VALLIAMMAI ENGINEERING COLLEGE

KATTANKULATHUR

CE6302-MECHANICS OF SOLIDS

QUESTION BANK

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DEPARTMENT: CIVIL **SEMESTER: III**

SUBJECT CODE: CE2201 **SUBJECT NAME: MECHANICS OF SOLIDS**

UNIT 1- STRESS AND STRAIN

PART – A (2 Marks)

1. Define longitudinal strain and lateral strain.
2. State Hooke's law.
3. Define modular ratio, Poisson's ratio
4. What is modulus of elasticity?
5. What is the use of Mohr's circle?
6. What do you meant by stiffness?
7. Explain lateral strain with a neat sketch
8. What are principal planes?
9. Give the expression for major principal stress in a two dimensional system
10. What are the types of stresses developed in thin cylinders subjected to internal pressure?
11. Write the relationship between bulk modulus, rigidity modulus and Poisson's ratio.
12. Draw stress – strain diagram for mild steel, brittle material and a ductile material and indicate salient points.
13. What is principle of super-position?
14. Draw the Mohr's circle for a state of pure shear and indicate the principal stresses.
15. Differentiate thin cylinder & thick cylinder
16. What is the procedure for finding the thermal stresses in a composite bar?
17. Define the term 'obliquity' and how it is determined.
18. Define Factor of safety.
19. What do you meant by thermal stresses?
20. Define working stress & allowable stress

PART – B (16 Marks)

1. A tensile test was conducted on a mild steel bar. The following data was obtained from the test:

   (i) Diameter of the steel bar = 3 cm

   (ii) Gauge length of the bar = 20cm

   (iii) Load at elastic limit = 250 kN

   (iv) Extension at a load of 150 kN = 0.21 mm

   (v) Maximum load = 380 kN

   (vi) Total extension = 60 mm

   (vii) Diameter of rod at failure = 2.25 cm

   Determine:

   (1) The Young's modulus

   (2) The stress at elastic limit

   (3) The percentage of elongation

   (4) The percentage decrease in area.

2. Three bars made of copper; zinc and aluminium are of equal length and have cross section 500, 700, and 1000 sq.mm respectively. They are rigidly connected at their ends. If this compound member is subjected to a longitudinal pull of 250 kN, estimate the proportional of the load carried on each rod and the induced stresses. Take the value of E for copper = 1.3×10^{5} N/mm^2, for zinc = 1×10^5 N/mm^2 and for aluminium = 0.8×10^5 N/mm^2.
3. A bar 0.3m long is 50mm square in section for 120mm of its length, 25mm diameter for 80mm and of 40mm diameter for its remaining length. If the tensile force of 100kN is applied to the bar calculate the maximum and minimum stresses produced in it, and the total elongation. Take E = 2×10^5 N/mm^2 and assume uniform distribution of stress over the cross section.
4. A bar of 25mm diameter is subjected to a pull of 40kN. The measured extension on gauge length of 200mm is 0.085mm and the change in diameter is 0.003mm.Calculate the value of Poisson's ratio and the three moduli.
5. A cylindrical vessel, whose ends are closed by means of rigid flange plates, is made up of steel plate 3 mm thick. The length and internal diameter of the vessel are 50 cm and 25

cm respectively. Determine the longitudinal and hoop stresses in the cylindrical shell due to an internal fluid pressure of 3 N/mm^2. Also calculate the increase in length, diameter and volume of vessel. Take $E = 2\times10^5$ N/mm^2 and μ =0.3.

