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06ME34

Third Semester B.E. Degree Examination, January 2013
Mechanics of Materials

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define: i) Hooke's law; ii) True stress; iii) Factor of safety. **(06 Marks)**

b. Derive an expression for extension in a bar of uniform cross section fixed at one end and suspended vertically, due to self weight. **(07 Marks)**

c. A stepped bar is subjected to forces as shown in Fig.Q.1(c). Determine the net deformation in the stepped bar. Take $E = 2 \times 10^5$ N/mm^2. **(07 Marks)**

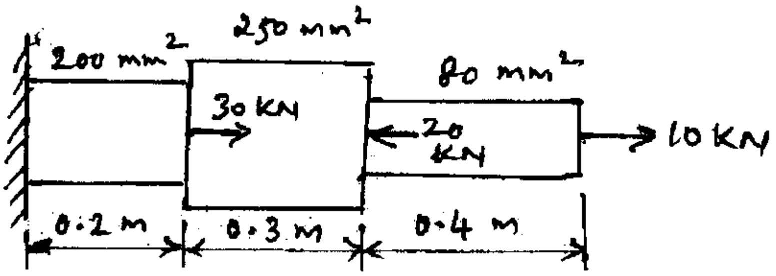

Fig.Q.1(c)

2 a. A 500mm long bar has rectangular cross section 20mm × 40mm. This bar is subjected to i) 40 kN tensile load on (20 × 40)mm faces; ii) 200 kN compressive load on (20 × 500)mm faces and iii) 300 kN tensile load on (40 × 500)mm faces. Find the change in volume of the bar if $E = 2 \times 10^5$ N/mm^2 and Poison's ratio $\frac{1}{m} = 0.3$. **(10 Marks)**

b. A horizontal bar hinged at one of its ends is supported by two vertical bars as shown in Fig.Q.2(b). If the temperature of the vertical bars is increases by 40°C, determine the forces, stresses and deformations induced in them.

Take $\alpha_{copper} = 18 \times 10^{-6}/^{o}C$

$\alpha_{steel} = 12 \times 10^{-6}/^{o}C$

$E_{copper} = 100$ GPa

$E_{steel} = 200$ GPa. **(10 Marks)**

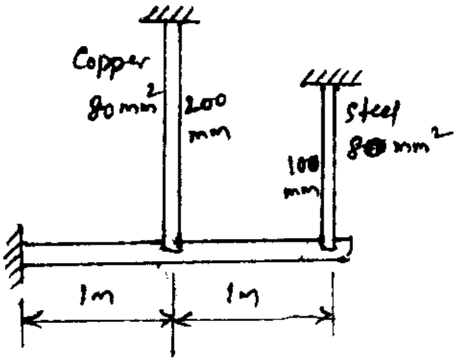

Fig.Q.2(b)

3 a. Find the diameter of a circular bar which is subjected to an axial pull of 160 kN, if the maximum allowable shear stress on any section is 65 N/mm^2. **(05 Marks)**

b. A rectangular bar is subjected to two direct stresses σ_x and σ_y in two mutually perpendicular directions. Prove that the normal stress (σ_n) on an oblique plane which is inclined at an angle 'θ' with the axis of minor stress is given by,

$$\sigma_n = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos 2\theta$$ **(07 Marks)**

c. At a certain point in a material under stress, the intensity of the resultant stress on a vertical plane is 10 μ/mm^2 inclined at 30° to the normal to that plane and the stress on a horizontal plane has a normal tensile component of intensity 6 N/mm^2, as shown in Fig.Q.3(c). Find the principal stresses and the location of the planes on which they act. **(08 Marks)**

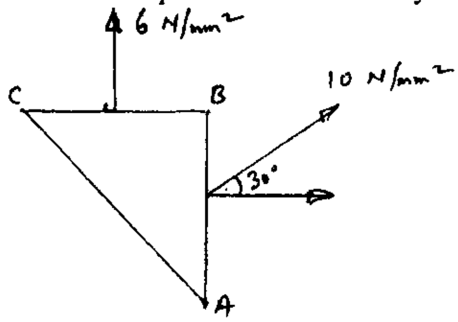

Fig.Q.3(c)

