Elementary Engineering Mathematics
Exercises #4 – Two Dimensional (2D) Vectors

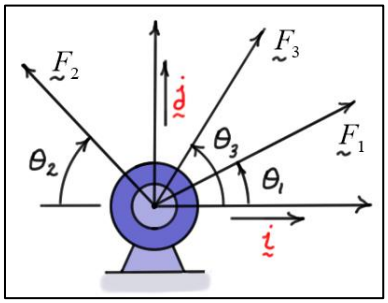
1. A force $\underset{\sim}{F}$ has a magnitude $\left|\underset{\sim}{F}\right| = 250$ (lb) and makes an angle $\theta = 135$ (deg) with the *X* axis. Express the force $\underset{\sim}{F}$ in terms of the unit vectors $\underset{\sim}{i}$ and $\underset{\sim}{j}$.

2. A force $\underset{\sim}{F}$ has a magnitude $\left|\underset{\sim}{F}\right| = 100$ (lb) and makes an angle $\theta = 55$ (deg) with the *X* axis. Express the force $\underset{\sim}{F}$ in terms of the unit vectors $\underset{\sim}{i}$ and $\underset{\sim}{j}$.

3. A force $\underset{\sim}{F} = -50\underset{\sim}{i} - 150\underset{\sim}{j}$ (lbs). Find the magnitude of $\underset{\sim}{F}$ and the angle between it and the $\underset{\sim}{i}$ direction. Express the angle in both degrees and radians.

4. A force $\underset{\sim}{F} = 80\underset{\sim}{i} - 100\underset{\sim}{j}$ (lbs). Find the magnitude of $\underset{\sim}{F}$ and the angle between it and the $\underset{\sim}{i}$ direction. Express the angle in both degrees and radians.

5. Given the three forces and angles $\left|\underset{\sim}{F}_1\right| = 50$ (lbs), $\theta_1 = 20$ (deg), $\left|\underset{\sim}{F}_2\right| = 100$ (lbs), $\theta_2 = 30$ (deg), and $\left|\underset{\sim}{F}_3\right| = 75$ (lbs), $\theta_3 = 70$ (deg), find (a) the total force $\underset{\sim}{F}$ in terms of the unit vectors $\underset{\sim}{i}$ and $\underset{\sim}{j}$, (b) the magnitude of $\underset{\sim}{F}$, (c) the angle that $\underset{\sim}{F}$ makes with the $\underset{\sim}{i}$ direction, and (d) a unit vector in the direction of $\underset{\sim}{F}$.



6. Given a force $\underset{\sim}{F} = 150\underset{\sim}{i} - 80\underset{\sim}{j}$ (lbs) and a unit vector $\underset{\sim}{n} = \frac{4}{5}\underset{\sim}{i} + \frac{3}{5}\underset{\sim}{j}$, find (a) the angle between the two vectors, (b) $\underset{\sim}{F}_{\parallel}$ the component of $\underset{\sim}{F}$ parallel to $\underset{\sim}{n}$, and (c) $\underset{\sim}{F}_{\perp}$ the component of $\underset{\sim}{F}$ perpendicular to $\underset{\sim}{n}$. Express all vectors in terms of unit vectors $\underset{\sim}{i}$ and $\underset{\sim}{j}$.

7. Given a force $\underset{\sim}{F} = 50\underset{\sim}{i} + 200\underset{\sim}{j}$ (lbs) and a unit vector $\underset{\sim}{n} = \frac{\sqrt{3}}{2}\underset{\sim}{i} + \frac{1}{2}\underset{\sim}{j}$, find (a) the angle between the two vectors, (b) the component of $\underset{\sim}{F}$ parallel to $\underset{\sim}{n}$, and (c) the component of $\underset{\sim}{F}$ perpendicular to $\underset{\sim}{n}$. Express the angle in degrees and radians and all vectors in terms of unit vectors $\underset{\sim}{i}$ and $\underset{\sim}{j}$.

8. A force $\underset{\sim}{F} = 150\underset{\sim}{i} - 80\underset{\sim}{j}$ (lbs) is applied at a point *A* whose coordinates are $(3,2)$ (ft). Find (a) $\underset{\sim}{M}_B$ the moment of $\underset{\sim}{F}$ about point *B* whose coordinates are $(4,5)$ (ft), and (b) the perpendicular distance from *B* to the line of action of $\underset{\sim}{F}$.

9. A force $\underset{\sim}{F} = 50\underset{\sim}{i} + 200\underset{\sim}{j}$ (lbs) is applied at a point *A* whose coordinates are $(2,5)$ (ft). Find (a) $\underset{\sim}{M}_B$ the moment of $\underset{\sim}{F}$ about point *B* whose coordinates are $(10,0)$ (ft), and (b) the perpendicular distance from *B* to the line of action of $\underset{\sim}{F}$.

10. A block is resting on an inclined plane under the action of its weight $\underset{\sim}{W}$ and the external force $\underset{\sim}{P}$. The plane exerts a friction force $\underset{\sim}{f}$ and normal force $\underset{\sim}{N}$ on the block holding it in place. Given $|\underset{\sim}{W}|=200$ (lbs), $|\underset{\sim}{P}|=100$ (lbs) and $\theta = 60^{\circ}$,

a) Express the forces $\underset{\sim}{W}$ and $\underset{\sim}{P}$ in terms of the unit vectors $\underset{\sim}{i}$ and $\underset{\sim}{j}$.

b) Find the friction and normal forces $\underset{\sim}{f}$ and $\underset{\sim}{N}$ so $\underset{\sim}{P}+\underset{\sim}{W}+\underset{\sim}{f}+\underset{\sim}{N}=\underset{\sim}{0}$.