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17/ENG03/049

ENG 282

CIVIL ENGINEERING

(1) Given that $f = x^2 i + (3x+2)j + \sin x\, k$; find
(a) df/dx (b) d^2f/dx^2 (c) $|df/dx|$ (d) $d/dx\,(f \cdot f)$ at $x = 2$

Solu.

$$f = x^2 i + 3x + 2j + \sin k$$

(a) $\dfrac{df}{dx} = 2x i + (3+0)j + \cos k$

$$\therefore \frac{df}{dx} = 2x i + 3j + \cos x\, k$$

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

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

$$= \sqrt{4x^2 + 9 + \cos^2 x}$$

At $x = 1$

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

$$= 3.74$$

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

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

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

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

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

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

$= 4 + 18 + 12 + 0.035$

$= 34.035$ //

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

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

Soln:

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

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

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

At $t = 0$

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

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

$= 2i + 12k$

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

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

$= \sqrt{148}$

$= 12.17$ //