VALLIAMMAI ENGINEERING COLLEGE
DEPARTMENT OF MECHANICAL ENGINEERING
QUESTION BANK
CE 6306 - STRENGTH OF MATERIALS

UNIT I

STRESS STRAIN DEFORMATION OF SOLIDS

PART- A (2 Marks)

1. What is Hooke's Law?
2. What are the Elastic Constants?
3. Define Poisson's Ratio.
4. Define: Resilience
5. Define proof resilience
6. Define modulus of resilience.
7. Define principal planes and principal stresses.
8. Define stress and strain.
9. Define Shear stress and Shear strain.
10. Define elastic limit.
11. Define volumetric strain.
12. Define tensile stress and compressive stress.
13. Define young's Modulus.
14. What is the use of Mohr's circle?
15. Define thermal stress.
16. Define Bulk modulus.
17. What is modulus of rigidity?
18. Define factor of safety.
19. State the relationship between young's modulus and modulus of rigidity..
20. What is compound bar?

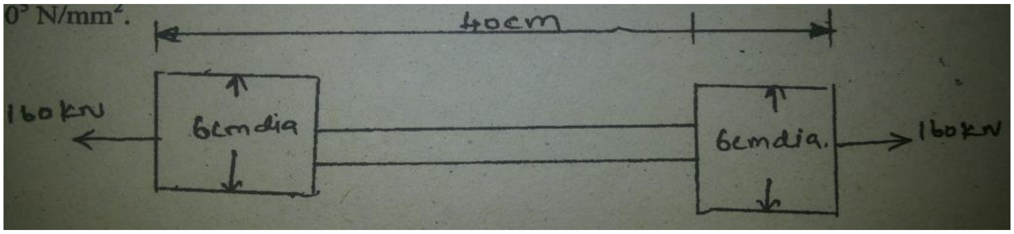
PART- B (16 Marks)

1. A Mild steel rod of 20 mm diameter and 300 mm long is enclosed centrally inside a hollow copper tube of external diameter 30 mm and internal diameter 25 mm. The ends of the rod and tube are brazed together, and the composite bar is subjected to an axial pull of 40 kN. If E for steel and copper is 200 GN/m2 and 100 GN/m2 respectively, find the stresses developed in the rod and the tube also find the extension of the rod.

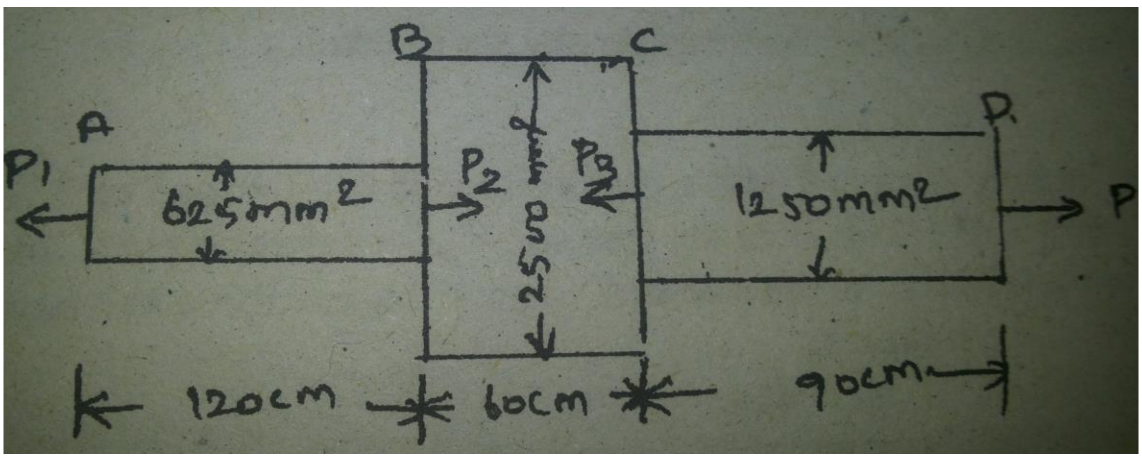
2. A cast iron flat 300 mm long and 30 mm (thickness) × 60 mm (width) uniform cross section, is acted upon by the following forces : 30 kN tensile in the direction of the length 360 kN compression in the direction of the width 240 kN tensile in the direction of the thickness. Calculate the direct strain, net strain in each direction and change in volume of the flat. Assume the modulus of elasticity and Poisson's ratio for cast iron as 140 kN/mm^2 and 0.25 respectively.

