SoL 1.1 :- The diffrential form of continuity =n is

$$\vec{\nabla} \cdot \vec{J} = -\frac{\partial \rho}{\partial t}$$

we know from Maxwells =n's :

$$\vec{\nabla} \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$$

Taking divergence on both sides,

$$\cancelto{0}{\vec{\nabla} \cdot (\vec{\nabla} \times \vec{H})} = \vec{\nabla} \cdot \vec{J} + \vec{\nabla} \cdot \frac{\partial \vec{D}}{\partial t}$$

∵ scalar triple product with 2 same vectors

$$\Rightarrow \quad \vec{\nabla} \cdot \vec{J} = -\frac{\partial \rho}{\partial t} \qquad \because \vec{\nabla} \cdot \vec{D} = \rho$$

Sol 1,2:-

$$\underset{\to}{\nabla} \times \underset{\to}{E} = -\frac{\partial \underset{\to}{B}}{\partial t}$$

$$\Rightarrow \iint \underset{\to}{\nabla} \times \underset{\to}{E} \cdot \hat{n}\, ds = \iint -\frac{\partial \underset{\to}{B}}{\partial t} \cdot \underset{\to}{ds}$$

$$\Rightarrow \oint_{l} \underset{\to}{E} \cdot \underset{\to}{dl} = -\frac{\partial}{\partial t} \iint \underset{\to}{B} \cdot \underset{\to}{ds}$$

$$\underset{\to}{\nabla} \times \underset{\to}{H} = \underset{\to}{J} + \frac{\partial \underset{\to}{D}}{\partial t}$$

$$\Rightarrow \iint \underset{\to}{\nabla} \times \underset{\to}{H} \cdot \underset{\to}{ds} = \iint \underset{\to}{J} \cdot \underset{\to}{ds} + \iint \frac{\partial \underset{\to}{D}}{\partial t} \cdot \underset{\to}{ds}$$

$$\Rightarrow \oint_{l} \underset{\to}{H} \cdot \underset{\to}{dl} = \iint \underset{\to}{J} \cdot ds + \frac{d}{dt} \iint \underset{\to}{D} \cdot \underset{\to}{ds}$$

$$\underset{\to}{\nabla} \cdot \underset{\to}{D} = \rho$$

$$\iiint \underset{\to}{\nabla} \cdot D\, dV = \iiint \rho\, dV \Rightarrow \oint\!\!\oint_{s} \underset{\to}{D} \cdot \underset{\to}{ds} = q_{tot}$$

$$\underset{\to}{\nabla} \cdot \underset{\to}{B} = 0$$

$$\Rightarrow \iiint \underset{\to}{\nabla} \cdot \underset{\to}{B}\, dV = 0$$

$$\Rightarrow \oint\!\!\oint B \cdot \underline{dS} = 0$$

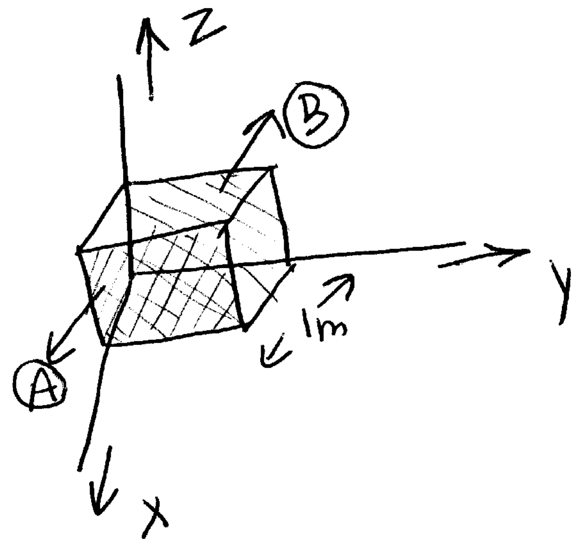
Sol 1.3 :-

(a) $\vec{D} = \hat{a}_x (3+x)$

we know :

$$\oint_s \vec{D} \cdot \vec{ds} = q$$

Lets calculate $\vec{D} \cdot \vec{ds}$ on each face.



$$\oint_s \vec{D} \cdot \vec{ds} = \underset{A}{(3+1)} \cdot 1 + \underset{B}{(3+0)} \cdot -1$$

