Government College of Engineering, Amravati

(An Autonomous Institute of Government of Maharashtra)

B. Tech. (CE/ME)

Winter – 2017

Course Code: CEU303

Course Name: Strength of Materials

Time: 2Hr 30 min **Max. Marks: 60**

Instructions to Candidate

1) All questions are compulsory.
2) Assume suitable data wherever necessary and clearly state the assumptions made.
3) Diagrams/sketches should be given wherever necessary.
4) Use of drawing instruments and non-programmable calculators is permitted.
5) Figures to the right indicate full marks.

1. a) The ultimate stress for a hollow steel column which carries an axial load of 1.9 MN is 480 N/mm^2. If the external diameter of the column is 200 mm, determine the internal diameter. Take factor of safety as 4 **06**

b) A steel bar, 600 mm long, is 28 mm in diameter for 240 mm of its length, 20 mm in diameter for 200 mm of its length and 16 mm in diameter for the remaining 160 mm of its length. It is subjected an axial pull of 20 kN. If E = 210 kN/mm^2, calculate the extension in the bar and strain energy stored in it. **06**

Cont.

OR

c) A rectangular block of steel 100 mm x 100 mm x 200 mm long is subjected stresses 110 MN/m^2 (tensile), 60 MN/m^2 (compressive) and 45 MN/m^2 (tensile) as shown in figure 1. If Poisson's ratio is 1/3 and E = 213 GN/m^2 Calculate the strain and the change in length in all the three directions. Also calculate the change in volume of the bar.

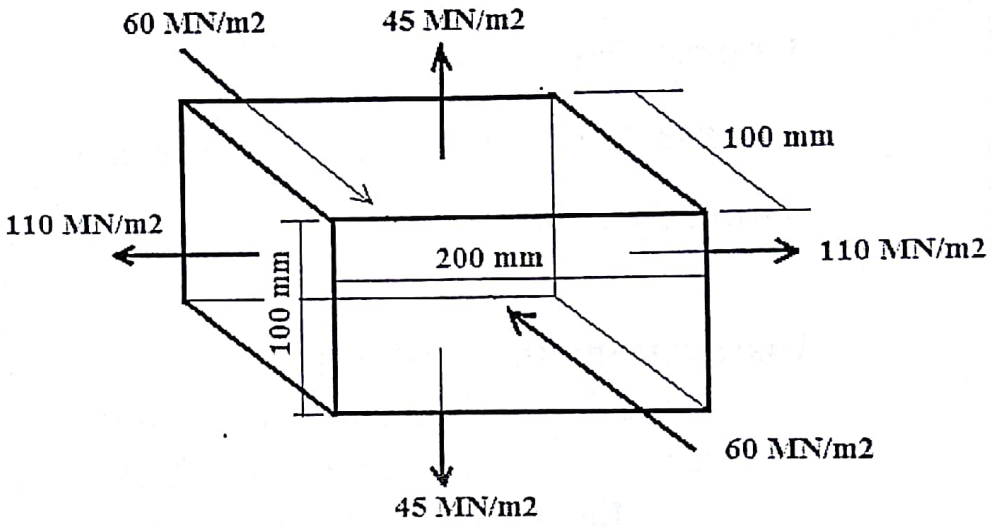

Figure 1

2. a) A simply supported bean of span L has an overhang of length 'a' at one end only. Determine the ratio a/L for which the maximum bending moment is the minimum anywhere in the entire beam length. The beam is subjected to uniformly distributed load over entire length.

b) A timber beam of rectangular section is to support a load of 20 kN uniformly distributed over a simply supported span of 3.6 m. If the depth of the section is to be twice the breadth and bending stress in timber is not to exceed 7 N/mm^2, find the dimensions of the section

