SCAD ENGINEERING COLLEGE CHERANMAHADEVI

DEPARTMENT OF MECHANICAL ENGINEERING

STRENGTH OF MATERIALS

QUESTION BANK

UNIT I-STRESSES STRAIN DEFORMATION OF SOLIDS

Year : II

Semester:III

1. Define- elastic limit.
2. Define- Elasticity?
3. What is stress?
4. What is strain?
5. What are the types of strain?
6. What are the types of stress?
7. State Hooke's law.
8. Define tensile stress and tensile strain.
9. Define compressive stress and compressive strain.
10. Define shear stress and shear strain.
11. Define – Young's modulus or Modulus of Elasticity?
12. What is principle of super position?
13. What is compound bar?
14. State the two conditions employed in solving a composite bar subjected to an axial load.
15. What you mean by thermal stresses?
16. Define- lateral strain or secondary strain?
17. Define- longitudinal strain or linear strain?
18. Define Poisson's ratio.
19. What are the types of Elastic constants?
20. Define volumetric strain?
21. Write the volumetric strain of a rectangular bar subjected to an axial force (P)?
22. Write the volumetric strain of a circular bar subjected to an axial force (P)?
23. Write the volumetric strain of a rectangular bar subjected to three forces which are mutually perpendicular?
24. Define Young's modulus or modulus of Elasticity?
25. Define Bulk modulus.
26. Define Shear modulus or modulus of rigidity?
27. State the relationship between Young's Modulus and Modulus of Rigidity.
28. Give the relationship between Bulk Modulus and Young's Modulus.
29. Give the relationship for change in length of a bar hanging freely under its own weight?

UNIT II

STRESSES IN BEAMS

Part-A (2 Marks)

1. Define point of contra flexure? In which beam it occurs?
2. What is mean by positive or sagging BM?
3. What is mean by negative or hogging BM?
4. Define shear force and bending moment?
5. What is meant by transverse loading of beam?
6. When will bending moment is maximum?
7. What is maximum bending moment in a simply supported beam of span ‘L’ subjected to UDL of ‘w’ over entire span?
8. In a simply supported beam how will you locate point of maximum bending moment?
9. What is shear force?
10. What is shear force and bending moment diagram?
11. What is cantilever beam?
12. What is simply supported beam?
13. What is overhang beam?
14. Define Point load or concentrated load?
15. Define Uniform distributed load?
16. Define Uniform varying load?
17. What are the types of beams?
18. What are the types of loads?
19. Draw the shear stress distribution diagram for a *I*–section.
20. In which point the bending moment is maximum?
21. Write the assumption in the theory of simple bending?
22. Write the theory of simple bending equation?
23. What types of stresses are caused in a beam subjected to a constant shear force ?
24. State the main assumptions while deriving the general formula for shear stresses.
25. Define: Shear stress distribution
26. What is the ratio of maximum shear stress to the average shear stress for the rectangular section?
27. What is the ratio of maximum shear stress to the average shear stress in the case of solid circular section?
28. A beam subjected to a bending stress of 5 N/mm2 and the section modulus is 3530 cm2.What is the moment of resistance of the beam?

29. State that theory of simple bending?
30. Define neutral axis?
31. What is the section modulus for a circular and a hollow circular section?
32. What is moment of resistance of the section?
33. What is flitched beam? Why it is used?
34. Define section modulus?
35. What types of stresses are caused in a beam subjected to a constant shear force?
36. What is the maximum value of shear stress for triangular section?
37. What is the shear stress distribution value of Flange portion of the I-section?
38. Draw the shear stress distribution in the case of ‘T’section.
39. What is the value of maximum of minimum shear stress in a rectangular cross section?

UNITIII

DEFLECTION OF BEAMS

Part-A (2 Marks)

1. Where the slope and deflection will be maximum for the cantilever with point load at its free end?
2. What are the units of slope and deflection?
3. State whether the following statement is true /false in a cantilever beam the maximum deflection equals sum of deflection by the individual load at the free end?
4. Name the method which employ BMD for the calculation of slope and deflection?
5. Calculate area of BMD of a cantilever carrying UDL of W/m for the full span of L?
6. What is the slope at the support for SSB of constant EI and span L carrying central concentrated load ?
7. Write the value of slope at the free end and of a cantilever beam of constant EI and span L carrying a concentrated load W at the free end?
8. State the two theorems in the moment area method?
9. State the Mohr’s theorem?
10. Write the maximum value of deflection for a simply supported beam of constant EI, span L carrying central concentrated load W?
11. Where the maximum deflection will occur in a SSB loaded with UDL of w KN/m run and note about the slope at the point?
12. Write the methods to find the deflection by analytical method?
13. Write the relation between slope and deflection?
14. Define radius of curvature?

15. Write the slope and deflection equation used in Double integration method?
16. what is the maximum deflection formula when a point load acts at the end of the cantilever beam?
17. what is the maximum deflection formula when a UDL acts at the end of the cantilever beam?
18. Write the equation In a cantilever beam UDL acts at the fixed end?
19. Write the Macaulay's method for slope and deflection?
20. Write the moment area method for slope and deflection?
21. What is conjugate beam method?

UNITIV

TORSION

Part-A (2 Marks)

1. Define Torsion
2. What are the assumptions made in Torsion equation
3. Define polar modulus
4. Write the polar modulus for solid shaft and circular shaft.
5. Why hollow circular shafts are preferred when compared to solid circular Shafts?
6. Write torsional equation
7. Write down the expression for power transmitted by a shaft
8. Write down the expression for torque transmitted by hollow shaft
9. Write the polar modulus for solid shaft and circular shaft
10. Write down the equation for maximum shear stress of a solid circular section in diameter 'D' when subjected to torque 'T' in a solid shaft shaft.
11. Define torsional rigidity
12. What is composite shaft?
13. What is a spring?
14. State any two functions of springs.
15. What are the various types of springs?
16. Classify the helical springs.
17. Define spring rate (stiffness).
18. What is spring index (C)?
19. What is solid length?
20. Define free length.

21. Define pitch.
22. Define helical springs.
23. What are the differences between closed coil & open coil helical springs?
24. What are the stresses induced in the helical compression spring due to axial load?
25. What is buckling of springs?
26. What is surge in springs?
27. Define active turns.
28. Define inactive turns.
29. What are the different kinds of end connections for compression helical springs?
30. Define –column
31. What are the causes to fail the column?
32. What is buckling or crippling load?
33. What are the causes to fail the long column?
34. What are the assumptions made in the Euler theory?
35. List the end conditions of the column?
36. What is effective length?
37. Define - slenderness ratio
38. Define strain energy
39. What is resilience?
40. State proof resilience
41. Define modulus of resilience

UNIT V

BI AXIAL STRESSES

Part-A (2 Marks)

1. When will you call a cylinder as thin cylinder?
2. In a thin cylinder will the radial stress vary over the thickness of wall?
3. Distinguish between cylindrical shell and spherical shell.
4. What are the assumption made for shear stress in circular bar?
5. Write the failure of thin cylinder shell due to an internal pressure?
6. What are the stress caused in thin cylinder?
7. What is the effect of riveting a thin cylindrical shell?
8. What do you understand by the term wire winding of thin cylinder?

