12/08/2024

Engineering Mechanics

- Solids
  - Rigid
  - Deformable
- Fluids

Books:

1. R.K. Bansal
2. D.S. Kumar

We will study about Rigid bodies

Engg. Mechanics

- Static — body at rest
- Dynamics — body at motion
  - Kinematics — motion x no force
  - Kinetics — motion + forces causing the motion are considered

System of forces:

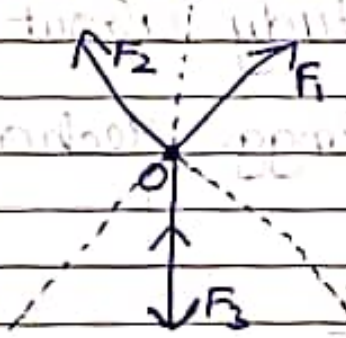
- Coplaner (act on one plane)
- Non-Coplaner (act on multiple plane)

__/__/__

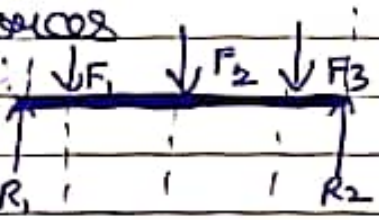
Coplanar Forces (Line of action)

- Concurrent Force
- Parallel force
  - like ∥ forces
  - unlike ∥ forces
- Collinear Force

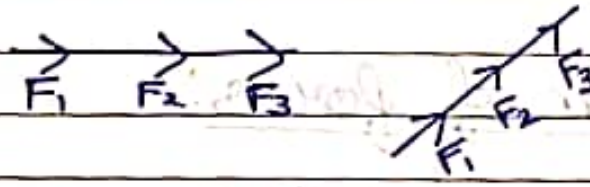
① Concurrent Forces



② Parallel Forces



③ Collinear Force

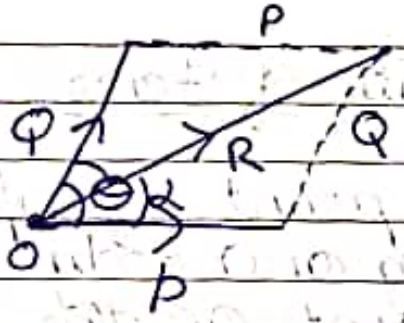


Laws of Mechanics:

1. Newton Laws
2. Parallelogram law of forces
3. Lami's Theorem
4. Law of transmissibility of forces

2. ||gm law of forces:

If two forces P & Q acting at a point are represented in magnitude and direction by the two adjacent sides of a parallelogram than the diagonal passing through their point of intersection represents the resultant both in magnitude and direction.



$$R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$$

$$\tan\alpha = \frac{Q\sin\theta}{P + Q\cos\theta}$$

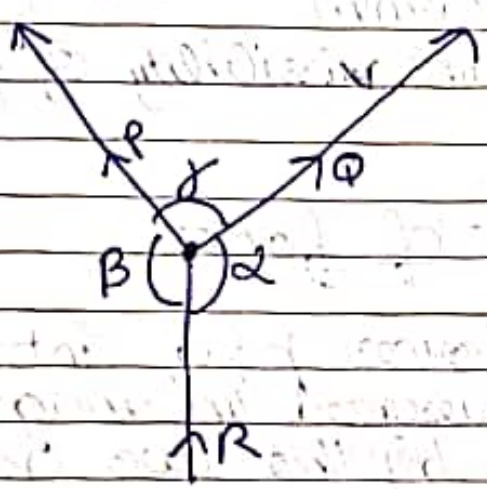
$$\tan\alpha = \frac{Q\sin\theta}{P + Q\cos\theta}$$

$$R = \sqrt{\Sigma(fx)^2 + (fy)^2}$$

$$\tan\theta = \frac{\Sigma fy}{\Sigma fx}$$

3. Lami's Theorem

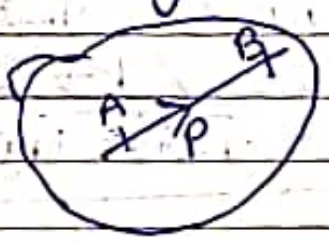
(8) If three forces acting at a point are in equilibrium than each force is proportional to the Sin of the angle between the other two forces.

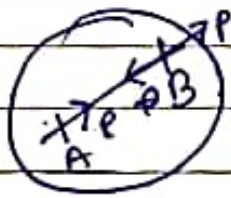


$$\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\alpha}$$

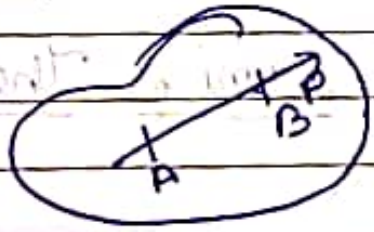
(9) Transmissibility of Force:

When the point of application of a force acting on a body is shifted to any other point on the line of action of force without changing its direction there occurs no change in the equilibrium state of the body.

