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Matno: 16/ENG01/010

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

at $t = 0$

$\frac{d^2r}{dt^2} = 2i + 0j + 12k$

$\left|\frac{d^2r}{dt^2}\right| = \sqrt{2^2 + 12^2} = 12.16.$

3. $\nabla\phi$ if $A = x^2yi + (xy + yz)j + xz^2k$

$B = yzi - 3xzj + 2xyk$, and

$\phi = 3x^2y + xyz - 4y^2z^2 - 3$ at $(1, 2, 1)$

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

$\nabla\phi = (6xy + yz)i + (3x^2 + xz - 8yz^2)j + (xy - 8y^2z)$

$\nabla\phi = (6(1)(2) + (2)(1))i + (3(1)^2 + (1)(1))j + ((1)(2) - 8(2)^2(1))$

$\nabla\phi = 14i + 4j - 16j + 2 - 32$

$\nabla\phi = 14i - 12j - 30k$

(ii) $\nabla A = \frac{\partial ax}{\partial x} + \frac{\partial ay}{\partial y} + \frac{\partial az}{\partial z}$

$\nabla A = (2xy)i + (x+z)j + (2xz)k$

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

$4 + 1 + 1 + 2 = 8$

(iii) $\nabla \times B$

Flux

$\nabla \times B$

$$= \begin{vmatrix} i & j & k \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ yz & -3xz & 2xy \end{vmatrix}$$

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

$= 5i - 2j - 4k$

(d) grad div A

Let $\text{div } A = C$ ie $\nabla C = (\text{grad div } A)$

$= i\frac{\partial C}{\partial x} + j\frac{dc}{dy} + k\frac{dc}{dz}$

~~$\nabla(\nabla C) = 2xyi + (x+z)j + 2xzk$~~

~~grad~~ $\nabla C = (2x+z+2z)\hat{i} + (2x)\hat{j} + (x+2x)\hat{k}$

$\nabla C = (2(1)+1+2(1))\hat{i} + (2(1))\hat{j} + (1+2(1))$

$\nabla C = 7\hat{i} + 2\hat{j} + 3\hat{k}$

(c) Curl curl A

$$\text{curl } A = \begin{vmatrix} i & j & k \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ x^2y & (xy+yz) & xz^2 \end{vmatrix}$$

$i(0-y) - j(z^2-0) + \hat{k}(y-x^2)$

$= -y\hat{i} - j + \hat{k}$

let $\text{Curl}\cdot(\nabla * A) = \nabla \times A = B$

$$\nabla \times B \begin{vmatrix} i & j & k \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ -y & -z^2 & (y-x^2) \end{vmatrix}$$

$(0-(-2z))\hat{i} - j(-2x) - 0) + k(0-(-1))$

$2z\hat{i} - j(-2x) + k(+1)$

$2z\hat{i} + 2xj + k$ at 1, 2, 1

Curl Curl A $= 3\hat{i} + 2j + k$.

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① Mathematical modelling is the process of using various mathematical structures (ie groups, equations, diagrams, scatter plots, tree diagrams, etc) to represent real world situations. The model provides an abstraction that reduces a problem to its essential characteristics.

(b) (i) Using the balanced law

(ii) By forming differential equations from an existing algebraic equation of the system.