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Question Paper Code : 40300

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Third/Fourth Semester

Mechanical Engineering

CE8395 — STRENGTH OF MATERIALS FOR MECHANICAL ENGINEERS

(Common to Aerospace Engineering/ Automobile Engineering/ Industrial Engineering/ Industrial Engineering and Management/ Manufacturing Engineering/ Marine Engineering/ Material Science and Engineering/ Mechanical Engineering/ Mechanical Engineering (Sandwich)/ Mechanical and Automation Engineering/ Mechatronics Engineering/ Production Engineering/ Robotics and Automation/ Safety and Fire Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Distinguish between stress and strength.

2. Define principal planes and principal stresses.

3. Discuss the importance of constructing bending moment diagram of a beam under loading.

4. List the advantages and disadvantages of using Flitched beams.

5. The maximum shear stress in a solid shaft is 20 N/mm^2 when the torque transmitted is 10 kNm. Determine the minimum diameter of the shaft to avoid failure.

6. List the advantages and disadvantages of carriage springs.

7. From the deflection curve of a beam, it is observed that the slope at both the ends is zero. What are the end conditions? Why?

8. State Maxwell's reciprocal theorem.

9. Distinguish between thin and thick shells.

10. State Lame's theorem.

PART B — (5 × 13 = 65 marks)

11. (a) For the compound bar shown in Figure 1. Calculate the stress in each segment if the temperature increases by 500C. Assume, for the aluminium segment: Area = 400 mm^2; Young's Modulus = 70 GPa; Co-efficient of thermal expansion= 23×10^{-6}/°C and for the steel segment: Area = 100 mm^2: Young's Modulus = 210 GPa: Co-efficient of thermal expansion = 12.4×10^{-6}/°C. (13)

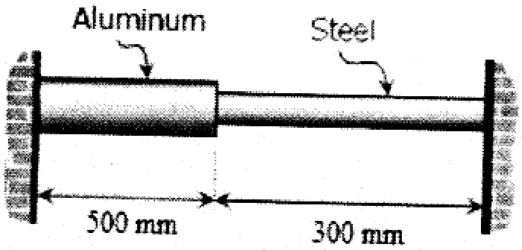

Figure 1

Or

(b) A material is subjected to stress as shown in Figure 2. Use the Mohr's circle to determine

(i) The principal stresses and their corresponding principal planes

(ii) The maximum shear stress and the planes of maximum shear stress

(iii) Show the principal stresses calculated above on a sketch of the element. (13)

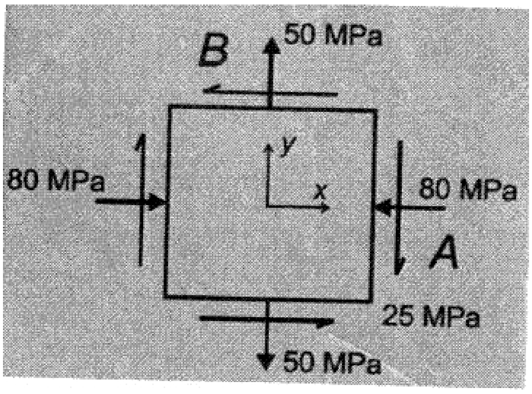

Figure 2

12. (a) Draw the shear force and bending moment diagrams for the loaded beam shown in Figure 3. Clearly indicate the maximum bending moment. (13)

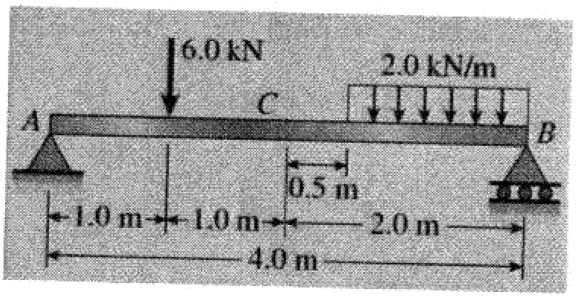

Figure 3

Or

(b) Calculate the maximum shear stress and maximum bending stress in the wooden beam shown in Figure 4 carrying a uniform load of 22.5 kN/m (including the self-weight). Assume that the beam is simply supported at the ends, length of the beam = 1.95 m, and the cross section is rectangular with width = 150 mm and height = 300 mm.

