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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Third Semester, B.E. - Industrial and Production Engineering

Semester End Examination; Dec. - 2014

Mechanics of Materials

Time: 3 hrs *Max. Marks: 100*

Note: *i) Answer **FIVE** full questions, selecting **ONE** full question from each Unit.*
ii) Assume suitable missing data if any.

Unit - I

1. a. Derive an equation for extension of a tapering bar of circular cross section. 6

b. A steel bar ABCD of varying sections is subjected to the axial forces as shown in Fig. Q1(b). Find the value of 'P' necessary for equilibrium if E = 210 kN/mm^2. 14
Determine;
i) Stress in various segments ii) Total elongation of the bar iii) Total strain in the bar.

2 a. A steel rod of 20 mm diameter is enclosed centrally in a hollow copper tube of external diameter 40 mm and internal diameter 25 mm. The composite bar is then subjected to an axial pull of 50 kN through rigid cover plates. If the length of each bar is equal to 200 mm Determine; 10
i) Stress in rod and tube ii) Load carried by each bar
$E \text{ for } steel = 2*10^5 N/mm^2$, $E \text{ for } copper = 1*10^5 N/mm^2$

b. A cube of 100 mm side is subjected to 10 N/mm^2 (Tensile), 8 N/mm^2 (compressive) and 6 N/mm^2 (Tensile) acting along X, Y and Z directions respectively. Determine the strains along three directions and change in volume. The Poisson's ratio = 0.25 and E = 2×10^5 N/mm^2. 10

Unit - II

3 a. At room temperature the gap between bars 'A' and 'B' shown in Fig. Q 3(b) is 0.25 mm. What are the stresses induced in the bars. If the temperature rise is 35 ºC. Given 10
$E_A = 2\times10^5 N/mm^2,\ A_A = 1000 mm^2,\ \alpha_A = 12*10^{-6} per^0C,\ L_A = 400 mm$
$E_B = 1\times10^5 N/mm^2,\ A_B = 800 mm^2,\ \alpha_B = 23*10^{-6} per^0C,\ L_B = 300 mm$

b. A steel tube of 50 mm diameter (outside) and 10 mm thick is fitted into a Copper tube of inner diameter 50 mm and 10 mm thick. They are connected by using 20 mm diameter pins at the ends. If the length of compound bar is 600 mm, find the stresses produced in the tubes and pins when temperature is raised by 25ºC. 10

Given $\alpha_S = 12\times10^{-6} per°C,\ \alpha_C = 17.5*10^{-6} per°C,$
$E_S = 2*10^5 N/mm^2,\ EC = 1.2\times10^5 N/mm^2$

Contd…..2

4 a. A point in a strained material is subjected to stress as shown in Fig. Q 4(a). Find analytically the normal, tangential, resultant stress on the plane EF. Also determine the maximum, minimum principal stresses its location, maximum shear stresses. 10

b. At a point in a strained material, there are two mutually perpendicular pensile stresses of 400 N/mm^2 and 300 N/mm^2. There is also a shear stress of 200 N/mm^2. Determine by Mohr's circle method the magnitude and direction of principal stresses and the greatest shear stress. 10

Unit - III

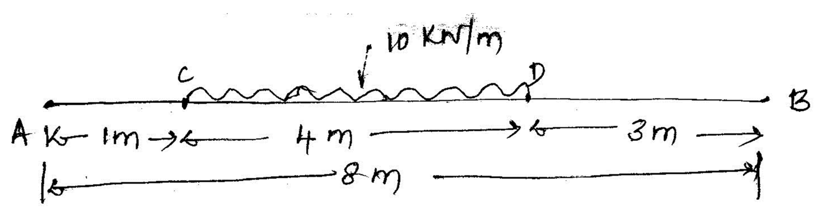
5 a. Explain: i) Circumferential stress ii) Radial stress
iii) Longitudinal stress in a thin cylindrical shell. 6

b. A thin cylinder of internal diameter 2 m contains a fluid at an internal pressure of 3 N/mm^2.Determine the maximum thickness of the cylinder if 6
(i) Longitudinal stress is not to exceed 30 N/mm^2
ii) Circumferential stress is not to exceed 40N/mm^2.

c. A pipe of 500 mm internal diameter and 75 mm thick is filled with a fluid at a pressure of 6 N/mm^2. Find the maximum and minimum hoop stress across the cross section of the cylinder and the radial pressure across the section. 8

6 a. Explain the following types of : 8
i) Beams ii) Supports iii) loads.

b. Draw the shear force and B.M. diagrams for a simply supported beam of length 8 m and carrying a uniformly distributed load of 10 kN/m for a distance of 4 m as shown in Fig. 12



Unit - IV

7 a. Explain theory of simple Bending and derive the relationship between bending stress and radius of curvature. 8

b. A cantilever has a length of 3 meters. Its cross section is of T - section with flange 100 mm × 200 mm and web 200 mm × 12 mm, the flange is in tension. What is the intensity of UDL that can be applied if the maximum tensile stress is limited to 30 N/mm^2? Also compute the maximum compressive stress. 12

8 a. Draw the shear stress distribution across: 8
i) I - section
ii) T - section

b. A beam of an I - section 200 mm × 300 mm has web thickness of 10 mm and flange thickness of 10 mm. It carries a shearing force of 10 kN at a section. Sketch the shear stress distribution across the section. 12

Unit - V

9 a. Derive an equation for deflection of a cantilever beam with a uniformly distributed load. 8

b. Find the slope and deflection at a free end of the cantilever shown in Fig. Q9(b). If $E = 200\,kN/mm^2$ *and* $I = 40 * 10^6\,mm^4$ 12

