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QUESTION BANK (DESCRIPTIVE)

Subject with Code : Introduction to Solid Mechanics(18CE0103) **Course & Branch**: B.Tech - CE

Year &Sem: II-B.Tech & I-Sem **Regulation:** R18

UNIT –I

SIMPLE STRESSES AND STRAINS &

COMPOUND STRESSES AND STRAINS

1. a) Define: Modulus of rigidity and Modulus of Elasticity [2M]

b) Define: Bulk-modulus and Poisson's Ratio. [2M]

c) What is thermal Stress? [2M]

d) Define principal stresses and principal plane. [2M]

e) What is the radius of Mohr's circle? [2M]

f) What is mean by position of principal planes? [2M]

2. a) A rod 150 cm long and of diameter 2 cm is subjected to an axial pull of 20 kN. If the modulus of elasticity of the material of the rod is $2x10^5$ N/ mm^2; determine: the Stress, Strain and Elongation of the rod. [7M]

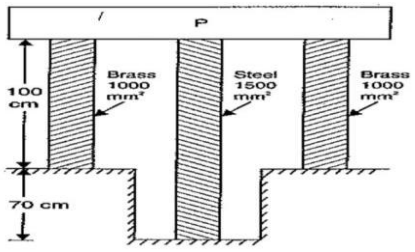
b) Explain about St.Venant's principle [3M]

3. A steel bar 50 mm wide, 12 mm thick and 300 mm long is subjected to an axial pull of 84 kN. Find the changes in the length, width, thickness and the volume of the bar. [10M]

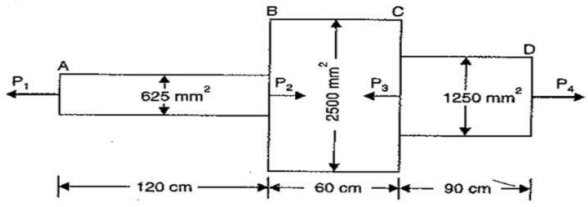
4. Derive the relation between Young's Modulus (E), Rigidity Modulus (G) and Bulk Modulus (K).

[10M]

5. Two brass rods and one steel rod together supports a load as shown in fig. If the stresses in brass and steel are not to exceed 60 N/mm^2 and 120 N/ mm^2, find the safe load that can be supported. Take E for steel = $2x10^5$ N/ mm^2 and for brass = $1x10^5$N/ mm^2. The cross-sectional area of steel rod is 1500 mm^2 and of each brass rod is 1000 mm^2 [10M]



6. A member ABCD is subjected to point loads P_1, P_2, P_3 and P_4 as shown in figure. Calculate the force P_2 necessary for equilibrium, if P_1=45 kN, P_3 =450 kN and P_4=130kN. Determine the total elongation of the member, assuming the modulus of elasticity to be 2.1 x 10^5 N/ mm^2 [10M]



7. The modulus of rigidity for a material is 0.51 x 10^5 N/ mm^2. A 10 mm diameter rod of a material was subjected to an axial pull of 10 kN and the changes in diameter was observed to be 3 x 10^{-3} mm. Calculate Poisson's ratio, E and K. [10M]

8. The normal stress in two mutually perpendicular directions are 600N/mm^2 and 300N/mm^2 both tensile. The complimentary shear stresses in these directions are of intensity 450 N/mm^2. Find the normal, tangential stresses on the two planes which are equally inclined to the planes carrying the normal stresses mentioned above. [10M]

9. Direct stresses of 120 N/mm^2 tensile and 90 N/mm^2 compressive exist on two perpendicular planes at a certain point in a body. They are also accompanied by shear stress on the planes. The greatest principal stress at a point due to these is 150 N/mm^2. [10M]

i) What must be the magnitude of shearing stresses on the two planes? [5M]

ii) What will be the maximum shearing stress at the point? [5M]

10. At a point in a strained material, the stresses on two planes, at right angles to each other are 20 N/mm^2 and 10 N/mm^2 both tensile. They are also accompanied by shear stress of a magnitude of 10 N/mm^2. Find the location of principal planes and evaluate the principal stresses [10M]

11. An elemental cube is subjected to tensile stresses of 30 N/mm^2 and 10 N/mm^2 acting on two mutually perpendicular planes and a shear stress of 10 N/mm^2 on these planes. Draw the Mohr's circle of stresses and hence or otherwise determine the magnitudes and directions of principal stresses and also the greatest shear stress. [10M]

