FORCE SYSTEMS

CHAPTER OUTLINE

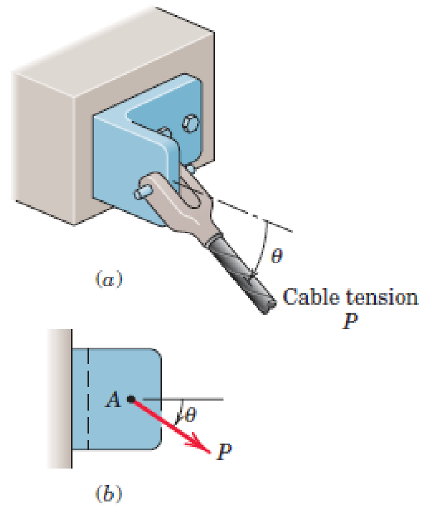
FORCE SYSTEMS

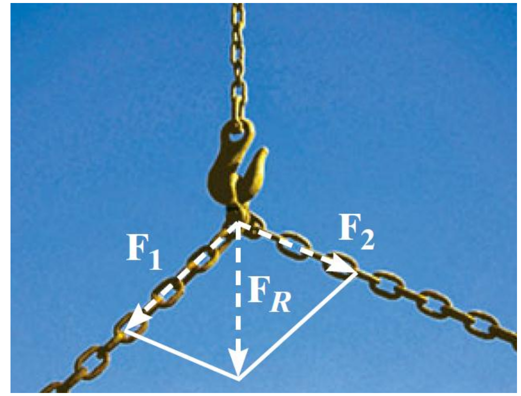
❖ Introduction

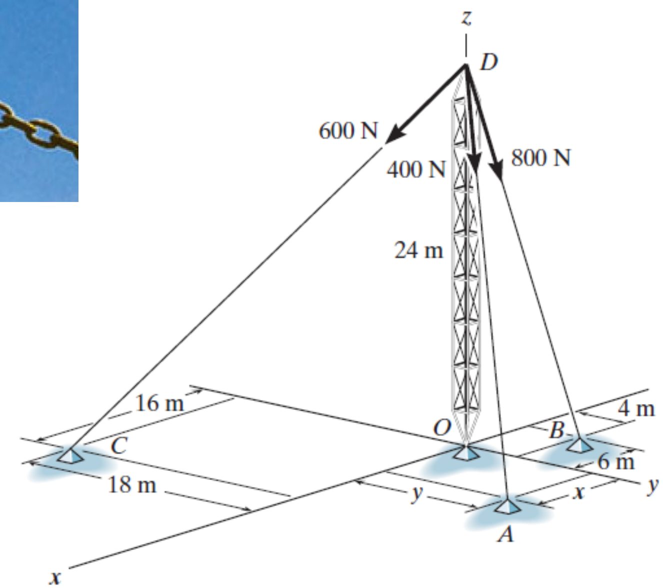
- We study the effects of forces which act on engineering structures and mechanisms.
- The experience gained here will help you in the study of mechanics and in other subjects such as stress analysis, design of structures and machines, and fluid flow.
- This chapter lays the foundation for a basic understanding not only of statics but also of the entire subject of mechanics, and you should master this material thoroughly.

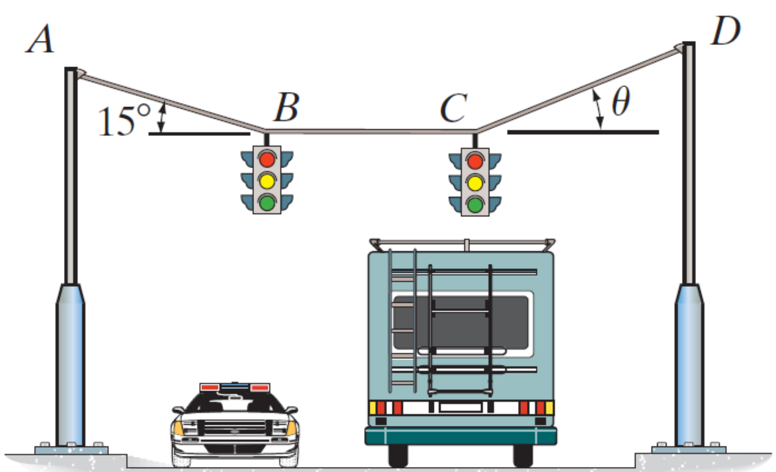
Engineering Mechanics I (Statics)

