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 Civil Engineering  
 ENGG 282

①  $f = x^2 i + (3x+2) j + \sin x k$

②  $\frac{df}{dx} = 2xi + 3j + \cos x k$

③  $\frac{d^2f}{dx^2} = 2i - \sin x k$

④  $\left| \frac{df}{dx} \right| = \sqrt{2^2 + 3^2 + 1}$  i.e. at  $x = \left| \frac{df}{dx} \right| = 2i + 3j + k$   
 $= \sqrt{13}$

⑤  $f \cdot f = [x^2 i + (2x+2) j + \sin x k] \cdot [x^2 i + (3x+2) j + \sin x k]$   
 $= x^4 + (3x+2)^2 + \sin^2 x [i \cdot i + j \cdot j + k \cdot k = 1]$

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

$= 4 + 4(5) + 2(1) = 26$

⑥  $r = (t^2 + 3t) i - 2 \sin 3t j + 3e^{3t} k$

⑦  $\frac{dr}{dt} = (2t+3) i - 6 \cos 3t j + 9e^{3t} k$

⑧  $\frac{d^2r}{dt^2} = 2i + (18 \sin 3t) j + 27e^{3t} k$

⑨ at  $t=0 = 2i + 0 + 27k$

$\left| \frac{d^2r}{dt^2} \right| = \sqrt{2^2 + 27^2}$   
 $= 27.07$