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Mechatronics Engineering

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

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

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

$$c) \left| \frac{dF}{dx} \right| = \sqrt{(2)^2 + (3)^2 + (1)^2} \cdot 2xi + 3j + \cos x k \text{ at } x=1$$
$$= \sqrt{4+9+1}$$
$$= \sqrt{14}$$
$$= 3.74$$

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

$$F \cdot F = (x^2 i + (3x+2)j + \sin x k) \cdot (x^2 i + (3x+2)j + \sin x k)$$
$$= x^4 i + (9x^2 + 12x + 4)j + (\sin^2 x)k$$

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

$$= 4 + 18 + 12 + 0.035 \text{ at } x=1$$

$$= 34.034$$

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

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

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

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

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

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

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

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

$$= 2\sqrt{37}$$

$$= 12.77$$