3. a) Derive the expression $\tau = \frac{(SA\,\bar{y})}{b\,I}$ with usual notations. **06**

b) A solid circular shaft is to transmit 300 kW power at 100 RPM. Find the diameter of the shaft if the shear stress is not to exceed 80 N/mm^2 . What percentage saving in weight would be obtained if this shaft is replaced by a hollow one, whose internal diameter is equal to 0.6 times the external diameter, if the length, the material, maximum shear stress being the same. **06**

4. Solve any two of the following.

a) A column of timber section 150 mm x 200 mm is 6 m long, both ends being fixed. If the modulus of elasticity for timber is 17.5 kN/mm^2 , determine (1) Crippling load (2) Safe load for column if factor of safety is 3.0 **06**

b) Calculate the increase in volume of boiler shell 3.0 m long, 1.2 m in diameter, when subjected to an internal pressure of 2 MPa. The wall thickness of the shell is such that maximum tensile stress is not to exceed 30 Mpa. Take E = 201 GPa and Poisson's ratio is 0.3 **06**

c) A cantilever beam of length 2 m carries a point load of 20 kN at its center and another load of 20 kN at its free end. If E = 100 GPa and second moment of area is 10^8 mm^4 for the cantilever, then determine by moment area method, the slope and deflection of the cantilever at the free end. **06**

5 a) Solve any two the following

A bar 1.5 m long and 10 mm in diameter hangs vertically and has a collar securely fixed at the **06**

lower end. Find the maximum stress induced in the bar when a load of 150 kN falls on the collar from a height of 25 mm. Take E = 200 GPa. Also find the strain energy stored in the rod

b) A masonry pier 3 m x 4 m supports a vertical point load of 40 kN at point P(1.0, 0.5) m, with origin at center of the section..Neglecting the self weight of the pier, find the stresses developed at each corner of the pier. Sketch the stress distribution along two adjacent sides. **06**

c) The stresses at a point in bar are 200 MPa tensile, and 100 MPa compressive. Determine the resultant stress in magnitude and the direction on plane inclined at 60 degrees to the axis of the major stress. Also determine the maximum intensity of shear stress in the material at that point. **06**

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Third Semester B. Tech. (CE / ME)

Winter – 2016

Course Code: CEU303

Course Name: Strength of Materials

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Instructions to Candidate

1) All questions are compulsory.
2) Assume suitable data wherever necessary and clearly state the assumptions made.
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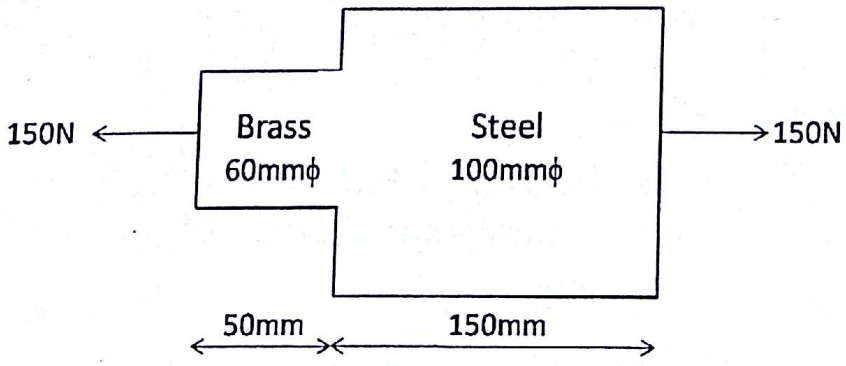
4) Use of logarithmic table, drawing instruments and non-programmable calculators is permitted.
5) Figures to the right indicate full marks.

Q.1 **a** Compound bar of brass and steel is as shown in fig. Find the stresses in each part of bar. Also find total elongation. E-brass =2.1 x 10^5 Mpa and E-steel =2.6 x 10^5 MPa. **4**



b A reinforced concrete column of 75 cm diameter, has 10 rods of 12 mm diameter embedded in it and carries a load of 1000 KN .Find stresses in steel and concrete. Take E-steel =2.1 x 10^5 MPa. and E-concrete =1.4 x 10^5 Mpa. **6**

Contd...

