E8-202 Class 9 Dipanjan Gope

Scalar potential

$\langle \nabla\phi, f_t \rangle$

$= \iint_S \nabla\phi \cdot f_t \, dt$

Now, $\nabla \cdot sV = s\nabla \cdot V + V \cdot \nabla s$

$$\iint \nabla \cdot sV \, ds = \oint (sV) \cdot \hat{n} \, dl = 0$$

$$\Rightarrow \iint_T \nabla s \cdot V \, dt = - \iint_T s \nabla \cdot f_t \, dt$$

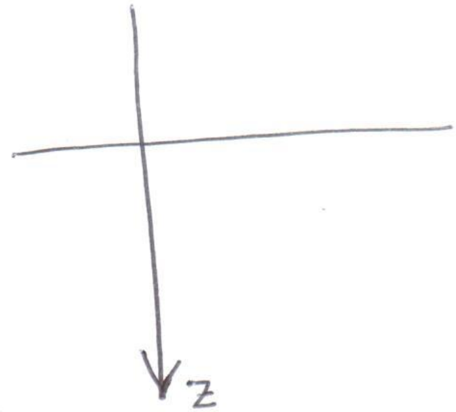
$$\langle \nabla\phi, f_t \rangle = + \int_T \nabla \cdot f_t \int_S G \frac{\nabla \cdot f_s}{j\omega} \, ds \, dt$$

$$= \frac{l_s l_t}{j\omega A_s A_t \, 4\pi\epsilon_0} \int_T \int_S \frac{e^{-jkr}}{r} \, ds \, dt$$

Surface impedance:-

Skin depth.

$E_x = E_0 e^{-jkz}$.



Now $k = \omega\sqrt{\mu\epsilon}$

~~Assum~~ $\epsilon = \epsilon_{real} - j\epsilon_{imag}$.

$= \epsilon_r \epsilon_0 + \frac{\sigma}{j\omega\epsilon_0}\epsilon_0$ → for good conductor dominates

$$k = \omega\sqrt{\mu\frac{\sigma}{j\omega}}$$

$$\cancel{= \sqrt{\omega\mu}}$$

$$\nabla \times H = j\omega D + J_{ic}$$

$$= j\omega\epsilon_0\epsilon_r E + \sigma E + J_i$$

$$= j\omega E\epsilon_0\left[\epsilon_r + \frac{\sigma}{j\omega\epsilon_0}\right]$$

$$= j\omega E\epsilon_0\left[\epsilon_r - j\frac{\sigma}{\omega\epsilon_0}\right]$$

$$J = J_0 e^{-jkz}$$

$$= J_0 e^{-j\omega\sqrt{\frac{\mu\sigma}{j\omega}}z}$$

$$= J_0 e^{-\sqrt{j\mu\sigma\omega}\,z}$$

$$= J_0 e^{-\sqrt{\frac{\mu\sigma\omega}{2}}z} e^{-j\sqrt{\frac{\mu\sigma\omega}{2}}z}$$

Real part.

$$J = J_0 e^{-\sqrt{\frac{\mu\sigma\omega}{2}}z}$$

$$= \sqrt{\frac{2}{\omega\mu\sigma}} = \sqrt{\frac{1}{\pi\mu f\sigma}}$$

$$J = J_o e^{-\frac{z}{\delta}} e^{-j\frac{z}{\delta}}$$

Derive Z_s.

Case 1 :-

$$P = \int_0^d \frac{J_0^2 e^{-\frac{2x}{\delta}}}{\sigma}$$

$$= \frac{J_0^2}{\sigma}\left(-\frac{\delta}{2}\right) e^{-\frac{2x}{\delta}} \Big|_0^d$$

$$= \frac{J_0^2}{\sigma}\left(1 - e^{-\frac{2d}{\delta}}\right)\frac{\delta}{2}$$

Case 2 :-

$$P = J_s^2 Z_s$$

where

$$J_s = \int_0^d J_0 e^{-x/\delta}\, dx$$

$$= J_0 \delta \left(1 - e^{-d/\delta}\right)$$

$$\Rightarrow \quad J_0^2 \delta^2 \left(1 - e^{-d/\delta}\right)^2 \cdot Z_s = \frac{J_0^2}{\sigma} \left(1 - e^{-2d/\delta}\right) \frac{\delta}{2}$$

$$\Rightarrow \quad Z_s = \frac{\left(1 + e^{-d/\delta}\right)}{\left(1 - e^{-d/\delta}\right)} \frac{1}{2\sigma\delta}$$

$$\frac{d}{\delta} \to 0 \quad \Rightarrow \quad Z_s = \frac{1}{2\sigma\delta}$$

Circuit excitation:-

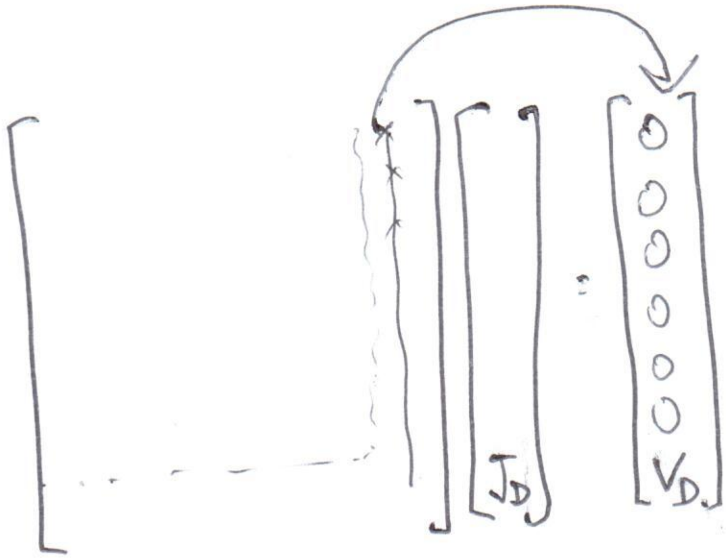
Delta gap voltage

$$\int E_{inc} \cdot f_r \, dt$$

$$= \int \frac{V}{d} \hat{n} \cdot f_l \, dt$$

$$= \frac{V}{d} \cdot l d = V l .$$

Delta gap current



$$J_D = \frac{1\,\text{Amp}}{l}$$