CBCS SCHEME

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21AE/AS44

Fourth Semester B.E. Degree Examination, June/July 2023
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. Derive the equilibrium equations for a 3D stress system. **(10 Marks)**

b. Displacement field at a point on a body is given as follows:
$u = (x^2 + y)$, $v = (3 + z)$, $w = (x^2 + 2y)$
Determine strain components at (3, 1, –2) and express them in matrix form. **(07 Marks)**

c. Define the following:
(i) Body forces (ii) Surface forces (iii) Traction forces **(03 Marks)**

OR

2 a. Derive a relation between modulus of elasticity and modulus of rigidity. **(08 Marks)**

b. A steel rail is 12.6m long and is laid at a temperature of 24° the maximum temperature expected is 44°C.
i) Estimate the minimum gap to be left between two rails so that temperature stresses donot develop.
ii) Calculate the thermal stresses developed in the rails if the (a) No expansion joint is provided. (b) If a 2mm gap is provided for expansion (c) If the stress developed is 20 MN/m^2, what is the gap between the rails?
Take $E = 2\times10^5$ MN/m^2 and $\alpha = 12\times10^{-6}/°C$ **(12 Marks)**

Module-2

3 a. Discuss the types of beams and derive the relation between shear force, load intensity and bending moment in a beam. **(08 Marks)**

b. For the beam as shown in Fig.Q3(b), draw the shear force and bending moment diagram locate the point of contra flexure if any.

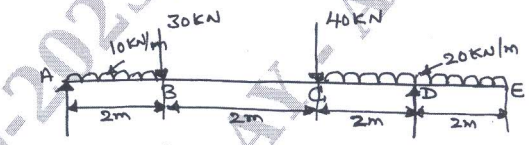

Fig.Q3(b) **(12 Marks)**

OR

4 a. What are the assumptions made in theory of simple bending? Derive an equation for bending stress. **(10 Marks)**

b. A beam with I-section as shown in Fig.Q4(b) is subjected to a bending moment 120 kN-m and a shear force of 60 kN. Determine the bending stress and shear stress distribution along the depth of the section.

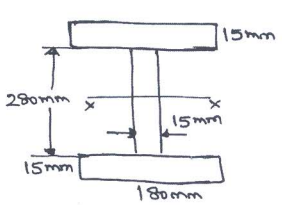

Fig.Q4(b) **(10 Marks)**

Module-3

5 a. Derive the deflection equation $EI\frac{d^2y}{dx^2} = M$ **(10 Marks)**

b. Using double integration method, determine the slope and deflection for a cantilever beam subjected to concentrated load at its free end. **(10 Marks)**

OR

6 a. Derive the torsional equation for a circular shaft with usual notations. State the assumptions made. **(10 Marks)**

b. A solid shaft transmits 250 kW at 100 rpm if the shear stress is not to exceed 75 N/mm^2, what should be the diameter of shaft? If the shaft is replaced by a hollow one whose internal diameter = 0.6 times the outer diameter. Determine the size of shaft and percentage of saving in weight, the maximum shear stress being the same. **(10 Marks)**

Module-4

7 a. Define principles of virtual work for a rigid body and state the differences between principles of virtual work and principles of complimentary virtual work. **(10 Marks)**

b. An overhanging beam ABC is loaded with material 4 kN/m, if it has span of 6m as shown in Fig.Q7(b). Find the reactions at A and B using principles of virtual work.

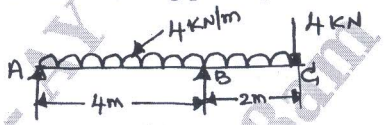

Fig.Q7(b) **(10 Marks)**

OR

8 a. Write a note on the following :

i) Castiglian's I theorem ii) Principle of minimum potential energy. **(10 Marks)**

b. A cantilever beam of length l carries uniformly distributed load W per unit length over its entire length as shown in Fig.Q8(b). Determine (i) strain energy stored by the cantilever beam. (ii) If W = 10 kN/m, l = 2m and EI = 2×10^5 kN-m^2. Determine the strain energy stored.

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

Module-5

9 a. Define Creep. Explain with a neat sketch the three stages of creep. **(08 Marks)**

b. List the difference between ductile and brittle fracture. **(04 Marks)**

c. What is stress relaxation? Obtain an expression for stress relaxation. **(08 Marks)**

OR

10 a. List different types of fatigue loading with examples. **(05 Marks)**

b. Discuss the factors affecting fatigue life of a material. **(05 Marks)**

c. What is fatigue? Explain S-N curve with a neat sketch. **(10 Marks)**

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