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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Third Semester B.Tech Degree (S,FE) Examination December 2020

Course Code: CE201

Course Name: MECHANICS OF SOLIDS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks Marks

1	a)	Define Poisson's ratio and prove that the limiting value of Poisson's ratio is 0.5	(3)
	b)	A circular rod of 100 mm diameter and 500 mm long is subjected to a tensile force of 900 kN. Determine the change in volume if Poisson's ratio is 0.3 and Young's modulus is $2\text{x}10^5$ N/mm².	(5)
	c)	A compound steel tube consists of a steel tube of 120 mm internal diameter and 140 mm external diameter and an outer brass tube whose external diameter is 160 mm and internal diameter is 140 mm. The composite bar is then subjected to an axial compression of 500 kN. If 'E' for steel is 200 kN/mm² and for brass 100 kN/mm². Find the stresses in and the amount of deformation. Both the tubes are of length 180 mm.	(7)
2	a)	Draw the stress-strain diagram for mild steel and explain all salient points.	(5)
	b)	A bar of cross section 30 x 30 mm and 250 mm long is subjected to a pull of 100 kN in the direction of its length. The extension of the bar was found to be 0.125 mm, while the decrease in each lateral dimension was found to be 0.0038 mm. Find (i) Poisson's ratio, (ii) Young's modulus of elasticity, (iii) Modulus of rigidity and (iv) Bulk modulus.	(10)
3	a)	Derive an expression to find strain energy due to axial load.	(5)
	b)	A steel rail is 13 m long and is laid at a temperature of 25˚C. The maximum temperature expected is 45˚C. Take E = $2\ \text{x}10^5$ MN/m² and $\propto = 12\text{x}10^{-6}$ /°C (i) Estimate the minimum gap to be left between the two rails so that the temperature stresses do not develop in the rail. (ii) Calculate the thermal stresses developed in the rails if a 2 mm gap is provided for expansion. (iii) If the stress developed is 20 MN/m², what is the gap between the rails?	(10)

PART B

Answer any two full questions, each carries 15 marks

4 a) Draw the shear force and bending moment diagram for a cantilever of 6m subjected to a UDL of 15 kN/m over the entire span and a concentrated load of 25 kN at the free end. (8)

b) Derive the bending equation, stating the assumptions made. (7)

5 a) Establish the relation between intensity of loading, shear force and bending moment. (5)

b) Draw shear force and bending moment diagram for the beam shown in Fig. I and mark all important points. (10)

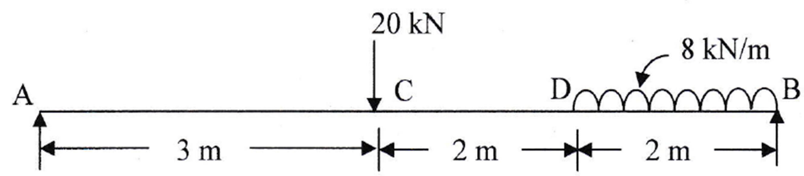

Fig. 1

6 a) A rectangular section is to be cut from a circular log of wood of diameter 400 mm. Find the dimensions of the strongest section in bending. (4)

b) A flitched beam consists of a wooden joist 150 mm wide and 300 mm deep strengthened by steel plate 10 mm thick and 300 mm deep on either side of the joist. If the maximum stress in the wooden joist is 8 N/mm², find the moment of resistance of the section. Take $E_s = 20\ E_w$. (5)

c) A simply supported rectangular beam of span 5 m has a cross section of 150 mm x 200 mm and carries a point load of 20 kN at 2 m from the right support. Draw the shear stress distribution at the mid span section of the beam. (6)

PART C

Answer any two full questions, each carries 20 marks.

7 a) A close-coiled helical spring made of steel wire of diameter 6 mm has 15 coils. The spring has mean coil diameter of 100 mm and is subjected to an axial load of 'W' kg producing a maximum shear stress of 100 N/mm². Determine the load W and the deflection produced due to the load. Take G = 80 kN/mm². (5)

b) At a point in a strained material, the normal stresses on two mutually perpendicular planes are 120 N/mm² (tensile) and 50 N/mm² (compressive). The shear stress across these planes is 35 N/mm². Find using Mohr's stress circle, (15)

(i) the principal stresses and their planes and

(ii) maximum shear stress and their planes.

8 a) A closed cylindrical vessel made of steel plates 4 mm thick with plane ends, carries fluid under a pressure of 3 N/mm². The diameter of the cylinder is 25 cm and length is 75 cm. Calculate the longitudinal and hoop stresses in the cylinder wall and determine the change in diameter of the cylinder due to fluid pressure. Take E = 2.1×10^5 N/mm² and $\mu = 0.28$. (6)

b) A solid circular shaft is required to transmit 245 kW power at 250 rpm. The maximum torque may be 1.5 times the mean torque. The shear stress in the shaft should not exceed 40 N/mm² and the twist 1° per metre length. Determine the diameter of the shaft. Take modulus of rigidity: 80 kN/mm². (6)

c) State moment-area theorems to find the slope and deflection of beams. Using moment-area method, derive expression to find the maximum slope and deflection of a cantilever of length 'L' carrying a point load of "W" at the free end. (8)

9 a) Find the slope at A and deflection at D, of the beam shown in Fig. 2 using Macaulay's method. Take E = 2 $\times 10^5$ N/mm² and I = 5 x 10^8 mm^4. (12)

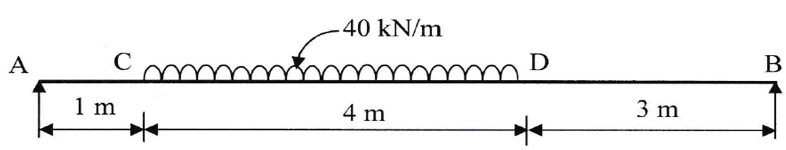

Fig. 2

b) A 2m long column has a circular cross section of 5 cm diameter, one of the ends of the column is fixed in direction and position and the other end is free. Taking factor of safety as 3, calculate the safe load using (a) Rankine's formula taking yield stress as 560 N/mm² and Rankine's constant as 1/1600 and (b) Euler's formula, with E as 1.2×10^5 N/mm². (8)

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