Assignment No. 1
Statics

Operations with coplanar forces and resultant of force systems

1 If the combined moment of the two forces about C is zero, determine the magnitude R of the resultant; also find P. (Ref. fig.1)

Ans. P= 3733.2N, R=2236N, $\theta = 26.56^{\circ}$

Second quadrant

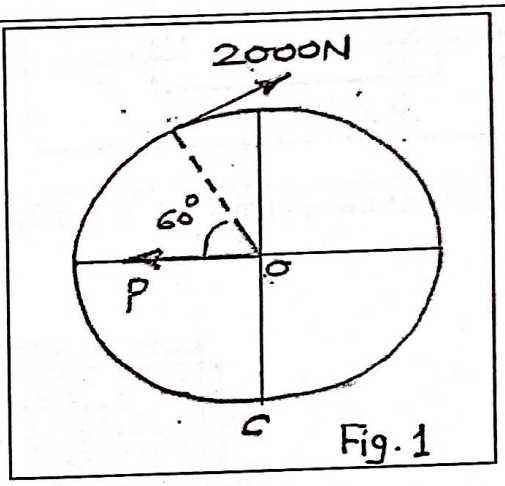


Fig. 1

2 If the resultant force system in figure 2 is along the line AB, then find the magnitude of angle α and the magnitude of the resultant force.

Ans. α= 25.19°, R= 1085.04N

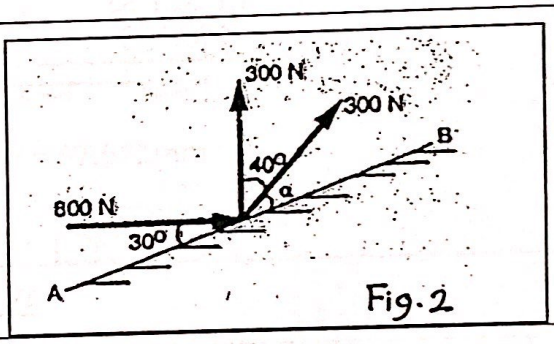


Fig. 2

3 A 4.8 m long beam is subjected to the forces as shown in figure 3. Reduce the given system of forces to (a) an equivalent force-couple system at A. (b) an equivalent force-couple system at B. (c) a single resultant force.

Ans. a) R= 600N (⇓), MA= 1880Nm

b) R= 600N (⇓), MB= 100Nm

c) R= 600N (↓), x= 3.13m to the right of A

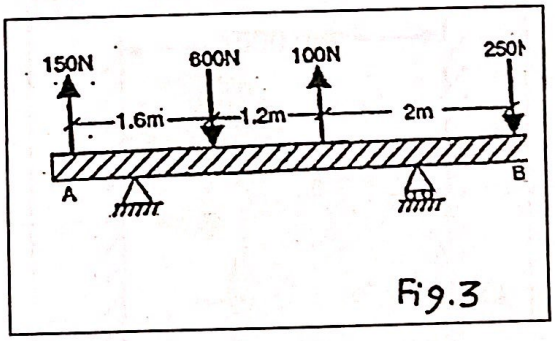
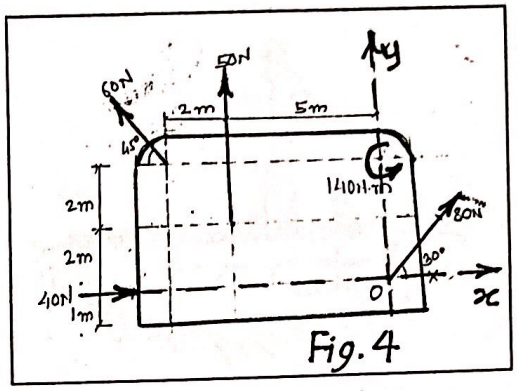
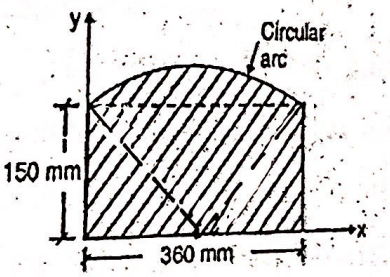