9. What are the types of stresses setup in the thin cylinders?
10. Define – hoop stress?
11. Define- longitudinal stress?
12. A thin cylinder of diameter d is subjected to internal pressure p . Write down the expression for hoop stress and longitudinal stress.
13. State principle plane.
14. Define principle stresses and principle plane.
15. What is the radius of Mohr's circle?
16. What is the use of Mohr's circle?
17. List the methods to find the stresses in oblique plane?
18. A bar of cross sectional area 600 mm^2 is subjected to a tensile load of 50 KN applied at each end. Determine the normal stress on a plane inclined at 30° to the direction of loading.
19. In case of equal like principle stresses, what is the diameter of the Mohr's circle?
20. Derive an expression for the longitudinal stress in a thin cylinder subjected to a uniform internal fluid pressure.
21. Explain the uses of principal stress ?
22. Explain the uses of principal strain?
23. A steam boiler of 800 mm diameter is made up of 10mm thick plates. If the boiler is subjected to an internal pressure of 2.5Mpa, find the circumferential and longitudinal stresses induced in the boiler plates
24. A cylindrical shell of 1.3m diameter is made up of 18mm thick plates .find the circumferential and longitudinal stress in the plates, if the boiler is subjected to an internal pressure of 2.4Mpa take efficiency of joints as 70%.
25. A gas cylinder of internal diameter 40mm is 5mm thick. If the tensile stress in the material is not to exceed 30Mpa,find the maximum pressure which can be allowed in the cylinder.
26. A thick cylindrical shell of 400mm diameter is to be designed for an internal pressure of 2.4Mpa.find the suitable thickness of shell, if the allowable circumferential stress is 50Mpa.
27. A cylindrical shell of 500mm diameter is required to withstand an internal pressure of Mpa.find the minimum thickness if the shell, if maximum tensile strength in plate material is 400Mpa and efficiency of the joints is 65% .take factor of safety as 5.

UNIT I

BASICS AND AXIAL LOADING

Part-B (16 Marks)

1. A rod of 150 cm long and diameter 20cm is subjected to an axial pull of 20 KN. If themodulus of elasticity of the material of the rod is 2x 10^5 N/mm^2 Determine 1. Stress 2.Strain 3.the elongation of the rod (16)

2. A wooden tie 3m long 75mm wide and 100mm thick is subjected to an axial pull of 4500 kg and the stretch is 4mm.Find the value of E for timber.(16)

3. The rod of a hydraulic lifts 12m long and 4cm in diameter. It is attached to a plunger 11cm in diameter working under a pressure of 500kg/cm^2.If E equals 2 x 10^6 kg/cm^2 find the change in length of the rod. (16)

4. A tie bar 25mm diameter carries a load which causes a stress of 1200 kg/cm^2.If it is attached to a cast iron bracket by means of 4 holes which can be stressed up to 900 kg/cm^2, find the diameter of the bolts. (16)

5. A steel punch can be worked to a compressive stress of 8 tons/cm^2.Find the least diameter of the hole which can be punched through a steel plate of 12mm thickness if its ultimate shear strength is 3.2 tons/cm^2. (16)

6. A mild steel flat 12cm wide by 2cm thick and 6m long carries an axial pull of 30 tons. E =2000tons/cm^2, 1/m = 0.26.Calculate the change in dimensions and volume. (16)

7. A steel bar 3mm long carries a pull of 8 tons. It is 3cm diameter for 90cm length, and 2.8cm diameter for 120cm long and 2.5cm diameter for the remaining 90cm length. Find the total elongation of the bar and

the energy stored in it. E= $2x10^6$ kg/cm^2.

(16)

8. A straight bar of steel 3m long has rectangular section which varies uniformly from 10cm x 12mm at one end to 25mm x 12mm at the other end . What is the change in length and a pull of 2300kg? E= $2x10^6$ kg/cm^2. (16)

9. A weight of 25 kg is dropped into a collar at the end of a vertical bar 1.8m long and 25mm dia from a height of 10 cm. Calculate the maximum instantaneous extension and stress produced in the section. E=$2x10^6$ kg/cm^2. (16)

10. A wrought iron bar 5cm dia has to transmit shock energy of 8Kg-m. Calculate the maximum instantaneous stress and the elongation produced. Assume E=$2x10^6$ kg/cm^2.

(16)

11. Find the stresses in steel for the following data: Reinforced concrete column size 30mmX300mm, steel bars 4 numbers of 28mm diameter. Es/Ec=18, σc=stress in concrete 5 N/mm^2. Find also the safe axial load. (16)

12. A straight rectangular bar 3 m long 12 mm thick tapers uniformly from 100 mm at one end to 25 mm at the other. Find the extension of the bar under a load of 25 kN. E=200 kN/mm^2 2. The extension in a rectangular steel bar of length 400mm and thickness 10mm is found to 0.21mm .The bar tapers uniformly in width from 100mm to 50mm. If E for the bar is 2x 10^5 N/mm^2, Determine the axial load on the bar

(16)

13. A rod of 250 cm long and diameter 3.0cm is subjected to an axial pull of 30 KN. If the modulus of elasticity of the material of the rod is 2x 10^5 N/mm^2 Determine 1.Stress 2.Strain 3. The elongation of the rod (16)

14. Find the young's modulus of a rod of diameter 30mm and of length 300mm which is Subjected to a tensile load of 60 KN and the extension of the rod is equal to 0.4 mm

(16)

15. The extension in a rectangular steel bar of length 400mm and thickness 3mm is found be 0.21mm .The bar tapers uniformly in width from 20mm to 60mm E for the bar is 2 x 10^5 N/mm^2 Determine the axial load on the bar. (16)

16. The ultimate stress for a hollow steel column which carries an axial load of 2Mn is 500N/mm^2 .If the external diameter of the column is 250mm, determine the internal diameter Take the factor of safety as 4.0. (16)

17. (i) Define the modulus of rigidity and Poisson's ratio.

(4)

(ii) A bar 30 mm in diameter was subjected to a tensile load of 54 kN and measured extension on 300 mm gauge length was 0.112 mm and change in diameter was 0.00366 mm. Calculate Poisson's ratio and the values of three elastic module.

(12)

18. (i) Derive a relation for change in length of a bar of uniformly tapering circular section subjected to an axial tensile load 'W'.

