USN | | | | | | | | | | **15AE34**

Third Semester B.E. Degree Examination, June/July 2019
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. Briefly explain state of stress at a point. **(04 Marks)**

b. Derive equilibrium equation for the plane state of stress in rectangular coordinate system. **(06 Marks)**

c. At a point P, the rectangular stress components are $\sigma_x = 1$, $\sigma_y = -2$, $\sigma_z = 4$ and $\tau_{xy} = 2$, $\tau_{yz} = -3$ and $\tau_{xz} = 1$ all in units of kPa. Find the principal stresses and check for invariance. **(06 Marks)**

OR

2 a. Define: i) Hooke's law ii) Factor of safety iii) Proof stress iv) Poisson's ratio **(04 Marks)**

b. Explain Tresca's criterion. **(04 Marks)**

c. A bar of 800 mm length is attached rigidly at A and B as shown in Fig.Q2(c). Forces of 30 kN and 60 kN act as shown on the bar. If E = 200 GPa, determine the reactions at the two ends. If the bar diameter is 25 mm, find the stresses and change in length of each portion.

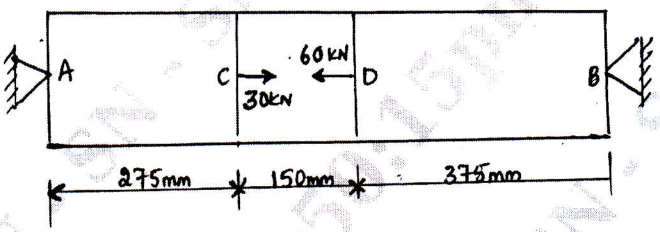

Fig.Q2(c) **(08 Marks)**

Module-2

3 a. State and prove the implications of the Euler-Bernulli assumptions. **(08 Marks)**

b. A beam having T section with its flange of (180 mm × 10 mm) and web of (10 mm × 220 mm) is subjected to sagging bending moment 15 kN-m. Determine the maximum tensile stress and maximum compressive stress and their location in the section. Draw a sketch showing bending stress distribution. **(08 Marks)**

OR

4 a. Determine the displacement field and axial force for the beam shown in Fig.Q4(a).

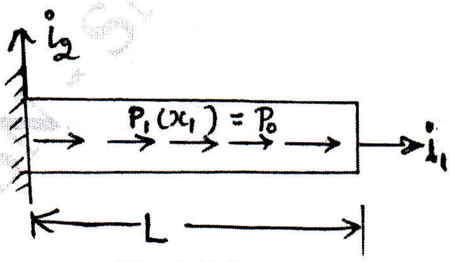

Fig.Q4(a) **(05 Marks)**

b. Formulate the sectional constitutive laws of three dimensional Euler-Bernoulli beam theory. **(11 Marks)**

Module-3

5 a. A solid shaft is to transmit 192 kW at 450 rpm. Taking the allowable shear 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 were to be replaced by a hollow shaft, whose internal diameter is 0.8 times external diameter. The length, material, power to be transmitted and speed are equal in both cases. Torsional strength of both solid and hollow shafts should be equal. **(07 Marks)**

b. Briefly discuss the application of Vonmises criterion for a propellar shaft under torsion and bending. **(04 Marks)**

c. A propeller shaft is subjected to a turning moment of 500 N-m and axial thrust of 20 kN. Allowable stress in material is 80 MPa. Determine the diameter of the propeller shaft based in Tresca's criterion. **(05 Marks)**

OR

6 a. Determine the shear flow distribution in the thin walled Z-section as shown in Fig.Q6(a) due to shear load Sy applied through the shear centre of the section.

Take $I_{xx} = \frac{h^3t}{3}$, $I_{yy} = \frac{h^3t}{12}$, $I_{xy} = \frac{h^3t}{8}$.

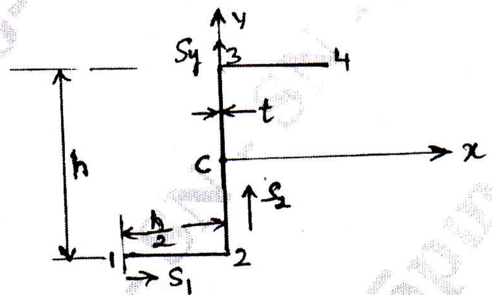

Fig.Q6(a) **(10 Marks)**

b. Formulate Bredt-Batho equation for torsion of closed section. **(06 Marks)**

Module-4

7 a. Explain principle of virtual work for a single particle. Obtain the equilibrium of a particle. **(08 Marks)**

b. Derive an expression for internal virtual work due to bending moment. **(08 Marks)**

OR

8 a. Explain strain energy and complementary energy. **(08 Marks)**

b. State Castiglino's second theorem. Using Castiglino's theorem find the deflection at the free end of a Cantilever shown in Fig.Q8(b).

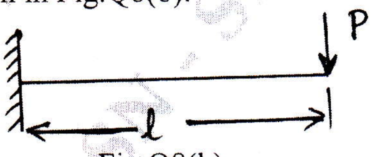

Fig.Q8(b) **(08 Marks)**

Module-5

9 a. Explain the Vonmise's criterion for yielding under combined loading. **(06 Marks)**

b. Derive equilibrium equations for buckling of beams. **(10 Marks)**

OR

10 a. State the assumptions and explain Kirchhoff plate theory. **(12 Marks)**

b. Write a note on buckling of plates. **(04 Marks)**

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