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10/ENG04/027 Date No.

ELECT/ELECT

(i) mathematically modelling is the process of setting up a model solving it mathematically, and interpreting the result in physical or in order terms.

ii) a) Using Balance Law - Law of conservation of mass

b) Forming a differential equation from an existing algebraic equation of the system.

2) $r = (t^2+3t)i - 2\sin 3t\, j + 8e^{2t}k$

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

ii) $\frac{d^2r}{dt^2} = \frac{d}{dt}\left(\frac{dr}{dt}\right)$

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

iii) $\frac{d^2r}{dt^2}\Big|_{t=0} = 2i + 18\sin 3(0)\, j + 12e^{2(0)}k$.

$= 2i + 12k$.

$= \sqrt{2^2+12^2}$

$= \sqrt{148} = 2\sqrt{37}$

$= 12.17$

$\left|\frac{d^2r}{dt^2}\right|_{t=0} = 12.17$ units

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

$B = yzi - 3xzj + 2xyk$ at point (x,y,z) $(1,2,1)$

$\phi = 3x^2y - xyz - 4y^2z^2 - 3$.

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

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

$\nabla\phi = 6(1)(2) + (2)(1))i + 3(1)^2 + (1)(1) - 8(2)(1)^2)j +$ Date No.

$(1)(2) - 8(2)^2(1)k$

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

ii $\nabla \cdot A = \frac{\partial a_x}{\partial x} + \frac{\partial a_y}{\partial y} + \frac{\partial a_z}{\partial z}$ (div A)

$A = (x^2y)i + (xy + yz)j + (xz^2)k$

$(2x + x + z)$

$= 2xy + x + z + 2xz$

x, y, z

at point $(1, 2, 1)$

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

$\nabla \cdot A = 4 + 2 + 2$

$\nabla \cdot A = 8$

(iii) $\nabla \times B = \begin{vmatrix} i & j & k \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ yz & -3x & 2xy \end{vmatrix}$

$= i\left[\frac{\partial}{\partial y}(2xy) - \frac{\partial}{\partial z}(-3x)\right] - j\left[\frac{\partial}{\partial x}(2xy) - \frac{\partial}{\partial z}(yz)\right] + k\left[\frac{\partial}{\partial x}(-3x) - \frac{\partial}{\partial y}(yz)\right]$

$\nabla \times B = i[2x + 3x] - j$