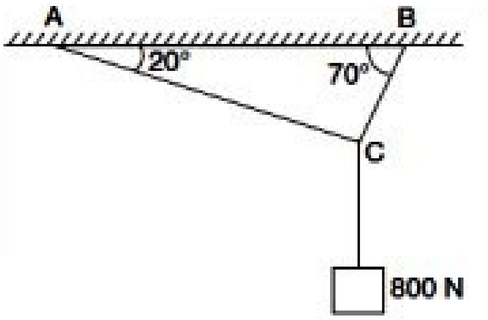
SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY, PUTTUR
(AUTONOMOUS)
Siddharth Nagar, Narayanavanam Road – 517583
QUESTION BANK (DESCRIPTIVE)

Subject with Code: Engineering Mechanics (20CE0102)
Course & Branch: B.Tech – 1st Year Civil
Year &Sem: I–B.Tech. & II–Sem **Regulation:** R20

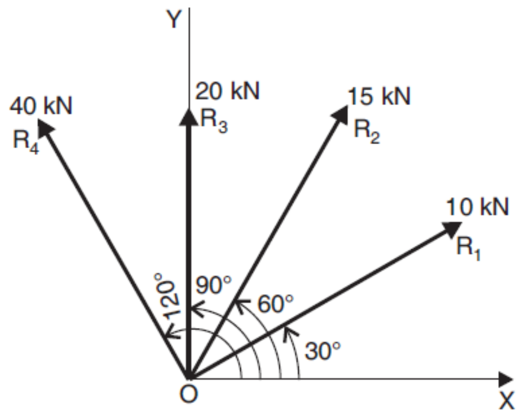
UNIT –I
STATICS OF PARTICLES / STATICS OF RIGID BODIES

1. (a) Classify different system of forces with suitable examples. [L2][CO1][6M]
   (b) The resultant of two forces when they act at right angles is 10N, whereas when they act at an angle of 60° the resultants is √148. Determine the magnitude of the two forces. [L3][CO1][6M]

2. (a) State and prove parallelogram law of forces. [L2][CO1][7M]
   (b) A weight of 800N is supported by two chains as shown in Fig-1.2. Determine the tension in each chain using Lami's theorem. [L3][CO1][5M]



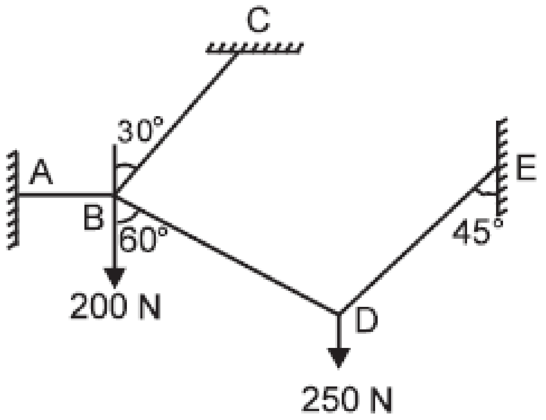
Fig–1.2



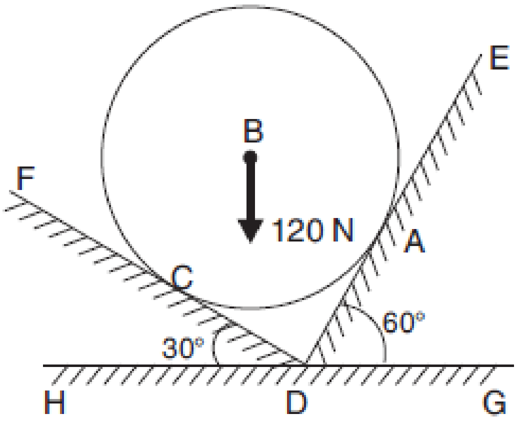
Fig–1.3

3. Four forces of magnitude 10 kN , 15 kN, 20 kN and 40 kN are acting at a point O as shown in Fig-1.3. The angles made by 10 kN, 15 kN, 20 kN and 40 kN with X-axis are 30°, 60°, 90° and 120° respectively. Find the magnitude, direction and inclination of the resultant force. [L4][CO1][12M]

4. A system of connected flexible cable shown in Fig-1.4 is supporting two vertical forces 200 N and 250 N at points B and D. Determine the forces in various segments of the cable. [L4][CO1][12M]