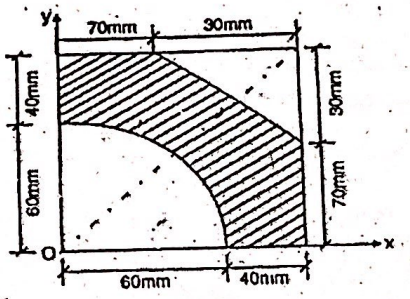
Fig. 3

4	Determine the resultant of four forces and one couple that acts on the plate. Locate its position with respect to origin O. (Ref. Fig. 4) Ans. R= 167.65N, O= 74.16° First quadrant d= 1.723m w.r.t. O clockwise rotation @ O	 Fig. 4
5	Determine the coordinates of the centroids of the plane laminae w.r.to the given frame of reference. (Ref. fig. 5 & 6)	



Ans. X=180mm, Y=106mm

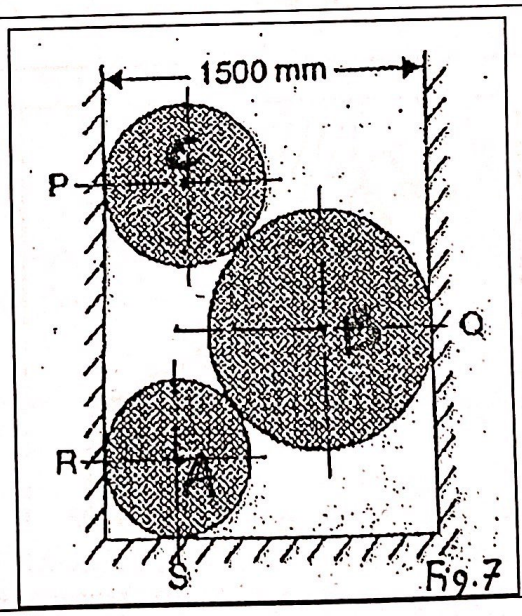
Fig 5

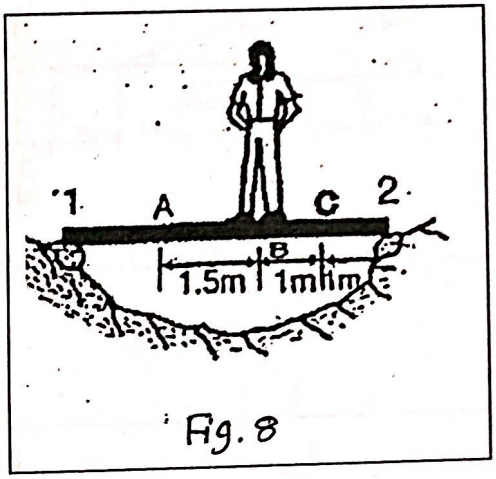
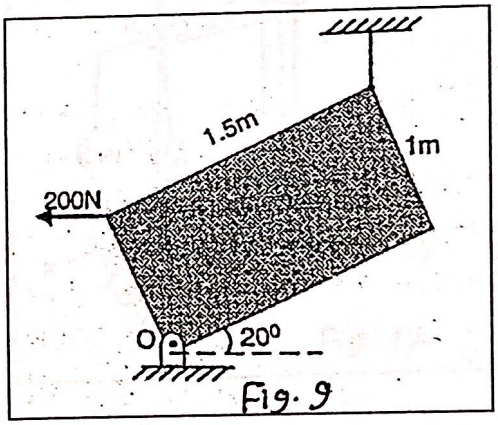
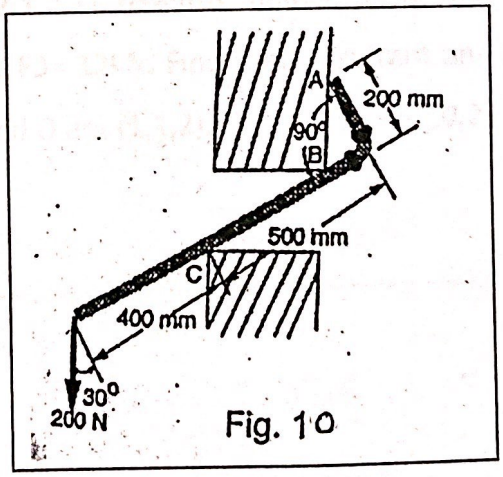