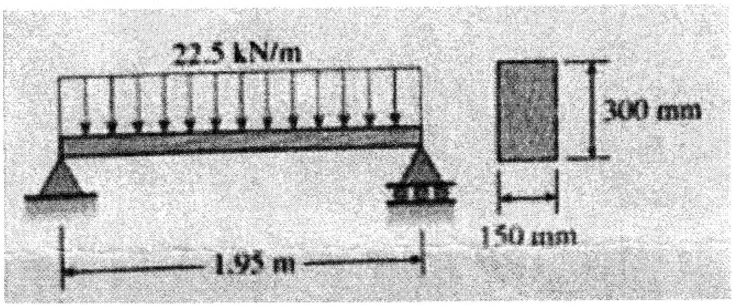

Figure 4

13. (a) A brass tube of external diameter 40 mm and internal diameter 25 mm closely surrounds a steel rod of 25 mm diameter to form a composite shaft. If a torque of 10 kNm is to be resisted by this shaft, find the maximum stresses developed in each material and the angle of twist in 1 m length. Assume modulus of rigidity of brass and steel as 40 GPa and 80 GPa respectively. (13)

Or

(b) Two close coiled helical springs are compressed between two parallel plates by a load of 1 kN. The springs have a wire diameter of 10mm and the radii of coils are 50 and 75 mm- Each spring has 10 coils and is of the same initial length. If the smaller spring is placed inside the larger one such that both the springs are compressed by same amount, calculate

(i) the total deflection and

(ii) the maximum stress in each spring. Assume G = 40 GPa for both the springs. (13)

14. (a) A contilever beam of 8 m long carries a load of 100 kN at a distance of 3 m from the free end, and a load of 50 kN at a distance of 3 m from the fixed end. Calculate the deflection and slope at 5 m from the fixed end. Assume E = 70 GPa and Moment of Inertia = 10×10^7 mm^4. (13)

Or

(b) Determine the deflection at the free end of the beam shown in Figure 5 using Conjugate beam method and verify the same by moment area method. (13)

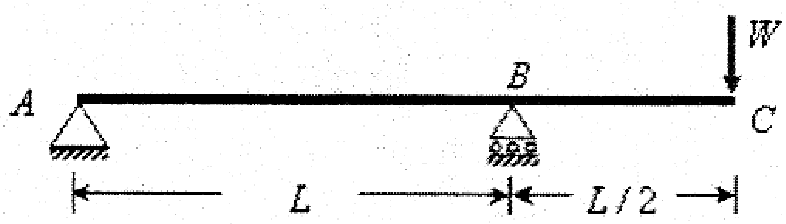

Figure 5

15. (a) A thin cylindrical shell having 800 mm outside diameter and 10 mm thickness and length 2 m is subjected to an internal pressure of 2 MPa, calculate

(i) The hoop and longitudinal stresses developed,

(ii) Maximum shear stress,

(iii) The changes in diameter, length and volume. Assume Young's modulus, E = 210 GPa and Poisson's ratio = 0.3. (13)

Or

(b) Calculate the maximum and minimum hoop stress across the cross-section of a pipe having 500 mm internal diameter and 120 mm thick. Assume that the pipe contains a fluid at a pressure of 10 N/mm^2. Sketch the radial pressure and hoop stress distribution across the cross-section. (13)

PART C — (1 × 15 = 15 marks)

16. (a) A point in a strained material, the intensities of normal stress across two planes at right angles to each other are 500 N/mm^2 (tensile) and 100 N/mm^2 (compressive) and a shear stress of 200 N/mm^2 across the planes as shown in Figure 6. Locate the principal planes and evaluate the principal stresses. Also locate the planes of maximum shear stress and find the values. Find normal, tangential stresses on a plane inclined at 300 as shown in Figure 6. (15)

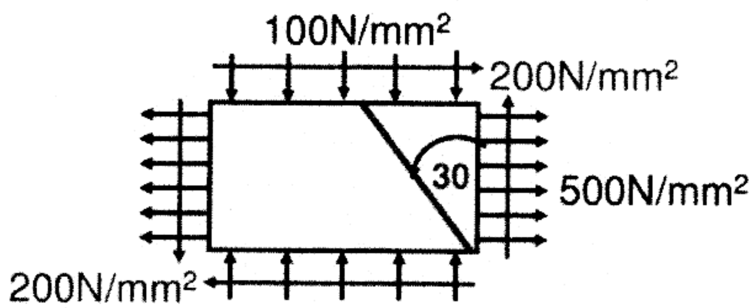

Figure 6

Or

(b) The industrial robot is held in the stationary position as shown in Figure 7. Draw the shear and moment diagrams of the arm ABC if it is pin connected at A and connected to a hydraulic cylinder BD. Assume the arm and grip have a uniform weight of 0.3 N/mm and support the load of 200 N at C. (15)

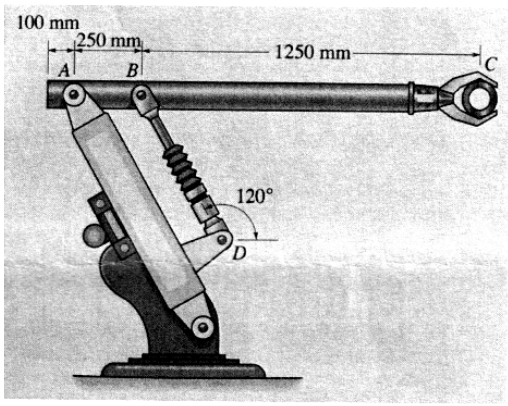

Figure 7