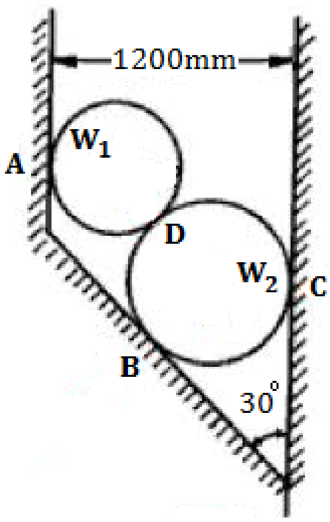
Fig–1.4



Fig–1.5

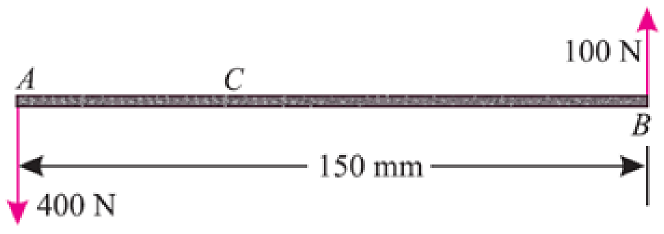
5. (a) A ball of weight 120 N rests in a right-angled groove, as shown in Fig-1.5. The sides of the groove are inclined to an angle of 30° and 60° to the horizontal. If all the surfaces are smooth, then determine the reactions R_A and R_C at the points of contact. [L4][CO1][10M]
   (b) Define the term "Couple" [L2][CO1][2M]

6. Two smooth spheres weight W_1 = 300 N and W_2 = 600 N and radius 400mm and 600mm respectively are placed in a smooth trench as shown in Fig-1.6. Find the reactions exerted on the walls and floor at the points of contacts A, B, C and D. [L4][CO1][12M]



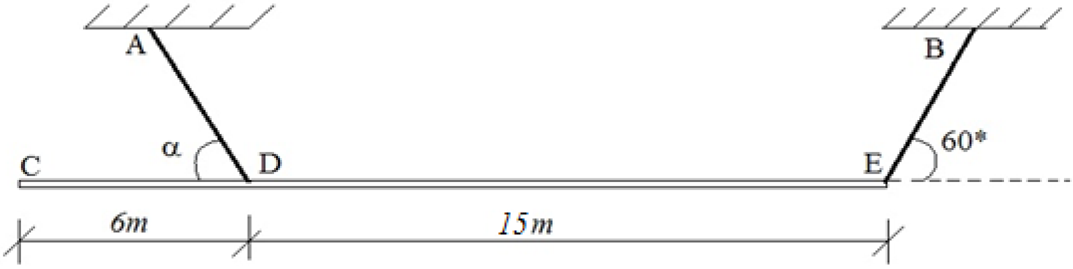
Fig–1.6

7. (a) State and prove Varignon's theorem. [L2][CO1][8M]
   (b) Two unlike parallel forces of magnitude 400 N and 100 N are acting in such a way that their lines of action are 150 mm apart as shown in the Fig-1.7. Determine the magnitude of the resultant force and the point at which it acts. [L3][CO1][4M]



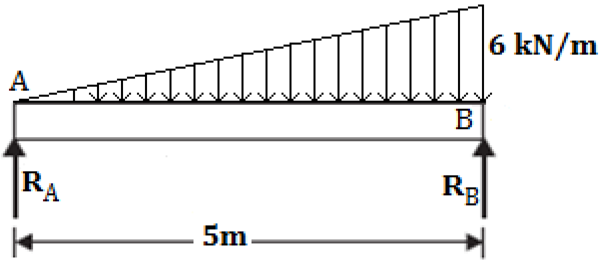
Fig–1.7

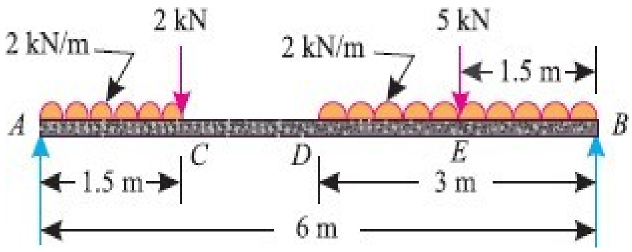
8. A uniform plate girder of mass 350 kg is held in horizontal position by two cables attached at A and B as shown in the Fig-1.8. Find the tension in the cable AD, BE and the angle α. [L4][CO1][12M]



Fig–1.8

9. (a) A simply supported beam AB of span 5m carries a uniformly varying load of 6 kN/m over the entire span as shown in Fig-1.9a. Find the reactions at A & B [L4][CO1][4M]

