Name: Chikere Chibu-udom

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1 $M = pi - 6j - 3K$
$N = 4i + 3j - K$
$O = i - 3j + 2K$

a $M \cdot N = 0$ (since M and N are perpendicular, $M \cdot N = 0$)
$(pi - 6j - 3K) \cdot (4i + 3j - K) = 0$
$4p - 18 + 3 = 0$
$\frac{4p}{4} = \frac{15}{4}$
$\therefore p = 3.75$

b $M \cdot (N \times C) = \begin{vmatrix} p & -6 & -3 \\ 4 & 3 & -1 \\ 1 & -3 & 2 \end{vmatrix} = 0$

$= p((3\times2) - (-3\times-1)) - -6((4\times2) - (-1\times1)) - 3((4\times-3) - (3\times1))$
$= 3p + 54 + 45 = 0$
$\frac{3p}{3} = \frac{-99}{3}$
$\therefore p = -33$

2 $A = 3i + 2j + 5K$ let $A + B + C = D$
$B = 2i - j + 6K$
$C = 5i + 2j - 3K$
$A + B + C = 3i + 2i + 5i + 2j - j + 2j + 5K + 6K - 3K$
$\therefore D = 10i + 3j + 8K$

$\cancel{D}\cdot\ a_x = 10 \quad a_y = 3 \quad a_z = -6$

$|D| = \sqrt{10^2 + 3^2 + (-6)^2}$

$|D| = \sqrt{145}$

a $\therefore$ direction cosines

$\cos\alpha = \dfrac{a_x}{|D|} = \dfrac{10}{\sqrt{145}} = 0.830$

$\cos\beta = \dfrac{a_y}{|D|} = \dfrac{3}{\sqrt{145}} = 0.249$

$\cos\gamma = \dfrac{a_z}{|D|} = \dfrac{-6}{\sqrt{145}} = -0.498$

b unit vector $= e_D$

$= e_D = \dfrac{\bar{D}}{|D|} = \dfrac{10i + 3j + 8k}{\sqrt{145}}$

3 $F = 3ui + u^2 j + (u+2)k$

$V = 2ui + 3uj + (u-2)k$

Find $\int_0^1 (F.\times V)\,du$

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

$= i(u^2(u-2) - 3u(u+2)) - j(3u(u-2) - 2u(u+2)) + k(3u(3u) - u^2(2u$

$= i(u^3 - 2u^2 - 3u^2 + 6u) - j(3u^2 - 6u - 2u^2 + 4u) + k(6u^2 - 2u^3)$

$\cancel{i} = (u^3 - 5u^2 + 6u)i - (u^2 - 2u)j + (-2u^3 + 6u^2)k$

$\int (F\times V)\,du = i\left(\dfrac{u^4}{4} - \dfrac{5u^3}{3} + \dfrac{6u^2}{2}\right) - j\left(\dfrac{u^3}{3} - \dfrac{2u^2}{2}\right) + k\left(\dfrac{-2u^4}{4} + \dfrac{6u^3}{3}\right)$

$= i\left(\dfrac{u^4}{4} - \dfrac{5u^3}{3} + 3u^2\right) - j\left(\dfrac{u^3}{3} - u^2\right) + k\left(\dfrac{-u^4}{2} + 2u^3\right) + C$

$$\therefore \int_0^1 (F \times V)\,du = i\left(\frac{(1)^4}{4} - \frac{5(1)^3}{3} + 3(1)^2\right) - j\left(\frac{(1)^3}{3} - (1)^2\right) + K\left(\frac{(-1)^4}{2} + 2(1)^3\right) + c$$

$$= i\left(\frac{(0)^4}{4} - \frac{5(0)^3}{3} + 3(0)^2\right) - j\left(\frac{0^3}{3} - 0^2\right) + K\left(\frac{0^4}{2} + 2(0)^3\right) + c$$

$$= \frac{19}{12} i + \frac{2}{3} j + \frac{5}{2} K$$