OR

c A steel rail is 12.6 m long and is laid at a temperature of 24^0C.The maximum temperature expected is 44^0C 6

i) Estimate minimum gap to be left between two rails so that temperature stresses do not develop.

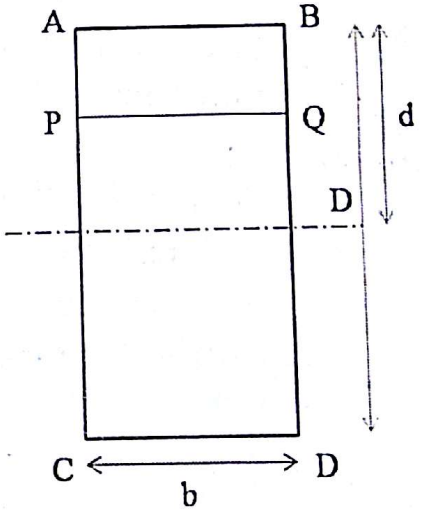
ii)Calculate the thermal stresses developed in the rail if a)No expansion joint is provided

b) If 2 mm gap is provided for expansion

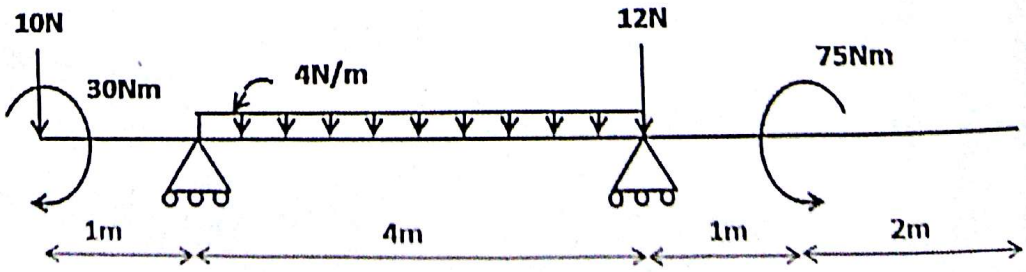
iii) If stress developed is 20×10^5 MPa ,What is the gap between the rails ?

Take $E= 2 \times 10^5$ MPa and $\alpha= 12 \times 10^{-6} / {}^0$C.

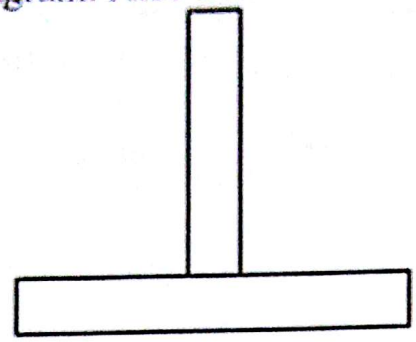
Q.2 a Find the shear stress at any fiber PQ of rectangular c/s having breadth b and depth d as shown in fig .Also draw shear stress distribution diagram.

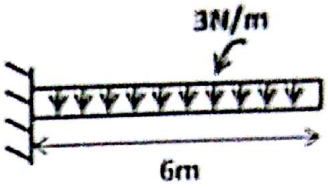


b Draw SFD and BMD for given beam. Locate the point of contraflexure, point of maximum bending moment if any.



Q.3 a A cantilever beam is loaded as shown in fig. Find the stresses at section 2m from fixed end. The c/s of beam is inverted T of 50 mm thickness and 150 mm wide and 150 mm is the length of web. Also find stresses at junction of web and flange. Draw stress distribution diagram. Also find maximum shear stress. 8





b A steel bar 20 mm diameter and 1 m long is freely suspended from roof is provided with collar at other end. If modulus of elasticity is 2×10^5 MPa and maximum perm. stress is 300 MPa, find 6

i) Maximum load which can fall from height 50 mm on the collar.

ii)Maximum height from which a 600 N load can fall on the collar.

E P=?

