ii) State 'Hooke's Law'. Define limit of proportionality.
- (iii) State the relation between principal planes and the planes of maximum shear stress.
- (iv) Find the radius of gyration of a circle of diameter 'd'.
- (v) Define:
  - (i) Point of Contraflexure and
  - (ii) O.C. Neutral Axis

P.T.O.

- (vi) State middle third rule with neat sketch.  
 (vii) What is the “No tension condition”? State.  
 (viii) State the assumptions in theory of pure torsion of circular shaft.

b) Attempt any TWO of the following:

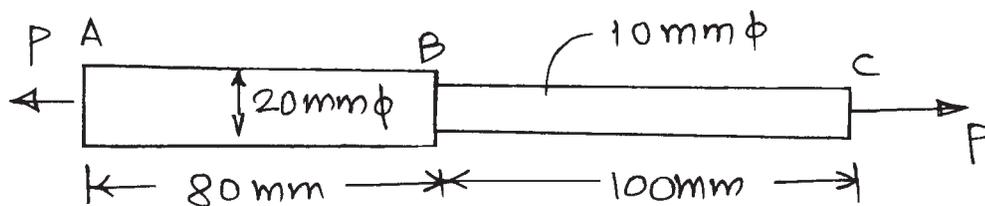
8

- (i) A copper wire of length 500mm is subjected to an axial pull of 5 kN. Find the minimum diameter if the stress is not to exceed  $70 \text{ N/mm}^2$ . Also calculate the elongation if  $E = 100 \text{ kN/mm}^2$ .  
 (ii) A square bar 20mm size is subjected to an-axial load. Find out maximum axial load the bar can carry if maximum principal stress is not to exceed  $30 \text{ N/mm}^2$ . Tensile and maximum shear stress is not to exceed  $12 \text{ N/mm}^2$ .  
 (iii) A simply supported beam of span 6m carries two point loads of 8 kN and 10 kN at 2m and 4m from the left hand support respectively. Draw SFD and BMD showing all important values.

2. Attempt any FOUR of the following:

16

- a) Determine the force and elongation of the compound bar shown in Figure No. 1 if the maximum stress induced in it is  $100 \text{ N/mm}^2$ . Both sections are circular. Take  $E = 200 \text{ kN/mm}^2$



**Fig. No. 1**

- b) A copper tube having 20mm inside diameter and 4mm thickness of metal is pressed fit on a steel rod 20mm diameter. Determine the stress induced in each metal due to temperature rise of  $60^\circ\text{C}$ . Take  $\alpha_c = 16 \times 10^{-6}/^\circ\text{C}$ ,  $\alpha_s = 11 \times 10^{-6}/^\circ\text{C}$   
 $E_s = 200 \text{ kN/mm}^2$ ,  $E_c = 160 \text{ kN/mm}^2$

- c) A metal bar of  $30\text{mm} \times 30\text{mm}$  in section is subjected to an axial compressive load of 500 kN. A contraction of 200mm gauge length is found to be 0.6mm and the increase in thickness is 0.04mm. Find the value of Poisson's ratio and the three elastic constants.
- d) State effective length of columns for different end conditions with neat sketches.
- e) The principal stresses at a point in the section of a member are  $100\text{ N/mm}^2$  and  $50\text{ N/mm}^2$  both tensile. Find the normal and tangential stresses across a plane passing through that point inclined at  $60^\circ$  to the plane having  $100\text{ N/mm}^2$  stress.
- f) At a point in the web of a girder, the bending stress  $\sigma_b$  and the shear stress is  $\tau$ . The principal stresses at a point are 80 MPa tensile and 20 MPa compressive. Evaluate the values of  $\sigma_b$  and  $\tau$ . Determine the direction of principal planes.

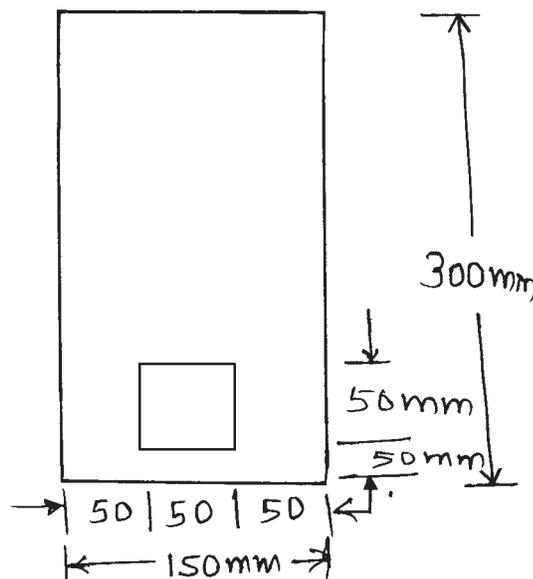
**3. Attempt any FOUR of the following: 16**

- a) A simply supported beam of span 7m carries a u.d.l. of 5 kN/m over 4m span from left support and a point load of 10 kN at 2m from the right hand support. Draw SFD and BMD.
- b) A cantilever beam of span 2m carries udl of 400 N/m over the entire span. It has also an upward reaction of 200 N at its free end. Find SFD and BMD. Also locate point of zero shear.
- c) A simply supported beam 5m long carries a point load of 10 kN and anticlockwise moment of 5 kN-m at a distance of 2m from left hand support. Draw SFD and BMD.
- d) A beam of span 7m is simply - supported at A and B.  $AB = 6\text{m}$ ,  $BC = 1\text{m}$ , BC is overhang portion. Portion AB carries udl of 20 kN/m and a point load of 50 kN at point C. Draw SFD and BMD.
- e) Find the polar moment of Inertia of a hollow circular section having external diameter 100 mm and thickness 10mm. Also find the radius of gyration.
- f) Find moment of Inertia of a 'Tee' section  $200\text{mm} \times 200\text{mm} \times 20\text{mm}$  about the centroidal horizontal axis.

