Sem III / CBCGS / Auto / MJ-19

3 Hours Total Marks: 80

- Question-1 is compulsory.
- Answer any three from remaining five questions.
- Assume any suitable data wherever required but justify the same. Assumptions made should be clearly stated.
- Illustrate answers with sketches wherever required.

I Answer any four of the following:

Ia. A material has Young's Modulus of 2×10^5 N/mm^2 and Poisson's Ratio of 0.32. Calculate the Modulus of Rigidity and Bulk Modulus of the material. *05*

Ib. Derive the relationship between the rate of loading, shear force and bending moment in a beam. *05*

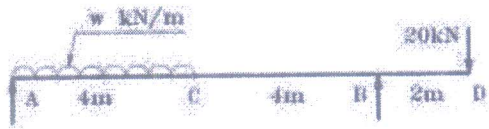
Ic. A simply supported beam of span 4 m with EI constant throughout the span is subjected to a load of 24 kN at 3 m from left end support. Find total strain energy of the beam in bending. *05*

Id. State the assumptions made in the theory of pure bending and derive the formula, *05*

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

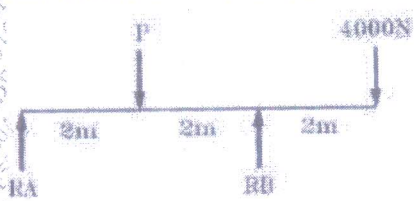
Ie. A short column of external diameter 400 mm and internal diameter 200 mm carries an eccentric load of 90 kN. Find the greatest eccentricity, which the load can have without producing tension on the cross section. *05*

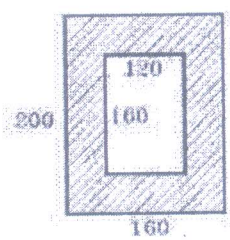
IIa. For a beam loaded as shown in figure, calculate the value for UDL, w so that bending moment at C is 50 kNm. Draw the shear force and bending moment diagrams for the beam for the calculated value of w. Locate the point of contra flexure, if any. *12*



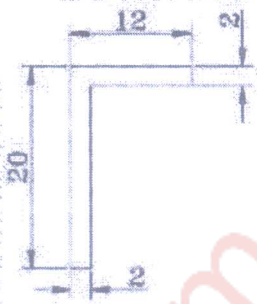
IIb. An elemental cube is subjected to tensile stresses of 30 N/mm^2 acting on two mutually perpendicular planes and a shear stress of 10 N/mm^2 on these planes. Draw the Mohr's circle of stresses and hence or otherwise determine the magnitudes and directions of principal stresses and also the greatest shear stress. *08*

IIIa. A box beam supports the loads as shown in figure. Compute the maximum value of P that will not exceed bending stress σ = 8 MPa or shear stress τ= 1.2 MPa for section between the supports. Also, draw the shear stress distribution diagram at a section where shear force is maximum. *12*

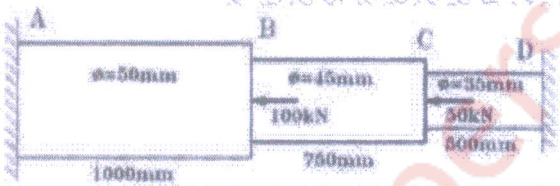




IIIb. Find the principal moments of inertia and directions of principal axes for the angle section shown. All dimensions are in cm. *08*



IVa. A stepped round bar ABCD is fixed to unyielding support at sections A&D as shown in figure. It is subjected to axial loads at sections B and C. Determine, stresses in each portion of the bar and deflections of sections B and C. Take E= 200 GN/m^2 *10*

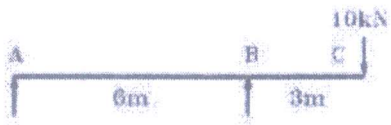


IVb. A cylindrical vessel of 1.5 m diameter and 4 m long is closed at ends by rigid plate. It is subjected to an internal pressure of 3 N/mm^2. If maximum circumferential stress is not to exceed 150 N/mm^2, find the thickness of the shell. Find change in diameter, length and volume of the shell. *10*

Assume E= 2 x 10^5 N/mm^2 and Poisson's ratio= 0.25.

Va. Determine the diameter of a solid steel shaft that will transmit 150 kW at a speed of 3 rev/sec, if the allowable shearing stress is 85 MPa. Also, determine the diameter of a hollow steel shaft, whose inside diameter is ¾th of its outside diameter for the same conditions. What is the ratio of angle of twist per unit length for these two shafts? *10*

Vb. An overhanging beam ABC is loaded as shown in figure. Find the slopes over each support and the deflection at the right end. Take E= 2 x 10^5 N/mm^2 and I= 5 x 10^8 mm^4 *10*



VIa. A steel tube of 30 mm external diameter and 20 mm internal diameter encloses a copper rod of 15 mm diameter to which it is rigidly fixed at each end. If at a temperature of 10 °C, there is no longitudinal stress, calculate the stresses in the rod and tube when the temperature is raised to 200 °C. Take E for steel and copper as 2.1 x 10^5 N/mm^2 and 1 x 10^5 N/mm^2 respectively. The value of coefficient of linear expansion for steel and copper is given as 11 x 10^{-6}/°C and 18 x 10^{-6}/°C respectively. *10*

VIb. From the following data, determine the thickness of cast iron column. Assume both the ends of the column are fixed. *10*

Length of the column= 3 m	Factor of Safety= 5
External diameter= 200 mm	Ultimate compressive stress= 570 N/mm^2
Safe working load= 600 kN	Rankine constant= 1/ 1600