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

At $(1, 2, 1)$

$\bar{\nabla} \cdot C = i(4 + 1 + 2) + j(2) + k(1 + 2)$

$= 7i + 2j + 3k$

ii) Curl curl A

Curl $A = \bar{\nabla} \times A$

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

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

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

At $(1, 2, 1)$

Curl $A = -2i - j + k$

Curl Curl $A = \bar{\nabla} \times (\bar{\nabla} \times A)$

$\bar{\nabla} \times (\bar{\nabla} \times A)$

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

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

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

At point $(1, 2, 1)$

$\bar{\nabla} \times (\bar{\nabla} \times A)$ ~~[illegible]~~ $= i(1 + 2(1)) + 2(1)^2 j + k$

$= 3i + 2j + k$

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

At $(1,2,1)$

$\frac{\partial \phi}{\partial x} = 12 + 2 = 14$

$\frac{\partial \phi}{\partial y} = 3 + 1 - 16 = -12$

$\frac{\partial \phi}{\partial z} = 2 - 32 = -30$

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

$\bar{\nabla} \cdot A = \frac{\partial A_x}{\partial x} + \frac{\partial a_y}{\partial y} + \frac{\partial a_z}{\partial z}$

$A = a_x i + a_y j + a_z k$

$\bar{\nabla} \cdot A = 2xy + (x+z) + 2xz$

At $(1,1,1)$

$\bar{\nabla} \cdot A = 4 + 2 + 2 = 8$

iii) $\bar{\nabla} \cdot B$

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

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

$= 5xi - yj - 4zk$

At $(1,2,1)$

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

iv) grad div A

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

Let div $A = c = \bar{\nabla} \cdot A$

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

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ASSIGNMENT

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 results in physical and other terms.

bi) Exponential growth/decay Case of ODE
ii) Mixing problems.

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

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

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

iii) $\left.\frac{d^2r}{dt^2}\right|_{t=0} = 2i + 12k$

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

$= 2\sqrt{37} = 12.7$

) $A = x^2yi + (xy+y^2)j + xz^2k$
$B = yzi - 3xz + 2xyk$
$\phi = 3x^2y + xyz - 4y^2z^2 - 3$

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

$\frac{\partial\phi}{\partial x} = 6xy + y^2$

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