3. A bar of 30 mm diameter is subjected to a pull of 60 kN. The measured extension on gauge length of 200 mm is 0.09 mm and the change in diameter is 0.0039 mm. calculate the Poisson's ratio and the values of the three moduli.

4. The bar shown in fig. is subjected to a tensile load of 160 KN. If the stress in the middle portion is limited to 150 N/mm^2, determine the diameter of the middle portion. Find also the length of the middle portion if the total elongation of the bar is to be 0.2mm. young's modulus is given as equal to 2.1 x 10^5 N/mm^2.



5. 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 and P4 = 139 KN. Determine the total elongation of the member, assuming the modulus of elasticity to be 2.1 x 10^5 N/mm^2.



6. A steel rod of 20mm diameter passes centrally through a copper tube of 50mm external diameter and 40mm internal diameter. The tube is closed at each end by rigid plates of negligible thickness. The nuts are tightened lightly home on the projecting parts of the rod. If the temperature of the assembly is raised by 50˚C, calculate the stress developed in copper and steel. Take E for steel and copper as 200 GN/m^2 and 100 GN/m^2 and α for steel and copper as 12 x 10^{-6} per ˚C and 18 x 10^{-6} per ˚C.

7. Two vertical rods one of steel and the other of copper are each rigidly fixed at the top and 50cm apart. Diameters and lengths of each rod are 2cm and 4m respectively. A cross bar fixed to the rods at the lower ends carries a load of 5000 N such that the cross bar remains horizontal even after loading. Find the stress in each rod and the position of the load on the bar. Take E for steel = 2 x 10^5 N/mm^2 and E for copper = 1x 10^5 N/mm^2.

8. Drive the relationship between modulus of elasticity and modulus of rigidity. Calculate the modulus of rigidity and bulk modulus of a cylindrical bar of diameter 30 mm and of length 1.5 m if the longitudinal strain in a bar during a tensile stress is four times the lateral strain. Find the change in volume, when the bar is subjected to a hydrostatic pressure of 10 N/mm2. Take E = 1X 10^5 N/mm^2 A) what are the different types of machining operations that can be performed on a lathe? And explain any six in detail.

9. (A). 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.

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

10. 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 2x 10^5 N/mm^2.Determine the axial load on the bar.

UNIT II

BEAMS – LOADS AND STRESSES

PART- A (2 Marks)

1. State the different types of supports.
2. What is cantilever beam?
3. Write the equation for the simple bending theory.
4. What do you mean by the point of contraflexure?
5. What is mean by positive or sagging BM?
6. Define shear force and bending moment.
7. What is Shear stress diagram?
8. What is Bending moment diagram?
9. What are the different types of loading?
10. Write the assumption in the theory of simple bending.
11. What are the types of beams?
12. When will bending moment is maximum.
13. Write down relations for maximum shear force and bending moment in case of a cantilever beam subjected to uniformly distributed load running over entire span.
14. Draw the shear force diagram for a cantilever beam of span 4 m and carrying a point load of 50 KN at mid span.
15. Sketch (a) the bending stress distribution (b) shear stress distribution for a beam of rectangular cross section.
16. A cantilever beam 3 m long carries a load of 20 KN at its free end. Calculate the shear force and bending moment at a section 2 m from the free end.
17. Derive the relation between the intensity of load and shear force, in bending theory.
18. A clockwise moment M is applied at the free end of a cantilever. Draw the SF and BM diagrams for the cantilever.
19. What is maximum bending moment in a simply supported beam of span 'L' subjected to UDL of 'w' over entire span?
20. What is mean by negative or hogging BM?