(8)

(ii) A reinforced concrete column 500 mm × 500 mm in section is reinforced with 4 steel bars of 25 mm diameter; one in each corner, the column is carrying a load of 1000 kN. Find the stresses in the concrete and steel bars. Take E for steel = 210 × 10^3 N/mm^2 and E for concrete = 14 × 10^3 N/mm^2. (8)

19. A steel tube 30 mm external diameter and 25 mm internal diameter encloses a gun metal rod 20 mm diameter to which it is rigidly

joined at each end. The temperature of the whole assembly is raised to 150ºC. Find the intensity of stress in the rod when the common temperature has fallen to 20ºC. The value of the Young's modulus for steel and gun metal are 2.1×10^5 N/mm^2 respectively. The coefficient of linear expansion for steel is 12×10^{-6} per ºC and for gun metal is 20 $\times 10^{-6}$ per ºC. (16)

20. A metallic bar 250 mm × 100mm × 50mm is loaded as shown in figure . Find the change in volume. Take E = 2×10^5 N/mm^2 and Poisson's ratio = 0.25. Also find the change that would be made in the 4MN load, in order that there should be no change in the volume of the bar. (16)

21. A steel rod of 20 mm passes centrally through a copper tube of 50 mm external diameter and 40 mm internal diameter. The tube is closed at each end by rigid plates. If the temperature of the assembly is raised by 50ºC, calculate the stresses developed in the copper and steel. Take Es = 200 kN/mm2. Ec = 100 kN/mm^2, αs = 12×10^{-6} per ºC, αc =18 × 10-6 per ºC (16)

22. A member ABCD is subjected to loads as shown in Fig. Q 12b. Find the value of P and determine the total change in length of the bar. E = 210 kN/mm^2. AB = 300 mm, BC = 200 mm, CD = 300 mm AAB = 25 mm^2, ABC =100 mm^2, ACD = 50 mm^2

(16)

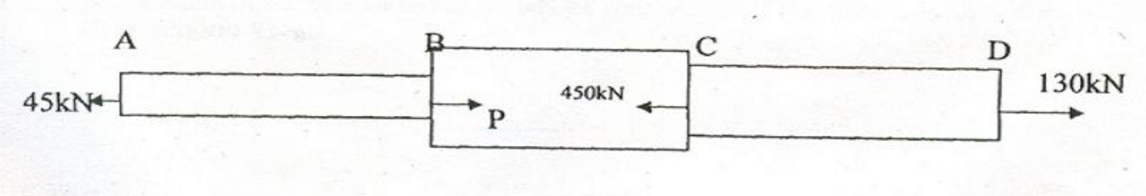
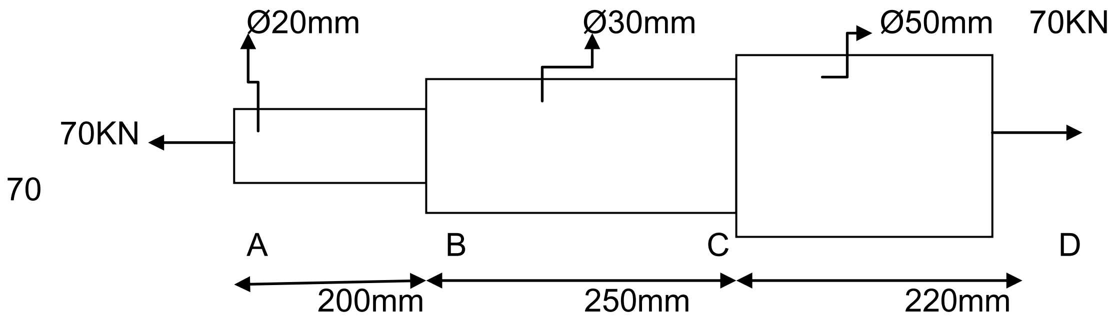


Fig. Q. 12 b

23. (i) Find the stresses in each section of the bar shown in Fig. Q. 11(a) (ii) Find the total extension of the bar shown in Fig. Q. 11(a). E = 2.1×10^5 N/mm^2. (16)



24. (i) A steel rod of 25 mm diameter is placed inside a copper tube of 30mm internal diameter and 5 mm thickness and the ends are rigidly connected. The assembly is subjected to a compressive load of 250 kN. Determine the stresses induced in the steel rod and copper tube. Take the modulus of elasticity of steel and copper as 200Gpa and 80 Gpa respectively. (10)

(ii) Find the total strain energy stored in a steel bar of diameter 50 mm and length 300 mm when it is subjected to an axial load of 150 kN. Take modulus of elasticity of steel as 200×10^3 MPa.

(6)

25. A straight rectangular bar 3 m long 12mm thick tapers uniformly from 100mm at one end to 25mm at the other. Find the extension of the bar under a load of 25kN. E = 200 kN/mm^2.

(16)

26. (i) Derive a relation for change in length of a bar hanging freely under its own weight.

(6)

(ii) A tapered bar, 100 mm diameter at one end and 200 mm diameter at the other, and 1000 mm long, is initially free of stress. If the temperature of the bar drops by 200C, determine the maximum stress in the bar, take E = $2X10^5$ Mpa and $\alpha = 12.5X10^{-6}$/C.

(10)

27. (i) Derive a relation for elongation of a circular bar of uniformly tapering section subjected to an axial tensile load.

(6)

(ii) The modulus of rigidity of a material is $4X10^4$ MPa. A 10mm diameter rod of this material is subjected to an axial pull of 5 kN and the change in diameter is observed to be 0.002 mm. Calculate the modulus of elasticity and the Poisson's ratio of this material.

(10)

28. A steel shaft ABCD having a total length of 2400 mm is contributed by three different sections as follows. The portion AB is hollow having outside and inside diameters 80 mm and 50 mm respectively, BC is solid and 80 mm diameter. CD is also solid and 70 mm diameter. If the angle of twist is same for each section, determine the length of each portion and the total angle of twist. Maximum permissible shear stress is 50 MPa and shear modulus 0.82×10^5 MPa.

(16)

29. A rod 200 cm long and diameter of 3 cm is subjected to an axial pull of 30 KN. If the Young's modulus of the material of the rod is $2x10^5$ $N/mm^{2.}$ Determine (i) Stress, (ii) Strain, (iii) Elongation of the rod. Find the Young's modulus of rod of diameter 30 mm and length 300 mm which is subjected to a tensile load of 60 KN

(16
)

30. Find the Young's modulus of rod of diameter 30 mm and length 300 mm which is subjected to a tensile load of 60 KN and the extension of the rod is equal to 0.4 mm.

(16)

31. A rod circular in section tapers from 20 mm diameter at one end to 10 mm diameter at the other end and is 200 mm long .On applying an axial pulls of 6000 N, it was found to extend by 0.068 mm. Find the Young's modulus of the material of the rod.

(16)

32. A copper rod 5 mm in diameter when subjected to a pull of 750 N extends by 0.125 mm over a gauge length of 327 mm.Find the Young's modulus for copper.