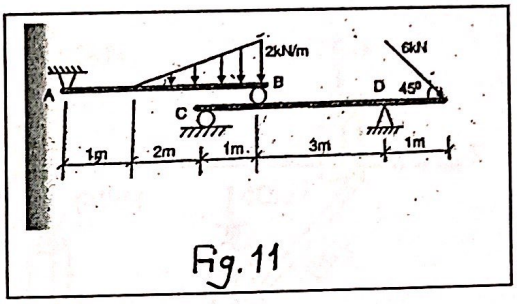
Ana: X = Y = 57.641mm

Fig 6

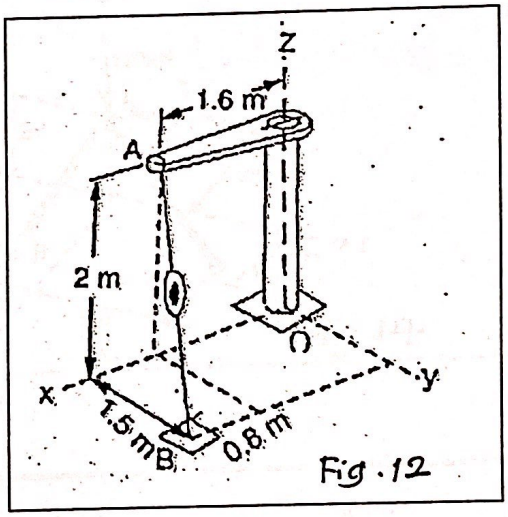
Equilibrium

6	Three cylinders A,B,C weighing 150 N, 400 n and 200 N respectively are piled in a channel as shown in figure 7. Determine the reactions offered by the walls. Radius of A= 400mm, B=600mm, C=500mm. Ans. R_P = 78N (→), R_Q = 424N(←), R_R = 346N, R_S = 750N (↑)	 Fig.7

7	A 90 kg man stands on the small footbridge at point B. The man is to be replaced by two persons, one at A and one at C, so that the external effects on the bridge are not to be altered in the process. What should be the mass of each of the new persons? (Ref. Fig. 8) Ans. $m_A = 36kg$, $m_C = 54kg$	 Fig. 8
8	A 1 kN uniform rectangular plate is held in vertical plane by a hinge at O and rope is shown in Fig. 9. Determine the reaction at the hinge O and the tension in the rope. Ans. $O_x = 200N (\rightarrow)$, $O_y = 677.2N (\uparrow)$, $R_o = 706N (\ )$, $\Theta_o = 73.54^\circ$ First Quadrant, Tension T= 322.85N	 Fig. 9
9	The smooth pipe rests against the wall at the points of contact A, B, and C. Determine the reaction at these points needed to support the vertical force of 200N. Neglect the pipe's thickness in the calculations. (Ref. fig. 10) Ans. $R_A = 115N (\rightarrow)$, $R_B = 53.1N$, 60^0 fourth quadrant $R_C = 284N$, 60^0 second quadrant	 Fig. 10

10	Determine the reactions at the supports of the following beam. (Ref. fig. 11) Ans. R_A =0.75kN (↑), R_B = 2.25kN, R_C = 0.63kN (↑), R_D = 7.23kN, $\Theta_D = 54.1^0$ Second quadrant	 Fig. 11

Space Forces

11	The Cable AB exerts, 1.2kN tension on the lever in the direction from A to B. Express this force in a vector form and calculate the moment of this force about point O. also calculate the magnitude of this moment.(Ref. fig. 12). Ans. M_o –(1.37)i + (2.197)j + (1.099)k, M_o = 2.814kNm	 Fig. 12
12	Three forces F1, F2 &F3 act from point A(-1,2,1) towards points B, C, and D respectively. Knowing that F1 = F2 = 10kN and F3= 12kN. Find their resultant and its direction cosines. Co-ordinates of points B, C and D are (1,1,2), (2,-2,-1) and (-2,0,2) Ans. R= (10.256)i – (17.918)j – (9.242)k R = 22.49kN, l= 0.473, m= -0.787, n=-0.39	