4. Attempt any FOUR of the following:

16

- Find the M.I. of a triangular section having base 80 mm and height 200 mm about the horizontal axis parallel to the base. Also calculate the M.I. about the base and about an axis passing through its vertex and parallel to the base.
- Find  $I_{xx}$  for an unequal angle section of size  $120\text{ mm} \times 80\text{ mm} \times 10\text{ mm}$  thick.
- Find moment of Inertia about X-X axis for the section shown in Figure No. 2.

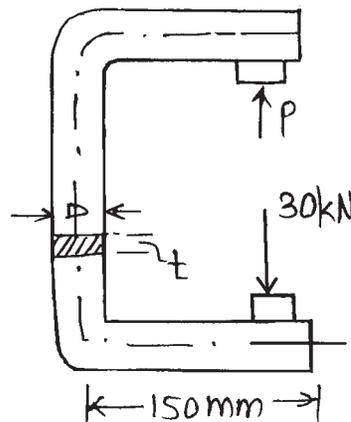
Fig. No. 2

- A built up column section is made of an I-section  $150 \times 80 \times 10\text{ mm}$  with one flange plate  $80\text{ mm} \times 10\text{ mm}$  riveted to each of the flanges. Find the minimum radius of gyration of the section.
- A timber beam having rectangular section  $80\text{ mm} \times 240\text{ mm}$ . This beam is cantilever of length 2 m and subjected to udl. of  $5\text{ kN/m}$  over entire length. Find extreme fibre stress at the section where bending moment is maximum.
- A circular section 20 cm diameter is subjected to a shear force of 5 kN when used as beam. Determine the maximum shear stress induced and draw the shear stress distribution diagram.

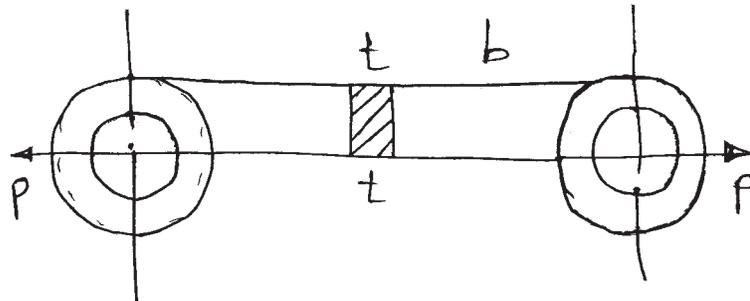
5. Attempt any FOUR of the following:

16

- a) Find diameter of circular section of a beam of 6 m span to carry load of 80 kN at the centre of span, if permissible bending stress is limited to  $8.4 \text{ N/mm}^2$ .
- b) A simply supported beam of span 2 m and cross section of  $100 \text{ mm} \times 200 \text{ mm}$  carries a u.d.l. of  $5 \text{ kN/m}$  over - the entire span. Find the maximum intensity of shear stress in the beam at a section 0.5 m to the right of the left hand support.
- c) A short column of external diameter 200 mm and internal diameter 150 mm carries an eccentric load. Find the eccentricity which the load can have without producing tension in the section of column.
- d) A hollow circular steel column having external diameter 300 mm and internal diameter 250 mm carries an eccentric load of 100 kN acting at an eccentricity of 100 mm. Calculate minimum and maximum stresses.
- e) A C-clamp as shown in Figure No. 3 carries a load of 30 kN. The cross section of the clamp at X-X is rectangular, having width equal to twice the thickness. Assuming that the C-clamp is made of steel causing with allowable stress of  $120 \text{ N/mm}^2$ . Find its dimensions.

**Fig. No. 3**

- f) A M.S. link as shown in Figure No. 4 by full lines, transmits a pull of 80 kN. Find dimensions  $b$  and  $t$  if  $b = 3t$ . Assume the permissible tensile stress as 75 MPa.



**Fig. No. 4**

**6. Attempt any FOUR of the following:**

**16**

- Calculate limit of eccentricity of a rectangular cross section of size 1200 mm  $\times$  2400 mm and sketch it.
- Differentiate between the polar modulus and section modulus. Also define torsional rigidity.
- Find the power transmitted by a shaft 40 mm diameter rotating at 250 rpm if the maximum permissible shear stress is 80 N/mm<sup>2</sup>.
- A solid shaft transmits 1000 kW at 120 rpm. If the shear stress of the material is not to exceed 80 N/mm<sup>2</sup> and maximum torque is likely to exceed 25% over its mean value, find the diameter of the shaft.
- A solid circular shaft of 40 mm diameter is subjected to torque of 0.25 kN-m causing an angle of - twist of 4° in 2 m length. Determine the modulus of rigidity for the material of shaft.
- Find the maximum stress in propeller shaft 400 mm external diameter and 200 mm internal diameter when subjected to a twisting moment of  $4.65 \times 10^8$  N-mm. If the modulus of rigidity is  $0.82 \times 10^5$  N/mm<sup>2</sup>, How much will be the twist in a length of 20 times the external diameter.