Q4 **Solve any TWO of following**

a The cylindrical shell is 5 m long and having 1m internal diameter and 25 mm thickness. Calculate maximum intensity of shear stress induced and also the changes in the dimensions of the shell , if it is subjected to an internal fluid pressure of 4.5 N/mm^2.Take $E = 2 \times 10^5$ MPa and $\mu = 0.3$. 6

b Prove that buckling load $P = 4 \pi^2 EI/(l^2)$ when both ends of long column are fixed. 6

c The state of stress at point in a strained material is as shown in fig. Determine direction of principal planes, 6

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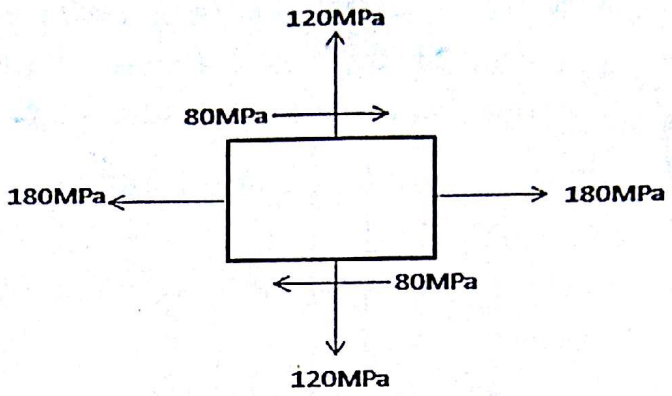
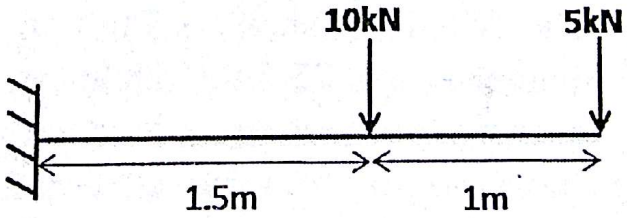
magnitude of principal stresses, magnitude maximum shear stress and its direction. Indicate all above planes by a sketch.



Q. 5 Solve any TWO of following

a) A hollow propeller shaft of steam ship is to transmit 3750 KW at 240 rpm. If the internal diameter is 0.8 times the external diameter and if the maximum shear stress developed is to be limited to 160 N/mm^2, determine the size of shaft. 6

b Determine the slop and deflection at free end of cantilever beam as shown in fig. by moment area method. Take EI = 4000 KNm^2 6



c A load of 75 KN is carried by a column made of cast iron .The external and internal diameters are 200 mm and 180 mm resp. If the eccentricity of load is 35 mm, find 6
i)Maximum and minimum stress intensities
ii)Up to what eccentricity there are no tensile stress in the column.

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Third Semester B. Tech. CE/ME

Winter - 2015

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Course Name: Strength of Materials

Time: 2 hr. 30min. **Max. Marks: 60**

Instructions to Candidate

1) All questions are compulsory.
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4) Figures to the right indicate full marks.

1. (a) Write assumptions made in theory of pure torsion. 02

(b) Draw stress strain diagram for mild steel. Also explain the salient points of the diagram. 04

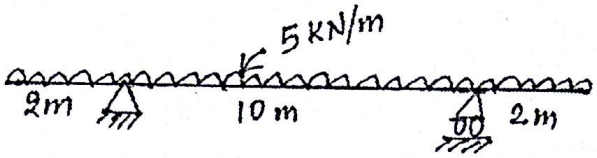
(c) A tension test bar 4 m long side made of two parts, one 2.5 m long has cross sectional area 1000 mm^2 and another 1.5 m long has cross sectional area 2000 mm^2. If an axial load of 100 kN is gradually applied, find total strain energy produced in bar and compare it with strain energy for a uniform bar of same length and same volume under same load. Take E = 200 GPa. 06

2. (a) Derive the expression $(T/Ip) = (\zeta/R) = (G\theta/L)$. 06

(b) In a tensile test on steel tube of external diameter 06

18 mm and internal diameter 12 mm, an axial pull of 2 kN produces stretch of 6.72×10^{-3} mm in length of 100 mm and lateral contraction of 3.62×10^{-4} mm in outer diameter. Calculate values of three moduli and poisons ratio of material.