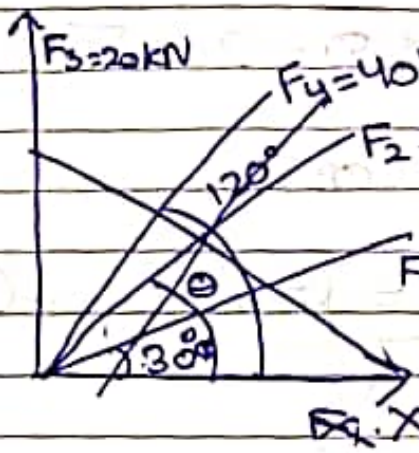




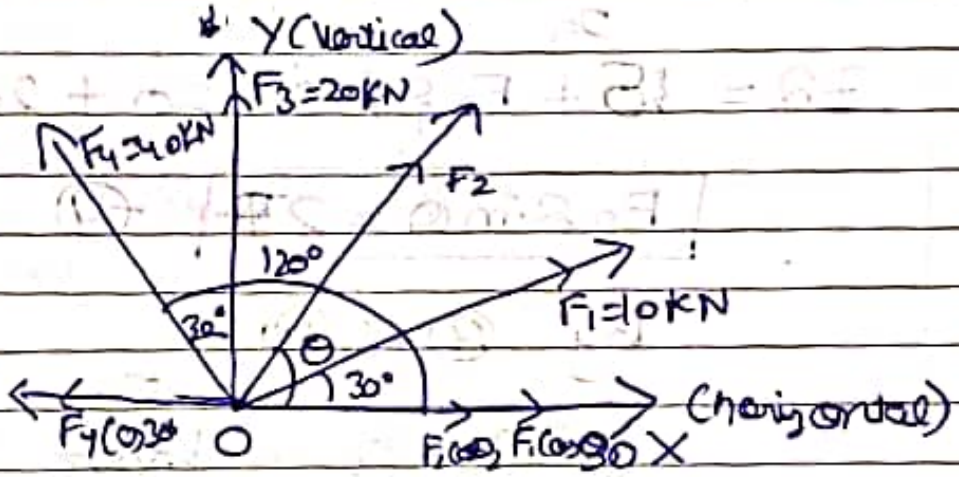
without disturbing the equilibrium of the body.



Ques



Ques



F2 ; θ

R = R=72KN.

Soln: $\boxed{\Sigma Fx = 0}$

$f_{y_1} = 10 \sin 30°$ $\quad f_{1x} = 10 \cos 30°$

$f_{y_2} =$ $\quad f_{2x} =$

$\Sigma fx = 10 \cos 30 + F_2 \cos\theta - F_4 \cos 30°$

$0 = 10 \cos 30 + F_2 \cos\theta - F\,40 \cos 30$ —(1).

$R = \Sigma fy = F_1 \sin 30 + F_2 \sin\theta + F_3 + F_4 \sin 30$

$72 = 10 \sin 30 + F_2 \sin\theta + 20 + 40 \sin 30$

$0 = \frac{10}{2} \times \frac{\sqrt{3}}{1} + F2 \cos\theta - \frac{40}{2} \times \frac{\sqrt{3}}{1}$

$$0 = 5\sqrt{3} + F_2\cos\theta - 20\sqrt{3}$$

$$0 = -15\sqrt{3} + F_2\cos\theta$$

$$\boxed{F_2\cos\theta = 15\sqrt{3}} \quad -(3)$$

$$72 = 15\times\frac{1}{2} + F_2\sin\theta + 20 + 20\times\frac{1}{2}$$

$$72 = 15 + F_2\sin\theta + 20 + 20$$

$$\boxed{F_2\sin\theta = 27} \quad -(4)$$

By (3) & (4)

$$\frac{F_2\sin\theta}{F_2\cos\theta} = \frac{27}{15\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$$

$$\tan\theta = \frac{5\sqrt{3}}{9} \times \frac{\sqrt{3}}{\sqrt{3}} \quad \frac{27\sqrt{3}}{45}$$

