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19/ENG05/019
MECHATRONICS

1 $x = 7t^2$, $y = 6t^2 - 4t$, $z = t - 5$

position vector $r = xi + yj + zk$

$$\therefore \quad r = 7t^2 i + (6t^2 - 4t)j + (t-5)k$$

Velocity $dr/dt = 14t + (12t - 4)j + k$

$$dr/dt = 14t + (12t - 4)j + k$$

2 $A = i + 2j - 4k$, $B = 2i + 3j + k$, $C = 4j - 3k$ Find $A \times (B \times C)$

$$(B \times C) = \begin{vmatrix} i & j & k \\ 2 & -3 & 1 \\ 0 & 4 & -3 \end{vmatrix}$$

$$i(9 - 4) - j(-6 - 0) + k(8 - 0)$$
$$i(5) - j(-6) + k(8)$$

$$(B \times C) = 5i + 6j + 8k$$

$$A \times (B \times C) = \begin{vmatrix} i & j & k \\ 1 & 2 & -4 \\ 5 & 6 & 8 \end{vmatrix}$$

$$i[16 - (-24)] - j[8 - (-20)] + k[6 - 10]$$
$$i(16 + 24) - j(8 + 20) + k(-4)$$
$$i(40) - j(28) \cancel{+k} - k(4)$$

$$= 40i - 28j - 4k$$

$$A \times (B \times C) = 40i - 28j - 4k.$$

3 $R = 4\sin 3t\, i + 4e^{3t} j + 7t^3 k$ find the integral of R with respect to t

Solution

$$\int R\,dt = \int \left[(4\sin 3t) i + (4e^{3t}) j + (7t^3) k \right] dt$$

$$= \int (4\sin 3t) i\, dt + (4e^{3t}) j\, dt + (7t^3) k\, dt$$

$$= \left(4 \times -\tfrac{1}{3} \cos 3t\right) i + \left(4 \times \tfrac{1}{3} e^{3t}\right) j + \left(\frac{7t^4}{4}\right) k$$

$$\int R\,dt = \left(-\tfrac{4}{3} \cos 3t\right) i + \left(\frac{4}{3} e^{3t}\right) j + \left(\frac{7t^4}{4}\right) k + C$$

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4) $A = 7i + 2j - k$, $B = 2i + j + 4k$, $C = i + j + k$

$(A+C) \cdot (B-A)$

$(A+C) = (7i + 2j - k) + (i + j + k)$

$= (8i + 3j)$

$(B-A) = (2i + j + 4k) - (7i + 2j - k)$

$= (-5i - j + 5k)$

$(A+C) \cdot (B-A)$

$= (8i + 3j) \cdot (-5i - j + 5k)$

$-40 \quad -3 \quad 0$

$= -43$

5) $x = t$, $y = t^2$ $z = t^3$

when $t = 1$

$r = ti + t^2 j + t^3 k$

$dr/dt = i + 2tj + 3t^2 k$

, at $t = 1$ $i + 2j + 3k$

$\left|\frac{dr}{du}\right|_{t=1} = \sqrt{1^2 + 2^2 + 3^2} = \sqrt{1+4+9} = \sqrt{14}$

$= 3.74$

Hence $T = \frac{i + 2j + 3k}{3.74}$