PART- B (16 Marks)

1. Three blanks 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.

2. A beam of uniform section 10 m long carries a udl of 2KN/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

3. 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/mm^2 find the load w.

4. 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.

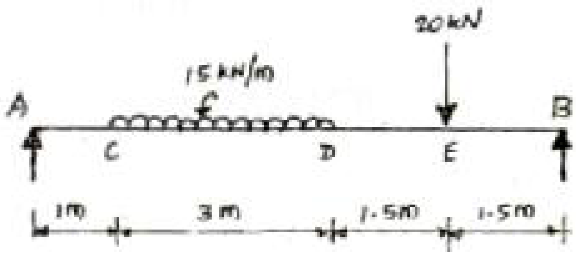
5. A Simply supported beam of effective span 6 m carries three point loads of 30 KN, 25 KN and 40 KN at 1m, 3m and 4.5m respectively from the left support. Draw the SFD and BMD. Indicating values at salient points.

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

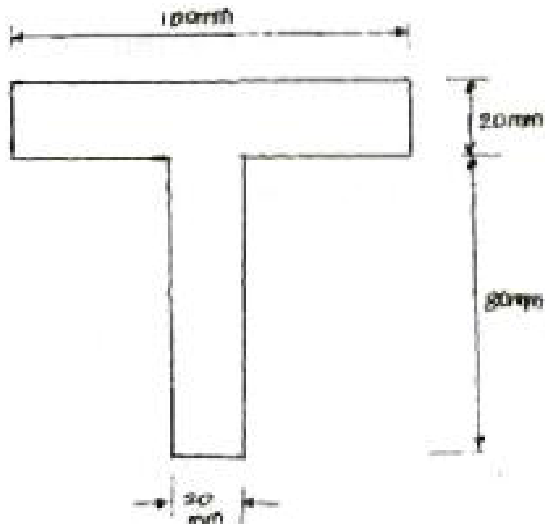
7. A Simply supported beam 6 metre span carries udl of 20 KN/m for left half of span and two point loads of 25 KN end 35 KN at 4 m and 5 m from left support. Find maximum SF and BM and their location drawing SF and BM diagrams.

8. A cantilever 1.5m long is loaded with a uniformly distribution load of 2 kN/m run over a length of 1.25m from the free end it also carries a point load of 3kn at a distance of 0.25m from the free end. Draw the shear force and bending moment diagram of the cantilever.

9. For the simply supported beam loaded as shown in Fig. , draw the shear force diagram and bending moment diagram. Also, obtain the maximum bending moment.



10. A cast iron beam is of T-section as shown in Fig. The beam is simply supported on a span of 6 m. The beam carries a uniformly distributed load of 2kN/m on the entire length (span). Determine the maximum tensile and maximum compressive stress.



UNIT III
TORSION
PART-A (2 Marks)

1. Define torsional rigidity of the solid circular shaft.

2. Distinguish between closed coil helical spring and open coil helical spring.

3. What is meant by composite shaft?

4. What is called Twisting moment?

5. What is Polar Modulus ?

6. Define: Torsional rigidity of a shaft.

7. What do mean by strength of a shaft?

8. Write down the equation for Wahl factor.

9. Define: Torsional stiffness.

10. What are springs? Name the two important types.

11. How will you find maximum shear stress induced in the wire of a close-coiled helical spring carrying an axial load?

12. Write the expressions for stiffness of a close coiled helical spring.

13. Find the minimum diameter of shaft required to transmit a torque of 29820 Nm if the maximum shear stress is not to exceed 45 N/mm^2.

