SE/Sem III/ CBCGS/ MECH/ AUTO/ M-J-18/ SOM. 22/05/18

QP CODE : 27637

(Three Hours) Marks 80

- *Q1 is compulsory. Answer any three from the remaining five questions.*
- *Assume suitable data, wherever required.*
- *State the assumptions and justify the same.*
- *Illustrate answers with sketches, wherever required.*
- *Write legibly with blue or black ink pen. Use pencil only to draw diagrams and graphs.*

I Answer any four of the following.

a. Define bulk modulus. Derive an expression for Young's modulus, in terms of bulk modulus and Poisson's Ratio. *[05]*

b A short column of external diameter 400 mm and internal diameter 200 mm carries an eccentric load of 80 kN. Find the greatest eccentricity, which the load can have without producing tension on the cross section.

c. State the assumptions in the theory of pure bending and derive the formula, *[05]*

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

d. Find the maximum shear stress induced in a solid circular shaft of diameter 150 mm, when it transmits 150 kW power at 180 rpm. *[05]*

e. A steel bar of 50 mm x 50 mm in section and 3 m length is subjected to an axial pull of 140 N. Calculate the strain energy stored in the bar. Find also the extension of the bar. Take E= 200 GPa *[05]*

f. A cantilever of length 4 m carries uniformly varying load of intensities zero at free end and 2 kN/m at fixed end. Draw shears force and bending moment diagrams for the beam. *[05]*

II a. A compound tube consists of a steel tube of 140 mm internal diameter and 160 mm external diameter; and an outer brass tube of 160 mm internal diameter and 180 mm external diameter. Both the two tubes are of 1.5 m length. If the compound tube carries an axial compressive load of 900 kN, find its reduction in length. Also, find the stresses and the loads carried by each tube. *[10]*

$$E_s = 2 \times 10^5 N/mm^2,\ E_b = 1 \times 10^5 N/mm^2$$

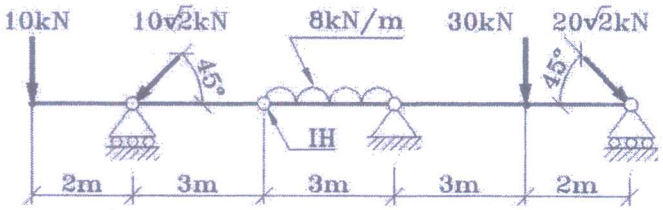
b. A point load of 10 kN applied to a simply supported beam at mid-span, produces a deflection of 6 mm and a maximum bending stress of 20 N/mm^2. Calculate the maximum value of the momentary stress produced, when a weight of 5 kN is allowed to fall through a height of 18 mm on the beam at the middle of the span. *[10]*

III a. Two mutually perpendicular planes of an element of material are subjected to tensile stress of 105 N/mm^2, compressive stress of 35 N/mm^2 and shear stress of 70 N/mm^2. Find graphically or otherwise, *[10]*

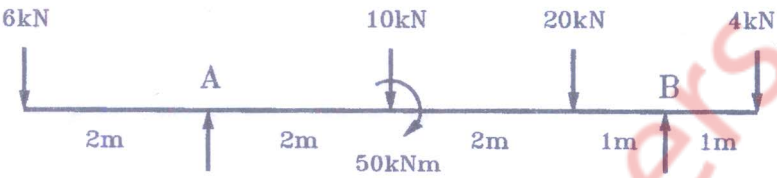
i. Magnitude and the direction of principal stresses

ii. Magnitude of the normal and the shear stresses on a plane, on which the shear stress is maximum

b. Draw axial force , shear force and bending moment diagrams for the beam loaded as shown in figure. Locate all important points. *[10]*



IV a. Determine the position and the amount of maximum deflection for the beam shown in the figure. Take, $EI = 1.8 \times 10^4\ kNm^2$. *[10]*



b. A weight of 200 kN is supported by three adjacent short pillars in a row, each 500 mm^2 in section. The central pillar is made of steel and the outer ones are of copper. The pillars are adjusted such that at 15 °C, each carries equal load. The temperature is then raised to 115 °C. Estimate the stresses in each pillar at 15°C and 115 °C. Take: E_s=2x10^5 N/mm^2, E_c= 0.8x10^5 N/mm^2, α_s= 1.2x10^{-5}/°C, α_c= 1.85x10^{-5}/°C *[10]*

V a. A hollow shaft, having an internal diameter 40% of its external diameter, transmits 562.5 kW power at 100 rpm. Determine external diameter of the shaft, if shear stress is not to exceed 60 N/mm^2, and the twist in a length of 2.5 m should not exceed 1.3°. Assume that the maximum torque is 1.25 time the mean torque and $G = 9 \times 10^4\ N/mm^2$. *[10]*

b. A closed cylindrical vessel made of steel plates 4 mm thick with plane ends carries fluid under a pressure of 3 N/mm^2. The diameter of the cylinder is 250 mm and the length is 750 mm. Calculate the longitudinal and hoop stresses in the cylinder wall and determine the changes in diameter, length and volume of the cylinder. *[10]*

$$E = 2.1 \times 10^5 N/mm^2, \qquad \frac{1}{m} = 0.286$$

VI a. A hollow cast iron column of 200 mm external diameter, 150 mm internal diameter and 8 m long has both ends fixed. It is subjected to axial compressive load. Taking factor of safety as 6, $\sigma_c = 560\ N/mm^2$, $\alpha = \frac{1}{1600}$, determine the safe Rankine load. *[08]*

b. A simply supported beam carries a UDL of intensity 2.5 kN/m over a span of 5 m. The cross-section is T-section having flange 125 mm x 25 mm and web 175 mm x 25 mm. Calculate maximum bending stress and shear stress for the section of the beam. Also, draw the shear stress distribution diagram for maximum shear force. *[10]*

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