6. A hollow cylinder 2 m long has an outside diameter of 50 mm and inside diameter of 30 mm. If the cylinder is carrying a load of 25 kN, find the stress in the cylinder. Also find the deformation of the cylinder, if the value of modulus of elasticity for the cylinder material is 100 GPa.
7. A cylindrical shell of 500 mm diameter is required to withstand an internal pressure of 4 MPa. Find the minimum thickness of the shell, if maximum tensile strength for the plate material is 400 MPa and efficiency of the joints is 65%. Take factor of safety as 5.
8. A cylindrical shell 3m long which is closed at its ends has an internal diameter of 1m and a wall thickness of 15mm. calculate the circumferential and longitudinal stresses induced and also change in dimensions of the shell if it is subjected to an internal pressure of 1.5 MN/m^2
9. A short metallic column of 500mm^2 cross sectional area carries a axial compressive load of 100kN.For a plane inclined at 60^o with the direction of the load calculate i) Normal stress ii) Resultant stress iii) Tangential stress iv) Maximum shear stress v) Obliquity of resultant stress.
10. (i) Derive a relation for change in length of a bar hanging freely under its own weight. (6)
    (ii) Draw stress - strain curve for a mild steel rod subjected to tension and explain about the salient points on it. (10)
11. (i) Derive the relationship between bulk modulus and young's modulus. (6)
    (ii) Derive relations for normal and shear stresses acting on an inclined plane at a point in a stained material subjected to two mutually perpendicular direct stresses. (10)
12. Two vertical rods one of steel and other of copper are rigidly fixed at the top and 80cm apart. Diameter and length of each rod are 3cm and 3.5m respectively. A cross bar fixed to the rods at lower ends carries a load of 6kN such that the cross bar remains horizontal even after loading. Find the stress in each rod and position of load on the bar. Take E for steel as 2×10^5 N/mm^2 and for copper as 1×10^5 N/mm^2

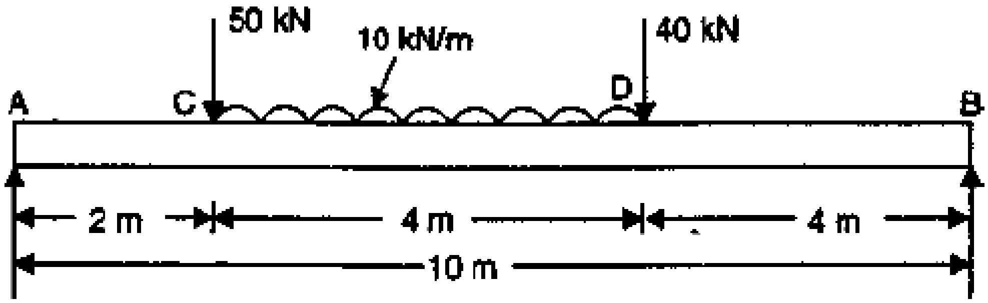
UNIT 2- SHEAR AND BENDING IN BEAMS

PART – A (2 Marks)

1. What is the maximum bending moment for a simply supported beam subjected to uniformly distributed load and where it occurs?
2. Define shear stress.
3. What is shear force in a beam?
4. What is bending moment in a beam?
5. List the types of supports
6. Derive the relation between bending moment and shear force.
7. What is meant by section modulus?
8. What is the differential relation between bending moment, shear force and the applied load?
9. Sketch the shear stress variation for symmetrical I section
10. What do you meant by point of contraflexure?
11. What is meant by moment of resistance of a beam?
12. Write any four assumptions in the theory of simple bending
13. Differentiate between hogging and sagging bending moment.
14. Sketch any 2 types of supports used for a beam indicating the reactions in each case.
15. A cantilever beam of span 4m is subjected to a udl of 2 kN/m over its entire length. Sketch the bending moment diagram for the beam.
16. How would you find the bending stress in unsymmetrical sections?
17. How do you locate the point of maximum bending moment?
18. What do you understand by neutral axis & moment of resistance? How do you locate Neutral axis?
19. A beam subjected to a bending stress of 5N/mm2 and the section modulus is 3530 cm3. What is the moment of resistance of the beam?
20. Draw the S.F. & B.M. diagrams for simply supported beam of length L carrying a point load W at its middle point.

PART – B (16 Marks)

1. A simply supported beam of length 10m carries the uniformly distributed load and two point loads as shown in Fig. Draw the S.F and B.M diagram for the beam and also calculate the maximum bending moment.



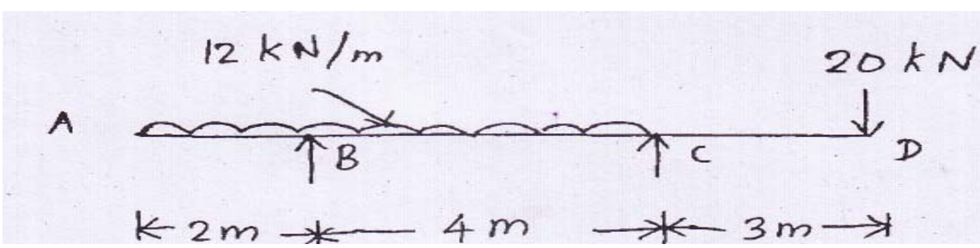
2. (i) Derive an expression for bending moment equation (8)

   (ii) A rectangular beam 300 mm deep is simply supported over the span of 4 m. Determine the uniformly distributed load per metre which the beam may carry, if the bending stress should not exceed 120N/mm^2. Take I=8×10^6 mm^4. (8)

3. A cantilever beam of 2 m long carries a uniformly distributed load of 1.5 kN/m over a length of 1.6 m from the free end. Draws shear force and bending moment diagrams for the beam.