14. Find the torque which a shaft of 50 mm diameter can transmit safely, if the allowable shear stress is 75 N/mm^2.

15. Differentiate open coiled helical spring from the close coiled helical spring and state the type of stress induced in each spring due to an axial load.

16. What is spring index (C)?

17. State any two functions of springs.

18. Write the polar modulus for solid shaft and circular shaft.

19. What are the assumptions made in Torsion equation

20. Write an expression for the angle of twist for a hollow circular shaft with external diameter *D*, internal diameter *d*, length *l* and rigidity modulus *G*.

PART- B (16 Marks)

1. Determine the diameter of a solid shaft which will transmit 300 KN at 250 rpm. The maximum shear stress should not exceed 30 N/mm2 and twist should not be more than 10 in a shaft length 2m. Take modulus of rigidity = 1 x 10^5 N/mm^2.

2. 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= 8x10^4 N/mm^2.

3. 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 10^5 Mpa. The mean diameter of the coil is 10 times that of the coil wire. Find the diameter and length of the wire.

4. 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 x 10^5 MPa

5. 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.

6. Calculate the power that can be transmitted at a 300 r.p.m. by a hollow steel shaft of 75 mm external diameter and 50 mm internal diameter when the permissible shear stress for the steel is 70 N/mm2 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 length of both the shafts are the same.

7. A solid cylindrical shaft is to transmit 300 kN power at 100 rpm. If the shear stress is not to exceed 60 N/mm^2, find its diameter. What percent saving in weight would be obtained if this shaft is replaced by a hollow one whose internal diameter equals to 0.6 of the external diameter, the length, the material and maximum shear stress being the same.

8. 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 125mm. The modulus of rigidity is 80 kN/mm2. Determine the maximum shear stress in the material of the spring. What number of coils must the spring have for its deflection to be 6 mm?

9. 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 is 125

N/mm^2 .The solid length of the spring is 50mm. Find the diameter of coil, diameter of wire and number of coils .C = 4.5 xl04N/mm^2.

10. A closely coiled 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 250 N. Determine

  I. the deflection of the spring
  II. maximum shear stress in the wire and
  III. stiffness of the spring and
  IV. frequency of vibration. Take C = 0.8 x 10^5 N/mm^2 .

UNIT IV

DEFLECTION OF BEAMS

PART-A (2 Marks)

1. State the condition for the use of Macaulay's method.
2. What is the maximum deflection in a simply supported beam subjected to uniformly distributed load over the entire span?
3. What is crippling load? Give the effective length of columns when both ends hinged and when both ends fixed.
4. Find the critical load of an Euler's column having 4 m length, 50 mm x 100 mm cross section and hinged at both the ends E = 200 kn/mm2.
5. 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/m2.
6. A cantilever beam of spring 2 m is carrying a point load of 20 kn at its free end. Calculate the slope at the free end. Assume EI = 12 x 10^3 KNm^2.
7. Calculate the effective length of a long column, whose actual length is 4 m when : a. Both ends are fixed b. One end fixed while the other end is free.
8. A cantilever is subjected to a point load W at the free end. What is the slope and deflection at the free end?
9. What are the methods for finding out the slope and deflection at a section?
10. Why moment area method is more useful, when compared with double integration?
11. Explain the Theorem for conjugate beam method?
12. What are the points to be worth for conjugate beam method**?**
13. What are the different modes of failures of a column?
14. Write down the Rankine formula for columns.
15. What is effective or equivalent length of column?
16. Define Slenderness Ratio.
17. Define the terms column and strut.
18. What are the advantages of Macaulay method over the double integration method, for finding the slope and deflections of beams?
19. State the limitations of Euler's formula
20. A cantilever beam of spring 4 m is carrying a point load of $2x10^3$Nat its free end. Calculate the slope at the free end. Assume EI = $2X10^5 N/mm^2$

PART-B (16 Marks)

1. A beam AB of length 8 m is simply supported at its ends and carries two point loads of 50 kN and 40 kN at a distance of 2 m and 5 m respectively from left support A. Determine, deflection under each load, maximum deflection and the position at which maximum deflection occurs. Take E = 2 x 10^5 N/mm^2 and I = 8.5 $X10^6$ mm^4 .

