Department of Civil Engineering
NATIONAL INSTITUTE OF TECHNOLOGY CALICUT
Monsoon Semester 2022
End-Semester Examination, 5 Dec 2022

Name:……..
Roll. No:……. Sl.No: ……

CE2001D MECHANICS OF SOLIDS

Duration: 3 hours | Maximum Marks: [50]

Note: *Answer* ***all*** *questions; Provide neat sketches; Assume missing data after stating; Read questions carefully*

1. (a) A simply supported cast iron beam of span 8 m has a cross-section as shown in Fig. 1. If the allowable stresses in compression and tension for cast iron are 80 MPa and 60 MPa respectively find the maximum permissible uniformly distributed load $q(x)$ the beam can carry. [6]
   (b) Draw the shear stress distribution for the beam cross-section in Fig. 1 if it is subjected to a shear-force of 120 kN. [4]

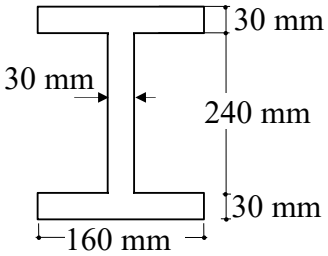

Figure 1

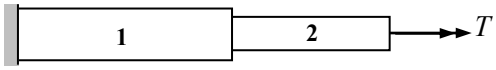

Figure 2

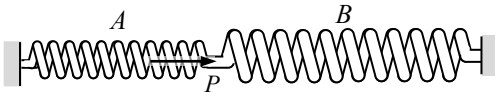

Figure 3

2. A simply supported composite beam of span 6 m carries a uniformly distributed load of intensity 5 kN/m. The beam is made of wood, 210 mm wide by 300 mm deep, reinforced on its lower side by a steel plate 10 mm thick and 210 mm wide. Find the maximum bending stresses σ_w and σ_s in wood and steel respectively due to the uniform load if their moduli of elasticities are E_w = 14 GPa and E_s = 210 GPa respectively. [6]
3. A circular stepped shaft of length: L_1 = 1.2 m, L_2 = 0.8 m, diameter: d_1 = 60 mm, d_2 = 40 mm, fixed at one end, is subjected to a torque of T = 500 Nm at the free end as shown in Fig. 2. Determine the angle of twist at the free end and the maximum shear stress developed in the shaft if G = 80 GPa. [6]
4. A load P = 300N is applied at the junction of two steel close-coiled helical springs as shown in Fig. 3. Spring A has 8 turns of 8 mm diameter wire on a mean radius of 40 mm; spring B has 12 turns of 12 mm diameter wire on a mean radius of 60 mm. Determine deflection of the load point and the maximum shearing stress developed in each of the springs if G = 80 GPa for each spring. (Hint: Draw the free body diagram and find P_A and P_B, the axial forces in the two springs. Use the equilibrium and compatibility conditions) [6]
5. An element in plane stress is subjected to stresses σ_x = 160 MPa, σ_y = –80 MPa and τ_{xy} = 40 MPa as shown in Fig. 4. (a) Determine the state of stress on a plane whose outward normal makes an angle of 30º with the x-axis. (b) Determine the principal stresses and the principal planes. (c) What is the maximum shear stress τ_{max}? (d) Show the principal stresses and the maximum shear stress on sketches of properly oriented elements and sketch the Mohr's circle. [6]

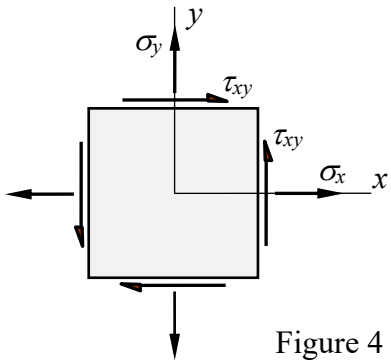

Figure 4

6. Determine the slope at A and deflection at C of the simply supported beam loaded as shown in Fig. 5 using *Macaulay's method*. Given: $EI = 6\times10^3$ kNm^2. [10]

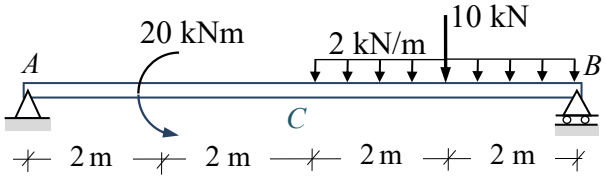

Figure 5

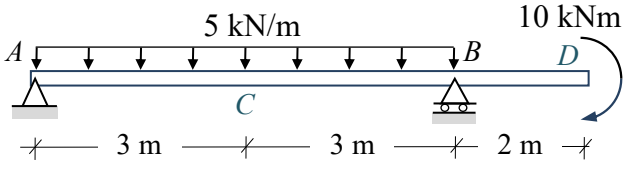

Figure 6

7. Use the *moment area method* or the *conjugate beam method* and find the slope at A and deflection at C of the cantilever loaded as shown in Fig. 6. Given: $EI = 6\times10^4$ kNm^2. [8]

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