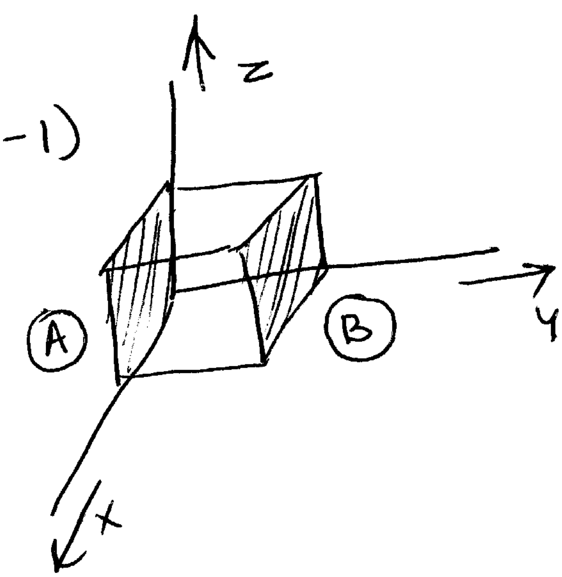
$$= 4 - 3 = 1 \text{ C}$$

other contributions are zero.

(b) $\vec{D} = \hat{a}_y (4+y^2)$

$$\oint_s \vec{D} \cdot \vec{ds} = \underset{B}{(4+1)(1)} + \underset{A}{(4+0)(-1)}$$

$$= 5 - 4 = 1 \text{ C}$$



sol 1.5 :- Source free $\Rightarrow \underline{\nabla} \cdot \underline{D} = 0$

Given : $\underline{E} = [\hat{a}_x A(x+y) + \hat{a}_y B(x-y)] \cos \omega t$

$\Rightarrow \quad \underline{\nabla} \cdot \underline{D} = 0$

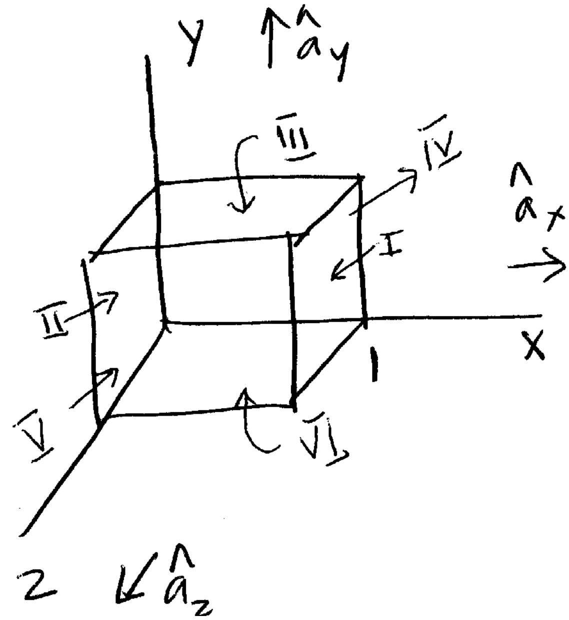
$\Rightarrow \quad A \frac{\partial}{\partial x}(x+y) + B \frac{\partial}{\partial y}(x-y) = 0$

$\Rightarrow \quad A - B = 0$

$\Rightarrow \quad A = B$

sol 1.8 :- $\underline{J_d} = \hat{a}_x\, yz + \hat{a}_y\, y^2 + \hat{a}_z\, xyz$

Calculate $\oiint \underline{J_d} \cdot \underline{ds}$ on each face.



I : $\int_0^1\int_0^1 yz\, dy\, dz$

$= \frac{y^2}{2}\Big|_0^1 \frac{z^2}{2}\Big|_0^1 = \frac{1}{4}$

$\overline{II}$: $-\int_0^1\int_0^1 yz\, dy\, dz = -\frac{1}{4}$

$\overline{III}$: $\int_0^1\int_0^1 y^2\, dx\, dz = 1$

$\overline{IV}$: $\int_0^1\int_0^1 xy(0) = 0$

$\overline{V}$: $\int_0^1\int_0^1 xyz\, dx\, dy$

$= \frac{x^2}{2}\Big|_0^1 \frac{y^2}{2}\Big|_0^1 = \frac{1}{4}$

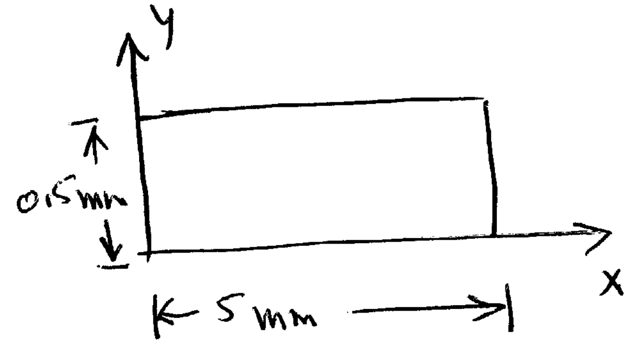
$\overline{VI}$: $\int_0^1\int_0^1 y^2\, dx\, dz = \int_0^1\int_0^1 (0)\, dx\, dz = 0$

