Con. 8739-13. **GS–6279**

(3 Hours) **[Total Marks : 100**

N.B. : (1) Question No. **1** is **compulsory**. Answer any **four** from the remaining **six** questions.
(2) Illustrate answers with neat **sketches** wherever **required**.
(3) Assume **suitable** data wherever is **required**.

1. Answer any **four** of the following :–

(a) Derive the flexure formula $\frac{M}{I} = \frac{f}{y} = \frac{E}{R}$ **5**

(b) Find the maximum power that can be transmitted through a 50mm diameter shaft at 150 rpm, if the maximum permissible shear stress in the shaft is 80 N/mm^2. **5**

(c) Derive an expression for deformation of a prismatic bar due to self weight, when fixed at one end and free at the other end. **5**

(d) For a circular shaft, derive the torsional formula $\frac{T}{J} = \frac{G\theta}{\ell} = \frac{\tau}{R}$ **5**

(e) Establish the relationship between shear force, bending moment and rate of loading in a beam. **5**

(f) Define Poissions ratio, Bulk modulus. Write the relations between the elastic constants. **5**

2. (a) A compound bar consists of a copper rod 20 mm in diameter and a steel tube 60 mm in external diameter, with thickness 5 mm. The copper rod and steel tube are assembled co-axially and their ends are rigidly fixed at 30°C. If the compound is heated to 130°C, determine the stress induced in each metal. **10**

Take $E_s = 200\ kN/mm^2$ $E_{cu} = 120\ kN/mm^2$

$\alpha_s = 12x10^{-6}/°C$ $\alpha_{cu} = 18x10^{-6}/°C.$

(b) Two round bars are each 500 mm long as shown in **fig. 1** Bar A is subjected to a sudden axial load such that it produces a maximum stress of 300 N/mm^2. What is the maximum stress produced in the bar B by the same sudden load ? When the bar B is also subjected to 300 N/mm^2 maximum stress, determine the ratio of energy stored by bars B to A. **10**

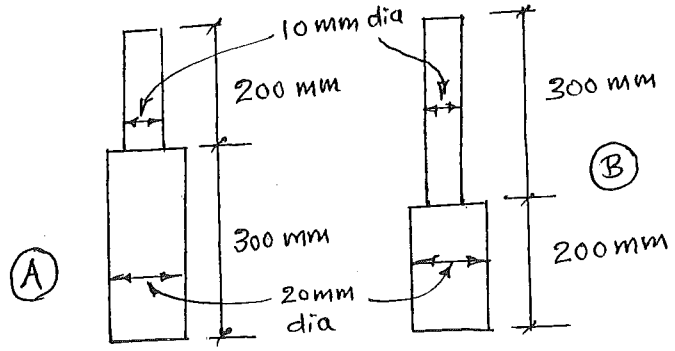

fig. 1

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3. (a) At a point in a strained material, the stresses on two mutually perpendicular planes are 80 MPa (T) and 50 MPa (C) accompanied by shear stress of 30 MPa. Find the normal, tangential and resultant stress intensities on a plane 60° to the plane carrying the tensile stress. Also determine the principal stresses, values of maximum shear stress and their orientations. **10**

(b) Determine the area of cross section of a steel pipe which is being used as a horizontal member of a jib crane supporting a maximum force of 25 kN. **10**

Use Euler's buckling formula with pinned ends and a factor of safety of 4. The internal diameter of the pipe is 0·75 times the external diameter.

Take $E = 2 \times 10^5$ N/mm^2. Refer **fig 2** below.

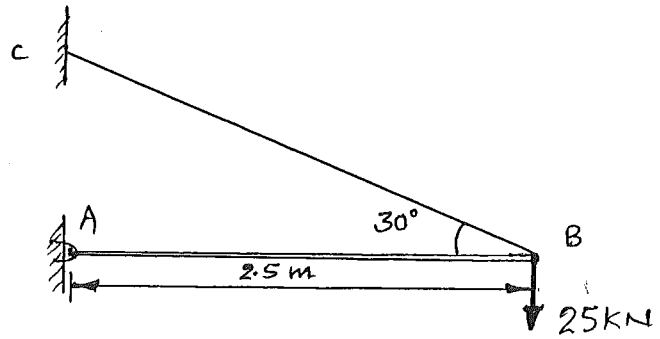
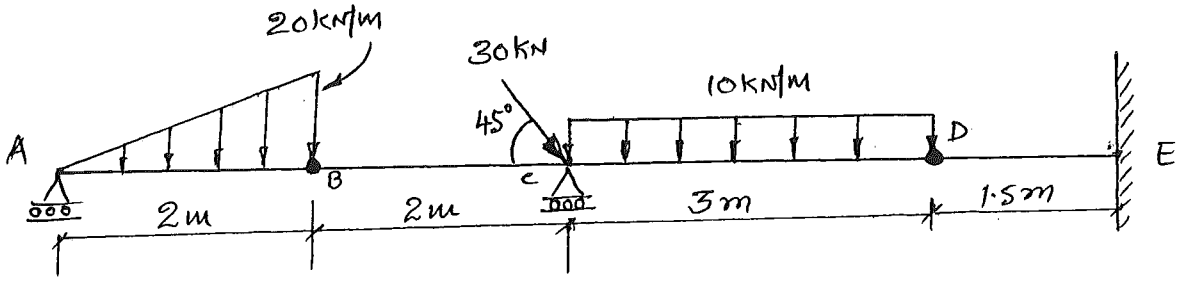