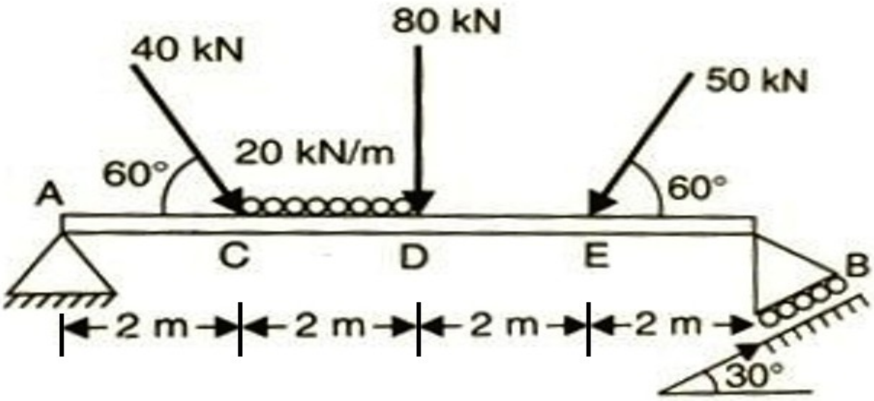




Fig–1.9a *Fig–1.9b*

(b) A simply supported beam AB of span 6m is loaded as shown in Fig-1.9b. Determine the reactions at A and B. [L2][CO1][8M]

10. A simply supported beam AB of length 8m, carries a system of loads as shown in the Fig-1.10. Calculate the reactions at A and B. [L4][CO1][12M]



Fig–1.10

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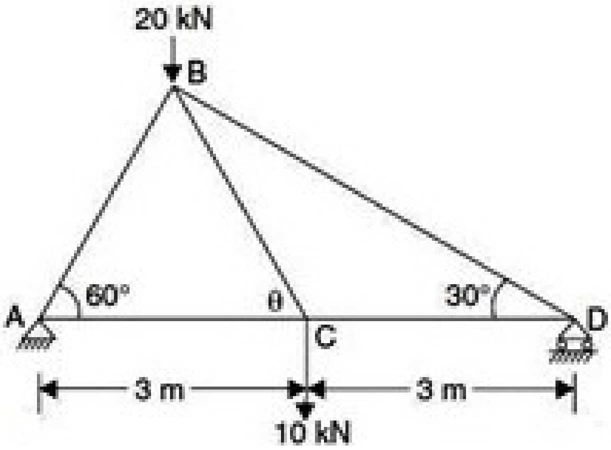
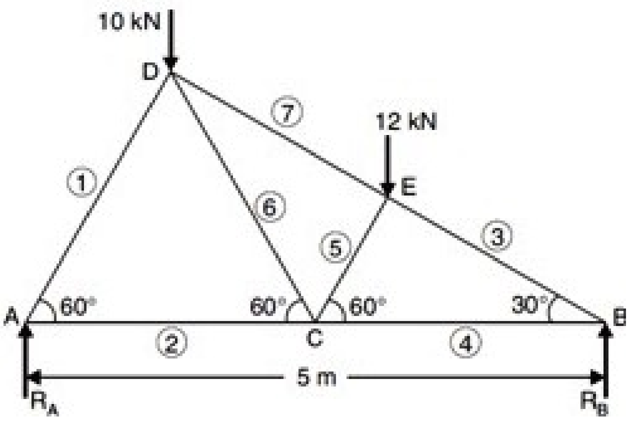
UNIT –II
ANALYSIS OF SIMPLE FRAMES / FRICTION

1. (a) Determine the forces in all the members of the truss shown in Fig-2.1 using method of joints. [L4][CO2][9M]
   (b) State the assumptions made in truss analysis [L2][CO2][3M]



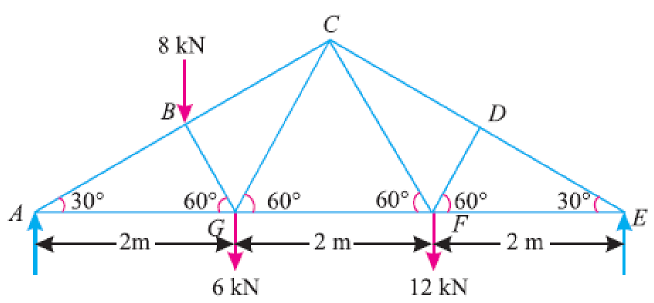
Fig–2.1



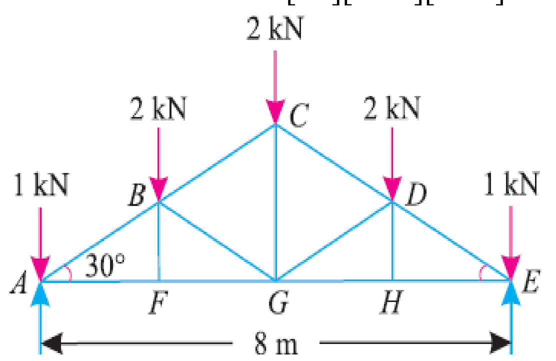
Fig–2.2

2. A truss of span 5m is loaded as shown in Fig-2.2. Find the reactions and forces in the members of the truss. [L4][CO2][12M]

3. An inclined truss is loaded as shown in Fig-2.3. Determine the nature and magnitude of the forces in the members BC, GC and GF of the truss [L4][CO2][12M]