3. (a) Draw shear force and bending moment diagram for beam as shown in fig. Indicate points of contra flexure and maximum bending moment. 06



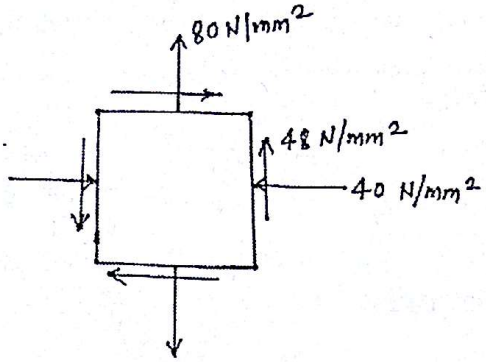
(b) Two wooden planks, each of 150 mm wide, 50 mm thick are connected together to form a beam. The shape of cross section is T with flange at top. If bending moment 3400 Nm is acting at the section, compute the maximum stress produced. Assume beam to be simply supported. Draw stress distribution diagram. 06

4. Solve any **TWO** of following.

(a) Find the Euler's crippling load for hollow cylindrical steel column of 40 mm external diameter and 2 mm thick. Length of column is 3 m and hinged at its both ends. Take E = 250 GPa. Also determine crippling load by Rankin's formula using $\sigma_c = 335$ kN/mm^2 and $\alpha = 1/7500$. 06

(b) At a point in a strained material, there is a tensile stress of 80 N/mm^2 on a horizontal plane and compressive stress of 40 N/mm^2 on a vertical plane. There is also shear stress of 48 N/mm^2 on each of these planes. Determine planes of 06

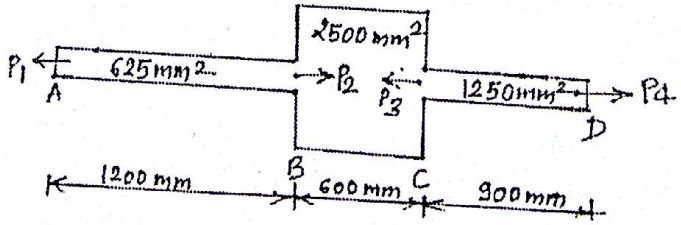
maximum shear stress at the point. Also determine resultant stress on the planes of maximum shear stress.



(c) A thin cylindrical shell, 2 m long has 200 mm diameter and thickness of metal 10 mm. It is filled completely with a fluid at atmospheric pressure. If an additional 25,000 mm^3 fluid is pumped in, find the pressure developed and hoop stress developed. Find also change in length and diameter. Take E = 2 x10^5 N/mm^2 and $\mu = 0.3$ 06

5. Solve any **TWO** of following.

(a) A member ABCD is subjected to point loads P1, P2, P3, P4 as shown in fig. Calculate the force P2 necessary for Equilibrium, if P1 = 45 kN, P3 = 450 kN, P4 =130 kN. Determine total elongation of the member assuming E = 2.1 x 10^5 N/mm^2 06



(b) Show that for a simply supported beam of length 06

L subjected to central point load W, deflection at mid span is given as $y = WL^3/48EI$ downwards. Also determine slope at supports. Use double integration method.

(c) A short column of hollow cylindrical section 25 cm outside diameter and 15 cm inside diameter carries a vertical load of 400 kN along one of the diameter planes 10 cm away from the axis of column. Find extreme values of stresses and state their nature. Also draw plan and cross section of column. 06

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Winter – 2013

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Course Name: Strength of Materials

Time: 2 Hrs. 30 Min. **Max. Marks: 60**

Instructions to Candidate

1) All questions are compulsory.
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4) Use of logarithmic table, drawing instruments and non-programmable calculators is permitted.
5) Figures to the right indicate full marks.

