2) If $r = (t^2 + 3t)i - 2\sin 3t j + 3e^{2t}K$ Determine (a) dr/dt (b) d^2r/dt^2
(c) $\left|\frac{d^2r}{dt^2}\right|$ at $t = 0$

Solution

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

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

(c) $\left|\frac{d^2r}{dt^2}\right|_{at\ t=0}$ $\therefore 2i + [18\sin(3)(0)]j + 12e^{2(0)}K$
$= 2i + 18\sin 0 j + 12e^0 K$
$= 2i + 18(0)j + 12(1)K$
$= 2i + 12K$

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

$\left|\frac{d^2r}{dt^2}\right| = \sqrt{4 + 144} = \sqrt{148} = 12.17$

EMG282

02/03/19

UDEOGU SAMUEL JAIHI 17/ENG06/080 MECHANICAL ENGINEERING 200L

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

Solution

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

(a) $dF/dx = 2x i + (3)j + \cos x k$

$\therefore dF/dx = 2x i + 3j + \cos x k$

(b) $d^2F/dx^2 = 2i - \sin x k$

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

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

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

$= \sqrt{4 + 9 + 0.999} = \sqrt{13.999} = 3.74$

(d) $\frac{d}{dx}(F \cdot F) \Rightarrow (F \cdot F) = [(x^2 i) + (3x+2)j + \sin x k] \cdot [(x^2)i + (3x+2)j + \sin x k]$

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

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

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

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

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

$= 4 + 18 + 12 + 0.035$

$= 34.035$