THAPAR INSTITUTE of ENGINEERING & TECHNOLOGY, PATIALA

DEPARTMENT OF CIVIL & MECHANICAL ENGINEERING

MECHANICS-UES009

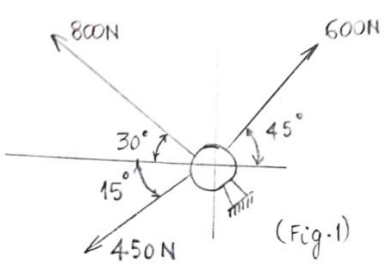
BE 1ST SEMESTER SESSION: 2020-21

TUTORIAL SHEET-01 (REPRESENTATION OF FORCES AND THEIR RESULTANTS)

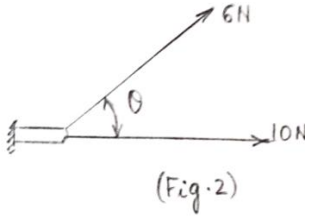
1. A force of 100 units acts along the line OP, terminating at P. If the coordinates of point O and P are (-3,1,2) and (10,5,8) respectively, specify the force in terms of unit vectors. $\left[87\hat{i} + 27\hat{j} + 40\hat{k}\right]$
2. Compute the magnitude of the force F, whose components along the x, y, and z direction are 15 kN, 26 kN and -33 kN respectively. Also compute the inclination with all axes.

   [44.61 kN, 70.35°, 54.35°, 137.71°]
3. Force 30 kN, 40 kN 50 kN and 60 kN are concurrent at O(1, 2, 3) and are directed through M(6, 3, -2), N(-4, -2, 5), P(-3, 2, 4) and Q(4, -3, 6), respectively. Determine the resultant of the system. $\left[-29.88\hat{i} - 65.35\hat{j} + 30.46\hat{k}\right]$
4. Determine the magnitude, direction and sense of the resultant of forces acting as shown in Fig. 1. $\left[-703.22\hat{i} + 707.795\hat{j}\right]$ **or 997.74 N and 134.81°**
5. Two forces of magnitude 10N and 6N act on the ring. If the largest magnitude of the resultant force the ring can support is 14N, determine the angle between the forces, Fig 2.

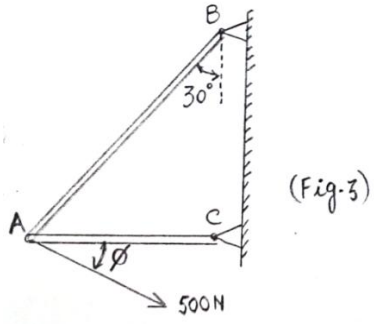
   [60°]
6. The forces F acting on the frame as shown in Fig. 3 has a magnitude of 500 N and is to be resolved into two components acting along struts AB and AC. Determine the angle ϕ, measured below the horizontal, so that the component FAC is directed from A towards C and has a magnitude of 400 N. **[76.14°]**
7. In Fig. 4, if the tensions in the pulley cable are equal i.e. 400N, express the force R exerted on the pulley by the two tensions. Determine the magnitude of R. $\left[-600\hat{i} - 200\sqrt{3}\hat{j}\right]$ **or 692.8 N and 210°**
8. Find out the magnitude, orientation and sense of the resultant force of the force system shown in Fig. 5. Forces are acting on the sides of the hexagon. **[0]**



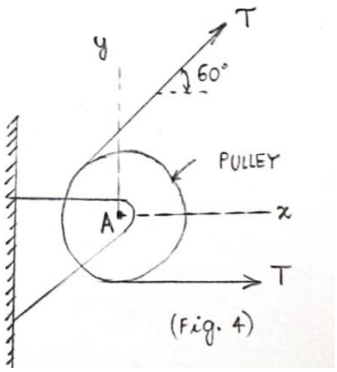
(Fig.1)



(Fig.2)



(Fig.3)



(Fig. 4)