(16

)

33. A straight bar of steel rectangular in section is 4 m long and is 18 mm thick. The width of the rod varies uniformly from 130 mm at one end to 50 mm at the other. If the rod is subjected to an axial tensile load is 50 KN, find the extension of the rod. Take E= $2x10^5$ N/mm^2.

(16)

34. A steel rod of 20 mm diameter is enclosed centrally in a hollow copper tube of external diameter 40 mm and internal diameter 354 mm. The composite bar is then subjected to an axial pull of 50 KN. Find the stress in the rod and tube .Take E_{s}=$1x10^5$ N/mm^2.

(16)

35. A steel rod of 20 mm diameter is enclosed centrally in a hollow copper tube of external diameter 30 mm and internal diameter 25 mm.The composite bar is then subjected to an axial pull of 40 KN. Find the stresses in the rod and tube. Take Es=200 KN/mm^2 and E_c=100 KN/mm^2 (16).

36. A steel rod of 25 mm diameter is enclosed centrally in a copper hollow tube of external diameter 40 mm and internal diameter 30 mm.The composite is then subjected to an axial pull of 4500 N .If the length of each bar is equal to 130 mm, determine: (i)The stress in the rod tube; (ii)Load carried by each bar. Take E=$2.1x10^5$ N/mm^2, Copper=$1.1x10^5$ N/mm^2. (16)

37. A reinforced concrete column 300x300 mm has 4 reinforcing steel bars of 25 mm diameter in each corner. Find the safe axial load on the concrete is subjected to a stress of 5 N/mm^2.What is the corresponding stress in steel. Take E_S/E_C=18.

(16)

38. A rod of 1.5 mm long 10 mm diameter is fixed at the ends and subjected to axial pull of 8 KN. Find the residual stress due to increase in temperature of 25^o C.

(16)

39. A steel rod of 4 mm long and 30 mm diameter is connected to two grips and the rod is maintained at a temperature of 70^oC.Find out the force exerted by the rod after its has been cooled to 25^oC, if (a)the ends do not yield, and (b) the ends yield by 1.5 mm. Take $E=2.1x10^5 N/mm^2$ $\alpha=12X10^{-6}/ ^Oc$. (16)

UNIT II

STRESSES IN BEAMS

Part-B (16 Marks)

40. A beam of length 10 m is simply supported at its ends carries two concentrated loads of 5 KN each at a distance of 3m and 7m from the left support and also a uniformly distributed load of 1 kN/m between the point loads. Draw shears force and bending moment diagrams. Calculate the maximum bending moment.

(16)

41. A Simply supported beam of length 6 M carries a udl of 20KN/m throughout its length and a point of 30 KN at 2 M from the right support. Draw the shear force and bending moment diagram. Also find the position and magnitude of maximum Bending moment.

(16)

42. A Simply supported beam of effective span 6 m carries three point loads of 30 KN, 25 KN and 40 KN at 1m, 3m and 4.5m respectively from the left support. Draw the SFD and BMD

(16)

43. (i) Derive the relation between shear force and bending moment. (6)

(ii) Draw the shear force and bending moment diagram for the beam shown in Fig. q. 11 and also indicate the points of contra flexure if any.

(10)

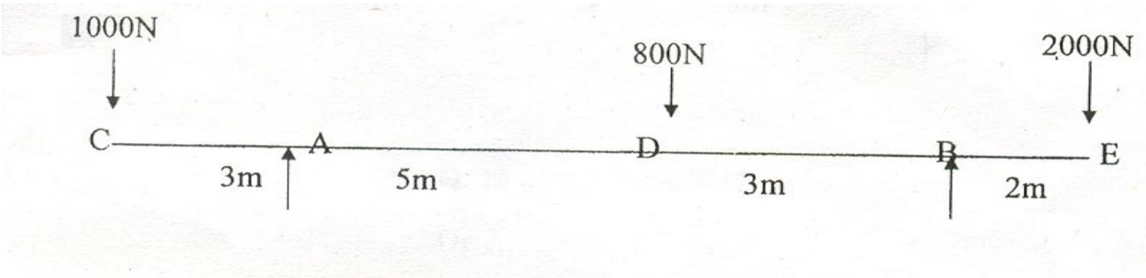
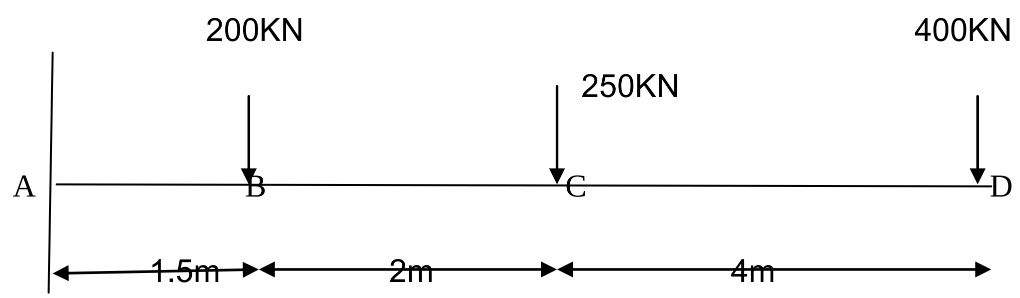


Fig. Q. 11

44. Draw the S.F and B.M diagram for the beam shown in Fig. Determine the points of contra flexure.

(16)

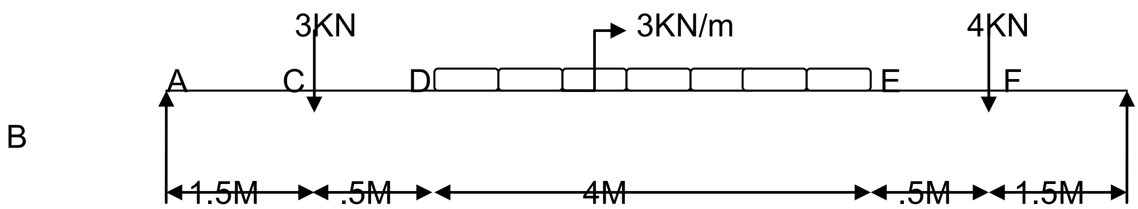


45. A Simply supported beam 6 metre span carries udl of 20 KN/m for left half of span and two point loads of 25 KN end 35 KN at 4 m and 5 m from left support. Find maximum SF and BM and their location drawing SF and BM diagrams.

(16)

46. A simply supported beam is loaded as shown in fig Draw the shear force and bending moment diagrams.

(16)



47. A girder 9m long is loaded with a UDL of 1.8 kN/m over a length of 4m from left end. Draw B.M and S.F diagrams for the girder and calculate the magnitude and position of the maximum B.M.

(16)

48. A cantilever of 2m length carries a point load of 20 KN at 0.8 m from the fixed end and another point of 5 KN at the free end. In addition, a u.d.l. of 15 KN/m is spread over the entire length of the cantilever. Draw the S.F.D, and B.M.D.