$$\tan\theta = \left(\frac{3\sqrt{5}}{5}\right)$$

$$\therefore \theta = \tan^{-1}\left(\frac{3\sqrt{5}}{5}\right)$$

$$\boxed{\theta = 47.4}$$

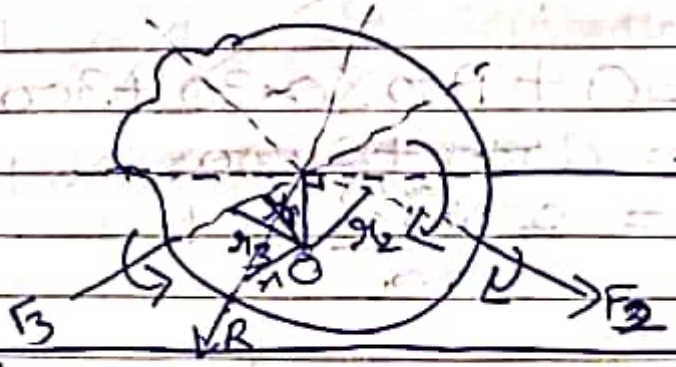
$$F_2\cos 47.4 = 15\sqrt{3}$$

$$F_2 = \frac{15\sqrt{3}}{\cos 47.4}$$

$$\boxed{F_2 = 16.7\,KN}$$

14/08/2024

Movement of the Force (M.9mfb)



Moment of force (M) = f X r

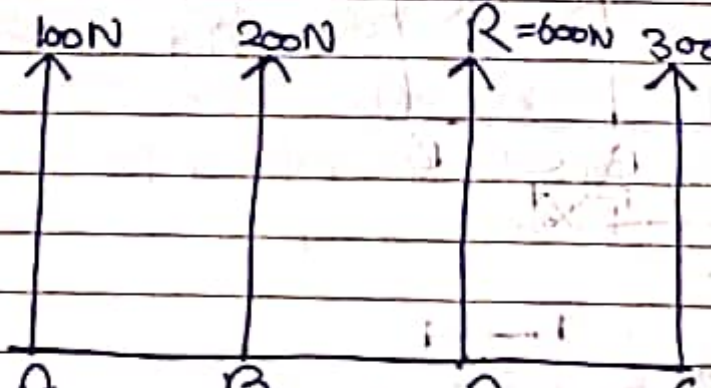
Clockwise (-ve)
$-F_1 r_1$
$-F_2 r_2$

Anticlockwise (+ve)
$F_3 r_3$

$$-F_1 r_1 - F_2 r_2 + F_3 r_3 = R \times r$$

↳ Principle of moments

Ques →



R = 100 + 200 + 300

R = 600N

-①.

Soln: R_x = Calculating moment about pt A.

$R_x \times x = 0 + 200 \times 0.30 + 300 \times 0.70$

$600\,x = 60 + 210$

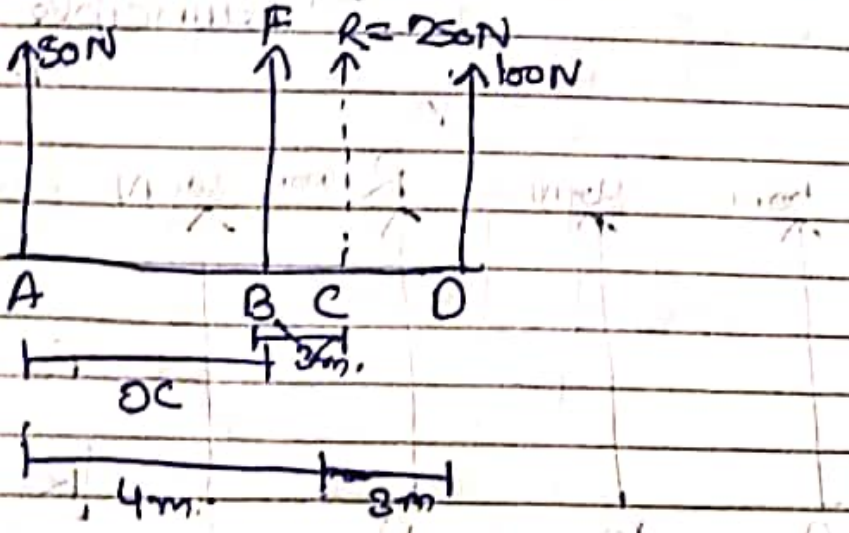
$x = \frac{270}{600}$

$x = 45\ cm$ — Ans 2 //;

Properties of resultant forces

- Magnitude
- Position
- Inclination or direction.

Ques:



F = ?

Its posⁿ, x = ?

