



# CBCS SCHEME

15AE34

## Third Semester B.E. Degree Examination, Jan./Feb.2021 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. Derive equilibrium equations for a 3-D stress system. (08 Marks)  
 b. Displacement field at a point on a body is given as follows:  
 $u = [y^2i + 3yzj + (4 + 6x^2)k] * 10^{-2}$ .  
 Determine strain components at (1, 0, 2) and express them in matrix form. (08 Marks)

OR

- 2 a. Draw the stress-strain curve for mild steel and mention the salient points. (06 Marks)  
 b. Define allowable stress. (02 Marks)  
 c. A stepped bar of steel, held between two supports as shown in figure below Fig.Q2 (c), is subjected to loads  $P_1 = 80$  kN and  $P_2 = 60$  kN. Find the reactions developed at the ends A and B.

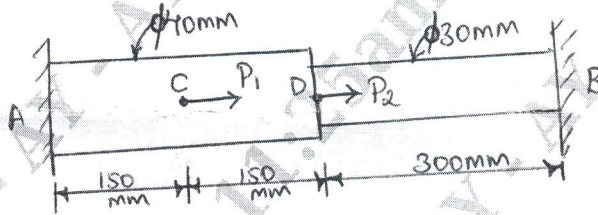


Fig. Q2 (c)

(08 Marks)

### Module-2

- 3 a. A beam of T-section has a length of 2.5 m and is subjected to a point load as shown in Fig. Q3 (a). Calculate the compressive bending stress and plot the stress distribution across section of the beam. The maximum tensile stress is limited to 300 MPa. Calculate the value of W.

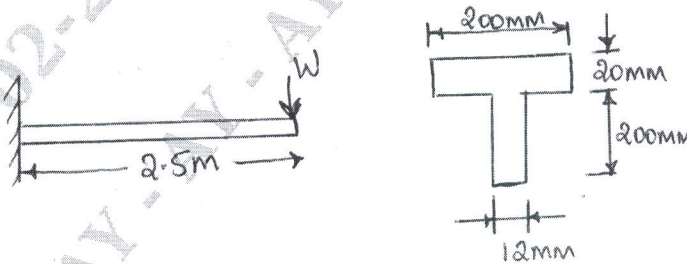


Fig. Q3 (a)

(12 Marks)  
(04 Marks)

- b. What are the Euler-Bernoulli assumptions?

OR

- 4 a. What is Three-Dimensional beam theory? Give its kinematic description. (08 Marks)  
 b. What are the governing equations for a three dimensional beam? Explain. (08 Marks)

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.

**Module-3**

- 5 a. A shaft required to transmit 60 kW at 150 rpm. If the maximum torque is 25% more than the mean torque for a maximum permissible shear stress of  $60 \text{ MN/m}^2$ . Find the diameter of shaft and also the angle of Twist for a length of 4 m. Take  $G = 80 \text{ GPa}$ . (10 Marks)
- b. Discuss the application of Von mises criterion and Tresca's criterion for a propeller shaft under Torsion and Bending. (06 Marks)

OR

- 6 a. Derive following equations for thin walled beams :  
 (i) Thin walled beam assumptions.  
 (ii) Stress flows.  
 (iii) Stress resultants. (10 Marks)
- b. What is warping of thin walled beam under torsion? Give its kinematic description. (06 Marks)

**Module-4**

- 7 a. Define principle of virtual work for a particle. Obtain the equilibrium of a particle. (08 Marks)
- b. What are the difference between principle of virtual work and principle of complementary virtual work? (08 Marks)

OR

- 8 a. Explain : (i) Maxwell's theorem (ii) Clapeyron's theorem. (08 Marks)
- b. Determine strain energy of the prismatic beam AB for the loading as shown in Fig. Q8 (b). Take  $E = 200 \text{ GPa}$ ,  $I = 195.3 \times 10^3 \text{ mm}^4$ . (08 Marks)

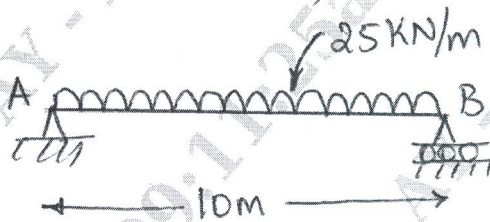


Fig. Q8 (b)

**Module-5**

- 9 a. A steel tube of 25 mm external diameter and 18 mm internal diameter. It is enclosed a copper rod of 15 mm diameter. The ends are rigidly fastened to each other. Calculate the stress in the rod and the tube when the temperature is raised from  $15^\circ\text{C}$  to  $200^\circ\text{C}$ . Take  $\alpha_{\text{st}} = 11 \times 10^{-6} / ^\circ\text{C}$ ,  $\alpha_{\text{cu}} = 18 \times 10^{-6} / ^\circ\text{C}$ ,  $E_{\text{st}} = 200 \text{ GPa}$ ,  $E_{\text{cu}} = 100 \text{ GPa}$ . (10 Marks)
- b. Explain Tresca's and Von Mises criterions. (06 Marks)

OR

- 10 a. Explain Kirchoff plate theory and mention its assumptions. (08 Marks)
- b. What are the constitutive law for laminated composite plate? (08 Marks)

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