4 a. Derive expressions for circumferential and longitudinal stresses in a thin cylinder subjected to internal fluid pressure. Show that the circumferential stress is twice the longitudinal stress. **(10 Marks)**

b. The internal and external diameters of a thick cylinder are 300mm and 500mm respectively. It is subjected to an external pressure of 4 N/mm^2. Find the internal pressure that can be applied if the permissible stress in cylinder is limited to 13 N/mm^2. Sketch the variation of loop stress and radial stress across the thickness of the cylinder. **(10 Marks)**

PART – B

5 a. Define the following terms:
   i) Shear force
   ii) Bending moment
   iii) Shear force diagram
   iv) Bending moment diagram. **(04 Marks)**

b. A beam is simply supported at its ends and carries uniforms distributed load of 20 per m length over its entire length. Derive expression for shear force and bending moment at an section at a dist of x from the left support. Draw shear force and bending moment diagrams. **(08 Marks)**

c. Draw the shear force and bending moment diagrams for the cantilever shown in Fig.Q.5(c). **(08 Marks)**

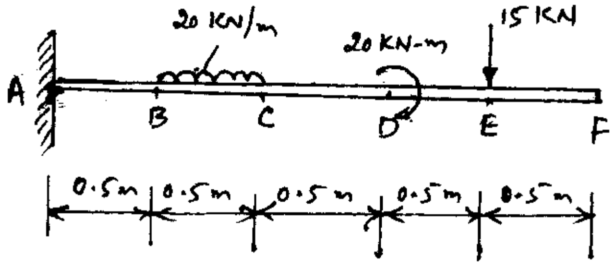

Fig.Q.5(c)

6 a. A cast iron beam is of I-section as shown in Fig.Q.6(a). The beam is simply supported on a span of 5m. If the tensile stress is not to exceed 20 N/mm^2, find the safe uniformly distributed load, which the beam can carry. Find also the maximum compressive stress. **(10 Marks)**

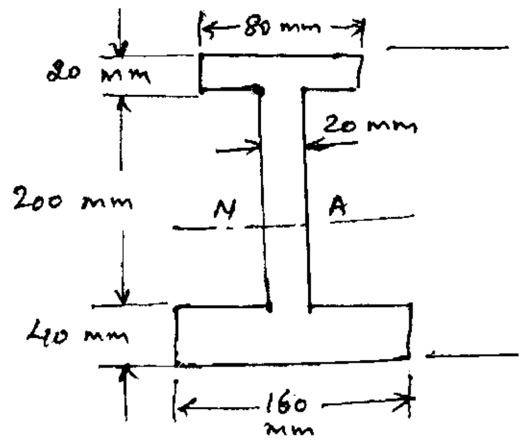

Fig.Q.6(a)

b. Prove that the shear stress distribution in a circular section of a beam which is subjected to a shear force F, is given by

$$\tau = \frac{16}{3} x \frac{F}{\pi d^2}\left[1 - \frac{4y^2}{d^2}\right]$$

where 'd' – is the diameter of the section

'y' – distance between neutral axis to section under consideration.

And show that, the max shear stress if 4/3 times the average shear stress. **(10 Marks)**

7 a. Prove that the slope and deflection at the free end of a cantilever beam of length L, which carries a gradually varying load from zero at the free end to w/m run at the fixed and are given by

$\theta = \frac{WL^3}{24EI}$, $y = \frac{WL^4}{30EI}$, when EI = flexural rigidity. **(10 Marks)**

b. A horizontal girder of steel having uniform section is 14m long and is simply supported at its ends. It carries concentrated loads of 120 kN and 80 kN at two points 3m and 4.5m from the two ends, respectively. I for the section of girder is 16×10^8 mm^4 and E = 210 kN/mm^2. Calculate the deflections of the girder at points under the two loads. Find also the maximum deflection. **(10 Marks)**

8 a. Derive the equation $\frac{T}{J} = \frac{T}{r} = \frac{G\theta}{L}$ with usual notation state the assumptions made in the derivation. **(10 Marks)**

b. State the assumptions made in the Euler's theory for axially loaded elastic long columns. Prove that the crippling load by Euler's formula for a column having one end fixed and other end free is given by

$P = \frac{\pi^2 EI}{4l^2}$ where, l – actual length of the column, I – moment of inertia, E – Young's modules. **(10 Marks)**

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