1. Solve any **TWO** of the following.

a) Determine the values of the stress in portions AC and CB of the steel bar shown in Figure No. 1 (a) when the temperature of the bar is – 45°C, knowing that a close fit exists at both of the rigid supports when the temperature is + 24°C. Use the values E = 200 GPa and $\alpha = 11.7 \times 10^{-6}/^{\circ}C$ for steel. **6**

b) Prove that, if the stresses of a cross-section are uniform then applied load or the resultant of the load system passes through the centroid of- **6**

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-the cross-section.

c) Derive the relationship between Young's modulus of elasticity, bulk modulus of elasticity and shear modulus of rigidity. 6

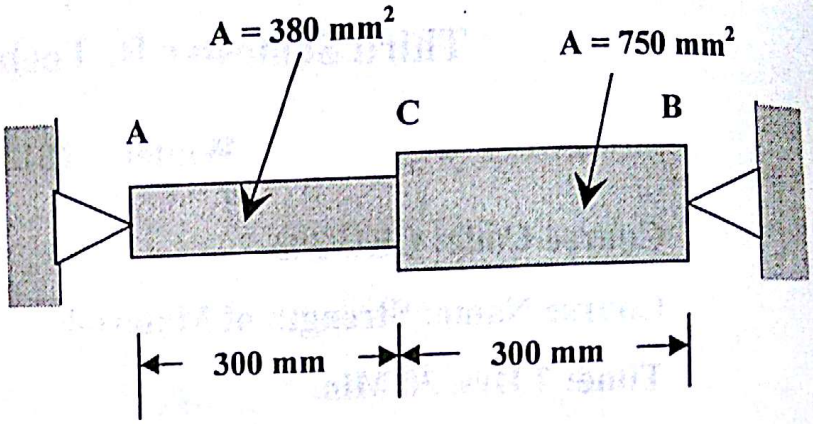

Figure No. 1 (a)

2 Solve any **TWO** of the following

a) Draw the shear force and bending moment diagrams (S.F.D. and B.M.D.) for the beam as shown in Figure No. 2 (a). 6

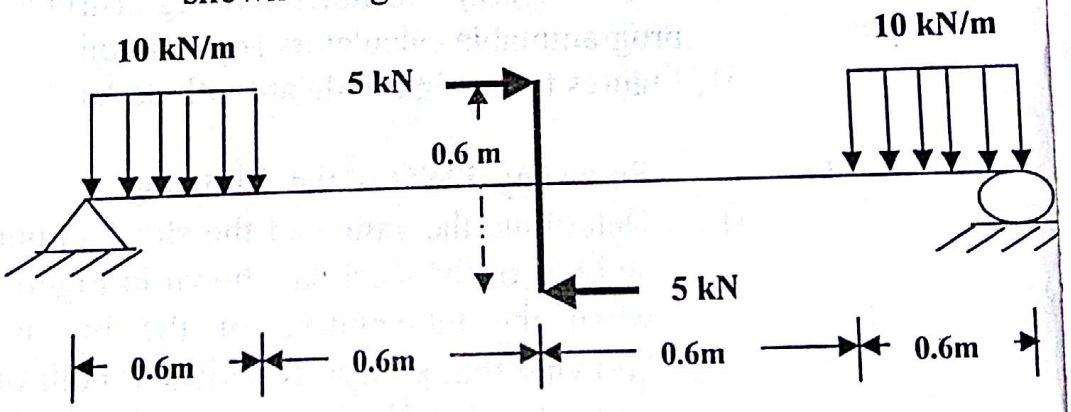

Figure No. 2 (a)

b) A beam of square cross section of side 'a' has to resist a maximum moment of M_{max}. The beam can be placed so that the plane of moment (i) is either parallel to the sides of the square or (ii) coincides 6

with the diagonal. Which of these positions will have minimum bending stress?