UNIT –II

SHEAR FORCE AND BENDING MOMENTS &

THEORY OF SIMPLE BENDING

1. **a)** Mention the different types of beams. [2M]

b) What do you understand by the term point of contra flexure? [2M]

c) What is maximum bending moment in a simply supported beam of span 'L' subjected to UDL of 'w' over entire span? [2M]

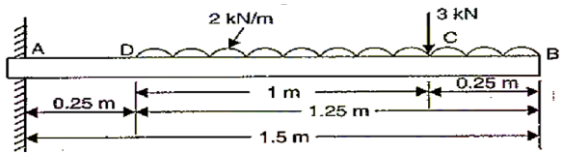
d) Mention the types of supports. [2M]

e) Write down the bending stress equation. [2M]

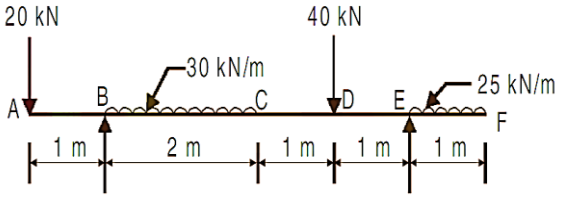
f) What is meant by Neutral axis of the beam? [2M]

2. Draw shear force and bending moment diagram for cantilever beam subjected to uniformly distributed load. [10M]

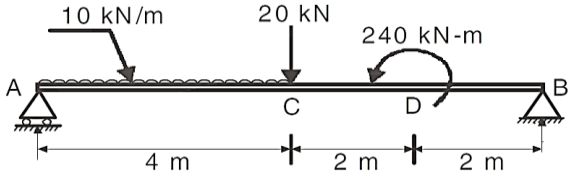
3. Draw the shear force and bending moment diagram for the cantilever beam shown in figure [10M]



4. Draw shear force and bending moment diagram for the following beam [10M]



5. Draw shear force and bending moment diagram for the following beam [10M]



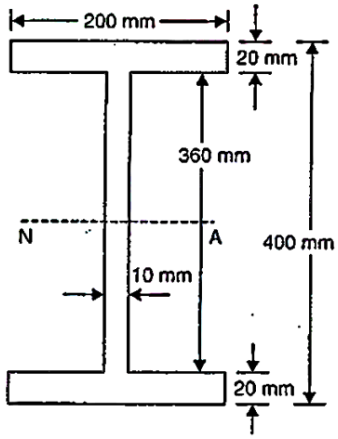
6. Draw shear force and bending moment diagram for simply supported beam subjected to Eccentric point load. [10M]

7. Derive the bending equation M/I = f/y = E/R, write all the assumptions made [10M].

8. A cast Iron beam is of T- section has the following dimensions Flange: 100 mm x 20 mm Web: 80 mm x 20 mm. The beam is simply supported on a span of 8 meters and carries a uniformly distributed load of 1.5 KN/m length of entire span. Determine the maximum tensile and compressive stresses. [10M]

9. A rolled steel joist of I section has a dimensions as shown in fig. This beam of I section carries a uniformly distributed load of 40 kN /m run on a span of 10 m, calculate the maximum stress

produced due to bending. [10M]



10. A beam is simply supported and carries a uniformly distributed load of 40KN/m run over the whole span. The section of the beam is rectangular having depth as 500 mm. If the maximum stress in the material of the beam is 120 N/mm^2 and moment of inertia of the section is 7 x $10^8 mm^4$, find the span of the beam. [10M]

11. A water main of 500 mm internal diameter and 20 mm thick is running full. The water main is of cast iron and is supported at two points 10 m apart. Find the maximum stress in the metal. The cast iron and weigh 72 x 10^3 N/m^3 and 1x 10^4 N/m^3 respectively [10M]

UNIT –III

SHEAR STRESS DISTRIBUTION &

TORSION OF CIRCULAR SHAFTS AND SPRINGS

1. **a)** State the assumptions while deriving the general formula for shear stresses. [2M]

b) What is the ratio of maximum shear stress to the average shear stress in the case of solid circular section? [2M]

c) Where the shear stress is max for Triangular section? [2M]

d) What are the assumptions made in torsion equation? [2M]

e) Write down the expression for power transmitted by a shaft. [2M]

f) State the differences between closed and open coil helical springs. [2M]

2. A rectangular beam 100 mm wide and 250 mm deep is subjected to a maximum shear force of 50 KN. Determine i) Average shear stress ii) Maximum shear stress iii) Shear stress at a distance of 25 mm above neutral axis. [10M]

3. An I-section has 100 mm wide and 12 mm thickness, a web of 120 mm height and 10 mm thickness. The section is subjected to bending moment of 15 KN-m and shear force of 10 KN. Find the maximum bending stress and maximum shear stress and draw shear stress distribution diagram [10M]

