

MR. PANDORAK SAMUEL OSUNTIBARI
 MATH 102
 DR. OKUNLOLA
 AERONAUTICAL ENGINEERING
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1. If $M = P\mathbf{i} - 6\mathbf{j} - 3\mathbf{k}$, $N = 9\mathbf{i} + 8\mathbf{j} - \mathbf{k}$, $O = \mathbf{i} - 3\mathbf{j} + 2\mathbf{k}$,
 Find the value of P for which (a) M and N are perpendicular
 to each other (b) M , N and O are coplanar

(a) M and N are perpendicular

$$\vec{M} \cdot \vec{N} = (P\mathbf{i} - 6\mathbf{j} - 3\mathbf{k}) \cdot (9\mathbf{i} + 8\mathbf{j} - \mathbf{k})$$

$$\vec{M} \cdot \vec{N} = 9P - 18 + 3$$

$$= 9P - 15$$

Perpendicular vectors = 0

$$0 = 9P - 15$$

$$-9P = -15$$

$$\frac{-9P}{-9} = \frac{-15}{-9}$$

$$P = 1.67$$

(b) M , N and O are Coplanar

$$\vec{M} \cdot \vec{N} \times \vec{O} = \begin{vmatrix} P & -6 & -3 \\ 9 & 8 & -1 \\ 1 & -3 & 2 \end{vmatrix}$$

$$P(6 - 3) - (-6)(18 - (-1)) + 3(-12 - 8)$$

For Coplanar vectors

$$3P + 54 + 45$$

$$0 = 3P + 99$$

$$-99 = 3P$$

$$\frac{-99}{3} = \frac{3P}{3}$$

$$P = -33$$

2. Find the direction cosines and the Unit Vector along the sum of $5i + 2j + 5k$, $2i - j + 6k$ and $5i + 2j - 8k$

$$A = 5i + 2j + 5k$$

$$B = 2i - j + 6k$$

$$C = 5i + 2j - 8k$$

$$A+B+C = 10i + 5j + 8k$$

$$|A+B+C| = \sqrt{10^2 + 5^2 + 8^2}$$

$$= \sqrt{193}$$

$$= 13.89$$

$$l = \frac{10}{13.89} = 0.7204$$

$$m = \frac{5}{13.89} = 0.3599$$

$$n = \frac{8}{13.89} = 0.5760$$