CBCS SCHEME

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15ME/MA34

Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
Mechanics of Materials

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Derive an expression for the extension of a uniformly tapering rectangular bar when it is subjected to an axial load P. **(08 Marks)**

b. Calculate the modulus of rigidity and bulk modulus of a cylindrical bar of diameter of 25mm and length 1.6m, if the longitudinal strain in a bar during a tension test is four times the lateral strain. Find the change in volume, when the bar is subjected to a hydrostatic pressure of $100 N/mm^2$. Take $E = 1 \times 10^5 N/mm^2$. **(08 Marks)**

OR

2 a. A mild steel rod of 20mm diameter and 300mm long is enclosed centrally inside a hollow copper tube of external diameter 30mm and internal diameter of 25mm. The ends of the tube and rods are brazed together, and the composite bar is subjected to an axial pull of 40kN. If E for steel and copper is $200 GN/m^2$ and $100 GN/m^2$ respectively. Find the stresses developed in the rod and tube. Also find the extension of the rod. **(08 Marks)**

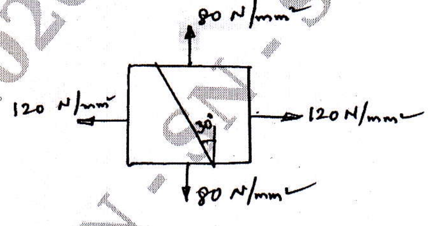
b. A steel bar is placed between two copper bars each having the same area and length as the steel bar at 15^0C. At this stage , they are rigidly connected together at both the ends. When the temperature is raised to 315^0C, the length of the bars increase by 1.5mm. Determine the original length and final stresses in the bars. Take $E_s = 2.1 \times 10^5 N/mm^2$;
$E_c = 1 \times 10^5 N/mm^2$; $\alpha_s = 0.000012$ per ^0C ; $\alpha_c = 0.0000175$ per ^0C. **(08 Marks)**

Module-2

3 a. Define Principal planes. Starting from the expression of normal and tangential stresses acting on inclined plane in an element subjected to 2D – stress state, derive the expressions for the magnitude and location of principal stresses. **(08 Marks)**

b. The direct stresses acting at a point in a strained material are as shown in fig. Q3(b). Find the normal , tangential and the resultant stresses on a plane 30^0 to the plane of the major principal stress. Find also the obliquity of the resultant stresses. **(08 Marks)**

Fig.Q3(b)



OR

4 a. A thick walled cylindrical pressure vessel has inner and outer radii of 200mm and 250mm respectively. The material of the cylinder has an allowable stress of $75 MN/m^2$. Determine the maximum internal pressure that can be applied and draw the sketch of radial pressure and circumferential stress distribution. **(08 Marks)**

b. Derive expressions for circumferential Loop stress and longitudinal stress in thin cylinder. State the assumptions made in the derivation. **(08 Marks)**

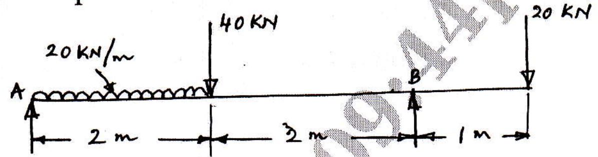
Module-3

5 a. Obtain the expressions for shear force and bending moment at a section of a cantilever beam carrying gradually varying load from zero at the free end to W per unit length at the fixed end. Draw the shear force and bending moment diagrams. **(06 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

b. Draw the shear force and bending moment diagrams for the overhanging beam shown in fig.Q5(b). Clearly indicate point of contra flexure. **(10 Marks)**

Fig.Q5(b)



OR

6 a. Derive the relation $\frac{M}{I} = \frac{\sigma_b}{Y} = \frac{E}{R}$ with usual notations and list the basic assumptions. **(10 Marks)**

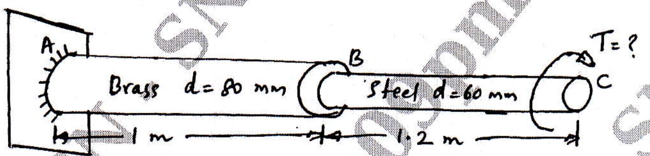
b. A simply supported beam of span 5m has a cross section 150mm × 250mm. If the permissible stress is $10 N/mm^2$, find the maximum concentrated load P applied at 2m from one end, it can carry. **(06 Marks)**

Module-4

7 a. Determine the diameter of a solid shaft which will transmit 300 KW at 250 rpm. The maximum shear stress should not exceed $30 N/mm^2$ and twist should not be more than 1 in a shaft length of 2m. Take modulus of rigidity = $1 \times 10^5 N/mm^2$. **(08 Marks)**

b. The allowable shear stress in brass is $80 N/mm^2$ and in steel $100 N/mm^2$. Find the maximum torque that can be applied in the stepped shaft shown in fig. Q7(b). Find also the total rotation of free end with respect to the fixed end if $G_{brass} = 40\ kN/mm^2$ and $G_{steel} = 80 kN/mm^2$. **(08 Marks)**

Fig.Q7(b)



OR

8 a. Find an expression for crippling load for a column with one end fixed and other end free. **(08 Marks)**

b. Determine the buckling load for a strut of T – section, the flange width being 100mm, overall depth 80mm and both flange and stem 10mm thick as shown in fig. Q8(b). The strut is 3m long and is hinged at both ends. $E = 200 GN/m^2$. **(08 Marks)**

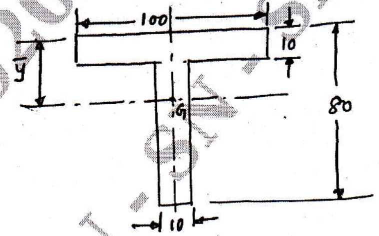


Fig.Q8(b)

Module-5

9 a. Using Castiglione's first theorem, find the deflection at the free end of a cantilever beam carrying a concentrated load at the free end. Assume uniform flexural rigidity. **(06 Marks)**

b. Derive an expression for strain energy stored in a body due to torsion. **(10 Marks)**

OR

10 a. Write short notes on :

i) Maximum Principal stress theory ii) Maximum shear stress theory. **(10 Marks)**

b. A bolt is subjected to an axial pull of 12kN together with a transverse shear force of 6kN. Determine the diameter of the bolt by using Maximum principal stress theory. Take Elastic limit in tension = $300 N/mm^2$, Factor of safety = 3. **(06 Marks)**