13 Find the resultant of the five loads and its point of application (Ref. fig. 13)

Ans. R=195kN (↓) at point

P=(3.54m, 3.23m, 0)

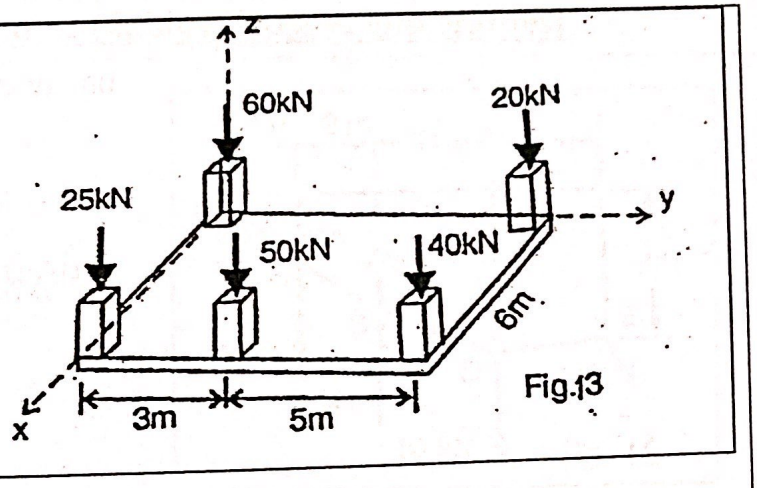


Fig.13

14 Find the force in the three legs of space tripod as shown in figure 14. All supports are boll and sockets type in xy plane.

Ans. F_{BA}= 85.38kN,

F_{CA}= 79.74kN

F_{DA}= 35.41kN

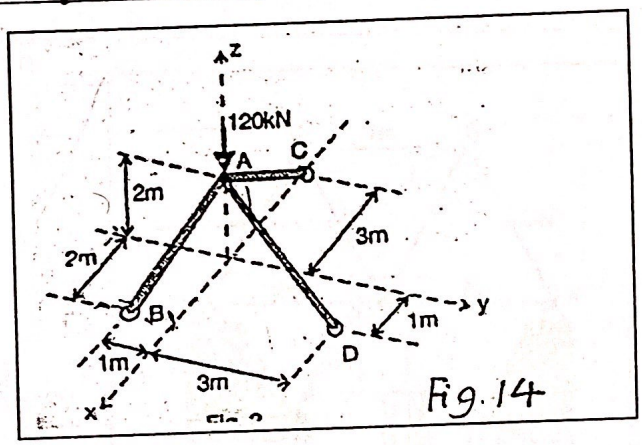


Fig. 14

15 A 35 kg plate is supported by three wires. Find the tension in each wire.

(Ref. fig.15)

Ans. T_A= 75N, T_B= 96.58N

T_C= 171.67N

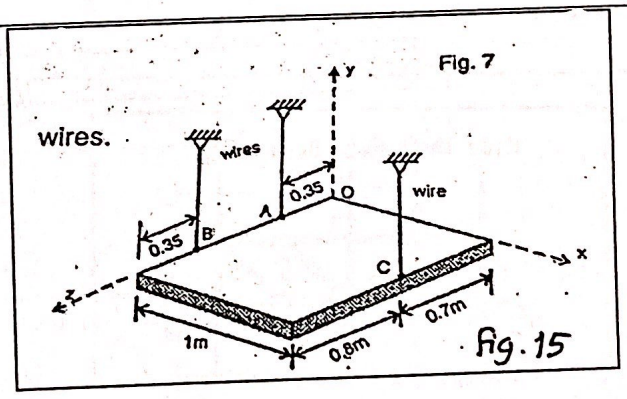


Fig. 15

Analysis of plane structures (Cables, Trusses and Frames)