2. A 1.2 m long column has a circular cross section of 45 mm diameter one of the ends of the column is fixed in direction and position and other ends is free. Taking factor of safety as 3, calculate the safe load using

(i) Rankine's formula, take yield stress = 560 N/mm^2 and a = 1/1600 for pinned ends.
(ii) Euler's formula, Young's modulus for cast iron = 1.2 x 105 N/mm^2.

3. For the cantilever beam shown in Fig.3. Find the deflection and slope at the free end. EI = 10000 kN/m^2.

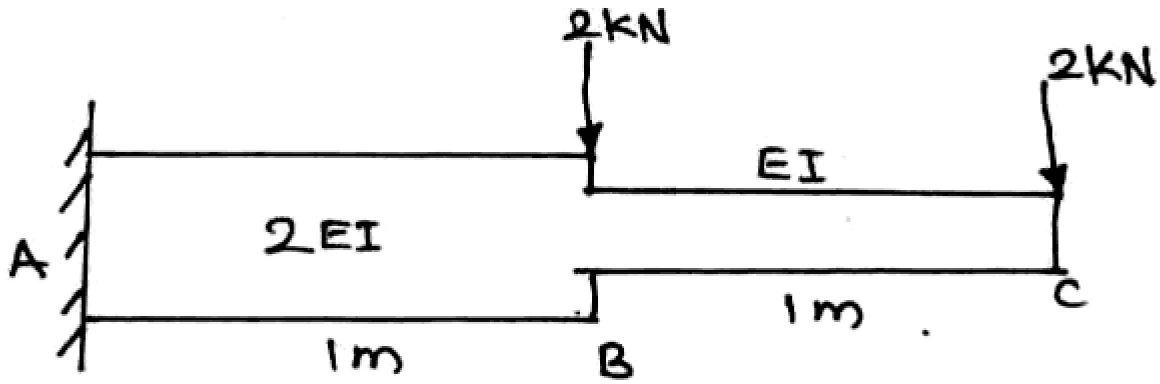


Fig.3

4.A 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 x 104 $kN\text{-}m^2$.

5. Find the Euler critical load for a hollow cylindrical cast iron column 150 mm 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/mm2. Compare this load with that given by Rankine formula. Using Rankine constants a =1/1600 and 567 N/mm^2.

6.A 3 m long cantilever of uniform rectangular cross–section 150 mm wide and 300 mm deep is loaded with a point load of 3 kN at the free end and a udl of 2 kN/m over the entire length. Find the maximum deflection. E = 210 kN/mm2. Use Macaulay's method.

7. A simply supported beam of span 6 m is subjected to a udl of 2 kN/m over the entire span and a point load of 3 kN at 4 m from the left support. Find the deflection under the point load in terms of EI. Use strain energy method.

8.A simply supported beam of uniform flexural rigidity EI and span l, carries two symmetrically placed loads P at one–third of the span from each end. Find the slope at the supports and the deflection at mid–span. Use moment area theorems.

9. Derive double integration method for cantilever beam concentrated load at free end.

10. Determine the section of a hollow C.I. cylindrical column 5 m long with ends firmly built in. The column has to carry an axial compressive load of 588.6 KN. The internal diameter of the column is 0.75 times the external diameter. Use Rankine's constants. a = 1 / 1600, σ_c = 57.58 KN/cm^2 and F.O.S = 6.