10a. A hollow shaft having internal diameter 40% of its external diameter, transmits 562.5 kW power at 100 rpm. Determine the internal and external diameters of the shaft if the shear stress is not to exceed 60 N/mm^2 and the twist is a length of 2.5 m should not exceed 1.3 degrees. The maximum torque being 25% greater than mean. Modulus of rigidity = 9 x10^4 N/mm^2. 10

b. A 1.5 m long column has a circular cross section of 50 mm diameter. One end 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; 10

i) Rankine's formula taking yield stress as 560 N/mm2 and $\alpha = 1/1600$

ii) Euler's formula taking $E = 1.2\times 10^5\,N/mm^2$

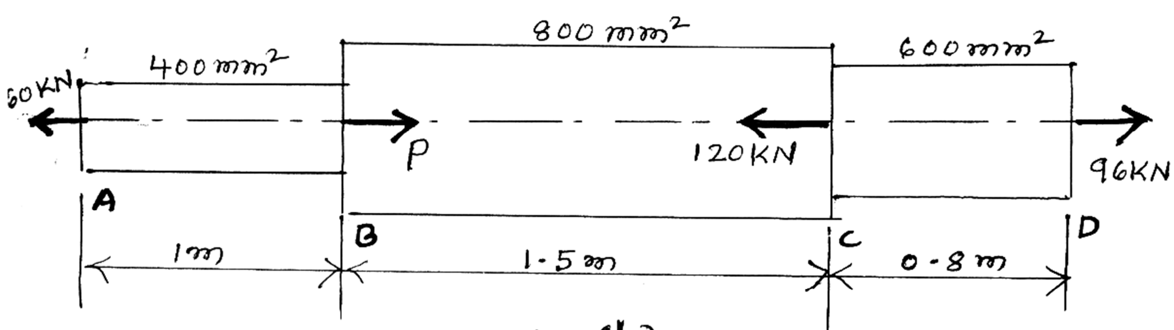


Fig q 1(b)

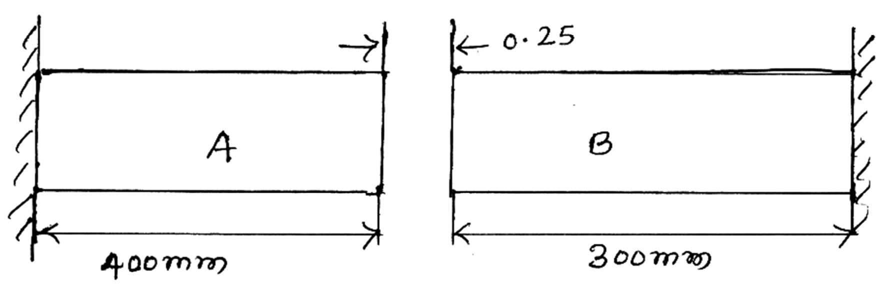


Fig q 3(a)

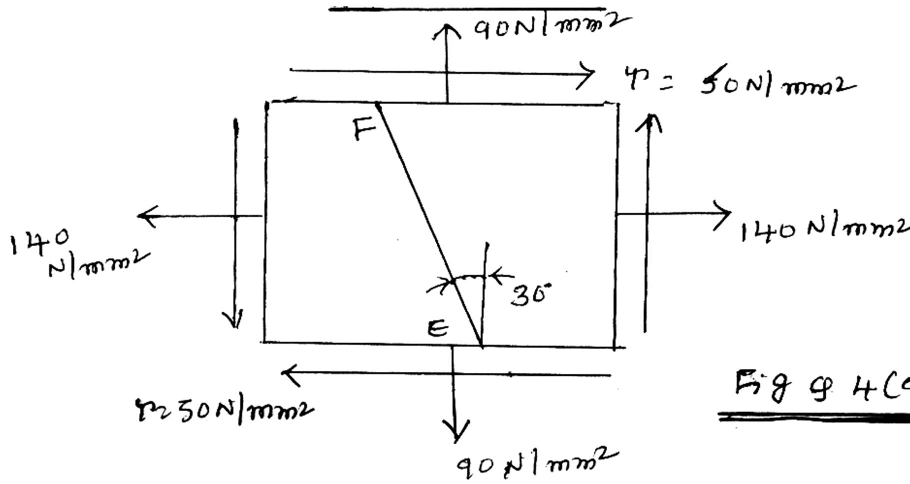
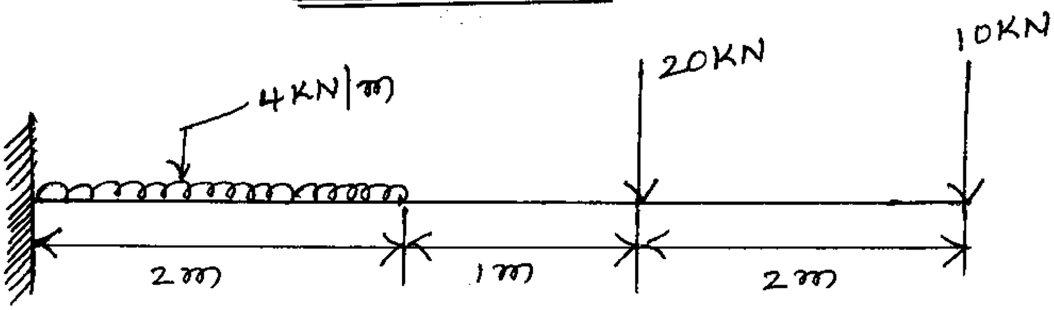


Fig Q 4(a)

Fig. Q 9(b)



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