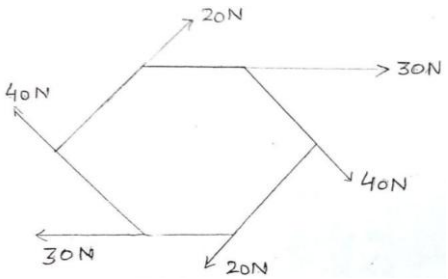


Fig. 5

THAPAR INSTITUTE of ENGINEERING & TECHNOLOGY, PATIALA

DEPARTMENT OF CIVIL & MECHANICAL ENGINEERING

MECHANICS-UES009

BE 1ST SEMESTER SESSION: 20: **20-21**

TUTORIAL SHEET-02 (EQUILIBRIUM OF FORCES-PART 1)

1. Two smooth circular cylinders each of weight 1000 N and radius 15 cm, are connected at their centres by a string AB of length of 40 cm and rest upon a horizontal plane, supporting above them a third cylinder of weight 2000 N and radius 15 cm, as shown in Fig. 1. Find string force in AB and the pressure produced on the floor at the points of contact D and E.

(894.4 N, 2000 N)

2. A rod *AB* as shown in Fig. 2, is held by a ball and socket point at A and supports a mass *C* weighing 1000 N at end *B*. The rod is in *xy* plane and is inclined to *y*-axis at an angle of 18°. The rod is 12 m long and has negligible weight. Find the forces in the cable *DB* and *EB*.

(1647 N, 1411 N)

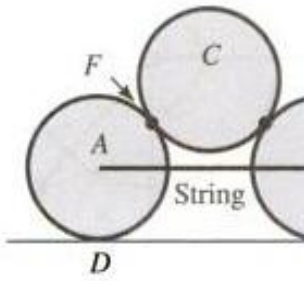
3. Two weights are suspended from B and C points of a rope as shown in Fig. 3. If the distance AD is 6m, how much will be the magnitude of W to maintain its equilibrium. **(5.75 kN)**

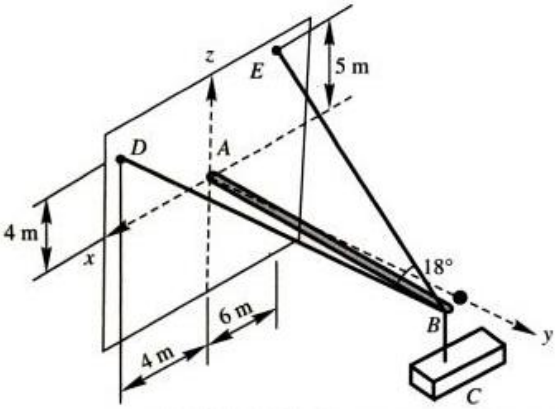
4. Two spherical weighing 60N and 100N are connected by a flexible string AB and rests on two mutually perpendicular planes PQ and QR (see Fig. 4). Find the tension in the string which passes freely through slots in smooth inclined planes PQ and QR. **(72.11 N)**

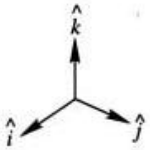
5. A tower of 20 m, height is supported by three ropes shown in Fig. 5. If force in member *AB* is 50 N, find the force in *AC* and *AD* so that the resultant of these forces should be vertical.

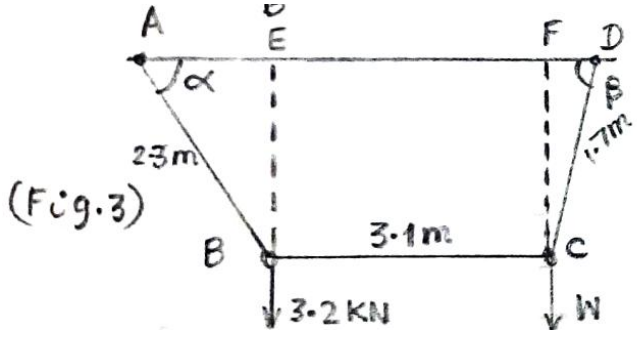
(26.84 N, 73.1 N)

6. Blocks *A* and *B* have masses 400 kg and 200 kg, respectively and rest on 27° incline as shown in Fig. 6. Blocks are attached to a post by cords and the post is held fixed by action of force *F*. Assuming all contact surfaces smooth and cords parallel to incline, determine the value of *F*. Also determine the ground reaction. **(882.8 N, 5346.1 N)**