16 If y_C= 3m, determine the distances y_B and y_D. Also find the reaction at E.

(Ref. fig. 16)

Ans. y_B= 1.733m, y_D= 4.20m, R_E= 21.5kN,

Θ_E= 3.8° first quadrant

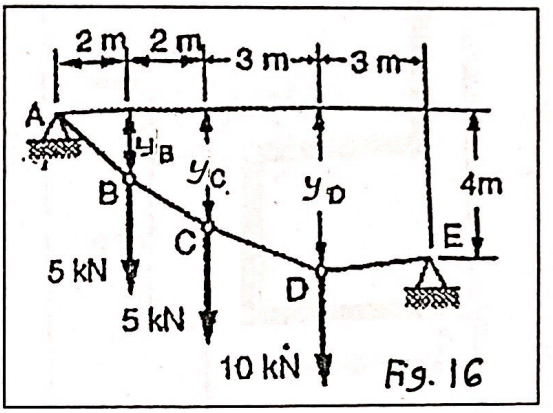


Fig. 16

17 Calculate the force in each member of the loaded truss using method of joints

(Ref. fig. 17)

Ans. $F_{AB} = F_{BC} = F_{CD}$= 2.11kN (C),

F_{DE}= 1.057kN (T),

$F_{CE} = F_{BE}$= 2.11kN (T), F_{AE}= 2.04kN (T)

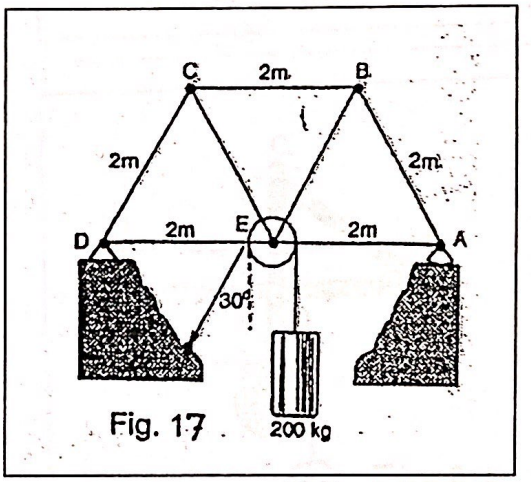


Fig. 17

18 A Mansard roof truss is loaded as shown in figure 18. determine the forces in the members GI, HI, HJ

Ans. F_{GI}= 4.65kN(T), F_{HI}= 1.80kN(C)

F_{HJ}= 4.65kN(C)

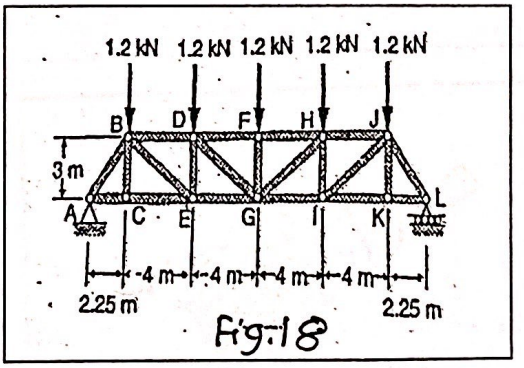


Fig. 18

19 Find the x and y component of the forces at A and C (Ref. fig. 19)

Ans. A_x= 350.5kN(←) R_A= 437.95N

A_y= 262.75kN(↑)

Θ_A = 30.06° second quadrant

B_x= 350.35N F_B = 437.95N

B_y= 262.78N

C_x= 350.35N (→) R_C = 417.96N

C_y= 227.72N (↑)