4. A simply supported beam 6 m long is carrying a uniformly distributed load of 5 kN/m over a length of 3 m from the right end. Draw shear force and bending moment diagrams for the beam and also calculate the maximum bending moment on the beam.

5. Draw shear force and bending moment diagram for the beam given in Fig.



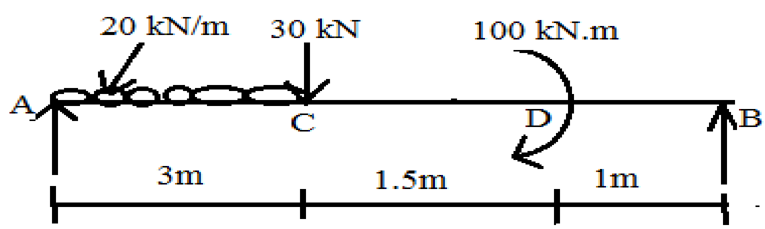
6. State the assurnptions made in the theory of simple bending and derive the bending formula.

7. A 100mm X 200mm rolled steel I section has the flanges 12mm thick and web 10mm thick. Find

   (i) The safe udl the section can carry over a span of 6m if the permissible stress is limited to 150 N/mm^2

   (ii) The maximum bending stress when the beam carries a central point load of 20kN.

8. The cross section of T beam is as follows: Flange thickness = 10mm; width of the flange = 100mm; thickness of the web = 10mm; depth of the web = 120mm; If a shear force of 2kN is acting at a particular section of the beam draw the shear stress distribution across the section.
9. An overhanging beam ABC is simply supported at A & B over a span of 6m and BC overhangs by 3m. If the supported span AB carries a central concentrated load of 8kNand overhang span BC carries 2kN/m draw the shear force and bending moment diagram.
10. A simply supported beam of span 4m carries a udl of 6kN/m over the entire span. If the maximum allowable stress due to bending is restricted to 150 N/mm^2, determine the cross sectional dimensions if the section is;
    (i) Rectangular with depth twice the breadth
    (ii) Solid circular section
    (iii) Hollow circular section having a diameter ratio of 0.6
11. Draw shear force and bending moment diagram for the beam shown in Fig.



12. A flitched beam consists of two timber joist 100mm wide and 240mm deep with a steel plate 180mm deep and 10mm thick placed symmetrically between the timber joists and well clamped. Determine
    i) The maximum fibre stress when the maximum fibre stress in wood is 80 kg/cm^2.
    ii) The combined moment of resistance if the modular ratio is 18.

UNIT 3- DEFLECTION

PART – A (2 Marks)

1. What are the methods for finding out the slope and deflection at a section?
2. Why moment method is more useful when compared with double integration?
3. What is conjugate beam method?
4. Write the maximum value of deflection for a cantilever beam of length L, constant EI and carrying concentrated load W at the end?
5. State the two theorems in moment area method?
6. What are the boundary conditions for a simply supported end?
7. When Macaulay's method is preferred?
8. What is meant by double integration method?
9. When do you prefer Moment area method?
10. What is the slope at the support for a simply supported beam of length L, constant EI and carrying central concentrated load?
11. What is meant by determinate and indeterminate beams?
12. What are the values of slope and deflection for a cantilever beam of length 'L' subjected to Moment 'M' at the free end?
13. Write the relation between deflection of bending moment and flexural rigidity for a beam?
14. Write down the formula used to find the deflection of beam by Moment-Area method.
15. What is slope of a beam?
16. Explain the theorem of conjugate beam method
17. What is the maximum deflection of a simply supported beam of span L, with UDL of w / m run throughout its span?
18. Write the basic equation of the elastic line of a deflected beam

PART – B (16 Marks)

1. A beam of length 6 m is simply supported at its ends and carries two point loads of 48 kN and 40 kN at a distance of 1 m and 3 m respectively from the left support. Find

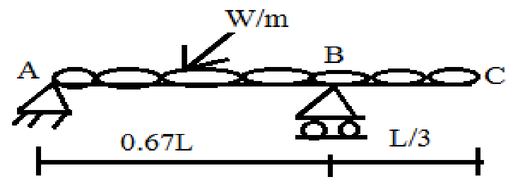
   (i) Deflection under each load

   (ii) Maximum deflection

   (iii) The point at which the maximum deflection occurs.