Soln $250 = 50 + F + 100$

$F + F_2 = 100\ N$

Moment about pt (A)

$R \times x = 0 + 100x + 250 \times 4 + 100 \times 3$

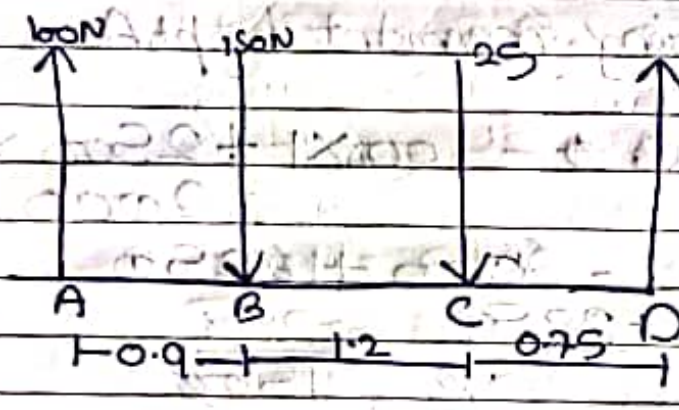
$250 \times 4 = 100x + 700$

$1000 - 700 = 100x$

$300 = 100x$

$x = 3m$

Ques



$R = ?$

Dist of R from A = ?

Soln:- $R = 100 + 200 - 150 - 25$

$R = 300 - 175$

$= 125\ N$

Calculating moment for about pt A.

$R \times x = 0 + 150 \times 0.90 - 25 \times 2.10 + 200 \times 2.85$

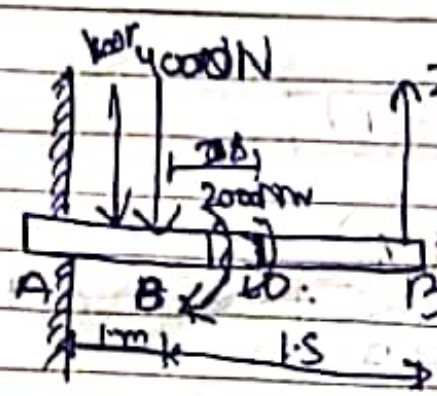
$125x = -135 - 52.5 + 570$

$125x = 570 - 187.5$

$x = \frac{382.5}{125}$

$x = 3.06m$

Resultant
- → magnitude
- → direction
- → position or pt on application.

Ques → 

Soln $R = -4000 + 2500$

$= -1500\,N.$

Calculating moment by pt A:

$-1500x = 0 + -4000 \times 1 + 2500 \times 2.5$

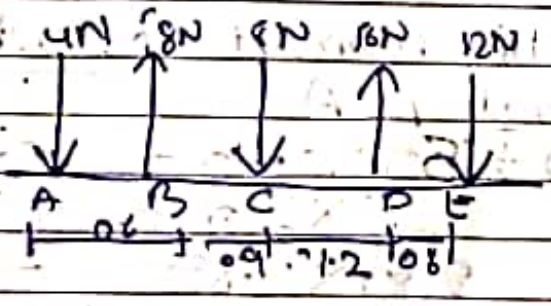
$- 2000$

$-1500x = -6500 + 6250$

$x = \frac{-250}{1500}$

$\boxed{x = -0.166\,m}$

Ques → R=? x=?



Soln

Soln $R = -4 + 8 - 8 + 16 - 12$

$= -16 + 8 + 8 + 16$

$\boxed{R = 0}$, if $R = 0$ → body is in equilibrium

→ resultant moment

A body is said to lie in equilibrium when

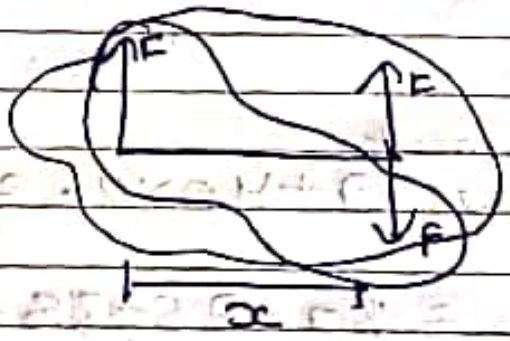
$$\left[\begin{array}{l}\Sigma Fx = 0 \\ \Sigma Fy = 0 \\ \Sigma M = 0\end{array}\right] \rightarrow \text{V.V. 9mb.}$$

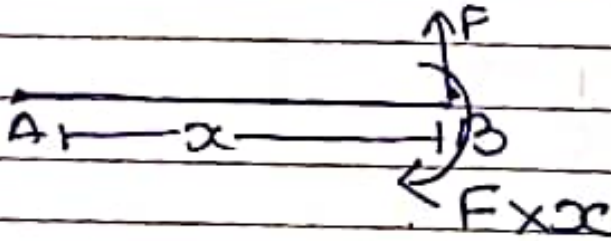
Calculating moment at pt A.

