Prelim Paper **Strength of Materials**

Time: 3 Hrs.] **[Marks : 80**

N.B.: (1) All question carry equal marks.
(2) Assume suitable data if necessary.
(3) Figures to the right indicate full marks.
(4) Question No. 1 is compulsory & Attempt any three questions from remaining five questions.

1. Answer any FOUR of the following: **[20]**

(a) Derive formula for elongation of bar due to its self weight.

(b) A circular alloy bar 2m long uniformly tapers from 30 mm diameter to 20 mm diameter. Calculate the elongation of the rod under an oxial force of 50 kN. Take 'E' for the alloys as 140 GPa.

(c) State the assumption in the theory of pure bending and derive the formula.

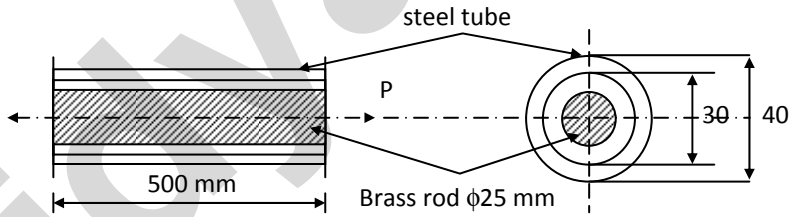
$$\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$$

(d) A hollow circular shaft of 80 mm internal diameter and 150 mm external diameter is subjected to a torque of 70 kN-m. Find maximum shear stress developed.

(e) Calculate the strain energy stored in a bar 2m long, 50 mm wide and 40 mm thick when it is subjected to a tensile load of 60 kN. Take 'E' as 200 GPa.

(f) A cantilever bean 4m long carries a gradually varying load, zero at the free end to 3 kN/m at the fixed end. Draw B.M. and S.F. diagrams for the beam.

2. (a) A composite bar is made up of a brass rod of 25 mm diameter enclosed in a steel tube of 40 mm external diameter and 30 mm internal diameter as shown in figure. The rod and tube, being coaxial and equal in length, are securely fixed at each end. If the stresses in brass and steel one not to exceed 70 MPa and 120 MPa respectively. Find the load (P) the composite bar can safely carry. **[10]**



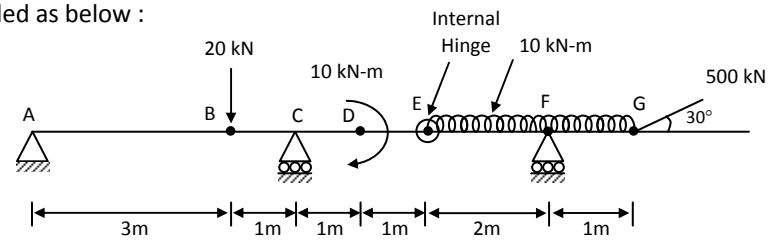
(b) A timber beam of rectangular section has a span of 4.8 meters and is simply supported at it ends. It is required to carry a total load of 45 kN uniformly distributed over the whole span. Find the values of the breadth (b) and depth (d) of the beam, if maximum bending stress is not to exceed 7 MPa and maximum deflection is limited to 9.5 mm. Take E for timber as 10.5 GPa. **[10]**

3. (a) A plane element in a boiler is subjected to tensile stresses of 400 MPa on one plane and 150 MPa on the other at right angles to the former. Each of the above stresses is accompanied by a shear stress of 100 MPa such that when associated with the minor tensile stress tends to rotate the element in anticlockwise direction. Find **[10]**

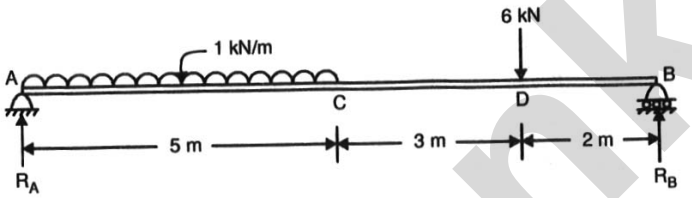
(i) Principal stresses and their directions

(ii) Maximum shearing stresses and the direction of the plane on which they act.

(b) Draw the axial force, shear force and bending moment diagrams for the beam loaded as below : **[10]**



4. (a) For the beam loaded as shown in the figure, find slopes at A and B and deflection at C and D. Also find the position and value of maximum deflection in the beam. Take E = 2×10^5 N/mm^2, I = 1×10^8 mm^4. **[10]**



(b) A thin cylindrical shell having 120 cm diameter, thickness of metal 15 mm and 4 m long, is subjected to an internal pressure of 2.5 N/mm^2. Find the Hoop stress, longitudinal stress, changes in length, diameter and volume of the shell. Take E = 2×10^4 kN/cm^2 and Poisson ratio = 0.3 **[10]**

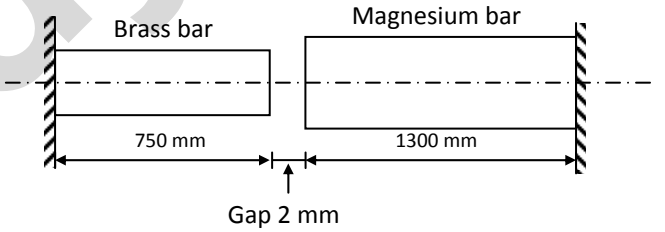
5. (a) A bimetallic thermal control shown in figure is made of bass bar of length 750 mm and cross sectional area 100 mm^2 and magnesium bar of length 1300 mm and cross sectional area 200 mm^2. The two bars are arranged so that the gap between their free ends is 2mm at room temperature, calculate : **[10]**

(i) The temperature rise at which the two bars come in contact.

(ii) The stress in the materials when the temperature increase is 300°C.

take, Eb = 150 GPa, Em = 65 GPa

$\alpha_b = 10 \times 10^{-6}$ / °C, $\alpha_m = 14.5 \times 10^{-6}$ /°C



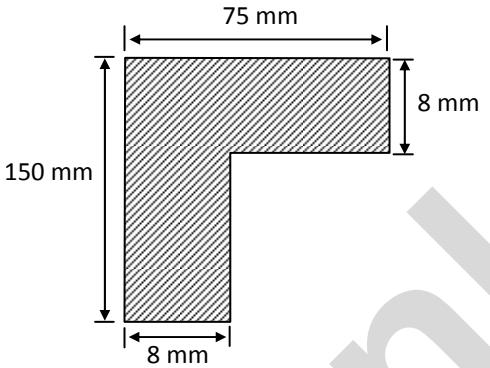
(b) Determine the diameter of the shaft to transmit 1 MW rotating at 220 r.p.m. and the marking conditions to be satisfied are : **[10]**

(i) That the shaft not twist more than 1° on length of 12 diameters and

(ii) The shear stress must not exceed 60 N/mm^2 take G = 84 kN/m^2.

6. (a) What is the minimum actual length of the column for which Eular's formula hold good. If the cross section of uniform column is a square of side 150 mm. The column has one end hinged and other end fixed. **[10]**
Take, σ_c = 250 N/mm^2 & E = 200 GPa

(b) An unequal angle as shown in fig. is used as a beam and carries a U.D.L. of 6 kN/m^2 over a span of 3 m find the maximum shear stress developmed and sketch the shear stress distriution across the section giving all important values. **[10]**



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