(16)

49. A beam of uniform section 10 m long carries a udl of KN/m for the entire length and a concentrated load of 10 KN at right end. The beam is freely supported at the left end. Find the position of the second support so that the maximum bending moment in the beam is as minimum as possible. Also compute the maximum bending moment.

(16)

50. A beam of length 10 m is simply supported at its ends carries two concentrated loads of 5 kN each at a distance of 3 m 7 m from the left support and also a uniformly distributed load of 1 kN/m between the point loads. Draw shear force and bending moment diagrams. Calculate the maximum bending moment.

(16)

51. A timber of rectangular section is to support a load of 20 kN uniformly distributed over a span of 3.6 m, when the beam is simply supported. If the depth of the section is to be twice the breadth and the stress in the timber is not to exceed 7 N/mm^2, find the breadth and depth of the cross section. How will you modify the cross section of the beam, if it carries a concentrated load of 30 kN placed at the mid span

with the same ratio of breadth to depth.

(16)

52. Three planks of each 50 x200 mm timber are built up to a symmetrical I section for a beam. The maximum shear force over the beam is 4KN. Propose an alternate rectangular section of the same material so that the maximum shear stress developed is same in both sections. Assume then width of the section to be 2/3 of the depth.

(16)

53. A timber of rectangular section is to support a load of 20 kN uniformly distributed over a span of 3.6 m, when the beam is simply supported. If the depth of the section is to be twice the breadth and the stress in the timber is not to exceed 7 N/mm^2, find the breadth and depth of the cross section. How will you modify the cross section of the beam, if it carries a concentrated load of 30 kN placed at the mid span with the same ratio of breadth to depth.

(16)

54. A T-shaped cross-section of a beam is to a vertical shear force of 100 kN. Calculate the shear stress at the neutral axis and at the junction of the web and the flange. Moment of inertia about the horizontal neutral axis is 11340 cm^4.

(16)

55. A beam of size 150 mm wide, 250 mm deep carries a uniformly distributed load of w kN/m over entire span of 4 m. A concentrated load 1 kN is acting at a distance of 1.2 m from the left support. If the bending stress at a section 1.8 m from the left support is not to exceed 3.25 N/mm2 find the load w. (16)

56. A horizontal girder of steel having uniform section is 14 m long and is simply supported at its ends. It carries a concentrated load of 120 kN and 80 kN at two points 3 m and 4.5 m from the two ends respectively. Take I for the section as 16×10^{-4} m^4 $E = 2.1 \times 10^{11}$ N/m^2 (16)

57. A timber beam of rectangular section is to support a load of 20 kN uniformly distributed over a span of 3.6 m, when the beam is simply supported. If the depth is twice the width of the section and the stress in timber is not to exceed 3.5 N/mm^2, find the dimensions of the cross section? (16)

58. A steel shaft ABCD having a total length of 2400 mm is contributed by three different sections as follows. The portion AB is hollow having outside and inside diameters 80 mm and 50 mm respectively, BC is solid and 80 mm diameter. CD is also solid and 70 mm diameter. If the angle of twist is same for each section, determine the length of each portion and the total angle of twist. Maximum permissible shear stress is 50 Mpa and shear modulus 0.82×10^5 MPa.

(16)

59. A timber beam 120 mm wide and 180 mm deep has a span of 5 mm. Calculate the maximum shear stress produced by a load of 5 KN.

(16)

60. A hollow beam of square section of outside width 130 mm and the thickness of material 30 mm.Calculate the maximum intensity of shear stress and sketch the distribution of shear stress across the section, if the SF at the cross section being 210 KN.

(16)

61. A beam of square section is used as beam with one diagonal horizontal. Find the magnitude and location of maximum shear stress in the beam. Sketch the shear stress distribution across the section. (16)

62. A 350 mmx125 mm I-girder has 30 mm thick flanges and 20 mm thick web subjected to shearing force of 145 KN. Calculate the maximum identity of shear stress and sketch the distribution of shear stress across the section. Calculate the percentage shear force carried by the web. (16)

63. A beam of T-section with flange 400 mm x 35 mm and web 320 mm x 35 mm is subjected to a shear force of 85 Kn. Find the maximum intensity of shear stress and sketch the distribution of stress across the section. (16)

64. A rolled stell joist 220 mm x175 mm wide has flange 20 mm thick and web 15 mm thick is loaded such that a certain section there is a bending moment of 70 KN.M together with a vertical shearing force. Calculate the value of the shearing force if the maximum stress in the beam is not to exceed 135 MPa. (16)

65. A beam of triangular section with base 330 mm and height 290 mm is used with the base horizontal. Calculate the intensity of maximum shear stress and plot the variation of shear stress along the section. (16)

66. A hollow steel cylinder 300 mm outer diameter and 200 mm internal diameter is acting as a beam and is subjected to a shear force ‘F’ perpendicular to the axis. Determine the average shear stress and the shear stress at the neutral axis, and at 35 mm, 50 mm, 65 mm, from the neutral axis. (16)

67. A beam of I section 50 cm deep and 19 cm wide has flange 2.5 cm thick and web 15 cm thick. It carries a shearing force of 40 tones at a section. Calculate the maximum intensity of shear stress in the section. Assuming the moment of inertia to be 64,500 cm^{4}. Sketch the shear stress distribution across the section.

(16)

UNITIII

DEFLECTION OF BEAMS

Part-B (16 Marks)

68. Obtain a relation for the slope and deflection at the free end of a cantilever beam AB of span 'l' and flexural rigidity EI when it is carrying a point load 'W' at free end.

(16)

69. Obtain a relation for the slope and deflection at the free end of a cantilever beam AB of span 'l' and flexural rigidity EI when it is carrying a uniformly distributed load 'w' over the entire length.

(16)

70. Find the maximum deflection of the beam shown in Fig. Q. 14(a). EI = 1×10^{11} kN/mm^2. Use Macaulay's method.

(16)

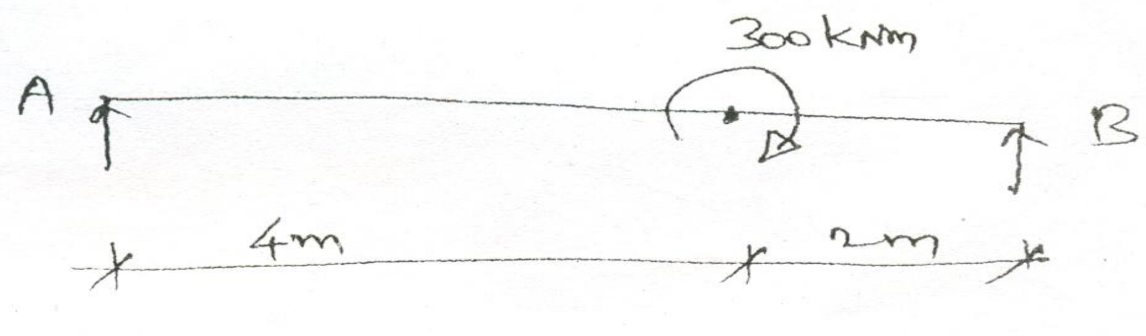


Fig. Q. 14(a)