❖ Force









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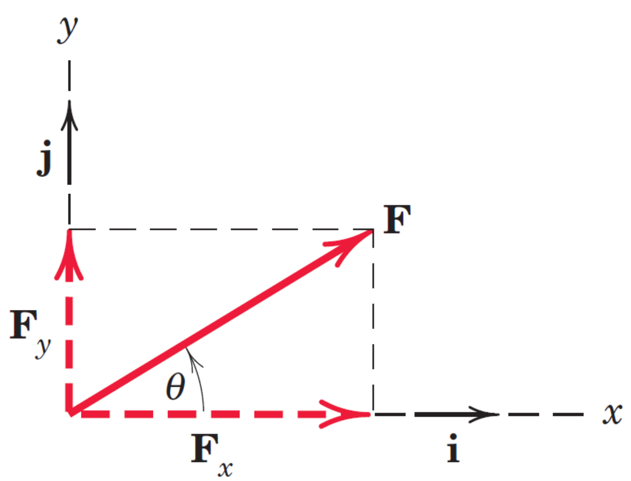
❖ SECTION A TWO-DIMENSIONAL FORCE SYSTEMS

2/3 Rectangular Components



$$\mathbf{F} = \mathbf{F}_x + \mathbf{F}_y$$

- where $\mathbf{F}_x$ and $\mathbf{F}_y$ are *vector components* of **F** in the *x*- and *y*-directions.

- In terms of the unit vectors **i** and **j**

$$\mathbf{F} = F_x\mathbf{i} + F_y\mathbf{j}$$

$$F_x = F\cos\theta \qquad F = \sqrt{F_x{}^2 + F_y{}^2}$$

$$F_y = F\sin\theta \qquad \theta = \tan^{-1}\frac{F_y}{F_x}$$

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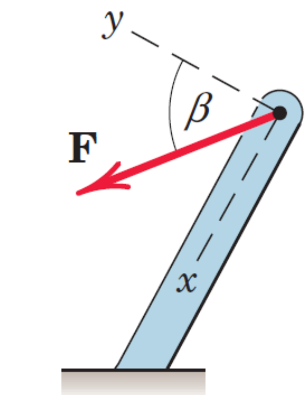
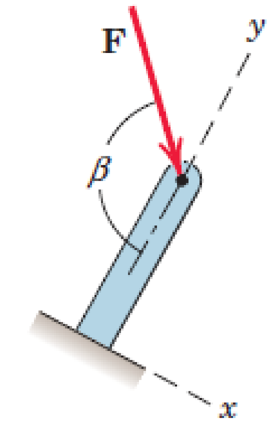
Fx:- horizontal component
Fy:- vertical component

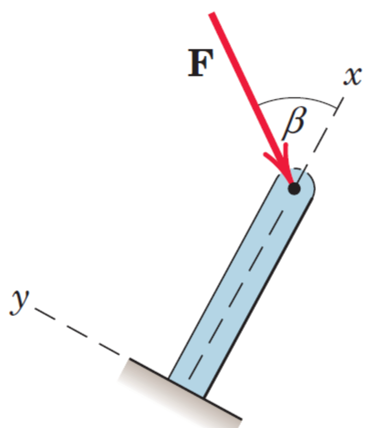
Near from the angle take cos β
Distant from the angle take sin β



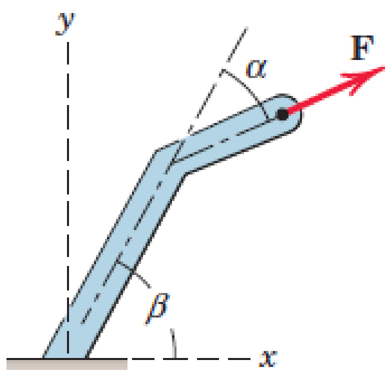
$$F_x = F \sin \beta$$
$$F_y = F \cos \beta$$



$$F_x = F \sin(\pi - \beta)$$
$$F_y = -F \cos(\pi - \beta)$$



$$F_x = -F \cos \beta$$
$$F_y = -F \sin \beta$$



$$F_x = F \cos(\beta - \alpha)$$
$$F_y = F \sin(\beta - \alpha)$$

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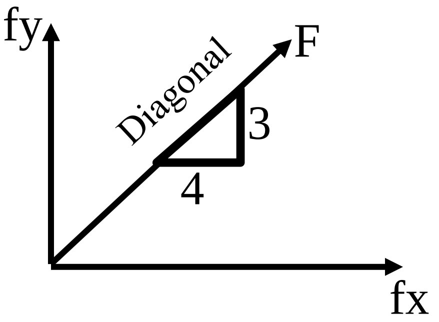
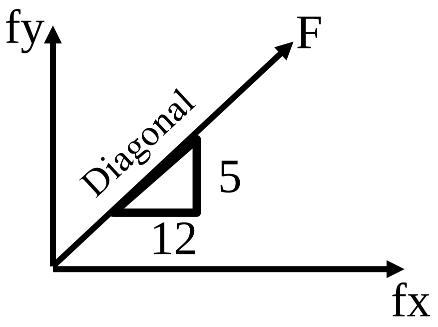
Diagonal = $\sqrt[2]{4^2 + 3^2} = 5$



