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MAT102
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1 If $M = pi - 6j - 3k$
$N = 4i + 3j - k$
$O = i + 3j + 2k$ find the value of P for which
(a) M and M are perpendicular
(b) M M and O are perpendicular Coplanar

Solution

If M and N are perpendicular
$M N = 0$

$(pi - 6j - 3k) \cdot (4i + 3j - k) = 0$
$4P - 18 + 3 = 0$
$4P = 18 - 3$
$4P = 15$
$P = 15/4$

If M N and O are Coplanar
$M \cdot (N \times O) = 0$

$$(N \times O) = \begin{vmatrix} i & j & k \\ 4 & 3 & -1 \\ 1 & 3 & 2 \end{vmatrix} = i\begin{vmatrix} 3 & -1 \\ 3 & 2 \end{vmatrix} - j\begin{vmatrix} 4 & -1 \\ 1 & 2 \end{vmatrix} + k\begin{vmatrix} 4 & 3 \\ 1 & 3 \end{vmatrix}$$

$= i(6 - (-3)) - j(8 - (-1)) + k(12 - 3)$
$= 9i - 9j + 9k$
$M \cdot (N \times O) = (pi - 6j - 3k)(9i - 9j + 9k) = 0$
$= 9p + 54 - 27 = 0$
$9p = -54 + 27$
$p = -27/9 = -3$

2 Find the direction Cosines and the unit Vector along the sum of $3i + 2j + 5k$, $2i + j + 6k$ and $5i + 2j - 3k$

Soln.

$(3i + 2j + 5k)$

$+ \; 2i \; \overline{+} j + 6k$

$5i + j + 11k$

$+ (5i + 2j - 3k) = r = 10i + 3j + 8k$

direction Cosines of $10i + 3j + 8k$

$$\text{Resultant} = \sqrt{10^2 + 3^2 + 8^2}$$

$$= \sqrt{173} = 13.15$$

$$\cos\alpha = \frac{a_x}{|r|} = \frac{10}{13.15}$$

$$\cos\beta = \frac{a_y}{|r|} = \frac{3}{13.15}$$

$$\cos\gamma = a_z = \frac{8}{13.15}$$

3 If $F = 3ui + u^2 j + (u+2)k$ and $V = 2ui - 3uj + (u-3)k$ evaluate the Integral of $F \times V \, du$ from 0 to 1

$$(F \times V) = \begin{vmatrix} i & j & k \\ 3u & u^2 & (u+2) \\ 2u & -3u & (u-3) \end{vmatrix}$$

$= i((u-3) \times u^2) - (-3u \times (u+2))] - j(3u(u-3) - 2u(u+2))$
$+ k(-9u^2 - 2u^3)$

$= i[u^3 - 3u^2 + 3u^2 + 6u] - j[3u^2 - 9u - 2u^2 - 4u] + k(-9u^2 \ldots$
$= i[u^3 + u^2 + 6u] - j[u^2 - 10u] + k(-9u^2 - 2u^2$

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$$\int (F \times V)\,du = \int_0^1 (u^3 + u^2 + 6u)_i - \int (u^2 - 10u)_j + \int (-9u^2 - 2u^3)_k$$

$$= \left[\frac{u^4}{4} + \frac{u^3}{3} + \frac{6u^2}{2}\right]_0^1 i - \left[\frac{u^3}{3} - \frac{10u^2}{2}\right]_0^1 j + \left[\frac{-6u^3}{3} - \frac{2u^4}{4}\right]_0^1 k$$

$+ c$

$$= \left[\frac{1}{4} + \frac{1}{3} + \frac{6}{2}\right] i - \left[\frac{1}{3} - \frac{10}{2}\right] j + \left[\frac{-9}{3} - \frac{2}{4}\right] k$$

$$= \left[\frac{1}{4} + \frac{1}{3} + 3\right] i - \left[\frac{1}{3} - 5\right] j + \left[-3 - \frac{1}{2}\right] k$$

$$\frac{43}{12} i + \frac{14}{3} j -$$