c) A simply supported beam of 3 m span carries a u.d.l. of 10kN/m over its entire span and a central point load of 20 kN. If a solid circular teak wood section is used, determine the size of the beam. The permissible stresses are 10 MPa in flexure and 1 MPa in shear. **6**

3 a) Two shafts, first one of solid circular section and second of hollow circular cross-section with a ratio of internal and external diameters of 0.9, are considered for the use in an application that has to transmit a maximum torque T_{max} = 10 kN.m. Which of these shafts will be economical for equal strength condition? Also determine the percent saving in the material **6**

b) Using Mohr's Circle method, find the principal stress and maximum shear stress. Knowing that an element has a tensile stress of 600 N/mm^2 and a compressive stress of 400 N/mm^2 acting on two mutually perpendicular planes and two equal shear stresses of 100 N/mm^2 on these planes as shown in Figure No. 3 (b). **6**

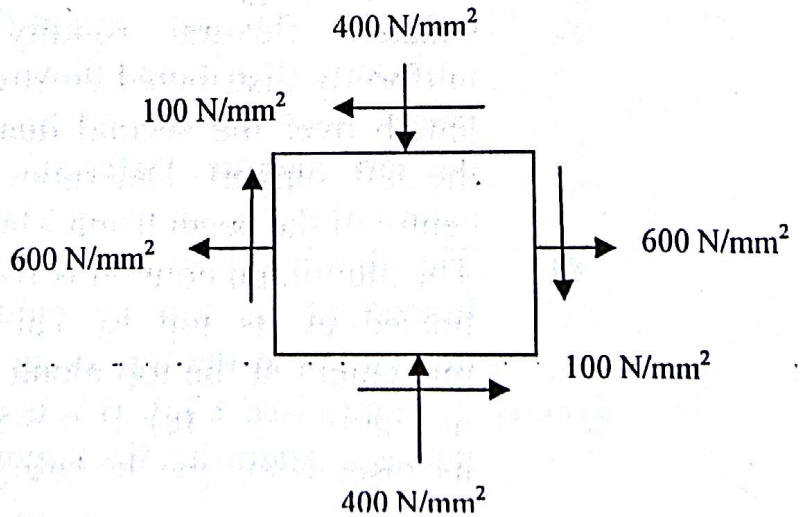

Figure No. 3 (b)

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4 a) Calculate the increase in the volume of the boiler shell 3 m long and 1 m in diameter when subjected to an internal pressure of 2 N/mm^2. The wall thickness is such that the maximum tensile stress is not to exceed 30 N/mm^2. Take $E = 0.21 \times 10^6$ N/mm^2, $\mu = 0.3$. 6

b) A hollow circular column having external diameter 250 mm and internal diameter 200 mm carries a vertical load of 90 kN at an eccentricity of 75 mm from the geometric centre of the column. Calculate the direct and bending stresses for the column. 6

5 Solve any **TWO** of the following

a) Using the moment-area theorems, compute the slope and deflection at the free end of the cantilever beam AB of span L for following two different cases: 6

(i) Moment M at the free end

(ii) Uniformly distributed load over the entire span.

For both of the above cases, assume the beam is of uniform cross section with constant EI.

b) A simply supported beam AB of length '4a' has a constant flexural rigidity EI and carries a uniformly distributed downward load 'w' per unit length over the second quarter of the span from the left support. Determine the deflection at the centre of the beam using Macaulay's method.

c) The aluminum column is fixed at its bottom and is braced at its top by cables so as to prevent movement at the top along the x –axis, as shown in Figure No. 5 (c). If it is assumed to be fixed at its base, determine the largest allowable load P 6

that can be applied. Use a factor of safety for buckling = 3.0. Take E_{al} = 70 GPa, σ_y = 215 MPa, A = 7.5 x 10^{-3} m^2, I_{xx} = 61.3 x 10^{-6} m^4, and I_{yy} = 23.2 x 10^{-6} m^4