4. A simply supported beam carries a uniformly distributed load of intensity 30 N/mm over the entire span of 2 m. The cross section of beam is a T-section having flange 125 x 25 mm and web 175 x 25 mm. Calculate the maximum shear stress for the section subjected to maximum shear force. Also draw the shear stress distribution. [10M]

5. Prove that the maximum shear stress in a circular section of a beam is 4/3 times the average shear stress [10M]

6. The shear force acting on a beam at a section is 'F'. The section of the beam is triangular base b and of an altitude h. The beam is placed with its base horizontal. Find the maximum shear stress and the shear stress at the neutral axis . [10M]

7. Derive the relation for a circular shaft when subjected to torsion $\frac{T}{J} = \frac{\tau}{R} = \frac{C\theta}{L}$ [10M]

8. A solid shaft of 200 mm diameter has the same cross sectional area as that of a hollow shaft of the same material with inside diameter of 150 mm. Find the ratio of the power transmitted by the hollow shaft by the same speed. [10M]

9. A hollow shaft is to transmit 300kW power at 80 rpm. If the shear stress is not exceed 60 N/mm2 and the internal diameter is 0.6 of the external diameter. Find the external and internal diameters assuming that the maximum torque is 1.4 times the mean. [10M]

10. A solid circular shaft transmits 75 kW power at 200 rpm. Calculate the shaft diameter, if the twist in the shaft is not to exceed 1^0 in 2 m length of shaft, and shear stress is limited to 50 N/mm2. Take C= 1 x 10^5 N/mm2. [10M]

11. A closely coil helical spring of round steel wire 10 mm in diameter having 10 complete turns with

a mean diameter of 12 cm is subjected to an axial load of 200 N. Determine : (i) Deflection of the beam spring (ii) Maximum shear stress in the wire and (iii) Stiffness of the spring. Take C= $8x10^4$ N/mm2. [10M]

UNIT –IV

DEFLECTIONS OF BEAMS

1. **a)** A cantilever is subjected to a point load W at the free end. What is the slope and deflection at the free end? [2M]

b) Calculate the maximum deflection of a simply supported beam carrying a point load of 100 KN at mid span. Span = 6 m, E= 20000 kN/m^2. [2M]

c) State the condition for the use of Macaulay's method. [2M]

d) Define: Mohr's Theorem for slope and deflection. [2M]

e) What is the relation between slope, deflection and radius of curvature of a beam? [2M]

f) What is the maximum deflection in a simply supported beam subjected to uniformly distributed load over the entire span? [2M]

2. Prove that the relation that $M=EI\frac{d^2y}{dx^2}$ [10M]

3. Derive the expression for slope and deflection of a simply supported beam carrying a point load at Centre using Moment area method [10M]

4. A beam 6 m long, simply supported at its ends, is carrying a point load of 50 kN at its center. The moment of inertia of the beam is given as equal to 78 x 10^6 mm^4 and. If E for the material of the beam = 2.1 x 10^5 N/mm^2, calculate: (i) deflection at the centre of the beam and (ii) slope at the supports. [10M]

5. A beam of length 6 m is simply supported at its ends and carries a point load of 40 kN at a distance of 4 m from the left support. Find the deflection under the load and maximum deflection. Also calculate the point at which maximum deflection takes place. Given moment of inertia of beam is 7.33 x 10^7 N/mm2 and E = 2 x 10^5 N/mm2. Use Macaulay's method. [10M]

6. A cantilever of length 3m carries a uniformly distributed load over the entire length. If the deflection at the free end is 40 mm, find the slope at the free end. [10M]

7. Derive the expression for slope and deflection of a cantilever beam carrying a point load at the free end by Moment Area method. [10M]

8. A beam of uniform rectangular section 200 mm wide and 300 deep is simply support at its ends. It carries a uniformly distributed load of 9 kN/m run over the entire span of 5 m. If the value of E for the beam material is 1 x 104 N/mm2, find: (i) Slope at the supports and (ii) Maximum deflection. [10M]

9. A simply supported beam carries a UDL of 20 kN/m over its span of 8 m. Determine the slope at the ends and the deflection at mid span by moment area method if E = 200 G N/m^2 and I= 30,000 cm^4. [10M]

10. Derive the expression for slope and deflection of a simply supported beam carrying a uniformly distributed load of w per unit length over the entire length using Macaulay's method [10M]

11. A beam of length 5 m of uniform rectangular section is supported at its ends and carries a uniformly distributed load over the entire length. Calculate the depth of the section if the maximum permissible bending stress is 8 N/mm^2 and central deflection not to exceed 10 mm.

