CBCS SCHEME

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17MT33

Third Semester B.E. Degree Examination, July/August 2021
Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions.***

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.

1 a. Derive the expression for analysis of uniformly tapering rectangular bar. **(10 Marks)**

b. A steel bar ABCD of varying sections is subjected to the axial forces as shown below, find the value of P necessary for equilibrium. If $E = 210\ kN/mm^2$. Determine
  (i) Stress in various segments
  (ii) Total elongation of bar.
  (iii) Total strain in the bar.

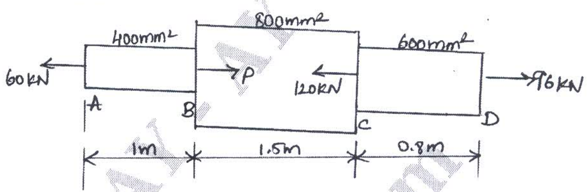

Fig. Q1 (b) **(10 Marks)**

2 a. A cube of 100 mm side is subjected to 10 N/mm^2(tensile), 8 N/mm^2 (compressive) and 6 N/mm^2(tensile) acting along X, Y and Z planes respectively. Determine the strains along the three directions and change in volume. The Poissions ratio = 0.25 and $E = 2 \times 10^5\ N/mm^2$.

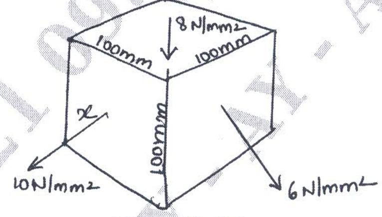

Fig. Q2 (a) **(10 Marks)**

b. Derive the relation between modulus of elasticity, modulus of rigidity and bulk modulus. **(10 Marks)**

3 a. Derive the expression for member subjected to direct stresses on two mutually perpendicular directions. **(08 Marks)**

b. Determine the principle stresses and the planes, maximum shear stress and the planes. Show the same on the elements separately. Using Mohr's circle.

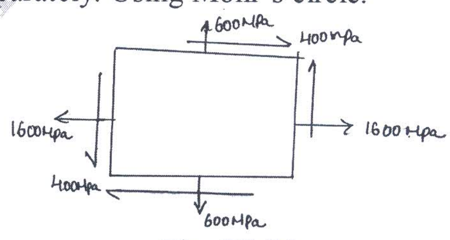

Fig. Q3 (b) **(12 Marks)**

4 a. Explain principal stresses and principle planes. **(06 Marks)**

b. An element is subjected to stresses as shown below,

(i) Principal stresses and their directions.

(ii) Normal and tangential stress on plane AC.

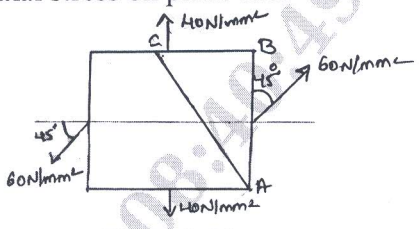

Fig. Q4 (b) **(14 Marks)**

5 a. Define beam and with figure, mention the type of loads. **(06 Marks)**

b. For the beam shown in Fig. Q5 (b) below. Draw the SFD and BMD. Locate the point of contraflexure, if any.

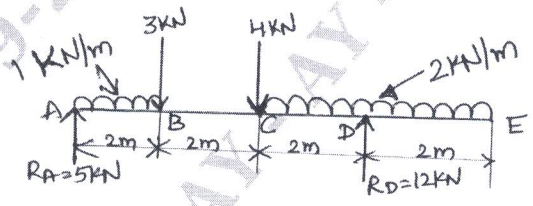

Fig. Q5 (b) **(14 Marks)**

6 Draw SFD and BMD for a simply supported beam as shown below.

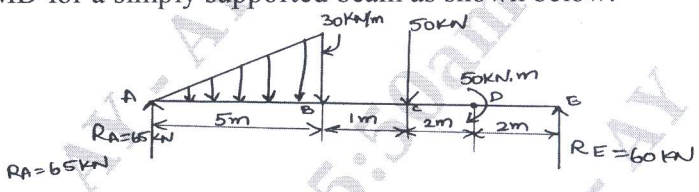

Fig. Q6 **(20 Marks)**

7 a. With assumptions of simple bending. Derive the relationship between bending stress and radius of curvature. **(12 Marks)**

b. A rolled I section of size 50mm × 75mm is used as a beam, with an effective span of 3 m. The flanges are 5 mm thick and web is 3.75 mm thick. Calculate the uniformly distributed load the beam can carry if the maximum intensity of shear stress induced is limited to 40 N/mm^2. **(08 Marks)**

8 a. Derive expression for Euler Bernoulli equation for deflection. **(10 Marks)**

b. A beam of length 5 m and of uniform rectangular section is simply supported at its ends. It carries a uniformly distributed load of 9 kN/m run over the entire length. Calculate the width and depth of beam if permissible bending stress is 7 N/mm^2 and central deflection is not to exceed 1 cm. Take E for beam material as 1×10^4 N/mm^2. **(10 Marks)**

9 a. State the assumption in the theory of pure torsion and derive the expression for shear stress produced in a circular shaft subjected to torsion. **(08 Marks)**

b. A solid shaft is subjected to a maximum torque of 25 kNm, find a suitable diameter of a solid shaft, if the allowable shear stress and the twist are limited to 80 N/mm^2 and 1° respectively for a length of 20 times the diameter of the shaft. **(06 Marks)**

c. A hollow shaft of 200 mm outer diameter has the same area as that of a solid shaft of diameter 100 mm. (i) Compare the power transmitted by the hollow shaft with that of the solid shaft for the same speed. **(06 Marks)**

10 a. State the assumptions in Euler's column theory and derive the equation for Euler's crippling load for a column when one end of the column is fixed and other end hinged or pinned. **(12 Marks)**

b. A hollow CI circular section column is 75 m long and is pinned at its both ends. The inner diameter of the column is 160 mm and the thickness of the wall is 20 mm. Find the safe load by Rankines formula, using a factor of safety of 5. Also find the slenderness ratio and ratio of Euler's and Rankine's critical loads. For Cast iron take $\sigma_c = 550\ N/mm^2$, $\alpha = \frac{1}{1600}$ and $E = 8 \times 10^4\ N/mm^2$. **(08 Marks)**

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