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Course Code: ENG 282

Question 1

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

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

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

$$c) \left| \frac{dF}{dx} \right| \quad \text{Recall } \frac{dF}{dx} = 2xi + 3j + \cos x k$$

$$\text{When } x=1, \quad \frac{dF}{dx} = 2i + 3j + k$$

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

$$\frac{d}{dx} (F \cdot F) \text{ at } x=1$$

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

$$= (x^2 - x^2) i + (3x+2)(3x+2) j + (\sin x)(\sin x) k$$

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

$$F \cdot F = 9x^2 + 12x + 4 j + (\sin^2 x) k$$

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

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

$$= 4 + 18 + 12 + 0.039$$

$$= 34.039$$

$$\frac{d}{dx} (F \cdot F) = 34.039$$

Question 2

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

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

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

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

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

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

$$= \sqrt{2^2 + (18 \sin 0)^2 + (12e^0)^2}$$

$$= \sqrt{4 + 144} = \sqrt{148}$$

$$= 2\sqrt{37}$$

$$= 12.17$$