Take E = 1.2 X 10^4 N/ mm2. [10M]

UNIT – V

COLUMNS

1. a) Define the terms column and what are the types of columns? [2M]

b) Define Slenderness Ratio and Buckling. [2M]

c) What are the different modes of failures of a column? [2M]

d) What is crippling load? Give the effective length of columns when both ends hinged and when both ends fixed. [2M]

e) How columns are classified depending upon slenderness ratio? [2M]

2. a) What are the assumptions made in Euler's theory? [3M]

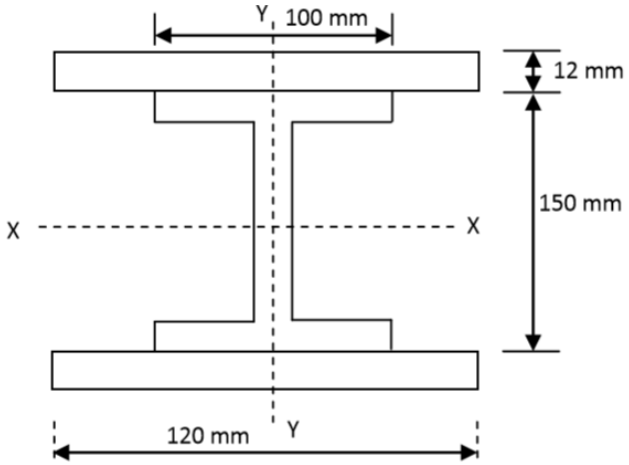
b) Find the ratio of buckling strength of a solid column to that of a hollow column of the same material and having the same cross –sectional area. The internal diameter of the hollow column is half of its external diameter. Both the columns are hinged and the same length. [7M]

3. Compare the Euler crippling loads of two columns-one of solid circular section and the second of hollow circular section of internal diameter 70% of the external diameter if they are of the same material, same length, same area, and same end conditions. [10M]

4. a) Determine the crippling load on a column when both ends of columns are hinged. [5M]

b) An angular section 240 x 120 x 20 mm is used as 6 m long column with both ends are fixed. What is the crippling load for the column? Take E = 210 GPa [5M]

5. A Built-Up column consisting of 150 mm × 100 mm R.S.J with 20 mm × 12 mm riveted in each plane as shown in figure given below. Calculate the safe load of the column carry of 4 m long having one end fixed and the other hinged with a factor of safety 3.5. Take the properties of the joist: area = 2167 mm2, I_{XX} = 8.39 × 10^6 mm^4, I_{YY} = 0.945 × 10^6 mm^4 and E= 2 x 10^5 N/mm^2 [10M]

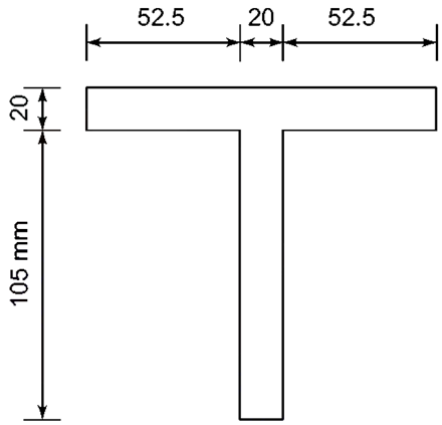


6. A rectangular column of wood, 3 m long, carries a load of 300 kN. Determine whether or not a section of size 200 mm x 150 mm will be able to carry this load if a factor of safety of 3 is to be used, assuming Euler's formula is applicable. E = 12.5 GPa and the permissible stress is 12 MPa. If this section will not be able to carry this load, design a square section to do so. [10M]

7. A built up section has an overall depth of 400 mm, width of flanges 50 mm and web thickness 30 mm. It is used as a beam with simply supported ends and it deflects by 10 mm when subjected to a load of 40 kN/m length. Find the safe load if this I-section is used as a column with both ends hinged. Use Euler's formula. Assume a factor of safety 1.75 and take $E = 2 \times 10^5$ N/mm^2. [10M]

8. Derive an Euler's load expression for the column with one end fixed and the other end hinged. [10M]

9. Determine the Euler critical load for the column section shown in Fig. if its length is 3 m and (i) if its ends are hinged and (ii) if its ends are fixed. E = 200 GPa. [10M]



10. a) What are the limitations of Euler's theory? [3M]

b) Derive the Euler's equation for the condition both ends are hinged. [7M]

11. Drive the equation for the Euler's crippling load for a both ends are fixed. [10M]

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