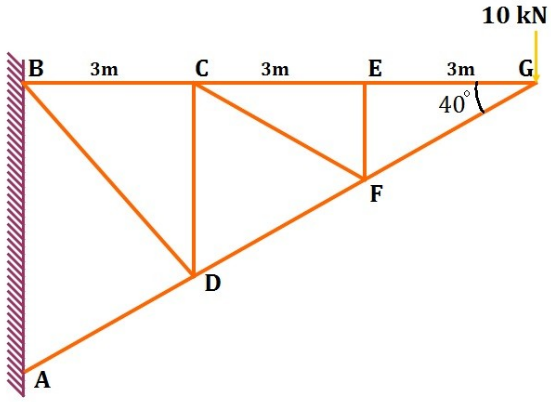
Fig–2.3



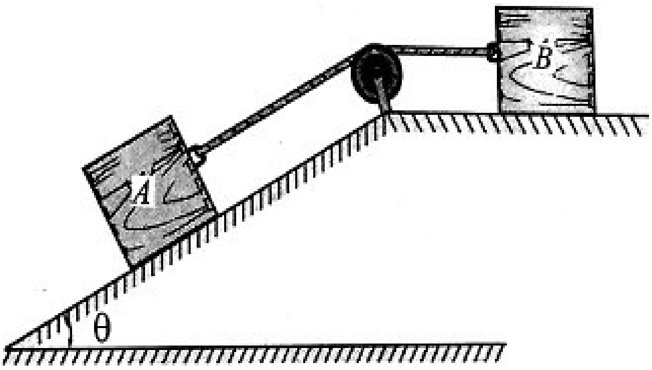
Fig–2.4

4. A king post truss of 8m span is loaded as shown in Fig-2.4. Find the forces in each member of the truss and tabulate the results. [L4][CO2][12M]

5. A cantilever truss is loaded with a point load of 10kN as shown in the Fig-2.5. Find the forces in the member CE, EG, EF, CF and DF, GF using method of section. [L3][CO2][12M]



Fig–2.5



Fig–2.6

6. (a) Find the value of 'θ' if the block 'A' and 'B' shown in Fig-2.6 have impending motion. Given weight of Block-A = 200 N and that of Block-B = 200 N, $\mu_A = \mu_B = 0.25$.
[L4][CO3][8M]
(b) What are the various laws of friction [L2][CO3][4M]

7. Two blocks W_1 and W_2 resting on two inclined planes are connected by a horizontal bar AB as shown in Fig-2.7. If W_1 is equals 1000 N, determine the maximum value of W_2 for which the equilibrium can exists. The angle of limiting friction is 20° at all rubbing faces.
[L4][CO3][12M]

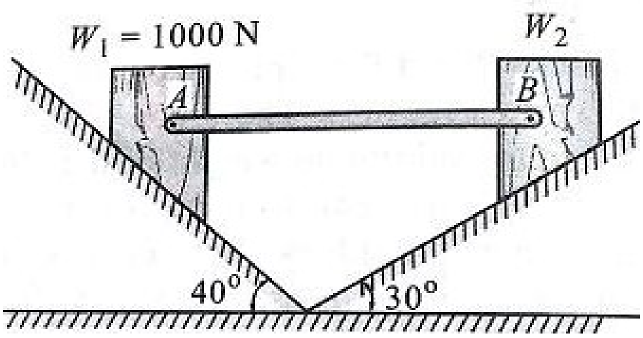


Fig-2.7

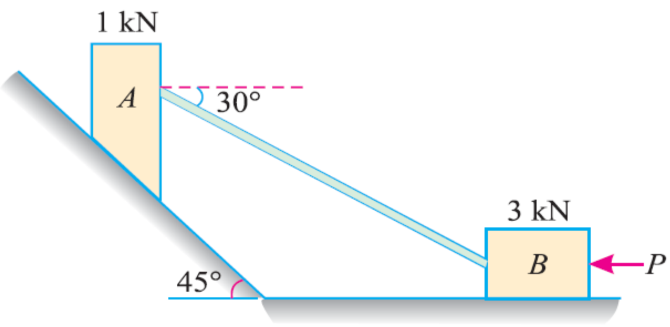
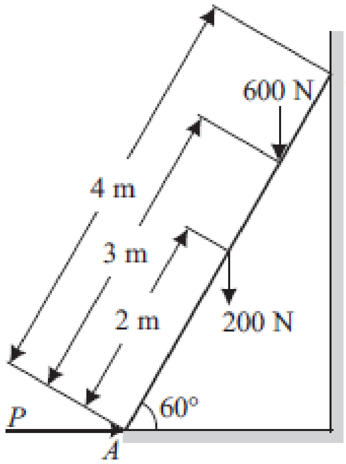