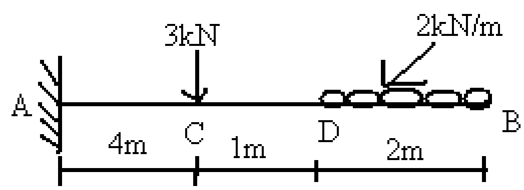
   Take $I=85\times10^6$ mm^4 $E = 2\times10^5$ N/mm^2
2. A steel joist, simply supported over a span of 6 m carries a point load of 50 kN at 1.2 m from the left hand support. Find the position and magnitude of the maximum deflection. Take EI = 14 X 10 ^{12} N/mm^2

3. For the beam shown in fig show that the deflection at the free end is $WL^4/684EI$. Use Macaulay's method.

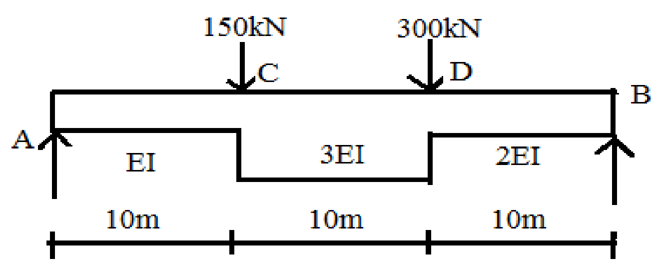


4. A cantilever of length 2.5m is loaded with an udl of 10 kN/m over a length 1.5m from the fixed end. Determine the slope and deflection at the free end. Determine the slope and deflection at the free end of the cantilever L = 9500cm^4, E = 210 GN / m^2 Using Moment area method.

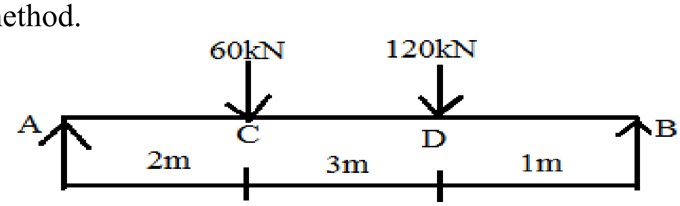
5. Find the slope and deflection at the free end of the cantilever shows in fig. Take EI = 1x10^{10} kN/mm^2



6. Using conjugate beam method, obtain the slope and deflections at A, B, C and D of the beam shown in fig. Take E = 200GPa and I = 2x10^{-2} m^4.



7. Obtain the deflection under the greater load for the beam shown in fig using the conjugate beam method.



8. A simply supported beam of span 3 m is subjected to a central load of 10 kN. Find the maximum slope and deflection of the beam. Take I = 12 ×10^6 mm^4 and E = 200 GPa.

9. A beam AB of span 6m is simply supported at its ends is subjected to a point load of 20kN at C at a distance of 2m from left end. Using moment area method, Compute the deflection at the point C, slope at the points A, B and C. Take I = 6 x10^8 mm^4 and E = 200GPa.
10. A steel cantilever of 2.5m effective length carries a load of 25kN at its free end. If the deflection at the free end is not exceed 40mm. What must be the I value of the section of the cantilever. Take E = 210 GN/m2 using moment area method.

UNIT 4- TORSION

PART – A (2 Marks)

1. What are the assumptions made in the theory of torsion?
2. Define torsion and polar modulus?
3. Write Torsional equation.
4. Why hollow circular shafts are preferred when compared to solid circular shafts?
5. Write the expression for power transmitted by a shaft.
6. Define springs. What are the different types of springs?
7. What is leaf spring?
8. A circular shaft is subjected to a torque of 10kNm. The power transmitted by the shaft is 209.33kW. Find the speed of shaft in revolution per minute.
9. Define spring stiffness.
10. What is a stepped shaft?
11. Compare close coiled and open coiled springs under the action of an axial load.
12. What is the value of maximum shear stress in a close coiled helical spring subjected to an axial force?
13. State the types of stresses when a closed coiled spring is subjected to (i) axial load and (ii) axial twisting moment.
14. Write the equation for strain energy stored in a shaft due to torsion.
15. What is the equivalent bending moment for a shaft subjected to moment M and torsion T?
16. A shaft is having a diameter of 30mm. What is its polar moment of inertia?
17. How will you apply a moment to produce bending in a shaft?
18. How will you apply a moment to produce torque in a shaft?
19. Write the expression for vertical deflection of the closed coiled helical spring due to axial load W.
20. What are the uses of leaf spring?