Component = force . $\dfrac{parllel\ dimensoin\ of\ the\ component}{\text{Diagonal}}$

fx = F. $\frac{4}{5}$

fy = F. $\frac{3}{5}$



Diagonal = $\sqrt[2]{12^2 + 5^2}$ = 13

fx = F. $\frac{12}{13}$

fy = F. $\frac{5}{13}$

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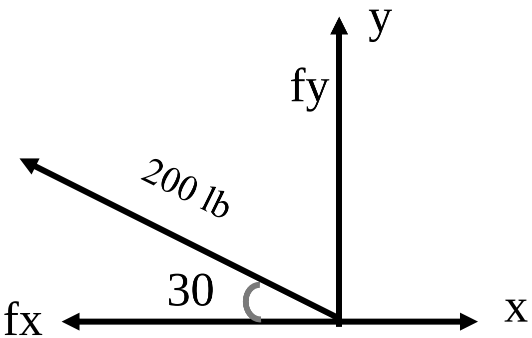
Ex:- a force of **200.lb** in directed as shown in fig below. Determine the x and y components of force.

$$fx = F.\cos\emptyset = -200.\cos 30$$
$$= -200\,.\,0.866$$
$$fx = -173.2\ lb.$$

$$fy = F.\sin\emptyset = 200.\sin 30$$
$$= 200\,.\,0.5$$
$$fy = 100lb.$$

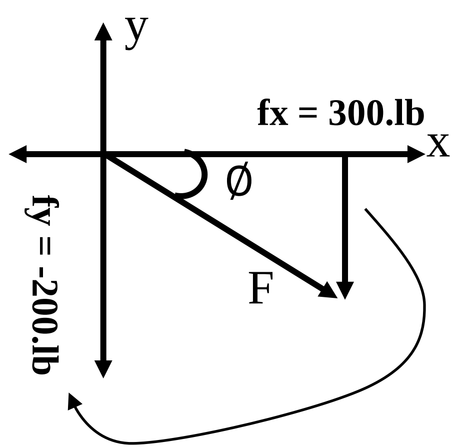


Ex:- the component of certain force are defined by **fx = 300.lb** and **fy = -200.lb** determine the magnitude inclination with X- axis, and pointing of the force .

$$F = \sqrt[2]{fx^2 + fy^2} = \sqrt[2]{300^2 + 200^2} = 361.\,lb$$

$$\tan\emptyset = \frac{200.\,lb}{300.\,lb} = 33.7\ (1.e\ -33.7\ or\ 326.3)$$

Result force = 361.lb, $\emptyset = 33.7$



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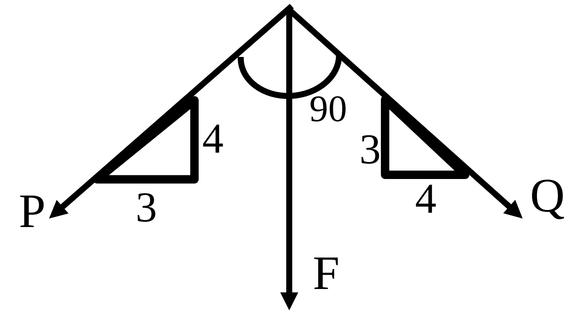
2- Analysis of two- dimensional orthogonal not in the x and y axis

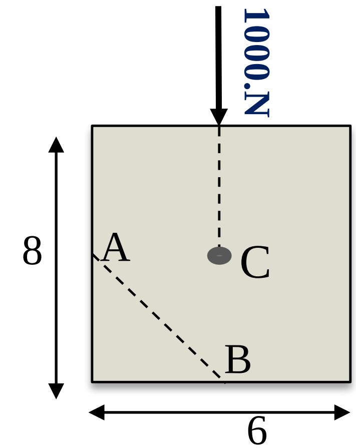
$$\text{Diagonal} = \sqrt[2]{4^2 + 3^2} = 5$$

$$p = F.\frac{4}{5}$$

$$Q = F.\frac{3}{5}$$



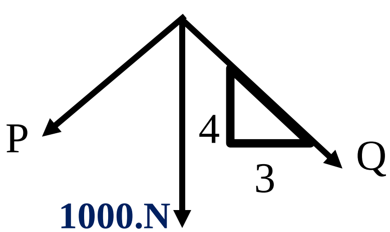
Ex:- Resolve the **1000.N** force of fig into two components: a shearing component parallel to AB and a normal component perpendicular to AB.



