Engineering Mechanics
Assignment–1

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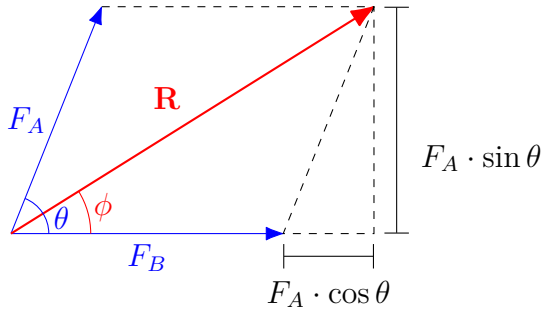
1. Determine the resultant of two concurrent forces with the help of law of parallelogram forces.

Let F_A and F_B be two concurrent forces and R be the resultant of the two forces:



$$R_x = F_B + F_A \cdot \cos\theta$$
$$R_y = F_A \cdot \sin\theta$$

By the Pythagorean Theorem,

$$\begin{aligned} R^2 &= {R_x}^2 + {R_y}^2 \\ &= (F_B + F_A \cdot \cos\theta)^2 + {F_A}^2 \cdot \sin^2\theta \\ &= ({F_B}^2 + {F_A}^2 \cdot \cos^2\theta + 2F_B F_A \cdot \cos\theta) + {F_A}^2 \cdot \sin^2\theta \\ &= {F_B}^2 + {F_A}^2 \cdot (\cos^2\theta + \sin^2\theta) + 2F_B F_A \cdot \cos\theta \\ &= {F_A}^2 + {F_B}^2 + 2F_A F_B \cdot \cos\theta \end{aligned}$$

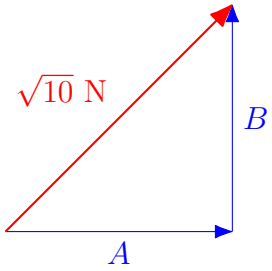
$\therefore$, the magnitude and direction of the resultant of the two forces is:

$$\boxed{\boldsymbol{R = \sqrt{{F_A}^2 + {F_B}^2 + 2F_A F_B \cdot \cos\theta}}}$$

$$\tan\phi = \frac{R_y}{R_x}$$

$$\boxed{\boldsymbol{\phi = \tan^{-1}\left(\frac{R_y}{R_x}\right)}}$$

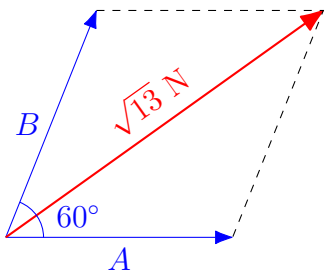
2. Find the magnitude of the two forces, such that if they act at right angles, their resultant is $\sqrt{10}$ N. But if they act at $60°$, their resultant is $\sqrt{13}$ N.



$$A^2 + B^2 = \left(\sqrt{10}\right)^2 = 10 \quad (1)$$
$$A^2 + B^2 + 2AB \cdot \cos 60° = \left(\sqrt{13}\right)^2 = 13$$
$$A^2 + B^2 + AB = 13 \quad (2)$$

From (1) & (2),

$$AB = 3$$
$$(A+B)^2 = A^2 + B^2 + 2AB = (10) + (2 \times 3) = 16$$
$$A + B = 4$$



Similarly,

$$A - B = 2$$

$$\boxed{\boldsymbol{A = 3\ \text{N}}} \quad \boxed{\boldsymbol{B = 1\ \text{N}}}$$

3. State following principles:

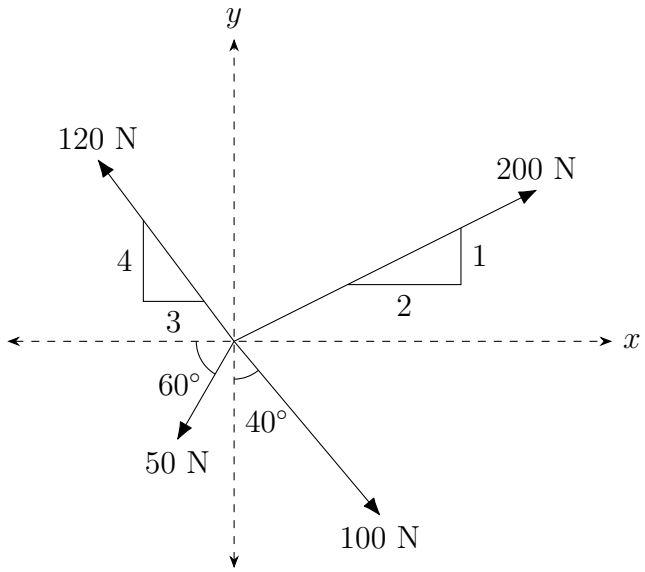
(a) Principle of transmissibility of forces

(b) Principle of superposition of forces

Principle of transmissibility of forces states that if a force acts at any point on a rigid body, it may also be considered to act at any other point on its line of action, provided this point is rigidly connected with the body.

Principle of superposition of forces states that the combined effect of a force system acting on a particle or a rigid body is the sum of the effects of the individual forces.

4. A system of four forces acting at a point on a body is as shown in the figure:



Let R be the resultant force with R_x being the horizontal component and R_y being the vertical component,

$$\begin{aligned}
R_x &= 200 \cdot \cos 26.56^\circ + 100 \cdot \sin 40^\circ - (120 \cdot \cos 53.13^\circ + 50 \cdot \cos 60^\circ) \\
&= \mathbf{146.17\ N} \\
R_y &= 200 \cdot \sin 26.56^\circ + 120 \cdot \sin 53.13^\circ - (50 \cdot \sin 60^\circ + 100 \cdot \cos 40^\circ) \\
&= \mathbf{65.52\ N} \\
R &= \sqrt{(R_x)^2 + (R_y)^2} = \sqrt{21365.66 + 4293.01} \\
\boxed{\boldsymbol{R} &= \mathbf{160.18\ N}} \\
\theta_R &= \tan^{-1}\left(\frac{R_y}{R_x}\right) = \tan^{-1}\left(\frac{65.52}{146.17}\right) \\
\boxed{\boldsymbol{\theta_R} &= \mathbf{24.14^\circ}}
\end{aligned}$$

5. What is force. State its effect and characteristics.

Force can be defined as a push or a pull on an object, it can alter the state of motion of an object.

$$F = m \cdot a$$

Characteristics & effects:

1. It can change the state of motion in an object, i.e., bring an object at rest in motion or vice-versa.
2. Force always has a magnitude and direction.
3. The resultant of multiple forces can be calculated by adding the individual forces with vector algebra.