Fig-2.8

8. Block-A weighing 1 kN rests on a rough inclined plane whose inclination to the horizontal is 45°. This block is connected to another block-B weighing 3 kN rests on a rough horizontal plane by a weightless rigid bar inclined at an angle of 30° to the horizontal as shown in Fig-2.8. Find horizontal force (P) required to be applied to the block (B) just to move the block (A) in upward direction. Assume angle of limiting friction as 15° at all surface where there is sliding.
[L4][CO3][12M]

9. A ladder 5m long rests on a horizontal ground and leans against a smooth vertical wall at an angle 70° with the horizontal. The weight of the ladder is 900N and acts at its middle. The ladder is at the point of sliding, when a man weighing 750N stands on a rung 1.5m from the bottom of the ladder. Calculate the coefficient of friction between the ladder and the floor.
[L4][CO3][12M]

10. A ladder of length 4 m, weighing 200 N is placed against a vertical wall as shown in Fig-2.9. The coefficient of friction between the wall and the ladder is 0.2 and that between floor and the ladder is 0.3. The ladder, in addition to its own weight, has to support a man weighing 600 N at a distance of 3m from A. Calculate the minimum horizontal force to be applied at A to prevent slipping. [L4][CO3][12M]



Fig–1.10

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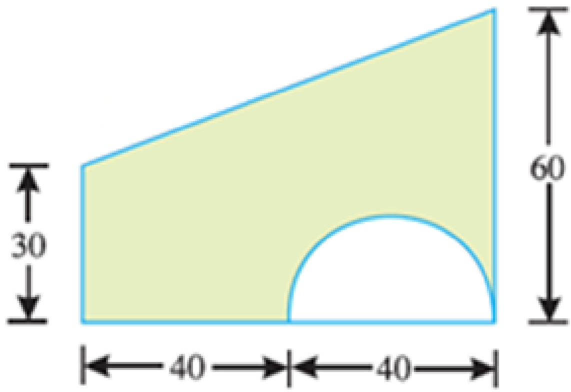
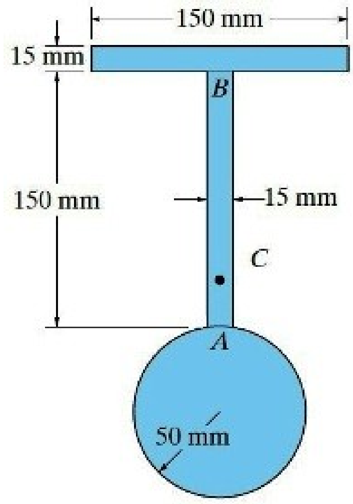
UNIT –III
CENTROID & CENTRE OF GRAVITY / AREA MOMENT OF INERTIA

1. Locate the centroid for the plane figure shown in fig-3.1 [L3][CO4][12M]



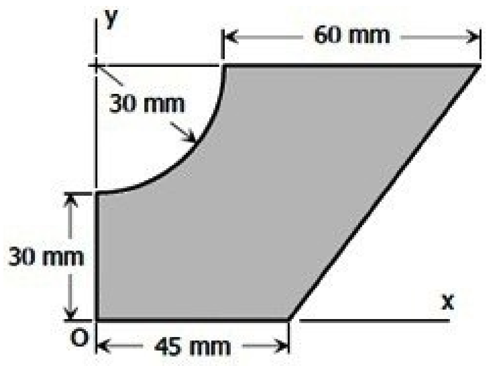
Fig–3.1



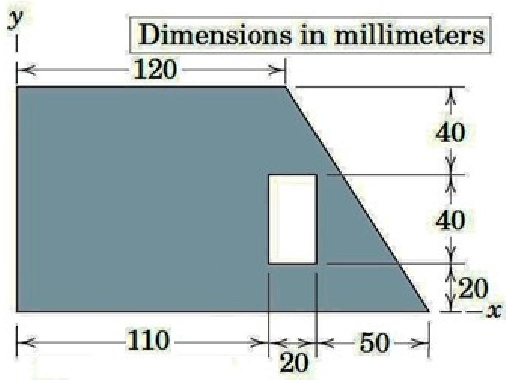
Fig–3.2

2. Determine the co-ordinate of centroid ‘C’ for the section shown in fig-3.2 [L3][CO4][12M]

3. A composite rectangular plane section is cut by a triangle & a quarter-circle as shown in fig-3.3 to fit it into a mechanical lathe. Determine its centroid so as to locate the point tof action of gravitation force. [L3][CO4][12M]



