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Mechanical Engineering

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Question 1

A particle moves along a curve $x = 8t^3$, $y = 4t^3 - 7t$ and $z = t + 3$, where t is time, find its:

- i Velocity
- ii acceleration

Solution

$$r = 8t^3 i + (4t^3 - 7t)j + (t + 3)k$$

i Velocity = $\frac{dr}{dt}$

$$\frac{dr}{dt} = 24t^2 i + (12t^2 - 7)j + k$$

\therefore Velocity = $24t^2 i + (12t^2 - 7)j + k$

ii acceleration = $\frac{d^2 r}{dt^2}$

$$\frac{d^2 r}{dt^2} = 48t i + 24t j$$

\therefore acceleration = $48t i + 24t j$

Question 2

Find the unit tangent vector to the space curve $x = 3t$, $y = t^3$ and $z = t^2$ at $t = 1$

Solution

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

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

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

$$\left| \frac{dr}{dt} \right| = \sqrt{3^2 + 3^2 + 2^2} = \sqrt{9 + 9 + 4} = \sqrt{22}$$

$$\text{Unit Tangent Vector } (T) = \frac{dr/dt}{|dr/dt|} = \frac{3i + 3j + 2k}{\sqrt{22}}$$