Θ_C= 33° first quadrant

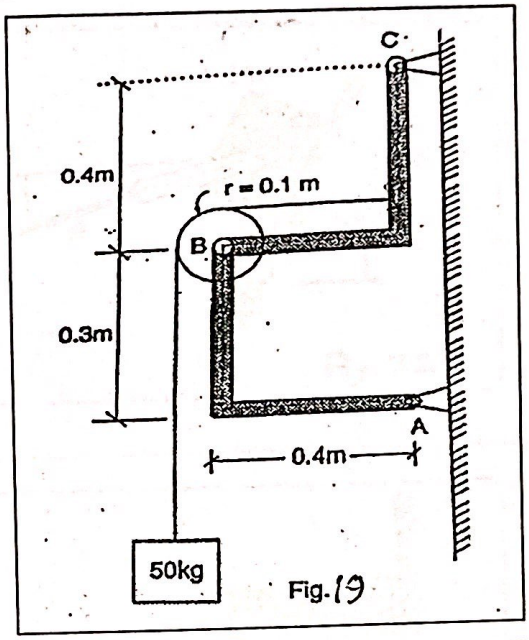


Fig.19

20 The frame structure as shown in the figure 20 supports a load of 1000N. Assuming ideal pins at all joints, find the axial force in the bar BC and the shear force on the pin at D. The pulley at E has a radius of 1.0m

All Dimension In meters.

Ans. F_{BC} = 1250N, F_D = 2016N

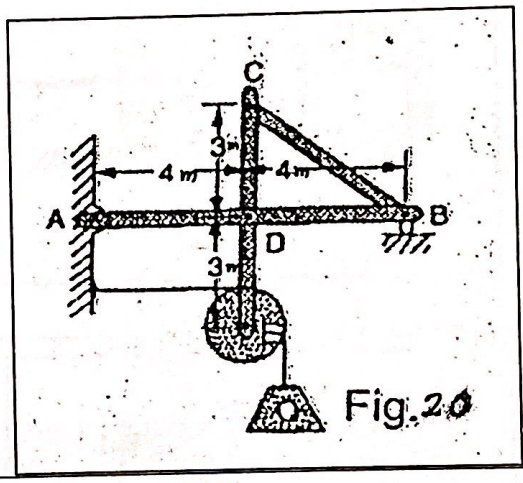


Fig.20

Friction

21 Determine the value of "P" required

a) Just to start motion of block A upward

b) To keep it moving up

c) To prevent it from moving down.

μ_s= 0.25 μ_k= 0.2

Ref. fig 21

Ans. a)P= 461.6N b) P=446.53N

c) P= 276.68N

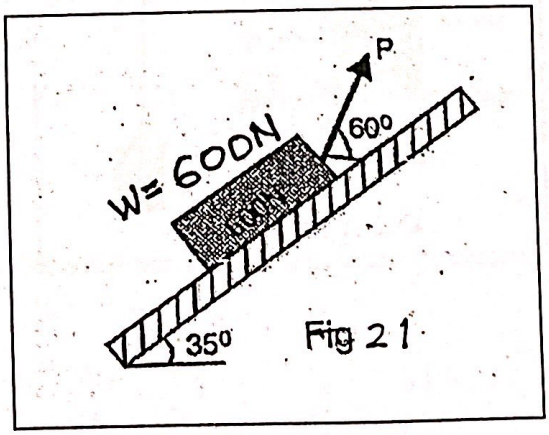
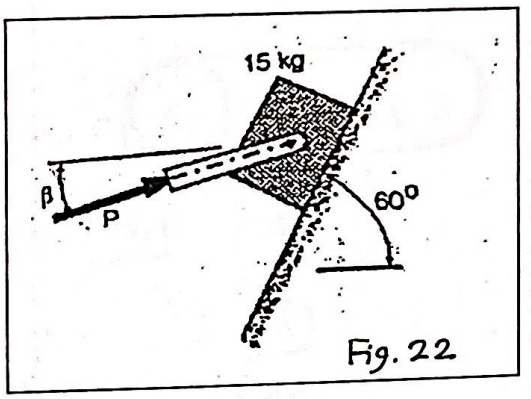
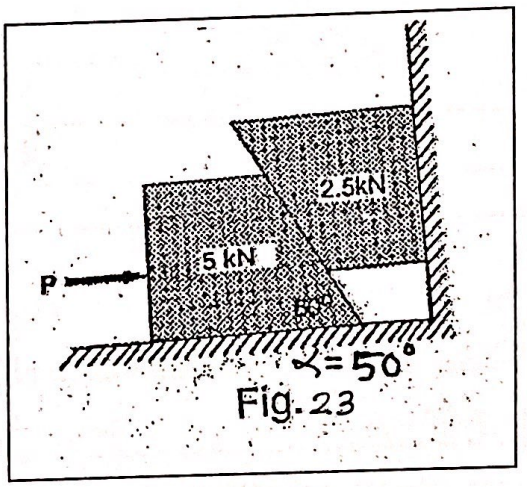
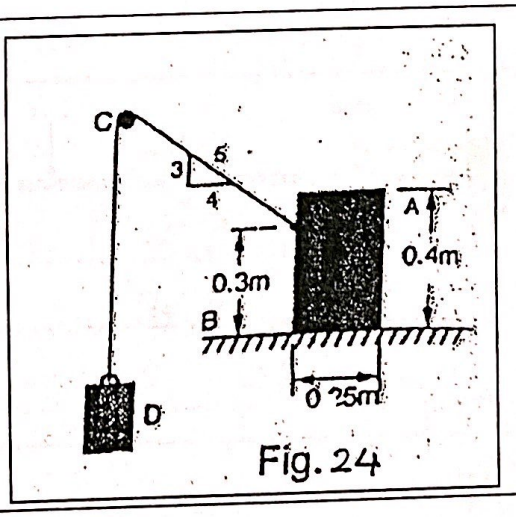