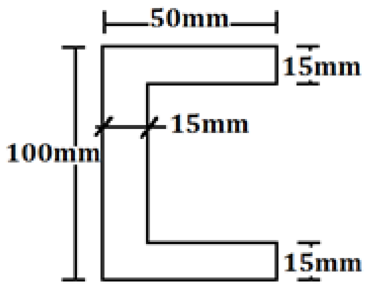
Fig–3.3



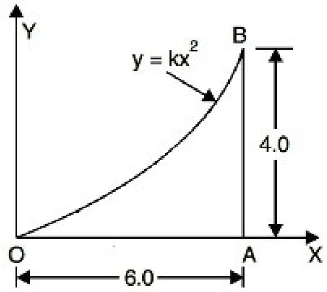
Fig–3.4

4. Determine the co-ordinate of the C.G for the composite plane figure shown in fig-3.4 [L3][CO4][12M]

5. (a) Determine the centroid for the channel section shown in fig-3.5a [L3][CO4][7M]
(b) Determine the co-ordinates of the C.G. of the area OAB shown in Fig. 3.5b if the curve OB represents the equation of a parabola, given by $y=kx^2$ [L3][CO4][[5M]

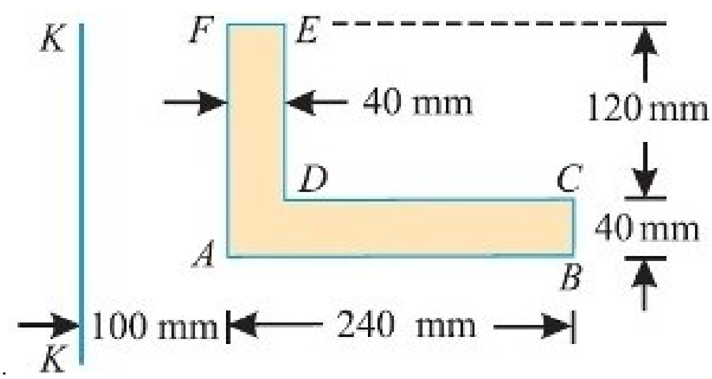


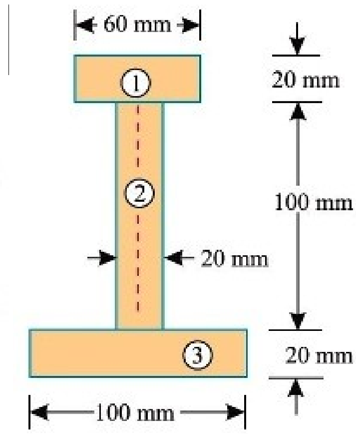
Fig–3.5a



Fig–3.5b

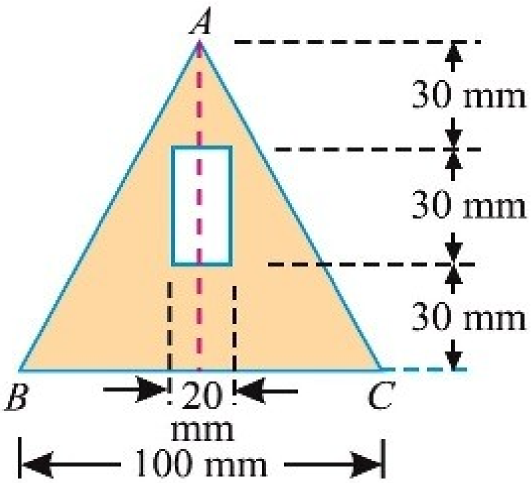
6. Figure 3.6 shows an area ABCDEF. Compute the moment of inertia of the above area about axis K-K. [L3][CO4][12M]





Fig–3.6 Fig–3.7

7. An I-section is made up of three rectangles as shown in Fig-3.7. Find the MOI of the section about the horizontal axis passing through the C.G of the section. [L3][CO4][12M]



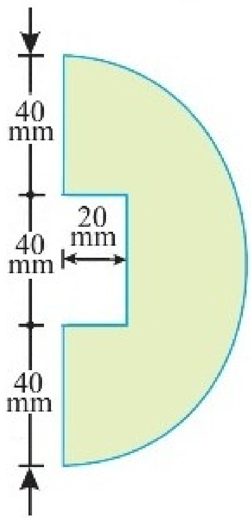


Fig – 3.8 Fig – 3.9

8. Find the moment of inertia for the section shown in fig-3.8 about its horizontal centroidal axis. [L3][CO4][12M]

9. Find the moment of inertia for the section shown in fig-3.9 about its vertical centroidal axis. [L3][CO4][12M]

10. (a) Define parallel axis theorem [L2][CO4][2M]
(b) How will you find the moment of inertia of a triangle about its centroidal axis. [L3][CO4][10M]

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UNIT –IV
SIMPLE STRESSES AND STRAINS / COMPOUND STRESSES

1. Define the following terminologies. [L2][CO5][12M]
   (a) Stress & its types
   (b) Strain & its types
   (c) Modulus of elasticity & Modulus of rigidity
   (d) Poisson's ratio & Bulk modulus

