EE 331 - LECT. #34 APR. 20, 2020

magnetic scalar potential V_m

recall,

$$\vec{E} = -\nabla V \;[V/m] \rightarrow \nabla^2 V = -\rho_v/\epsilon,\; \nabla^2 V = 0 \quad (\text{from } \nabla\cdot\vec{D} = \rho_v)$$

similarly,

$$\vec{H} = -\nabla V_m \;[A/m] \rightarrow \nabla^2 V_m = 0,\; \text{can't have } \vec{J} \neq 0 \text{ because } \nabla\cdot\vec{B} = 0$$

however, no one uses V_m, rather we use the following:

magnetic vector potential A

recall,

$$\nabla\cdot\vec{B} = 0 \qquad \text{meaning?}$$

also recall,

$$\nabla\cdot(\nabla\times\vec{A}) = 0 \quad \text{for } \vec{A} \text{ any arbitrary vector or vector field}$$

use to define magnetic vector potential:

$$\nabla\times\vec{A} = \vec{B} \qquad \text{because} \quad \nabla\cdot(\nabla\times\vec{A}) = \nabla\cdot\vec{B} = 0$$

where,

$$\vec{A} = \text{magn vector pot } [Wb/m],\; \text{now } \vec{A} \text{ not arbitrary}$$

so find $\vec{A}$, take curl of $\vec{A}$ to get $\vec{B}$, & use $\vec{B} = \mu\vec{H}$ to yield $\vec{H}$.

recall,

charge src

$$V = \frac{1}{4\pi\varepsilon}\int \frac{\rho_L \, dl'}{|\bar{r}-\bar{r}'|} \quad [V] \qquad \rho_s, \rho_v$$

for curr src can find $\bar{A}$:

curr src

line curr: $$\bar{A} = \frac{\mu}{4\pi}\int_L \frac{I\, d\bar{l}'}{|\bar{r}-\bar{r}'|} \quad [Wb/m]$$

sheet curr: $$\bar{A} = \frac{\mu}{4\pi}\int_S \frac{\bar{K}\, ds'}{|\bar{r}-\bar{r}'|} \quad [Wb/m]$$

vol curr: $$\bar{A} = \frac{\mu}{4\pi}\int_V \frac{\bar{J}\, dv'}{|\bar{r}-\bar{r}'|} \quad [Wb/m]$$

why use $\bar{A}$ at all to find $\bar{H}$? because $\bar{A}$ in same dir as curr.

example #27-a