Fig 21

22	Knowing that the coefficient of fraction between the 15kg block and the incline is $\mu_0 = 0.25$, determine the smallest value of P require to maintain the block in equilibrium, and the corresponding value of β. Ref. fig. 22 Ans. $P = 105.8N$, $\beta = 46^0$	 Fig. 22
23	Referring to figure the coefficients of fraction are as follows; 0.25 at the floor, 0.30 at the wall, and 0.20 between blocks. Find the minimum value of a horizontal force P applied to the lower block that will hold the system in equilibrium referring fig. 23. Ans. $P_{m/n} = 406N$	 Fig. 23
24	Block A has a mass of 50 kg and rests on surface B for which $\mu_s = 0.25$. If the coefficient of static friction between the cord and the fixed peg at C is $\mu_s = 0.3$, determine the greatest mass of the suspended cylinder D without causing motion. Ref. fig 24. Ans. 25.6kg	 Fig. 24

25 A cable is placed around three parallel pipes. knowing that the coefficients of friction are μ_s= 0.25 and μ_k = 0.20, determine (a) the smallest weight 'W for which equilibrium is maintained (b) the largest weight 'W which can be raised if pipe B is slowly rotated counterclockwise while pipe A and C remain fixed.

Ref fig. 25

Ans. (a) 10.59kg (b) 59.63kg

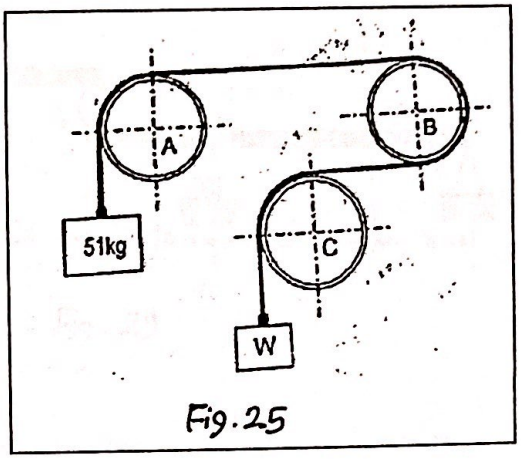


Fig.25

Virtual Work

26 For the beam ABCD shown in fig. 26. Find the reaction at supports by virtual work method only

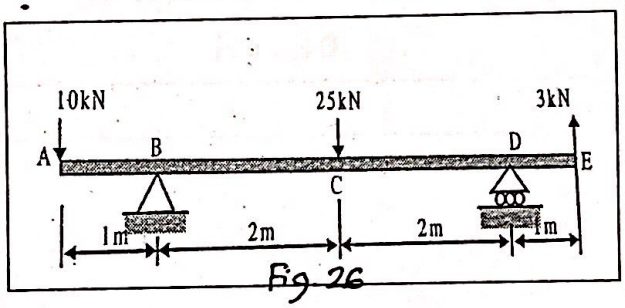


Fig 26

27 Using method of virtual work, determine the reaction at E for the compound beam AEH as shown in fig.27 The beam is having internal hinges at B and F