fig. 2

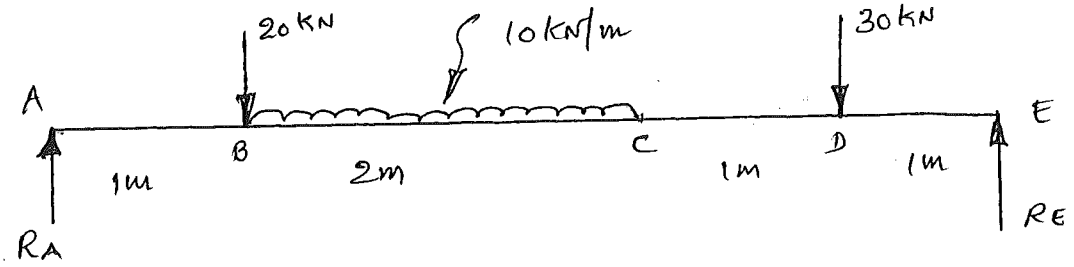
4. (a) Draw the axial force, shear force and bending moment diagrams for the beam loaded as shown below. Internal hinges at B and D. **10**



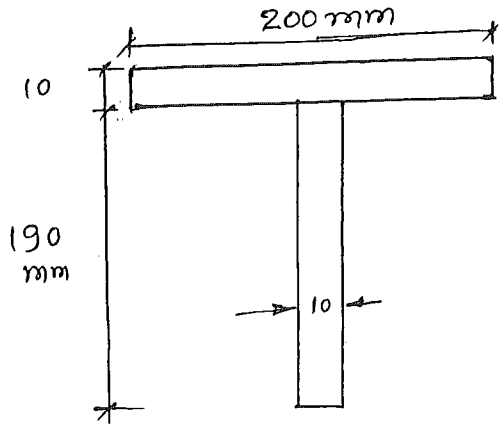
(b) A thin cylindrical shell, 3 m long and 1m in diameter is subjected to an internal pressure of 1 N/mm^2. If the thickness of the shell is 12mm, find the circumferential and longitudinal stresses. Find also the maximum shear stress and change in dimensions of the shell. Take E = 200 GPa, $\left(\frac{1}{m}\right) = 0 \cdot 3$. **10**

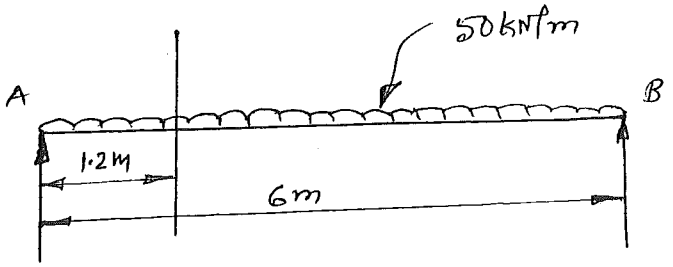
5. (a) A solid steel shaft transmits 560 kW at 300 rpm with a maximum shear stress of 60 N/mm^2. What is the shaft diameter ? What would be the diameter of the hollow shaft of the same material to transmit the same power at the same speed and same stress ? Take d_o = 2di compare the stiffness for equal length. **10**

(b) Determine the deflection at points B, C and D in the beam shown below. The beam has circular cross section of 200 mm diameter. Take E = 200 GPa. **10**



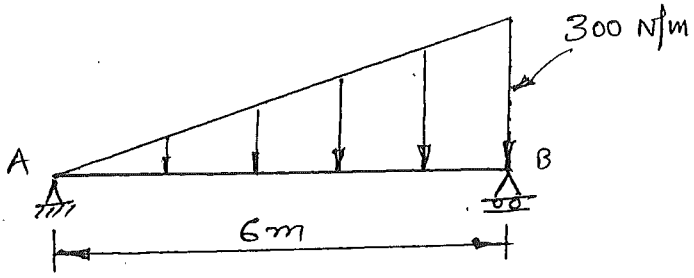
6. (a) A simply supported beam AB, 6m long is loaded with a udl of 50 kN/m over the entire span. At a section 1·2 m from end A, find SF and BM magnitudes to be resisted. Draw shear stress and bending stress distribution diagrams. Refer **figure** below. **10**





(b) A hollow circular column having external and internal diameters of 320 mm and 240 mm respectively carries a vertical load of 80 kN at the outer edge of the column. Calculate the maximum and minimum intensities of stress in the section and sketch the distribution. **10**

7. (a) A simply supported beam AB, carries a triangular loading as shown in **figure**. Determine for the entire beam the maximum tensile normal stress resulting from the loading. State the location of the stress. Cross section of the beam is 150 mm wide and 300 mm deep. **10**



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(b) A flitched beam consists of timber joists 100 mm wide and 300 mm deep with steel plate 15mm thick and 200 mm deep placed symmetrically and bolted with timber. If allowable stress in timber is 7·5 MPa. Calculate the total moment of resistance of composite section assuming $E_s = 20\ E_w$.