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Computer Engineering Engineering Mathematics Assignment 2

1) Given that $F = x^3i + (3x+2)j + \sin xk$, find

a) $\frac{df}{dx}$ b) $\frac{d^2f}{dx^2}$ c) $\left| \frac{df}{dx} \right|$ d) $(f \cdot f)$ at $x=1$

Solution

$$a) \frac{df}{dx} = 2xi + (3)j + \cos xk$$

$$\therefore \frac{df}{dx} = 2xi + 3j + \cos xk$$

$$b) \frac{d^2f}{dx^2} = 2i - \sin xk$$

$$c) \left| \frac{df}{dx} \right| = \sqrt{(2x)^2 + (3)^2 + (\cos x)^2}$$
$$= \sqrt{4x^2 + 9 + \cos^2 x}$$

$$\text{At } x=1$$

$$= \sqrt{4(1)^2 + 9 + \cos^2(1)}$$

$$= \sqrt{4 + 9 + 0.999}$$

$$= \sqrt{13.999}$$

$$= 3.74$$

$$d) \frac{d}{dx} (f \cdot f) = \left[(x^2i) + (3x+2)j + \sin xk \right] \cdot \left[(x^2i) + (3x+2)j + \sin xk \right]$$

$$= x^4 + (9x^2 + 6x + 6x + 4) + \sin^2 x$$

$$= x^4 + 9x^2 + 12x + 4 + \sin^2 x$$

$$\therefore \frac{d}{dx} (f \cdot f) = 4x^3 + 18x + 12 + 2 \sin x \cos x$$

$$\frac{d}{dx} (f \cdot f) \text{ at } x=1 = 4(1)^3 + 18(1) + 12 + 2 \sin(1) \cos(1)$$

$$= 4 + 18 + 12 + 2(0.0175)(0.999)$$

$$= 4 + 18 + 12 + 0.035$$

$$= 34.035$$

2) If $r = (t^2 + 3t)i - 2\sin 3tj + 3e^{2t}k$. Determine;

a) $\frac{dr}{dt}$ b) $\frac{d^2r}{dt^2}$ c) $\left| \frac{d^2r}{dt^2} \right|$ at $t = 0$

Solution

$$a) \frac{dr}{dt} = (2t + 3)i - 6\cos 3tj + 6e^{2t}k$$

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

$$c) \left| \frac{d^2r}{dt^2} \right|_{\text{at } t=0} = 2i + [18\sin(3)(0)]j + 12e^{2(0)}k$$

$$= 2i + 18\sin 0j + 12e^0k$$

$$= 2i + 18(0)j + 12(1)k$$

$$= 2i + 12k$$

$$\therefore \left| \frac{d^2r}{dt^2} \right| = \sqrt{(2)^2 + (12)^2}$$

$$\left| \frac{d^2r}{dt^2} \right| = \sqrt{4 + 144}$$

$$= \sqrt{148}$$

$$= 12.17$$