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Assignment II

1. Given that

$F = k^2\hat{i} + (3k+2)\hat{j} + \sin k$, Find;

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

Solution:

a) $\frac{dF}{dk} = 2k\hat{i} + 3\hat{j} + \cos k\,\hat{k}$

at $k = 1$

$\frac{dF}{dk} = 2(1)\hat{i} + 3\hat{j} + \cos(1)\hat{k}$

$= 2\hat{i} + 3\hat{j} + 0.9998\hat{k}$

b) $\frac{d^2F}{dk^2} = 2\hat{i} - \sin k\,\hat{k}$

at $k = 1$

$\frac{d^2F}{dk^2} = 2\hat{i} - \sin(1)\hat{k}$

$= 2\hat{i} - 0.075\hat{k}$

c) $\left|\frac{dF}{dk}\right| = 2\hat{i} + 3\hat{j} + 0.998\hat{k}$

$= \sqrt{(2)^2 + (3)^2 + (0.998)^2}$

$= \sqrt{13.096} = 3.74$

d) $\frac{d(F \cdot F)}{dk}$

$F \cdot F = [k^2\hat{i} + (3k+2)\hat{j} + \sin k\,\hat{k}] \cdot [k^2\hat{i} + (3k+2)\hat{j} + \sin k\,\hat{k}]$

$= k^4 + (9k^2 + 12k + 4) + \sin^2 k$

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

at $k = 1$

$$\frac{d}{dk}(F\cdot F) = 4+18+12+\sin(1)\cos(1)$$
$$= 4+30+0.035$$
$$= 34.035$$

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

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

solution:

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

at $t=0$

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

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

$t=0$

$$\frac{d^2r}{dt^2} = 2i + 18\cos 3(0) + 12e^{2(0)}\hat{k}$$
$$= 2\hat{i} + 12\hat{k}$$

c) $\left|\frac{d^2r}{dt^2}\right| = 2i + 12k$

$$= \sqrt{(2)^2+(12)^2}$$
$$= \sqrt{4+144}$$
$$= \sqrt{148}$$
$$= 2\sqrt{37}$$