2. A tension test was conducted on a specimen and the following readings were recorded. [L4][CO5][12M]
   (a) Diameter = 25 mm
   (b) Gauge length of extensometer = 200 mm
   (c) Least count of extensometer = 0.001 mm
   (d) At a load of 30 kN, extensometer reading = 60
   (e) At a load of 50 kN, extensometer reading = 100
   (f) Yield load = 160 kN
   (g) Maximum load = 205 kN
   (h) Diameter neck = 17 mm
   Final extension over 125 mm original length = 150 mm.
   Also determine the Young's Modulus, yield stress, ultimate stress, percentage elongation and percentage reduction in area.

3. A steel rod of 2cm diameter is enclosed centrally in a hollow copper tube of external diameter 4cm and internal diameter 3.5cm. The composite bar is subjected to an axial pull of 50kN. If the length of each bar is 20cm, E_S = 200GPa, E_C = 100GPa determine,
   (i) The stress in the rod and tube, and (ii) Load carried by each bar. [L4][CO5][12M]

4. A steel rod 5cm diameter and 6m long is connected to two grips and the rod is maintained at a temperature of 100°C. Determine the stress and pull exerted when the temperature falls to 20°C if (i) the ends do not yield, and (ii) the ends yield by 0.15cm. [L4][CO5][12M]

5. Find the extension of the bar shown in Fig. 4.1 under an axial load of 25 kN [L4][CO5][12M]

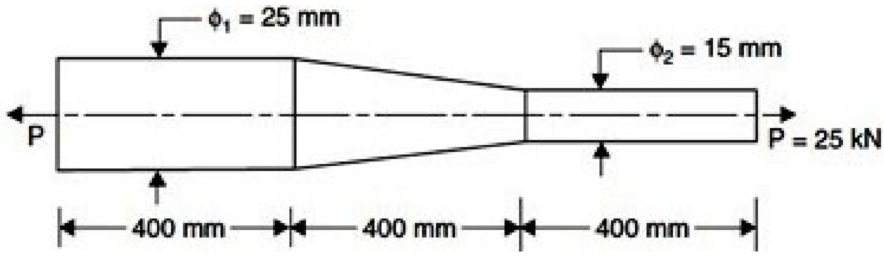

Fig – 4.1

6. A 400 mm long bar has rectangular cross-section 10mm × 30mm as shown in the fig-4.2. This bar is subjected to [L4][CO5][12M]
   (i) 15 kN tensile force on 10mm × 30mm faces,
   (ii) 80 kN compressive force on 10mm × 400mm faces, and
   (iii) 180 kN tensile force on 30mm × 400mm faces.
   Find the change in volume if $E = 2 \times 10^5$ N/mm^2 and $\mu = 0.3$.

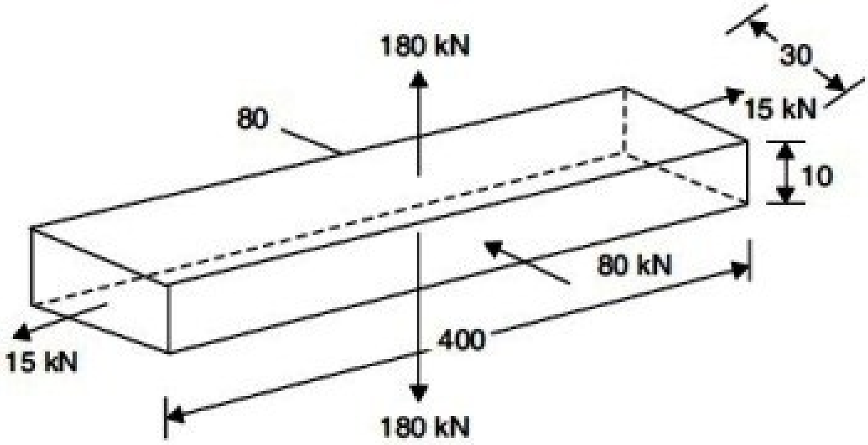

Fig – 4.2

7. (a) A bar of 25 mm diameter is tested in tension. It is observed that when a load of 60 kN is applied, the extension measured over a guage length of 200 mm is 0.12 mm and contraction in diameter is 0.0045 mm. Find Poisson's ratio and elastic constants E, G, K.
   [L4][CO5][8M]
   (b) A metallic bar 320mm long, 40mm wide and 30mm thick is subjected to a pull of 250 kN in the direction of its length. Determine the change in volume, if $E = 20 \times 10^6$ N/cm^2 & $\mu = 0.25$.
   [L4][CO5][4M]

