Engineering mechanics

 Deals with effect of forces on objects Mechanics principles used in vibration, spacecraft design, fluid flow, electrical, mechanical m/c design etc.

Statics: deals with effect of force on bodies which are not moving .

Dynamics: deals with force effect on moving bodies .We consider RIGID BODIES – Non deformable.

Scalar quantity: Only magnitude; time, volume, speed, density, mass…

Vector quantity: Both direction and magnitude; Force, displacement, velocity, acceleration, moment…

Force:

- action of one body on another - required force can move a body in the direction of action,otherwise no effect.

- some times plastic deformation, failure is possible

- Magnitude, direction.



Transmissibility principle:

A force may be applied at any point on a line of action without changing the resultant effects of the force applied external to rigid body on which it acts.

Magnitude, direction and line of action is important; not

point of application.



Finding the components of a force.:

Sometimes it is necessary to **resolve a force** into two components in

order to **study its pulling and pushing effect** in two specific directions.

Two dimensional force system

Rectangular components:

 $Fx=Fcosθ$

$$Fy=Fsinθ$$

$F=\sqrt{Fx^{2}+Fy^{2}}$

$θ=tan^{-1}\frac{Fy}{Fx}$

Components of Force

Examples:



Trigonometry analysis:

 **Redraw** a half portion of the parallelogram to illustrate the **triangular**

head to tail addition of the components. From this triangle, the magnitude of the resultant forcecan be determined using **the law of cosines,** and its direction is determined from the **law of sines.** The magnitudes of two force components are determined from the law of sines. The formulas are given in Figure.  **Cosine law:**

$$C=\sqrt{A^{2}+B^{2}-2ABcosθ}$$

**Sine law:**

$$\frac{A}{\sin(a)}=\frac{B}{\sin(b)}=\frac{C}{\sin(c)}$$

Ex: Resolve the force F=350

**Solution:**

**Ex2: The 500 ib force acting on the frame is to be resolved into two comp. acting along the axes AC and AB, if the comp along AC is 300.Determine the magnitude of the force along AB and the angle θ.**

****

***Solution:***

$$\frac{\sin(∅)}{300}=\frac{\sin(75)}{500}$$

 $\sin(∅)$ = 0.5796

$$∅=35.42$$

45+35.42+ θ+75=180$ ⇉$ θ = 24.58

$$\frac{F\_{AB}}{\sin((45+24.58))}=\frac{500}{\sin(75)} ⇉F\_{AB}=485$$

**Ex3.**



**Rectangular Components in Space (Three rectangular components)**:

 A forces have three rectangular components along the *x, y, z* coordinate axes and is represented by the vector sum of its **three rectangular components** .





The **magnitude** of **F** is expressed in Cartesian vector from as:

$$F=\sqrt{Fx^{2}+Fy^{2}+Fz^{2}}$$

The **direction** of F is defined by the **coordinate direction** angles α, β, and$ γ$.

$$cosα=\frac{lx}{l} ,cosβ=\frac{ly}{l}, cosγ=\frac{lz}{l}$$

$$cos^{2}α+cos^{2}β+cos^{2}γ=1$$