71. For the cantilever beam shown in Fig. Q. 14(b). Find the deflection and slope at the free end. EI = 10000 kN/m^2. (16)

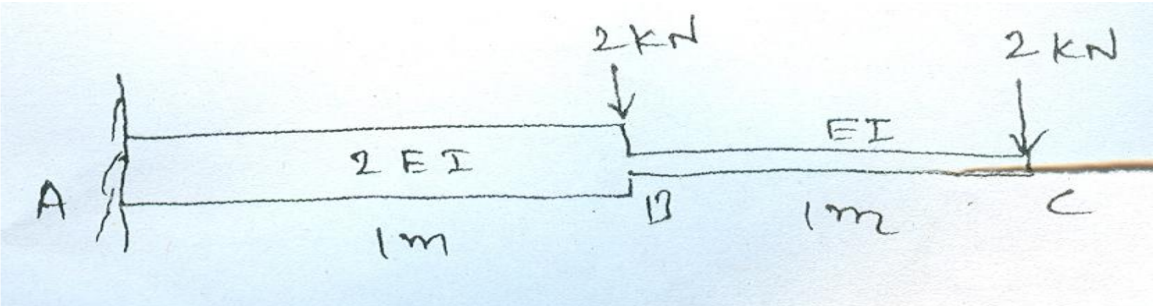


Fig. Q. 14(b)

72. Find the deflection at B and C for the cantilever loaded as shown in Fig. Q. 12 (a) using the principle of virtual work method. Take EI = 30000kNm^2 (16)

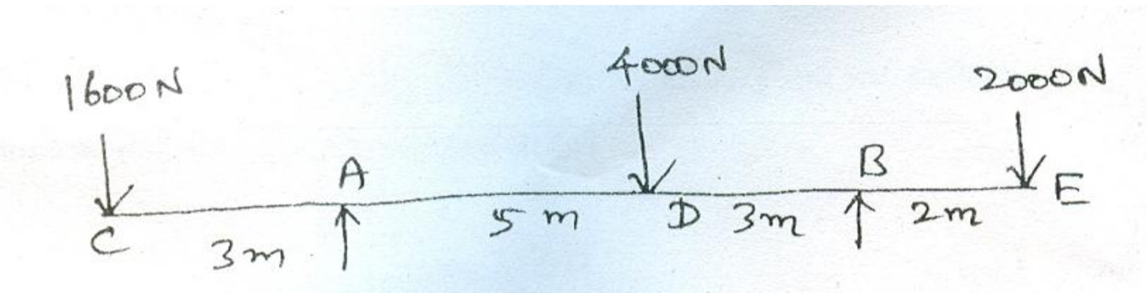


Fig. Q. 12(a)

73. An I section has top flange of 360mmX30mm thick, a bottom flange of 90mmX30mm thick, and a web of 30mm thickness and 360mm depth. The overall depth is 420mm. It has a vertical axis of symmetry. Calculate the maximum shear stress for a shear force of 100 kN.

(16)

74. Beam is simply supported at its ends over a span of 10 m and carries two concentrated loads of 100 kN and 60 kN at a distance of 2 m and 5 m respectively from the left support. Calculate (i) slope at the left support (ii) slope and deflection under the 100 kN load. Assume EI = 36×10^4 kN-m^2.

(16)

75. Derive relations for slope at the supports and maximum deflection for a simply beam AB with a bending couple M of clockwise nature at A. Use moment area method.

(16)

76. A simply supported beam of span L is subjected to equal loads W/2 at each 1/3rd span points. Find the expressions for deflection under the load and at mid span. Use McCaulay's Method.

(16)

77. A simply supported beam of 10 m span carries a uniformly distributed load of 1 kN/m over the entire span. Using Castigliano's theorem, find the slope at the ends. EI = 30,000 kN/m^2.

(16)

78. A 2m long cantilever made of steel tube of section 150 mm external diameter and10mm thick is loaded. If E=200 GN/m^2 calculate (1) The value of W so that the maximum bending stress is 150 MN/m (2) The maximum deflection for the loading

(16)

79. A beam of length of 10 m is simply supported at its ends and carries two point loads of 100 KN and 60 KN at a distance of 2 m and 5 m respectively from the left support.Calculate the deflections under each load. Find also the maximum deflection. Take I = 18 X 10^8 mm^4 and E = 2 X 10^5. (16)

80. A beam of length of 6 m is simply supported at its ends. It carries a uniformly distributed load of 10 KN/m as shown in figure. Determine the deflection of the beam at its mid-point and also the position and the maximum deflection. Take EI=4.5 X 10^8 N/mm^2.

(16)

81. An overhanging beam ABC is loaded as shown is figure. Determine the deflection of the beam at point C. Take I = 5 X 10^8 mm^4 and E = 2 X 10^5 N/mm^2.

(16)

82. A cantilever of length 2 m carries a uniformly distributed load of 2.5 KN/m run for a length of 1.25 m from the fixed end and a point load of 1 KN at the free end. Find the deflection at the free end if the section is rectangular 12 cm wide and 24 cm deep and E=1 X 10^4 N/mm^2

(16)

83. A cantilever of length 2m carries a uniformly distributed load 2 KN/m over a length of 1m from the free end, and a point load of 1 KN at the free end. Find the slope and deflection at the free end if E = 2.1 X 10^5 N/mm^2 and I = 6.667 X 10^7 mm^4 .

(16)

84. A cast iron beam is of T section The beam is simply supported on a span of 8 m. The beam carries an uniformly distributed load of 1.5 kN/m length on the entire span. Determine the maximum tensile and maximum compressive stresses.

(16)

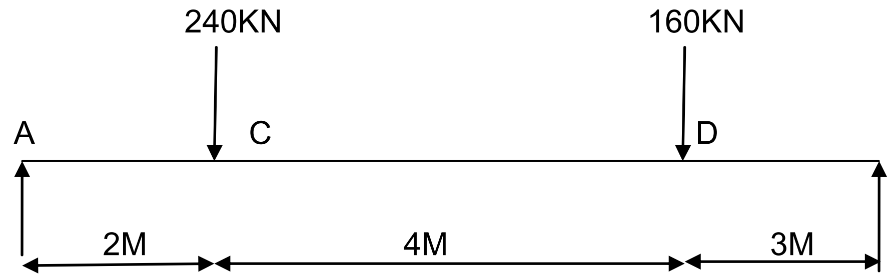
85. (i)State any four assumptions made in the theory of simple bending.(8)

(ii) Derive the bending formula M/I = f/y = E/R (8)

86. For the beam shown in Fig find deflection at C and maximum deflection. EI = 360000 kNm^2.

(16)

E



87. A cantilever beam of 5 m span carries a point load of 10 kN at midspan. Find the deflection at the free end. EI = 360000 kNm^2

(16)

UNIT IV

TORSION

Part-B (16 Marks)

88. A helical spring of circular cross-section wire 18 mm in diameter is loaded by a force of 500 N. The mean coil diameter of the spring is 125 mm. The modulus of rigidity is 80 kN/mm^2. Determine the maximum shear stress in the material of the spring. What number of coils must the spring have for its deflection to be 6mm?

