① $M = Pi - 6j - 3k$, $N = 4i + 3j - k$, $O = i - 3j + 2k$, find the value of P

(a) $\bar{M} \cdot \bar{N} = (Pi - 6j - 3k) \cdot (4i + 3j - k)$

$= 4P - 18 + 3$

$= 4P - 15$

$\bar{M} \cdot \bar{N} = 0$

$4P - 15 = 0$

$4P = 15$

$P = \frac{15}{4}$

(B) $\bar{M} \cdot (\bar{N} \times \bar{O}) = 0$

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

$= i(6 - (3)) - j(8 - (-1)) + k(-12 - 3)$

$= 3i - 9j - 15k$

$\bar{M} \cdot (\bar{N} \times \bar{O}) = (Pi - 6j - 3k) \cdot (3i - 9j - 15k)$

$= 3P + 54 + 45$

$= 3P + 99$

$\bar{M} \cdot (\bar{N} \times \bar{O}) = 0$

$3P + 99 = 0$

$3P = -99$

② $F = 3ui + u^2 j + (u+2)k$

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

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

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

$= i(u^3 - 2u^2 + 3u^2 + 6u) - j(3u^2 - 6u - 3u^2 - 4u) + k(-9u^2 - 3u^2)$

$= i(u^3 + u^2 + 6u) - j(u^2 - 10u) + k(-2u^3 - 9u^2)$

$= (u^3 + u^2 + 6u)i - (u^2 - 10u)j + (-2u^3 - 9u^2)k$

$\int_0^1 F\,du = \int_0^1 (u^3 + u^2 + 6u)i - (u^2 - 10u)j + (-2u^3 - 9u^2)k \cdot du$

$= \left[\left(\frac{u^4}{4} + \frac{u^3}{3} + 3u^2\right)i - \left(\frac{u^3}{3} - 5u^2\right)j + \left(-\frac{u^4}{2} - 3u^3\right)k\right]_0^1$

$\left[\left(\frac{(1)^4}{4} + \frac{(1)^3}{3} + 3(1)^2\right)i - \left(\frac{(1)^3}{3} - 5(1)^2\right)j + \left(\frac{-(1)^4}{2} - 3(1)^3\right)k\right) + c\Big]$

$-\left[\left(\frac{(0)^4}{4} + \frac{(0)^3}{3} + 3(0)^2\right)i - \left(\frac{(0)^3}{3} - 5(0)^2\right)j + \left(-\frac{(0)^4}{4} - 3(0)^3\right)k\right) + c\Big]$

$\left(\frac{43}{12}i + \frac{14}{3}j + \frac{5}{2}k + c\right) - (0 - 0 + 0 + c)$

$= \frac{43}{12}i + \frac{14}{3}j + \frac{5}{2}k$