$$R \times x = 0 + 8 \times 0.6 - 8 \times 1.5 + 16 \times 2.7 - 12 \times 3.3$$

$$R \times x = 4.8 - 12 + 43.2 - 43.2$$

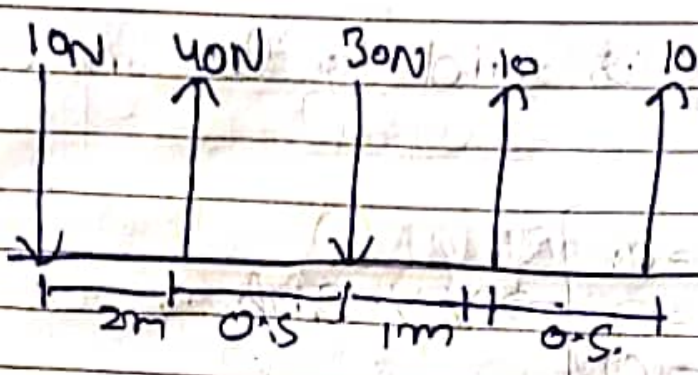
$$= -3.6 \text{ Nm} \neq 0$$





Resultant Movement of Couple.

Qu8



Soln $R = 20N$.

by PbA

$20x = 0 + 40 \times 2 - 30 \times 2.5 + 10 \times 3.5 + 10 \times 4$

$20x = 80 - 75 + 35 + 40$

$20x = 155 - 75$

$x = \frac{80}{20}$

$\boxed{x = 4m}$

If $R = 0$.

movement

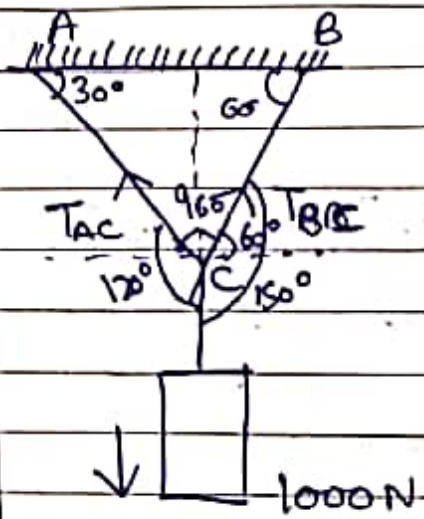
Res couple $= 0 + 40 \times 2 - 30 \times 2.5 - 10 \times 3.5 + 10 \times 4$

$= 80 - 75 - 35 + 40$

$= 120 - 120$

$= 10$ Nm, Anticlockwise

Ques →



T_{AC} & T_{BC} = ??

Soln Applying Lami's theorem:

$$\frac{T_{AC}}{\sin 150} = \frac{T_{BC}}{\sin 120^\circ} = \frac{1000}{\sin 90^\circ}$$

$$T_{BC} = 1000 \times \sin 120^\circ$$

$$= 1000 \times \frac{\sqrt{3}}{2}$$

$$\boxed{T_{BC} = 500\sqrt{2}\ N}$$

$$T_{AC} = 1000 \times \sin 150^\circ$$

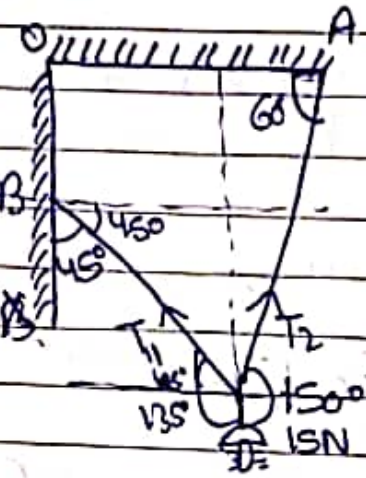
$$= 1000 \times \frac{1}{2}$$

$$\boxed{T_{AC} = 500\ N}$$

Horizontal → Cos

Vertical → Sin

Ques →



Fc. T_1 & T_2 = ??

Soln Applying Lami's Theorem.

$$\frac{T_1}{\sin 150^\circ} = \frac{T_2}{\sin 135^\circ} = \frac{15}{\sin 75^\circ}$$

$$T_2 = \frac{15 \times \sin 135}{\sin 75}$$

$$= \frac{15 \times 0.707}{0.97}$$

$$T_2 = 21.21\ N$$

$$T_1 = \frac{15 \times \sin 150}{\sin 75^\circ}$$

$$= \frac{15 \times 0.5}{0.97}$$

$$T_1 = 7.76\ N$$

$T_2 = 10.98N$