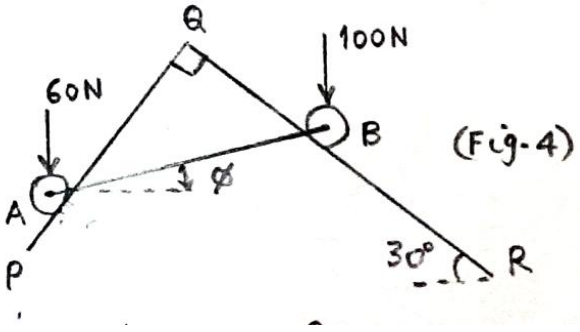




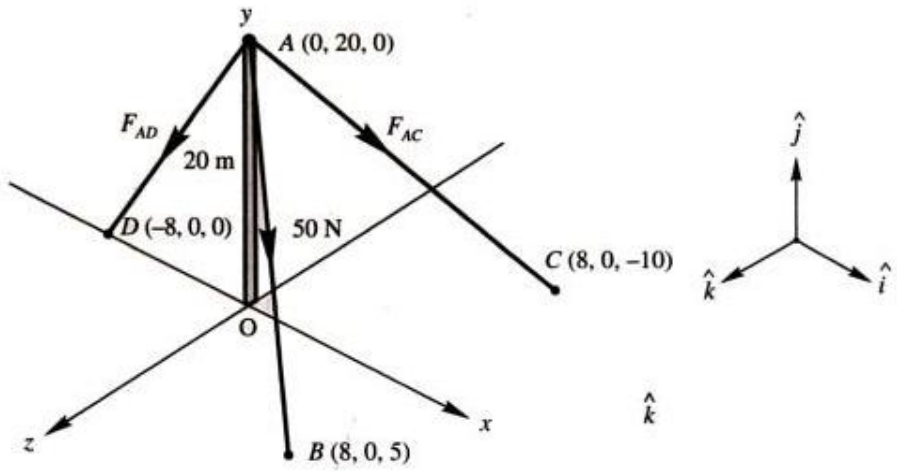




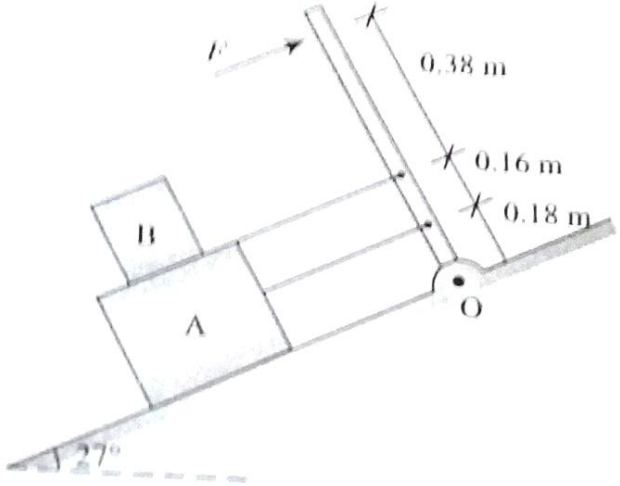
(Fig.3)



(Fig.4)


y
A (0, 20, 0)
F_{AD}
F_{AC}
20 m
D (–8, 0, 0)
50 N
C (8, 0, –10)
O
z
x
B (8, 0, 5)
$\hat{j}$
$\hat{k}$
$\hat{i}$
$\hat{k}$

]


0.38 m
0.16 m
0.18 m
B
A
O
27°

TUTORIAL SHEET-03 (EQUILIBRIUM OF FORCES-PART 2)

1. Determine the mass that must be supported at A and the angle α of the connecting rod in order to hold the system as shown in Fig. 1 in equilibrium.

2. A 2m diameter cylindrical tank is to be supported at each end of a hanger arranged as shown in Fig. 2. The total weight supported by the two hangers is 15 kN. Determine the force in the pins A and B due to the weight of the tanks. Hangers are weightless and contacts are frictionless.