(16)

89. Calculate the power that can be transmitted at a 300 rpm by a hollow steel shaft of 75 mm external diameter and 50 mm internal diameter when the permissible shear stress for the steel is $70N/mm^2$ and the maximum torque is 1.3 times the mean. Compare the strength of this hollow shaft with that of an solid shaft. The same material, weight and the length of both the shafts are the same.

(16)

90. Determine the diameter of a solid shaft which will transmit 300 KN at 250 rpm. The maximum shear stress should not exceed 30 N/mm_2 and twist should not be more than 10 in a shaft length 2m. Take modulus of rigidity = 1×10^5 N/mm^2.

(16)

91. The stiffness of the closed coil helical spring at mean diameter 20 cm is made of 3 cm diameter rod and has 16 turns. A weight of 3 KN is dropped on this spring. Find the height by which the weight should be dropped before striking the spring so that the spring may be compressed by 18 cm. Take C= 8×10^4 N/mm^2.

(16)

92. Derive the torsion relation making necessary assumptions.

(16)

93. Derive an expression for the stress on an oblique section of a rectangular body when it is subjected to direct stresses in two mutually perpendicular directions.

(16)

94. A hollow shaft, having an internal diameter 50% of its external diameter, transmits 600 kW at 150 rpm. Determine the external diameter of the shaft if the shear stress is not to exceed 65 N/mm^2 and the twist in a length of 3 m should not exceed 1.4 degrees. Assume

maximum torque = 1.2 times the mean torque and modulus of rigidity = 1×10^5 N/mm^2. (16)

95. It is required to design a closed coiled helical spring which shall deflect 1mm under an axial load of 100 N at a shear stress of 90 Mpa. The spring is to be made of round wire having shear modulus of 0.8 x 105 Mpa. The mean diameter of the coil is 10 times that of the coil wire. Find the diameter and length of the wire.

(16)

96. The stiffness of close coiled helical spring is 1.5 N/mm of compression under a maximum load of 60 N. The maximum shear stress in the wire of the spring is 125 N/mm^2. The solid length of the spring (when the coils are touching) is 50 mm. Find the diameter of coil, diameter of wire and number of coils. C = 4.5

(16)

97. A hollow shaft with diameter ratio 3/8 is required to transmit 500 kW at 100 rpm, the maximum torque being 20% greater than the mean. The maximum shear stress is not to exceed 60 N/mm2 and the twist in a length of 3 m is not to exceed 1.4ºCalculate the minimum diameters required for the shaft. C = 84 kN/mm^2

(16)

98. A solid shaft is subjected to a torque of 100 Nm. Find the necessary shaft diameter if the allowable shear stress id 100 N/mm^2 and the allowable twist is 3º per 10 diameter length of the shaft. Take C = 1×10^5 N/mm^2. (16)

99. Hollow steel shaft of outside diameter 75 mm is transmitting a power of 300 kW at 2000 rpm. Find the thickness of the shaft if the maximum shear stress is not to exceed 40 N/mm^2.

(16)

100. A close coiled helical spring is to have a stiffness of 1.5 N/mm of compression under a maximum load of 60 N. The maximum

shearing stress produced in the wire of the spring 125 N/mm^2. The solid length of the spring is 50 mm. Find the diameter of coil, diameter of wire and number of coils C = 4.5 × 10^4 N/mm^2.

(16)

101. (i) Derive a relation for deflection of a closely coiled helical spring subjected to an axial downward load W.

(8)

(ii)A quarter elliptic leaf spring 60 cm long is made of steel plates width 10 times the thickness. The spring is to carry a load of 3kN and the end deflection is limited to 5 cm. the bending stress of the plates must not exceed 3000 N/mm^2. Find suitable values of the size and number of plates to be used. Take e = 2 × 10^5 N/mm^2.

(8)

102. A shaft running at 140 rpm is required to transmit 37.5 kw.If the maximum torque Is likely to exceed the mean torque by 25%.Find the diameter of the shaft,if the Maximum shear stress is 60n/mm$^{2.}$Find also the angle of twist for a length of 2.25m. Take c=8x10^{4}N/mm^2.

(16)

103. Find the diameter of a solid shaft to transmit 115KW of power at 225rpm, if the shear stress is not to exceed 1^0 in a length of 3.25 m. Take C=8x10^{4}N/mm^2.

(16)

104. Find the power that can be transmitted by a 60 mm diameter shaft at 160 rpm if the permissible shear stress is 80N/mm^2 and the maximum torque is 30% greater than the mean torque.

(16)

105. Find the size of a square shaft to transmit 75KW at 120 rpm if shear stress is not to exceed 50 N/mm$^{2.}$

(16)

106. A shaft is 2m long 60 mm diameter at one end,and tapers at a uniform rate to 80mm diameter at the other end. The larger end is firmly fixed and a torque at 3500 Nm is applied to the smaller end. Find the

maximum shear stress and the total angle of twist.Take $C=8X10^4N/mm^2$. (16)

107. A hollow shaft of diameter ratio 3:5 is required to transmit 600kw at 110rpm the maximum torque being 12% greater that the mean.The shearing stress is not to exceed $60N/mm^2$ and the twist in a length of 3m is not to exceed one degree. Find the minimum external diameter of the shaft satisfying these conditions. Take $C=8.4x10^4N/mm^2$. (16)

UNIT V - BI AXIAL STRESSES

Part-B (16 Marks)

108. A thin cylindrical shell 1.5 m long, internal diameter 300 mm and wall thickness 10 mm is filled up with at atmospheric pressure. If the additional fluid of 300×10^3 mm^3 is pumped in the shell, find the pressure exerted by the fluid on the shell. Take $E = 2 \times 10^5$ M/mm^2 and 1/m = 0.3. Also find the hoop stress induced.

(16)

109. Find the Euler critical load for a hollow cylindrical cast iron column 150mm external diameter, 20 mm wall thickness if it is 6 m long with hinged at both ends. Assume Young's modulus of cast iron as 80 kN/mm^2. Compare this load with that given by Rankine formula. Using Rankine constants α = 1/1600 and 567 N/mm^2.

(16)

110. A cylindrical shell 3 m long which is closed at the ends has an internal diameter of 1 m and a wall thickness of 15 mm. Calculate the circumferential and longitudinal stresses induced and also change in the dimensions of the shell, if it is subjected to an internal pressure of 1.5 N/mm^2. Take $E = 2 \times 10^5$ N/mm^2, μ = 0.3.

