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10CV/EV/CT33

Third Semester B.E. Degree Examination, Feb./Mar. 2022
Strength of Materials

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Define: i) Hooke's law and ii) Modulus of rigidity. **(04 Marks)**

b. Derive a relation between modulus of rigidity, modulus of elasticity and Poisson's ratio. **(06 Marks)**

c. A stepped bar is subjected to an external loading as shown in Fig.Q.1(c). Calculate the change in length of the bar. Take E for steel = 200GPa, E for aluminium = 70GPa and E for copper = 100GPa. **(05 Marks)**

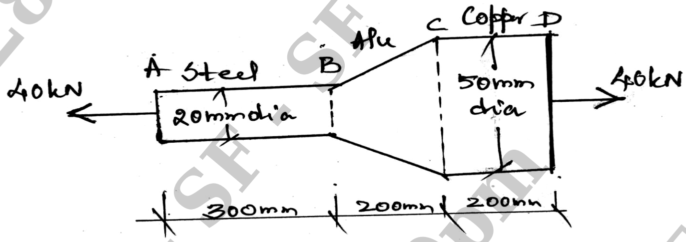

Fig.Q.1(c)

d. A solid alloy bar of 40mm diameter is used as tie. If the permissible tensile stress in material is $32 MN/m^2$, determine the capacity of the bar. If a hollow steel bar with internal diameter 20mm is used instead of solid bar, determine its external diameter if the permissible stress is $150\ MN/m^2$. **(05 Marks)**

2 a. Define composite section. **(02 Marks)**

b. A reinforced concrete column of size 0.3m × 0.3m contains 4no. 40mm diameter rods and subjected to a load of 500kN. Determine the stresses in concrete and steel if the modular ratio of steel to concrete is 15. **(08 Marks)**

c. A brass bar of 25mm diameter is enclosed within a steel tube of internal diameter 25mm and external diameter 50mm, the length of the composite bar is 1m and further the ends are rigidity held by means of rigid collars. Find the stresses induced in the materials when the temperature rises by 100°C. Find the final stresses if the composite bar is subjected to a tensile load of 600kN. E for steel = 200GPa; α for steel = 11.6×10^{-6}/°C, E for brass = 100GPa; α for brass = 18.7×10^{-6}/°C. **(10 Marks)**

3 a. Define:
i) Principal stresses,
ii) Critical planes,
iii) Principal planes. **(06 Marks)**

b. The stresses on a strained element are as shown in Fig.Q3(b). Determine:
i) Stresses when the element is rotated through an angle of 30° as shown.
ii) Principal plane and principal stresses.
Sketch the planes.

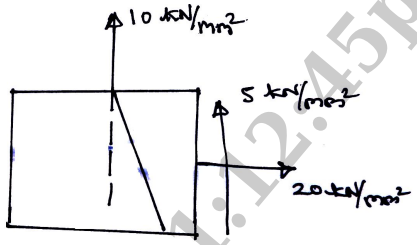

Fig.Q3(b) **(14 Marks)**

4 a. Define:
i) Hogging bending moment ii) Sagging bending moment iii) Point of contraflexure. **(06 Marks)**

b. Draw SFD and BMD for the beam shown in Fig.Q4(b) showing salient features.

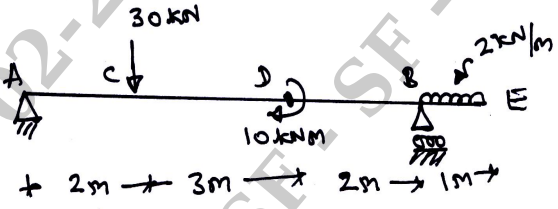

Fig.Q4(b) **(14 Marks)**

PART – B

5 a. Prove that maximum shear stress in a rectangular section of width b and depth d is equal to 1.5 times of its average shear stress. **(05 Marks)**

b. State the assumptions made in the theory of pure bending. **(05 Marks)**

c. A rolled I section of size 75 mm × 50 mm is used as a beam with an effective span of 3m. The flanges are 5 mm thick and web 3.7 mm thick. Calculate the uniformly distributed load the beam can carry if the maximum shear stress is 40 N/mm^2. **(10 Marks)**

6 a. Establish the relationship between slope, deflection and radius of curvature for a beam. **(06 Marks)**

b. A horizontal girder of steel having uniform section is 14 metres long and is simply supported at its ends. It carries concentrated loads of 120 kN and 80 kN at two points 3m and 4.5m from the two ends respectively. I for the section of the girder is 16×10^8 mm^4 and $E = 210 \times 10^3$ N/mm^2. Calculate the deflections of the girder at points under the two loads. Find also the maximum deflection. **(14 Marks)**

7 a. State the assumptions in the theory of pure torsion. **(05 Marks)**

b. Define: i) Polar section modulus, ii) Torsional rigidity. **(05 Marks)**

c. The external and internal diameters of a hollow shaft are 160 mm and 120 mm respectively. If the shaft is subjected to a torque of 20 kN-m, find:
i) Shear stress at the outer surface of the shaft
ii) Shear stress at the inner surface of the shaft
iii) Angle of hoist per metre length of the shaft.
Take C = 7.5×10^4 N/mm^2. **(10 Marks)**

8 a. Derive an expression for the Euler's crippling load for slender column having both ends of the column hinged. **(06 Marks)**

b. Find Euler's critical load for a hollow cylindrical cast iron column 200 mm external diameter and 25 mm thick, if it is 6 meters long and hinged at both ends. Take $E = 8 \times 10^4$ N/mm^2. Compare Euler's critical load with the Rankine's critical load taking $f_c = 550$ N/mm^2 and a = 1/1600. For what length of the column would the critical loads by Euler's and Rankine's formula will be equal? **(14 Marks)**