3. Two weightless bars BCD and AECF are hinged together at C. The pulley at D has a diameter of 1.2m and a mass of 200 kg. Making use of free body diagram, determine forces transmitted from one bar to another at C (Fig. 3).

4. A wall bracket consisting of bars AB, AC, and AD as shown in Fig. 4 is loaded at the joint A. Find forces in the members meeting at A.

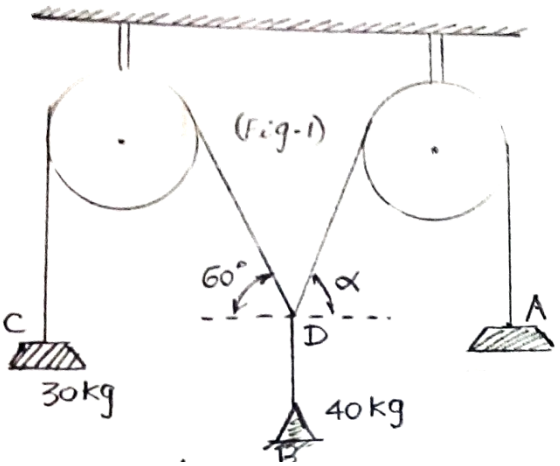
5. Beam MN supports beam PKQ with the help of three bars PN, PJ, and KN as shown in Fig. 5. Determine the reaction at supports M and N of the lower beam.

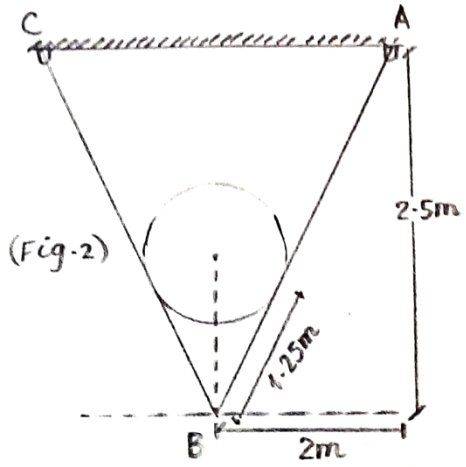
6. Draw the FBDs for the entire frame in Fig. 6 and for each of its parts. The weights of the members are negligible. The cable at *C* is attached directly to the pin. Determine the total number of unknowns and the total number of independent equilibrium equations, assuming that *P* is known.

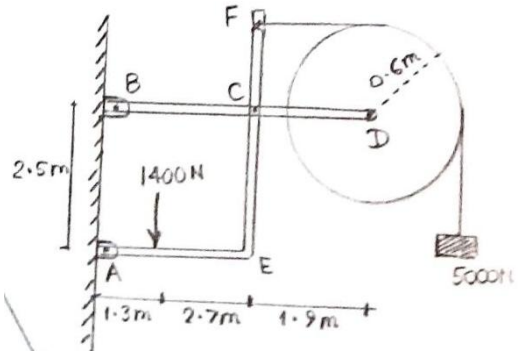
7. A bracket is subjected to a coplanar force system as shown in Fig. 7. Determine the magnitude and the line of action of the single resultant of the system. If the resultant is to pass through the point *B*, what should be the magnitude and direction of the couple?

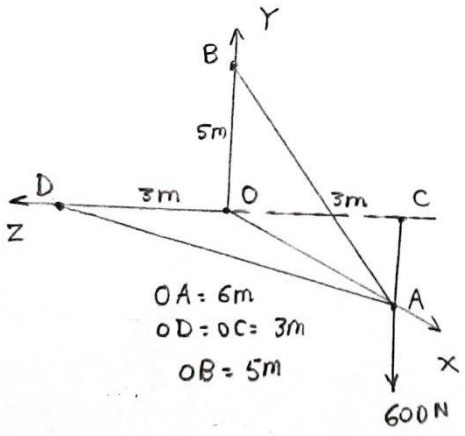
8. Replace the forces acting on the pipe as shown in Fig. 8 by an equivalent single force and couple system acting at point *A*.