PART – B (16 Marks)

1. i) Derive the torsion equation for a circular shaft of diameter‘d’ subjected to torque ‘T’.

   ii) Find the torque that can be transmitted by a thin tube 6 cm mean diameter and wall thickness 1 mm. the permissible shear stress is 6000 N/cm^2.

2. A close coiled helical spring is made of a round wire having ‘n’ turns and the mean coil radius R is 5 times the wire diameter. Show that the stiffness of the spring = 2.05 R/n. If the above spring is to support a load of 1.2kN with 120mm compression. Calculate mean radius of the coil and number of turns assuming G = 8200 N/mm^2 and permissible shear stress, $\lambda_{allowable}$ = 250 N/mm^2.

3. A steel shaft ABCD having a total length of 2400mm is contributed by three different sections as follows. The portion AB is hollow having outside and inside diameters 80mm and 50mm respectively, BC is solid and 80mm diameter. CD is also solid and 70mm in 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 $0.82x10^5$ MPa.

4. It is required to design a close coiled helical spring which shall deflect 1mm under and axial load of 100N at a shear stress of 90 MPa. The spring is to be made of round wire having shear modulus of $0.8x10^5$ MPa. The mean diameter of the coil is to times that at the coil wire. Find the diameter and length of the wire.

5. A solid circular shaft transmits 75kW power at 200rpm. Calculate the shaft diameter, if the twist in the shaft is not to exceed one degree in 2m length of shaft and shear stress is not exceed 50 N/mm^2. Assume the modulus of rigidity of the material of the shaft as 100 kN/mm^2.
6. A shaft has to transmit 110 kW at 160rpm. If the shear stress is not to exceed 65N/mm^2 and the twist in a length of 3.5m must not exceed 1o, find a suitable diameter. Take C = 8x104 N/mm^4.
7. A leaf spring 750mm long is required to carry a central load of 8kN. If the central deflection is not to exceed 20mm and the bending stress is not to be greater than

200N/mm^2. Determine the thickness, width and number of plates. Assume the width of the plates is 12 times, their thickness and modulus of elasticity of the springs material as 200kN/mm^2.

8. A closely coiled helical spring made out of a 10mm diameter steel bar has 12 complete coils, each of mean diameter of 100mm. Calculate the stress induced in the section of rod, the deflection under the pull and the amount of energy stored in the spring during the extension. It is subjected to an axial pull of 200N. Modulus of rigidity is 0.84x10^5 N/mm^2.
9. A close coiled helical spring has a stiffness of 5N/mm. its length when fully compressed with adjacent coils touching each other is 40 cm. the modulus of rigidity of the material of the spring is 8x10^4 N/mm^2. Determine the wire diameter and mean coil diameter if their ratio is 1/10. What is the corresponding maximum shear stress in the spring?
10. A circular shaft of 1000mm diameter and 2m length is subjected to a twisting moment which creates a shear stress of 20N/mm^2 at 30mm from the axis of the shaft. Calculate the angle of twist and the strain energy stored in the shaft. Take G=8x10^4 N/mm^2.

UNIT V
COMPLEX STRESSES AND PLANE TRUSSES
PART A(2 MARKS)

1. What is mean by perfect frame?

2. What are the different types of frames?

3. What is mean by Imperfect frame?

4. What is mean by deficient frame?

5. What is mean by redundant frame?

6. What are the assumptions made in finding out the forces in a frame?

7. What are the reactions of supports of a frame?

8. How will you Analysis of a frame?

10. What are the methods for Analysis the frame?
11. How method of joints applied to Trusses carrying Horizontal loads.

12. How method of joints applied to Trusses carrying inclined loads.

13. How will you determine the forces in a member by method of joints?
14. Define thin cylinder?
15. What are types of stress in a thin cylindrical vessel subjected to internal pressure?
16. What is mean by Circumferential stress (or hoop stress) and Longitudinal stress?
17. What are the formula for finding circumferential stress and longitudinal stress?
18. What are maximum shear stresses at any point in a cylinder?
19. What are the formula for finding circumferential strain and longitudinal strain?

20. 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?