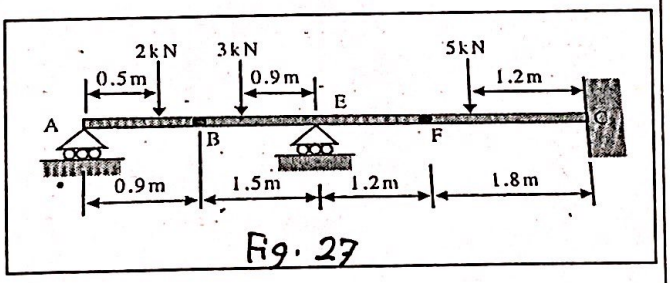


Fig. 27

28 An overhanging beam ABC of span 3m is load as shown in the figure 28. Find the reactions at A and B using principle of virtual work

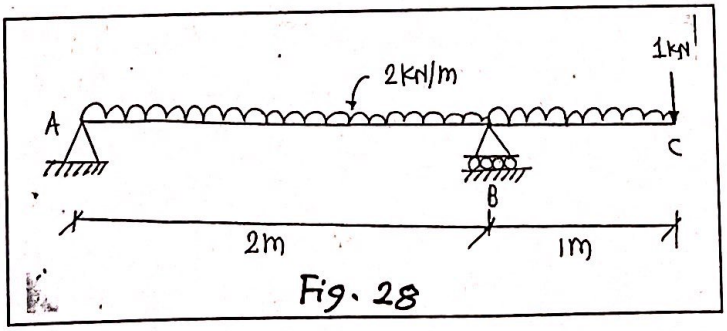
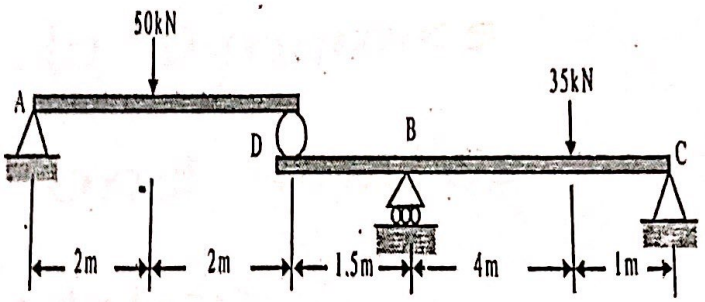
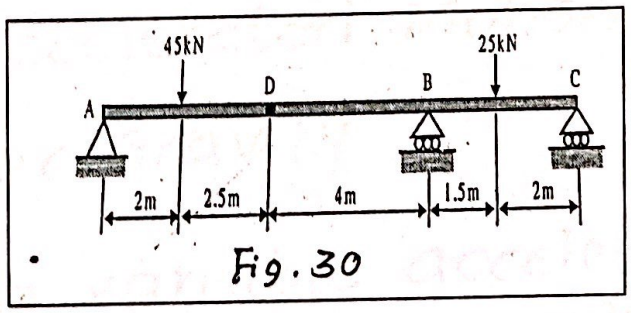


Fig. 28

29	Determine reactions at A, B and C as shown in fig 29. Use virtual work method. **Hint-** Consider beams AD and DBC separately. Ans. $R_A = 25kN\uparrow$ $R_B = 43.125kN\uparrow$ $R_C = 8.125kN\downarrow$ $R_D = 25kN$	 Fig. 29
30	Determine the reactions for the following beam by virtual work method. Ref. fig. 30. Ans. $R_A = 25kN\uparrow$ $R_B = 57.14kN\uparrow$ $R_C = 12.1kN\downarrow$	 Fig. 30