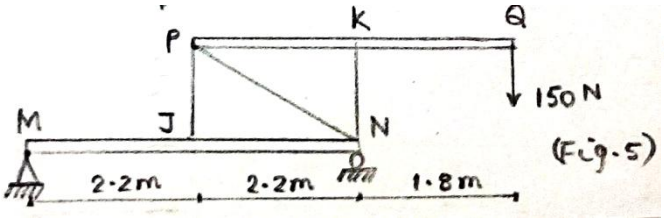
9. A ladder of length 5m has a weight of 200N. The foot of the ladder rests in the floor and the top of it leans against the vertical wall. Both the wall and the floor are smooth. The ladder is inclined at 60° with the floor; a weight of 300N is suspended at the top of the ladder. Find the value of the horizontal force to be applied at the foot of the ladder to keep it in equilibrium.

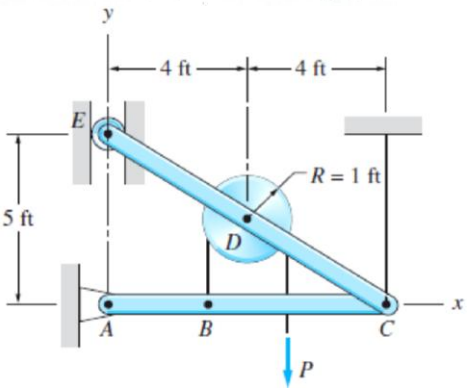

(Fig-1)
60°
α
C
D
A
30kg
40kg

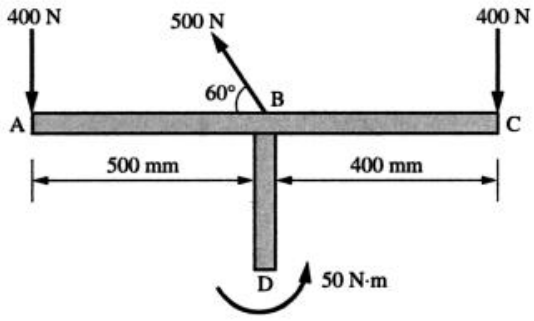

C
A
(Fig-2)
2·5m
1·25m
B
2m

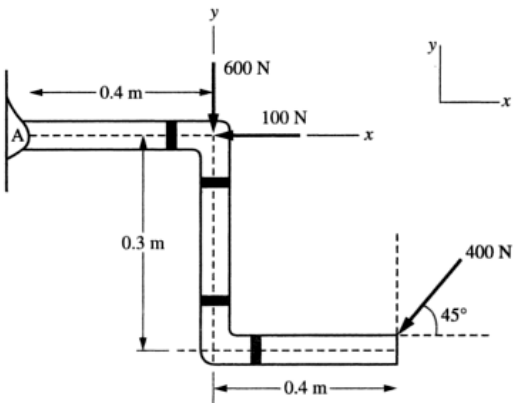

F
B
C
0·6m
D
2·5m
1400N
A
E
5000N
1·3m
2·7m
1·9m


Y
B
5m
D
3m
O
3m
C
Z
OA = 6m
OD = OC = 3m
OB = 5m
A
X
600N


P
K
Q
150 N
M
J
N
(Fig-5)
2·2m
2·2m
1·8m


y
4 ft
4 ft
E
R = 1 ft
5 ft
D
x
A
B
C
P


400 N
500 N
400 N
60°
B
A
C
500 mm
400 mm
D
50 N·m


y
600 N
0.4 m
100 N
x
A
0.3 m
400 N
45°
0.4 m

TUTORIAL SHEET-04 (ANALYSIS OF TRUSSES- METHOD OF JOINTS)

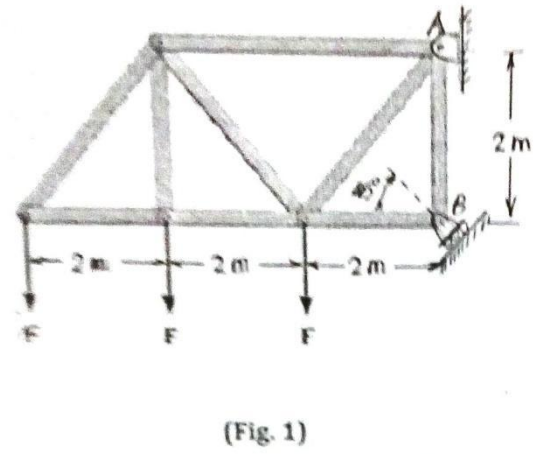
1. If the roller at B can sustain a maximum load of 3 kN, determine the largest magnitude of each of the three forces F that can be supported by the truss. (Fig.1)