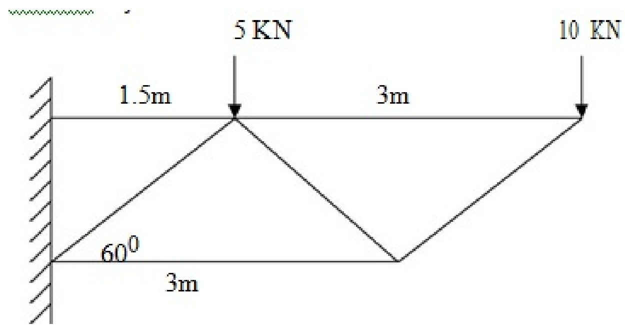
21. What are the formula for finding principal stresses of a thin cylindrical shell Subjected to internal fluid pressure p and a torque?

Part –B(16 MARKS)

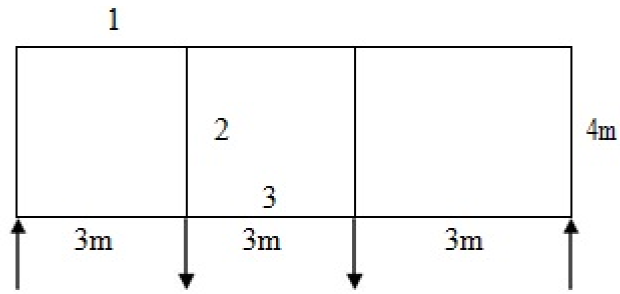
1.A rectangular block of material is subjected to a tensile stress of 110 N/mm^2 on one plane and a tensile stress of 47 N/mm^2 on the plane at right angle to the former. Each of the above stress is accompanied by a shear stress of 63 N/mm^2 Find (i) The direction and magnitude of each of the principal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

2.At a point in a strained material, the principal stresses are100 N/mm^2 (T) and 40 N/mm^2 (C). Determine the resultant stress in magnitude and direction 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?

3.A cantilever truss is show in fig. Find the forces in the members of the truss by the method of joint



4.A truss of span 9m is loaded as shown in fig. Find the reaction and forces in the members marked 1, 2, and 3 by using method of section.



5.At a point in a strained material, the principal stresses are 100 N/mm2 (T) and 40 N/mm2 (C) Determine the direction and magnitude 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

6. Find the magnitude and nature of the forces in the given truss carrying loads as shown in Fig. 12(a).

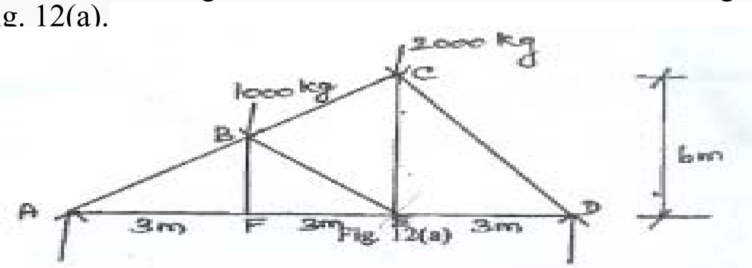
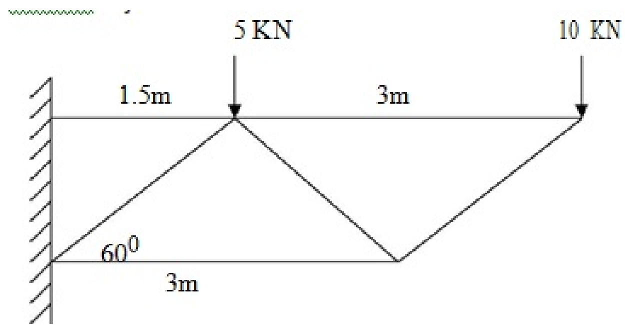


Fig. 12 (a)

7.A SS truss is show in fig. Find the forces in the members of the truss by the method of joint Fig. 12(a).

8.A cantilever truss is show in fig. Find the forces in the members of the truss by the method of section



9. The principal stress in the wall of a container are 40 MN/m^2 and 80 MN/m^2. Determine the normal, shear and resultant stresses in magnitude and direction in a plane, the normal of which makes an angle of 30^o with the direction of maximum principal stress.

10. Determine the normal, shear and resultant stress in magnitude and direction in plane, the normal of which makes an angle of 30^o with the direction of $30MN/m^2$ stress (Tensile). The Value of other tensile stress is $15MN/m^2$