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MECHATRONICS

1  $x = 7t^2$ ,  $y = 6t^2 - 4t$ ,  $z = t - 5$   
position vector  $r = xi + yj + zk$

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

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  $A \times (B \times C)$

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

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

$$i(5) - j(-6) + k(8)$$

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

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

$$i[16 - (-24)] - j[8 - (-20)] + k[6 - 10]$$

$$i(16 + 24) - j(8 + 20) + k(-4)$$

$$i(40) - j(28) - k(4)$$

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

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

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

Solution

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

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

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

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

$$4) A = 7i + 2j - k, B = 2i + 5j + 4k, C = i + j + k$$

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

$$(A+C) = (7i + 2j - k) + (i + j + k) \\ = (8i + 3j)$$

$$(B-A) = (2i + 5j + 4k) - (7i + 2j - k) \\ = (-5i - j + 5k)$$

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

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

$$= -40 - 3 + 0 = -43$$

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

$$\text{When } t = 1$$

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

$$\frac{dr}{dt} = i + 2tj + 3t^2k$$

$$\text{at } t = 1 \quad i + 2j + 3k$$

$$\left| \frac{dr}{dt} \right|_{t=1} = \sqrt{1^2 + 2^2 + 3^2} = \sqrt{1+4+9} = \sqrt{14} = 3.74$$

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