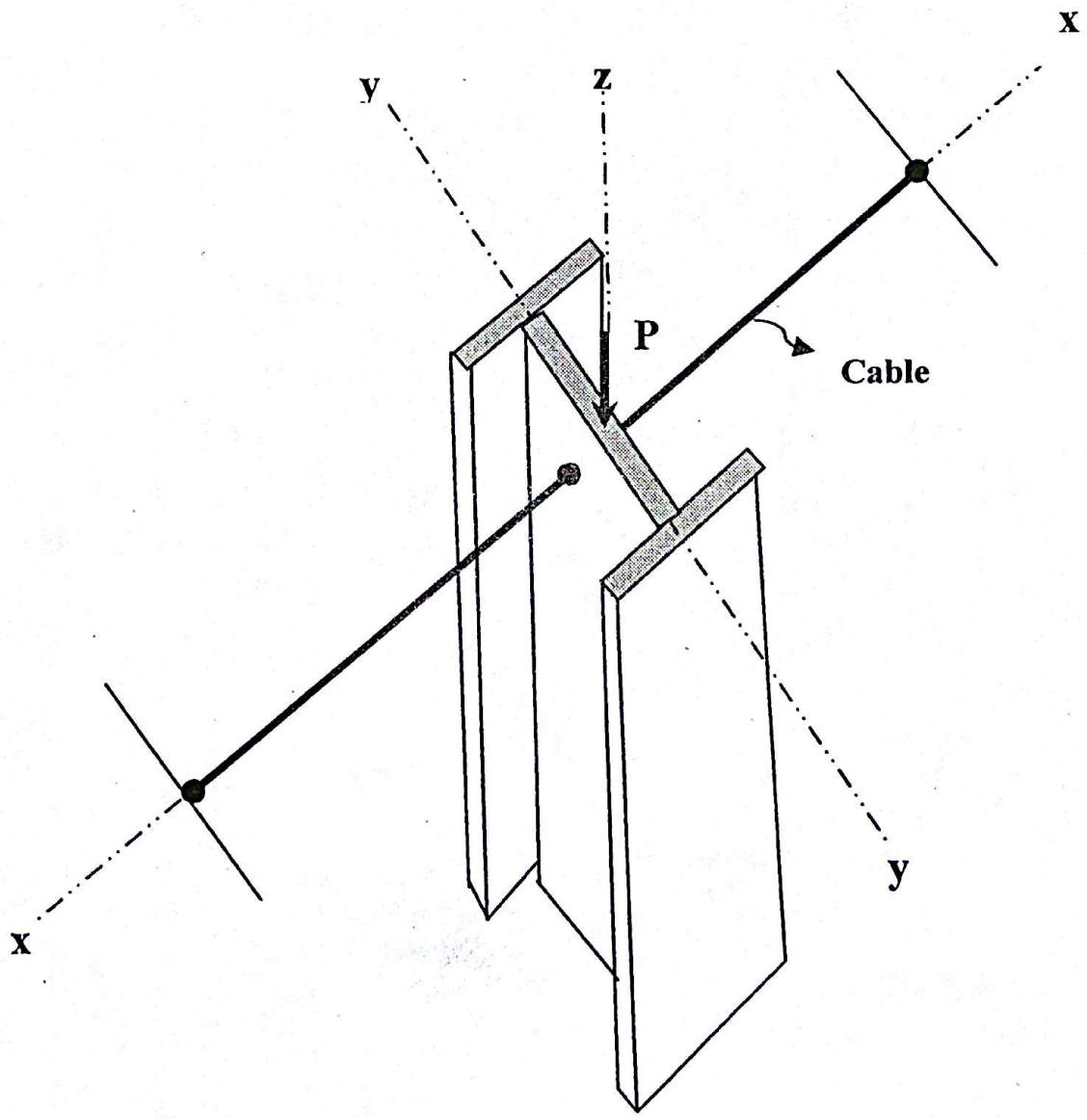

Figure No. 5 (c)