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16/Eng02/049 Compute Engineering
Assignment

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

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

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

iii) $\frac{d^2r}{dt^2} = 2i + 12k$

$$\left|\frac{d^2r}{dt^2}\right| = \sqrt{2^2+12^2} = \sqrt{4+144}$$
$$= \sqrt{148} = 2\sqrt{37}$$
$$\approx 12.7$$

③ $A = xy^2 i + (xy + y^2)j + xz^2 k$
$B = yz\,i - 3xz\,j + 2xy\,k$
$\phi = 3x^2y + xyz - 4y^2z^2 - 3$

i $\nabla\phi = \frac{\partial\phi}{\partial x}i + \frac{\partial\phi}{\partial y}j + \frac{\partial\phi}{\partial z}k$

$\frac{\partial\phi}{\partial x} = 6xy + yz$

$\frac{\partial\phi}{\partial z} = xy - 8y^2z$

$\frac{\partial\phi}{\partial y} = 3x^2 + xz - 8yz^2$

At $(\overset{x}{1}, \overset{y}{2}, \overset{z}{1})$

$\frac{\partial\phi}{\partial x} = 6(1)(2) + (2)(1) = 12 + 2 = 14$

$\frac{\partial\phi}{\partial y} = 3(1)^2 + 1(1) - 8(2)(1)^2 = 3 + 1 - 16 = -12$

$\frac{\partial\phi}{\partial z} = (1)(2) - 8(2)^2(1) = 2 - 32 = -30$

ii. $\nabla \cdot A = \frac{\partial a}{\partial x} + \frac{\partial ay}{\partial x} + \frac{\partial az}{\partial z}$

$A = ax\,i + ay\,j + az\,k$

$\nabla \cdot A = 2xy + (x+1) + 2xz$

At $(1,2,1)$

$\nabla \cdot A = 2(1)(2) + (1+1) + 2(1)(1)$

$= 4+2+2 = 8$

iii. $\nabla \times B = \begin{vmatrix} i & j & k \\ d/dx & d/dy & d/dz \\ yz & -3xz & 2xy \end{vmatrix}$

$= i(2x+3x) - j(2y-y) + k(-3z-z)$

$= 5x\,i - y\,j - 4z\,k$

At $(1,2,1)$

$\nabla \times B = 5i - 2j - 4k$

iv. grad div A

grad $(2xy + (x+2) + 2xz)$

let div $A = c = \nabla A$

$\nabla(\nabla \cdot A) = \nabla c = i\frac{\partial c}{\partial x} + j\frac{\partial c}{\partial y} + k\frac{\partial c}{\partial z}$

$= i(2y+1+2z) + j(2x) + k(1+2x)$

at $(1,2,1)$

$\nabla c = [i(2(2)+1+2(1)) + j\,2(1) + k(1+(2)(1))]$

$= 7i + 2j + 3k$

v. Curl A

Curl $A = \nabla \times A$

$= \begin{vmatrix} i & j & k \\ d/dx & d/dy & d/dz \\ x^2y & (xy+y^2) & xz^2 \end{vmatrix}$

$= i(0-y) - j(z^2-0) + k(y-x^2)$

$= y\,i - z^2 j + k(y-x^2)$

at $(1,2,1)$

Curl $= -2i - j + k$

Curl $A = \nabla \times (\nabla \times A)$

$$\nabla \times (\nabla \times A) \begin{vmatrix} i & j & k \\ d/dx & d/dy & d/dz \\ -y & -z^2(y-x^2) & \end{vmatrix}$$

$$= i(1+2z) - j(-2x-0) + k(0+1)$$

$$= i(1+2z) + 2x^2 j + k$$

at point $(1,2,1)$

$$\nabla \times (\nabla \times A) = i(1+2(1)) + 2(1)^2 j + k$$

$$= 3i + 3j + k$$

1a A mathematical model is a description of a system using mathematical concepts and language. Therefore modelling is the process of setting up a model, solving it mathematically and interpreting the result in physical and other terms

b i Exponential Growth Decay (use of ODE)

ii mixing Problems