(16)

111. Show that in the case of a thin cylindrical shell subjected to an internal fluid pressure the tendency to burst length wise is twice as great as a transverse section.

(16)

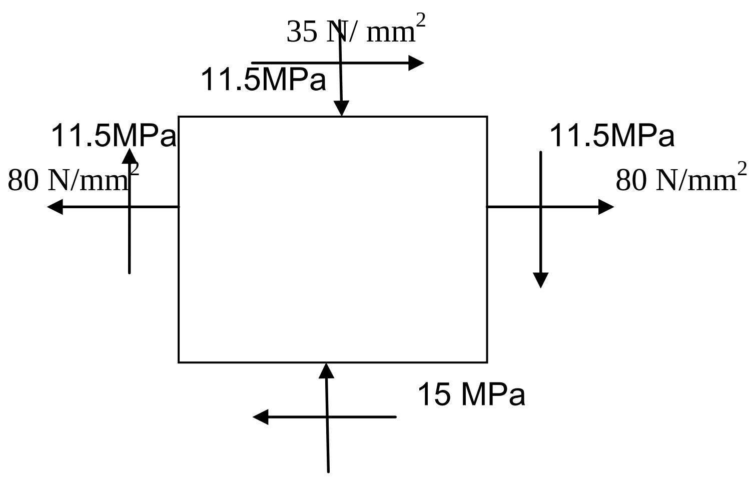
112. A Thin cylindrical shell 3 m long has 1m internal diameter and 15 mm metal thickness .Calculate the circumferential and longitudinal stresses induced and also the change in the Dimensions of the shell, if it is subjected to an internal pressure of1.5 N/mm^2 Take E = 2x10^5 N/mm^2 and poison's ratio =0.3. Also calculate change in volume.

(16)

113. A steel cylindrical shell 3 m long which is closed at its ends, had an internal diameter of 1.5 m and a wall thickness of 20 mm. Calculate the circumferential and longitudinal stress induced and also the change in dimensions of the shell if it is subjected to an internal pressure of 1.0 N/mm^2. Assume the modulus of elasticity and poison's ratio for steel as 200 kN/mm^2 and 0.3 respectively.

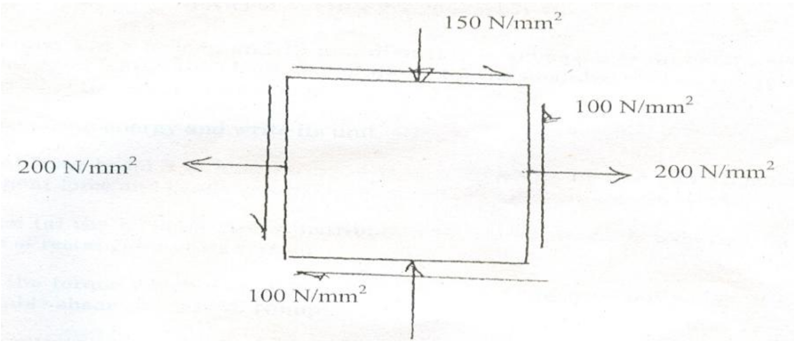
(16)

114. Stresses at a point are σ_x = 80 N/mm2,σ_y = -35 N/mm2, q = 11.5 N/mm2. Determine principal planes, principal stresses and maximum shear stress using graphical method.



35N/mm2

115. The state of stress at a certain point in a strained material is shown in Fig. 1. Calculate (i) principal stresses (ii) inclination of the principal planes (iii) normal, shear and resultant stresses on the plane MN. (16)



116. A closed cylindrical vessel made of steel plates 4 mm thick with plane ends, carries fluid under pressure of 3 N/mm^2 The diameter of the cylinder is 25cm and length is 75 cm. Calculate the longitudinal and hoop stresses in the cylinder wall and determine the change in diameter, length and Volume of the cylinder. Take E =$2.1x10^5$ N/mm^2 and 1/m = 0.286. (16)

117. A rectangular block of material is subjected to a tensile stress of 110 N/mm^2 on one plane and a tensile stress of 47 N/mm^2 on the plane at right angle to the former plane and a tensile stress of 47 N/mm^2 on the plane at right angle to the former. Each of the above stress is accompanied by a shear stress of 63 N/mm^2 Find (i) The direction and magnitude of each of the principal stress (ii) Magnitude of greatest shear stress (16)

118. At a point in a strained material, the principal stresses are100 N/mm2 (T) and 40 N/mm^2 (C). Determine the resultant stress in magnitude and direction in a plane inclined at 600 to the axis of major principal stress. What is the maximum intensity of shear stress in the material at the point? (16)

119. A rectangular block of material is subjected to a tensile stress of 210 N/mm_2 on one plane and a tensile stress of 28 N/mm_2 on the plane at right angle to the former plane and a tensile stress of 28 N/mm_2 on the plane at right angle to the former. Each of the above stress is accompanied by a shear stress of 53 N/mm_2 Find (i) The direction and magnitude of each of the principal stress (ii) Magnitude of greatest shear stress. (16)

120. A closed cylindrical vessel made of steel plates 5 mm thick with plane ends, carries fluid under pressure of 6 N/mm_2 The diameter of the cylinder is 35cm and length is 85 cm. Calculate the longitudinal and hoop stresses in the cylinder wall and determine the change in diameter, length and Volume of the cylinder. Take E =$2.1x10_5$ N/mm_2 and 1/m = 0.286. (16)

121. At a point in a strained material, the principal stresses are 200 N/mm_2 (T) and 60 N/mm2(C) Determine the direction and magnitude in a plane inclined at 60_0 to the axis of major principal stress. What is the maximum intensity of shear stress in the material at the point. (16)

122. At a point in a strained material, the principal stresses are 100 N/mm2 (T) and 40 N/mm^2 (C) Determine the direction and magnitude in a plane inclined at 60^0 to the axis of major principal stress. What is the maximum intensity of shear stress in the material at the point (16)

123. (i) State Moment-Area Mohr's theorem. (4)

(ii) A simply supported beam AB uniform section, 4 m span is subjected to a clockwise moment of 10 kN.m. Applied at the right hinge B. Derive the equation to the deflected shape of the beam. Locate the point of maximum deflection and find the maximum deflection. (12)

124. A cantilever of length 2α is carrying a load of W at the free end, and another load of W at its centre. Determine by moment area

method, the slope and deflection of the cantilever at the free end. `

(16)

125. The normal stresses in two mutually perpendicular directions are 110 N/mm2 and 47 N/mm^2 both tensile. The complementary shear stresses in these directions are of intensity 63 N/mm^2. Find the principal stresses and its planes.

(16)

A cylinder shell 3 m long which is closed at the ends has an internal diameter 1 m and wall thickness of 15 mm. Calculate the change in dimensions and change in volume if the internal pressure is 1.5 N/mm^2 E = 2 × 10^5 N/mm2. υ = 0.3.