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MATRIC NO: 17/ENG02/061

DEPARTMENT: COMPUTER ENGINEERING

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

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

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

$$\text{At } x=1, \frac{dF}{dx} = 2(1)i + 3j + \cos(1)k = 2i + 3j + 0.9999k$$

$$\frac{dF}{dx} = 2i + 3j + 1k$$

$$(b) \frac{d^2F}{dx^2} = \frac{d}{dx} (2xi + 3j + \cos xk) = 2i - \sin xk$$

$$\text{At } x=1, \frac{d^2F}{dx^2} = 2i - \sin(1)k = 2i - 0.018k$$

$$\frac{d^2F}{dx^2} = 2i - 0.018k$$

$$(c) \left| \frac{dF}{dx} \right| = \sqrt{2^2 + 3^2 + 1^2} = \sqrt{4 + 9 + 1} = \sqrt{14} = 3.74$$

$$\left| \frac{dF}{dx} \right| = 3.74$$

$$(d) \frac{d(F \cdot F)}{dx}, F \cdot F = x^2i + (3x+2)j + \sin xk \cdot (x^2i + (3x+2)j + \sin xk)$$
$$= (x^2 \cdot x^2)i \cdot i + (3x+2)(3x+2)j \cdot j + (\sin x \sin x)k \cdot k$$
$$= x^4 + 9x^2 + 6x + 6x + 2 \sin x \cos x \sin^2 x + 4$$
$$= x^4 + 9x^2 + 12x + \sin^2 x + 4$$

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

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

$$= 4 + 18 + 12 + 0.0349$$

$$= 34.0349 \approx 34.03$$

$$\frac{d}{dx}(F \cdot F) \quad x=1 = 34.03$$

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

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

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

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

$$\text{At } t=0, \frac{dr}{dt} = (2(0) + 3)i - 6 \cos 3(0) j + 6e^{2(0)} k = 3i - 6j + 6k$$

$$\frac{dr}{dt} = 3i - 6j + 6k$$

$$(b) \frac{d^2r}{dt^2} = \frac{d}{dt}((2t + 3)i - 6 \cos 3t j + 6e^{2t} k) = 2i + 18 \sin 3t j + 12e^{2t} k$$

$$\text{At } t=0, \frac{d^2r}{dt^2} = 2i + 18 \sin 3(0) j + 12e^{2 \cos} k = 2i + 12k$$

$$(c) \left| \frac{d^2r}{dt^2} \right|_{t=0} = \sqrt{2^2 + 12^2} = \sqrt{4 + 144} = \sqrt{148} = 12.166$$

$$\left| \frac{d^2r}{dt^2} \right|_{t=0} = 12.166$$