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Mechatronics Engineering
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1. $8(A+B)\cdot(C-A)$; $A = 5i - 7j - 6k$, $B = j + 4k$ $C = 9i - 4j + k$

$8(A+B) = 8(5i - 6j - 2k) = -40i + 48j + 16k$.

$(C-A) = 9i - 4j + k - (5i - 7j - 6k) = 4i + 3j + 7k$

$-8(A+B)\cdot(C-A) = (-40i + 48j + 16k)\cdot(4i + 3j + 7k)$

$= -160i + 144j + 112k$

2. Position vector $(r) = (3t)i + (t^2)j + (4t^3)k$

Tangent vector i.e

$r^{-1}(t) = -3i + 2tj + 12t^2k$

$r^{-1}(1) = -3i + 2(1)j + 12(t)^2k$

$= -3i + 2j + 12k$

Unit tangent vector

magnitude $\sqrt{(-3)^2 + 2^2 + 12^2} = \sqrt{157}$

$= \frac{-3}{\sqrt{157}}, \frac{2}{\sqrt{157}}, \frac{12}{\sqrt{157}}$

$= \langle 0.24, 0.16, 0.96 \rangle$

3. $r = (-8t^2)i + (t^2 - 4t)j + (t+1)k$

$\frac{dr}{dt} = (-16t)i + (2t - 4)j + 1(k)$

acceleration vector $= \frac{d^2r}{dt^2} = -16i + (2t)j$

4. $((A \times B) \times C)$

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

$= i\begin{vmatrix} 2 & -4 \\ -3 & 1 \end{vmatrix} - j\begin{vmatrix} 1 & -4 \\ 2 & 1 \end{vmatrix} + k\begin{vmatrix} 1 & 2 \\ 2 & -3 \end{vmatrix}$

$= i(2 - (-12)) - j(1 - (-8)) + k(-3 - 4)$

$= i(-10) - j(9) - 7k$

$= -10i - 9j - 7k$

$$[(A \times B) \times C] = \begin{vmatrix} i & j & k \\ -10 & -9 & -7 \\ 0 & 4 & -3 \end{vmatrix}$$

$$= 1\begin{vmatrix} -9 & -7 \\ 4 & -3 \end{vmatrix} - j\begin{vmatrix} -10 & -7 \\ 0 & 3 \end{vmatrix} + k\begin{vmatrix} -10 & -9 \\ 0 & 4 \end{vmatrix}$$

$$= i\,(27 - (-28)) - j\,(-10 - 0) + k(-40 - 0)$$

$$= 55i + 10j - 40k.$$

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

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

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

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