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Assignment title: Maths 102 for College 1 auditorium (Dr Oyelami's group)
Department: Mechatronics
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1.) A particle moves along a curve; $x = 7t^2$, $y = 6t^2 - 4t$, $z = t - 5$ where t is the time. Find the velocity.

solution

Let $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ be the position vector of any point on the curve

$$\vec{V} = \frac{d\vec{r}}{dt} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j} + \frac{dz}{dt}\hat{k}$$

$$\vec{V} = (14t)\hat{i} + (12t - 4)\hat{j} + (1)k$$

2) Find $A \times (B \times C)$

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

$$= 5i + 6j + 8k$$

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

$$= i\,|16 - (-24)| - j\,|8 - (-20)| + k\,|6 - 10|$$

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

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3.) Given $R = 4\sin 3t\, i + 4e^{3t} j + 7t^3 k$ integrate with respect to t.

$$\int_0^1 R\,dt = \int \left[(4\sin 3t)\, i + \cancel{4te}(4e^{3t}) j + (7t) k \right]$$

$$= -\frac{4}{3}\cos 3t\, i \Big|_0^1 + \frac{4e^{3t}}{3} j \Big|_0^1 - \frac{7t^2}{2} k \Big|_0^1$$

$$= \frac{-4}{3}\cos 3(1)\, i + \frac{4}{3} e^{3(1)} j - \frac{7(1)^2}{2} k$$

$$= -1.33i + 10.87j + 3.5k.$$

4.) If $A = 7i + 2j - k$, $B = 2i + j + 4k$, $C = i + j + k$, find $(A+C)\cdot(B-A)$

$$|A+C| = (7i + 2j - k) + (i + j + k) = 8i + 3j + 0k$$

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

$$|A+C|\cdot|B-A| = |8i + 3i + 0k| \cdot |-5i - j + 5k|$$

$$= -40 - 3 + 0$$

$$= -43.$$

5) Find a unit vector tangent to the space curve $x = t, y = t^2$
$z = t^3$ at point where $t = 1$

soln

$$\vec{r} = ti + t^2 j + t^3 k$$

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

at $t = 1$

$$\frac{dr}{dt} = i + 2(1)j + 3(1)^2 k$$

$$\frac{dr}{dt} = i + 2j + 3k$$

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

Hence $T = \dfrac{dr/dt}{|dr/dt|}$

$$T = \frac{i + 2j + 3k}{3.7}.$$