CBCS SCHEME

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18ME32

Third Semester B.E. Degree Examination, Aug./Sept.2020
Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Define (i) Hooke's law (ii) True stress **(04 Marks)**

b. Derive an expression for the extension of uniformly tapering rectangular bar subjected to axial load P. **(06 Marks)**

c. A stepped bar of steel, held between two supports as shown in Fig.Q1(c), is subjected to loads $P_1 = 80$ kN and $P_2 = 60$ kN. Find the reactions developed at the ends A and B.

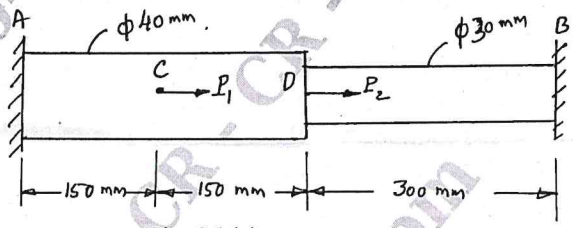

Fig.Q1(c) **(10 Marks)**

OR

2 a. A steel bar is placed between two copper bars, each having the same area and length and the steel bar at 15°C. At this stage, they are rigidly connected together at both the ends. When the temperature is raised to 315°C, the length of the bars increases by 1.5mm. Determine the original length and find stresses in the bars. Take $E_s = 2.1\times10^5$ N/mm^2, $E_c = 1\times10^5$ N/mm^2, $\alpha_S = 0.000012$/°C, $\alpha_C = 0.0000175$/°C. **(10 Marks)**

b. Establish a relationship between the modulus of elasticity and modulus of rigidity. **(10 Marks)**

Module-2

3 a. Derive an expression for the normal stress and shear stress on plane inclined at 'θ' to the vertical axis in two dimensional stress system with shear. Also prove that the sum of normal stresses on any two mutually perpendicular planes are always constant. **(12 Marks)**

b. A thin cylinder, 2 m long and 200 mm in diameter with 10mm thickness is filled completely with a fluid, at an atmospheric pressure. If an additional 25mm^3 fluid is pumped in, find the longitudinal and loop stress developed. Also find the change in the diameter, if $E = 2\times10^5$ N/mm^2 and Poisson's ratio = 0.3. **(08 Marks)**

OR

4 a. At a point in a loaded elastic member, there are normal stresses of 60 MPa and 40 MPa, (both tensile) at right angles to each other with positive searing stress of 20 MPa. Draw the Mohr's circle diagram and find (i) Principal stresses and their planes (ii) Maximum shear stress and its plane. **(10 Marks)**

b. The internal and external diameters of a thick cylinder are 300mm and 500mm respectively. It is subjected to an external pressure of 4 N/mm^2. Find the internal pressure that can be applied if the permissible stress in cylinder is limited to 13 N/mm^2. Sketch the variation of hoop stress and radial stress across the thickness of the cylinder. **(10 Marks)**

Module-3

5 a. A cantilever of length 2 m carries an uniformly distributed load of 1 kN/m run over a length of 1.5m from the free end. Draw the shear force and bending moment diagrams for the cantilever. **(06 Marks)**

b. Draw the shear force and bending moment diagrams for the overhanging beam carrying uniformly distributed load of 2 kN/m over the entire length and a point load of 2 kN as shown in Fig.Q5(b).

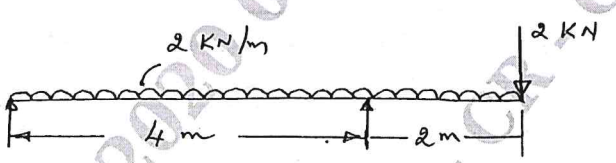

Fig.Q5(b) **(14 Marks)**

OR

6 a. Derive an expression for the shear stress distribution across the rectangular section of width 'b' and depth 'd'. Draw the figure showing the shear stress variation across the section. Also show that the maximum shear stress is 1.5 times the average shear stress. **(10 Marks)**

b. A 200mm × 80mm I-beam is to be used as a simply supported beam of 6.75m span. The web thickness is 6mm and the flanges are of 10mm thickness. Determine what concentrated load can be carried at a distance of 2.25 m from one support if the maximum permissible stress is 80 MPa. **(10 Marks)**

Module-4

7 a. A shaft is subjected to a maximum torque of 14 kN-m and a maximum bending moment of 10 kN-m at a particular section. Determine the diameter of the shaft according to maximum shear stress theory if the elastic limit in simple tension is 180 MPa. **(08 Marks)**

b. Derive the equation $\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{L}$ with usual notations. State the assumptions. **(12 Marks)**

OR

8 a. A solid shaft is to transmit 192 kW at 450 rpm. Taking allowable stress for the shaft material as 70 MPa, find the diameter of the solid shaft. What percentage of saving in weight would be obtained, if this shaft was to be replaced by hollow shaft, whose internal diameter is 0.8 times its external diameter? The length of the shaft, power to be transmitted and the speed are equal in both cases. **(10 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 as shown in Fig.Q8(b). Find also the total rotation of free end with respect to the fixed end if $G_b = 40$ kN/mm^2 and $G_s = 80$ kN/mm^2.

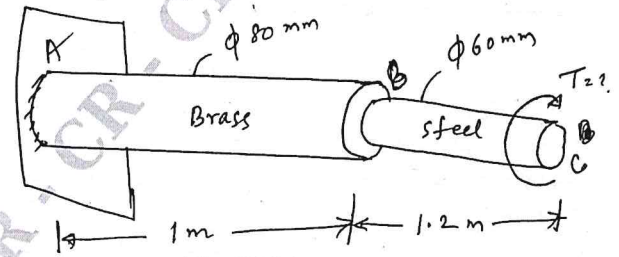

Fig.Q8(b) **(10 Marks)**

Module-5

9 a. Derive an expression for Euler's buckling load in long elastic column when both ends are fixed. State the assumptions. **(10 Marks)**

b. Derive an expression for strain energy stored in a beam under bending. Also find the strain energy in a cantilever beam carrying a point load at the free end. **(10 Marks)**

OR

10 a. Determine the buckling load for a strut of tee section, the flange width being 100mm, over all depth 80mm and both flange and stem 10mm thick. The strut is 3m long and is hinged at both ends. Take $E = 200\ GN/m^2$. **(10 Marks)**

b. State and prove Castigliano's first theorem. **(10 Marks)**

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