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17/mhs05/010
Biomedical Engineering

1) $F = x^2 i + (3x+2) j + \sin x\, k$

(a) $\frac{dF}{dx} = 2x i + 3j + \cos x\, k$

(b) $\frac{d^2F}{dx^2} = 2i - \sin x\, k$

(c) $\left|\frac{dF}{dx}\right| = \sqrt{(2)^2 + (3)^2 + 1^2}$; $2x i + 3j + \cos x\, k$ at $x = 1$

$= \sqrt{4 + 9 + 1}$

$= \sqrt{14} = 3.74$

(d) $d/dx (F \cdot F)$ at $x = 1$

$F \cdot F = (x^2 i + (3x+2) j + \sin x\, k) \cdot (x^2 i + (3x+2) j + \sin x\, k)$

$= x^4 i + (9x^2 + 12x + 4) j + (\sin^2 x)\, k$

$d/dx (F \cdot F) = 4x^3 + 18x + 12 + \sin(2x)$

$= 4 + 18 + 12 + 0.035$ at $x = 1$

$= 34.034$

$d/dx (F \cdot F) = 34.03$

2) $r = (t^2 + 3t) i - 2\sin^3 t\, j + 3e^{2t}$

$dr/dt = (2t + 3) i - 6\cos 3t\, j + 6e^{2t} k$

$\frac{d^2 r}{dt^2} = \frac{d}{dt}\left[\frac{dr}{dt}\right]$

$= d/dt \left[(2t+3) i + (-6\cos 3t) j + 6e^{2t} k\right]$

$\frac{d^2 r}{dt^2} = 2i + (18 \sin 3t) j + 12 e^{2t} k$

$\left|\frac{d^2 r}{dt^2}\right| = \sqrt{(2)^2 + (18 \sin 3 \cos)^2 + 12e^{2(0)^2}}$

$= \sqrt{4 + 144}$

$= 2\sqrt{37}$

$= 12.17$