$$Diagonal = \sqrt[2]{4^2 + 3^2} = 5$$

$$Q = 1000.\frac{4}{5} = 800.N$$

$$P = 1000.\frac{3}{5} = 600.N$$



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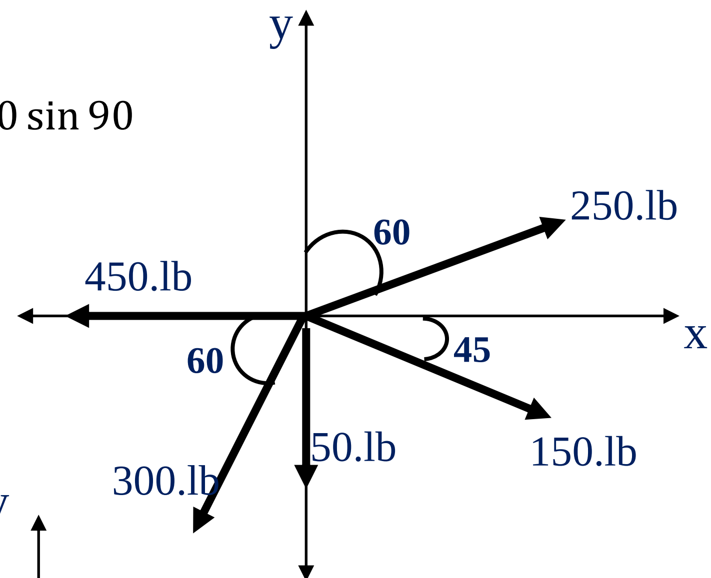
Ex:- Determine completely resultant of the concurrent force system shown in figure below.

$Rx = \sum x = 250 \sin 60 + 150 \cos 45 - 450 \cos 0 - 300 \cos 60$

$Rx = -277.43$



$Ry = \sum y = 250 \cos 60 + 150 \sin 45 - 300 \sin 60 - 50 \sin 90$

$Ry = -290.87$

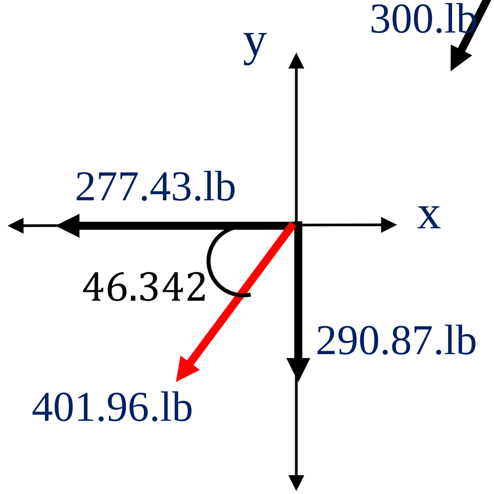
$$\mathbf{R} = \sqrt[2]{(\sum \boldsymbol{x})^2 + (\sum \boldsymbol{y})^2} = \sqrt[2]{(277.43)^2 + (290.87)^2}$$

$R = 401.96$ lb.

$$tan\, \emptyset = \frac{\sum y}{\sum x} = \frac{290.87}{277.43} = 1.048$$

$$\emptyset = \tan^{-1} 1.048$$

$$\emptyset = 46.342$$



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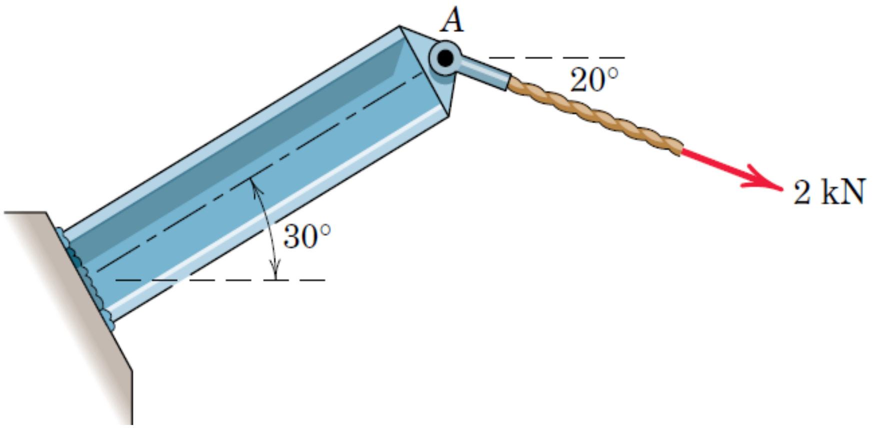
H.w.

Q1:- To satisfy design limitations it is necessary to determine the effect of the **2-kN** tension in the cable on the shear, tension, and bending of the fixed I-beam. For this purpose replace this force by its equivalent of two forces at ***A***, ***Ft*** parallel and ***Fn*** perpendicular to the beam. Determine ***Ft*** **and** ***Fn***.



Q2:- The two forces shown act at point ***A*** of the bent bar. Determine the resultant **R** of the two forces.