$\therefore$ net flux of $J_d = \oiint \underrightarrow{J_d} \cdot \underrightarrow{ds} = \frac{1}{4} - \frac{1}{4} + 1 + 0 + \frac{1}{4} + 0$

$= \frac{5}{4}$

Sol 1.13 :- $\quad J = \hat{a}_z 10^4 \cos(2\pi 10^9 t)$

current decays by $e^{-10^6 y}$ exponentially.



$\therefore \iint_S \vec{J} \cdot \vec{ds}$

$$= \int_0^{0.25} \int_0^{5} 10^4 e^{-10^6 y} \cos(2\pi 10^9 t)\, dx\, dy$$

$$= 10^4 \cos(2\pi 10^9 t) \times 5 \times \int_0^{0.25} e^{-10^6 y}\, dy$$

$$= 10^4 \cos(2\pi 10^9 t)\, 5 \left[\frac{e^{-10^6 \times 0.25} - 1}{10^{-6}} \right]$$

$$= -\frac{5}{100} \cos(2\pi 10^9 t) \left[\cancel{e^{-2.5 \times 10^5}}^{\to 0} - 1 \right]$$

$$= \frac{\cos 2\pi 10^9 t}{20}$$

Total Current $= 2 \times \cos 2\pi 10^9 t = \cos 2\pi 10^9 t$

Sol 1.18 :-

$$\underline{\mathcal{E}}(x,y,z,t) = Re\left[\underline{E}(x,y,z)\, e^{j\omega t}\right]$$

$$\underline{\mathcal{E}}(x,y,z,t) = \frac{1}{2}\left[\underline{E}\, e^{j\omega t} + (E\, e^{j\omega t})^{*}\right]$$

$$= \frac{1}{2}\left[Re[\underline{E}\, e^{j\omega t}] + Im[\underline{E}\, e^{j\omega t}] - Im[\underline{E}\, e^{j\omega t}] + Re[\underline{E}\, e^{j\omega t}]\right]$$

$$= Re\left[\underline{E}_1(x,y,z)\, e^{j\omega t}\right]$$

Similarly for $\underline{B}$.

Sol 1.29 :- Given : $\underline{E}^i = \hat{a}_x E_0 e^{-j\beta_0 z}$

$$\underline{E}^r = \hat{a}_x \Gamma_0 E_0 e^{+j\beta_0 z}$$

$$\underline{E}^t = \hat{a}_x T_0 E_0 e^{-j\beta z}$$

E_0 = constant $\quad \beta_0 = \omega\sqrt{\mu_0 \epsilon_0}$

$\beta = \omega\sqrt{\mu\epsilon}$

$$\eta_1 = \sqrt{\frac{\mu_0}{\epsilon_0}} \quad \eta_2 = \sqrt{\frac{\mu_0}{\epsilon}}$$

$$\Gamma_0 = \frac{\sqrt{\frac{\mu_0}{\epsilon}} - \sqrt{\frac{\mu_0}{\epsilon_0}}}{\sqrt{\frac{\mu_0}{\epsilon_0}} + \sqrt{\frac{\mu_0}{\epsilon}}}$$

; Like in RF

$$\Gamma = \frac{Z_2 - Z_1}{Z_2 + Z_1}$$

$$= \frac{\sqrt{\epsilon_0} - \sqrt{\epsilon}}{\sqrt{\epsilon} + \sqrt{\epsilon_0}}$$

$$T_0 = \frac{2\sqrt{\frac{\mu_0}{\epsilon}}}{\sqrt{\frac{\mu_0}{\epsilon}} + \sqrt{\frac{\mu_0}{\epsilon_0}}}$$

; $T = \frac{2Z_2}{Z_1 + Z_2}$

$$= \frac{2}{\sqrt{\epsilon}} \times \frac{\sqrt{\epsilon}\sqrt{\epsilon_0}}{\sqrt{\epsilon_0} + \sqrt{\epsilon}}$$

$$= \frac{2\sqrt{\epsilon_0}}{\sqrt{\epsilon_0} + \sqrt{\epsilon}}$$