8. At a point within a body subjected to two mutually perpendicular directions, the stresses are 100 MPa (tensile) and 75 MPa (tensile). Each of the above stresses is accompanied by a shear stress of 75 MPa. Determine the normal, shear and resultant stresses on an oblique plane inclined at an angle of 45° with the axis of minor tensile stress. [L4][CO5][12M]

9. State of stress at a point in a material is as shown in the Fig-4.3. Determine
   (i) Principal stresses (ii) maximum shear stress
   (iii) Plane of maximum shear stress and
   (iv) The resultant stress on the plane of maximum shear stress. [L4][CO5][12M]

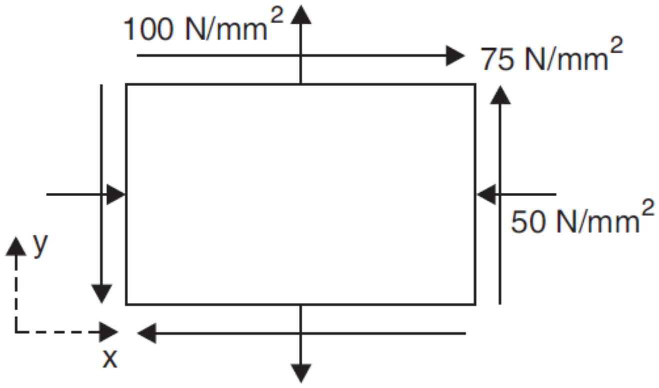

Fig – 4.3

10. The tensile stresses at a point across two mutually perpendicular planes are 120 N/mm^2 and 60 N/mm^2. Determine the normal, tangential and resultant stresses on a plane inclined at 30° to the axis of minor stress using Mohr's circle. [L5][CO5][12M]

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UNIT – V
THIN CYLINDERS / THICK CYLINDERS

1. Derive an expression for determining the circumferential stress (or hoop stress) and longitudinal stress for thin cylinder. [L4][CO6][12M]

2. A shell 3.25m long, 1m in diameter is subjected to an internal pressure of 1 N/mm^2. If the thickness of the shell is 10mm, find the circumferential and longitudinal stresses. Find also the maximum shear stress and the changes in the dimensions of the shell. Take E = 2 x 10^5 N/mm^2 and μ = 0.3 [L3][CO6][12M]

3. A 6mm thick metal cylinder is filled with an incompressible fluid at a pressure of 3 N/mm^2. The cylinder has an internal diameter of 250mm and is 750mm long. Find the additional volume of fluid pumped into the cylinder. [L3][CO6][12M]

4. A closed cylindrical vessel made of steel plates 4mm thick with plane ends, carries fluid under a pressure of 3 N/mm^2. The diameter of cylinder is 25cm and length is 75cm, calculate the longitudinal and hoop stresses in the cylinder wall and determine the change in diameter, length and volume of the cylinder. Take E = 210 GPa and μ = 0.286 [L3][CO6][12M]

5. A cylindrical shell 3m long which is closed at the ends has an internal diameter of 1m and a wall thickness of 15mm. 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 MPa. Take E = 200 GN/m^2 and μ = 0.3. [L3][CO6][12M]

6. An aluminum wire is stretched taut across the diameter of a steel cylindrical pressure vessel. The diameter of the vessel is 2000mm and thickness 10mm. If the vessel is pressurized to 1 MPa and at the same time the temperature drops by 50°C. What stress would develop in the wire? Take μ = 0.3; E_{Al} = 70 GPa; E_s = 200 GPa; α_{al} = 23.4 x 10^{-6} /°C; α_s = 11.7 x 10^{-6} /°C [L3][CO6][12M]

7. Derive an expression for finding the radial pressure (p_x) and hoop stress (f_x) at any radius x for a thick cylinder. [L4][CO6][12M]

8. A pipe of 200mm internal diameter and 50mm thickness carries a fluid at a pressure of $10 MN/m^2$. Calculate the maximum and minimum intensities of circumferential stresses across the section. Also sketch the radial stress (pressure) distribution and circumferential stress distribution across the section. [L3][CO6][12M]

9. A thick walled closed-end cylinder is made of an Al-alloy (E = 72 GPa and μ = 0.33), has inside diameter of 200mm and outside diameter of 800mm. The cylinder is subjected to internal fluid pressure of 150 MPa. Determine the principal stresses and maximum shear stress at a point on the inside surface of the cylinder. Also determine the increase in inside diameter due to fluid pressure. [L3][CO6][12M]

10. A compound tube is composed of a tube 250mm internal diameter and 25mm thick shrunk on a tube of 250mm external diameter and 25mm thick. The radial pressure at the junction is 8 N/mm^2. The compound tube is subjected to an internal fluid pressure of 84.5 N/mm^2. Find the variation of the hoop stress over the wall of the compound tube. [L3][CO6][12M]