2. A signboard, 3 m x 4 m area, is supported by two frames as shown in Fig.2. Calculate the forces in each member due to horizontal wind load of 1 kN/m^2 on the signboard. Assume all truss members are pinned and that two-sixth of the total load is concentrated at B and one-sixth at C.

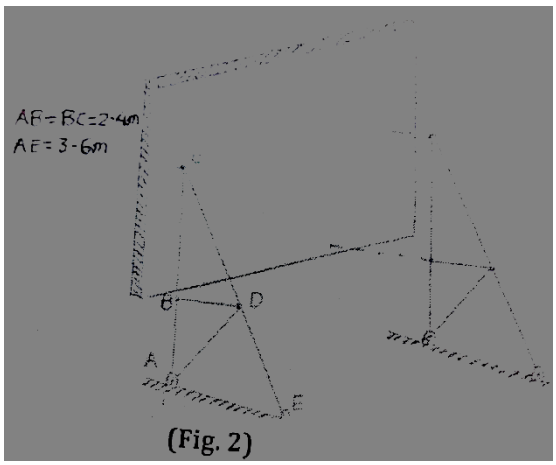
3. Determine the member forces in Fig.3.

4. Determine the forces in members BC, CF and FE in Fig.4.

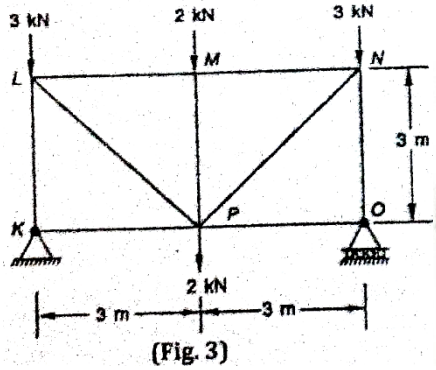
5. Determine the forces in members JE and GF of the truss shown in Fig.5. Indicate tension or compression. Also, indicate all zero force members.



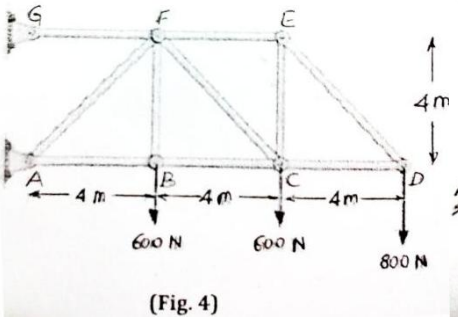
(Fig. 1)



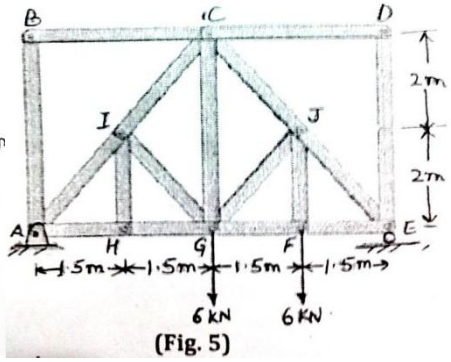
(Fig. 2)



(Fig. 3)



(Fig. 4)



(Fig. 5)

TUTORIAL SHEET-05 (ANALYSIS OF TRUSSES- METHOD OF SECTION)

1. Determine the axial forces in the members CF, FD, GD, GE, and EB of the simply supported loaded truss as shown in Fig. 1.
2. Determine axial forces in all the members of the trusses shown in Fig. 2.
3. Determine axial forces in all the members of the trusses shown in Fig. 3.
4. Find out the forces in all the members of the truss shown in Fig. 4. All the given forces shown in the figure are acting normal to *BD*.
5. Find the forces in the members CD, DG and GH for the truss shown in Fig. 5.