UNIT V
THIN CYLINDERS, SPHERES AND THICK CYLINDERS
PART-A (2 Marks)

1. A cylindrical pipe of diameter 1.5 m and thickness 1.5 cm is subjected to an internal fluid pressure of 1.2 N/mm^2. Determine the longitudinal stress developed in the pipe.
2. Find the thickness of the pipe due to an internal pressure of 10 N/mm^2 if the permissible stress is 120 N/mm^2. The diameter of pipe is 750 mm.
3. The principal stress at a point are 100 N/mm^2 (tensile) and 50 N/mm^2 (compressive) respectively. Calculate the maximum shear stress at this point.
4. A spherical shell of 1 m diameter is subjected to an internal pressure 0.5N/mm^2. Find the thickness if the thickness of the shell, if the allowable stress in the material of the shell is 75 N/mm^2.
5. Normal stresses *s x* and *s y* and shear stress *t* act at a point. Find the principal stresses and the principal planes.
6. Derive an expression for the longitudinal stress in a thin cylinder subjected to an uniform internal fluid pressure.
7. Distinguish between thick and thin cylinders.
8. What is mean by compressive and tensile force?
9. How will you determine the forces in a member by method of joints?
10. Define thin cylinder?
11. What are types of stress in a thin cylindrical vessel subjected to internal pressure?
12. What is mean by Circumferential stress (or hoop stress) and Longitudinal stress?
13. What are the formula for finding circumferential stress and longitudinal stress?
14. What are maximum shear stresses at any point in a cylinder
15. What are the formula for finding circumferential strain and longitudinal strain?
16. What are the formula for finding change in diameter, change in length and change volume of a cylindrical shell subjected to internal fluid pressure p?
17. Distinguish between Circumferential stress (or hoop stress) and Longitudinal stress?
18. Find the thickness of the pipe due to an internal pressure of 10 N/mm^2 if the permissible stress is 120 N/mm^2. The diameter of pipe is 750 mm.
19. what do you mean by a thick compound cylinder? how will you determine the hoop stresses in a thick compound cylinder?
20. what are the different methods of reducing hoop stresses?

PART –B (16 MARKS)

1.A thin cylinder 1.5 m internal diameter and 5 m long is subjected to an internal pressure of 2 N/mm^2. If the maximum stress is limited to 160 N/mm^2, find the thickness of the cylinder. E = 200 kN/mm^2 and Poisson’s ratio = 0.3. Also find the changes in diameter, length and volume of the cylinder.

2. At a point in a strained material the horizontal tensile stress is 80 N/mm^2 and the vertical compressive stress is 140 N/mm^2. The shear stress is 40N/mm^2. Find the principal stresses and the principal planes. Find also the maximum shear stress and its planes.

3. 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.

4. A closed cylindrical vessel made of steel plates 4 mm thick with plane ends, carries fluid under pressure of 3 N/mm2 The diameter of the cylinder is 25cm and length is75 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.

5. A cylindrical shell 3 m long, 1 m internal diameter and 10 mm thick is subjected to an internal pressure of 1.5 N/mm2. Calculate the changes in length, diameter and volume of the cylinder. E = 200 kN/mm^2, Poisson's ratio = 0.3.

6. 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 1.0N/mm^2. Assume the modulus of elasticity and Poisson's ratio for steel as 200kN/mm^2 and 0.3 respectively.

7. A cylindrical shell 3 m long which is closed at the ends has an internal diameter 1m 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 x 10^5 N/min2, μ= 0.3.

8. A cylindrical shell 3 m long which is closed at the ends, has an internal diameter of 1m and a wall thickness of 20 mm. Calculate the circumferential and longitudinal stresses induced and also changes in the dimensions of the shell, if it is subjected to an internal pressure of 2.0 N/mm^2 . Take E = 2 X 10^5 N/mm^2 and — 1= 0.3.m

9. 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

10. Determine the maximum hoop stress across the section of a pipe of external diameter 600mm and internal diameter 440mm. when the pipe is subjected to an internal fluid pressure of 50N/mm^2.

---------ALL THE BEST--------