## Relation b/w Conduction Current density & Displacement Current Density :-

for a medium having conductivity $\sigma$ & permittivity $\varepsilon$ then

$$\vec{J_c} = \sigma \vec{E}$$

$$\vec{J_d} = \varepsilon \frac{\partial \vec{E}}{\partial t}$$

If we incident a electromag. wave over such a medium

$$\vec{E} = E_0 e^{i(kz-\omega t)} \hat{x}$$

then

$$\vec{J_c} = \sigma \vec{E}$$

$$\vec{J_d} = \varepsilon(-i\omega)\vec{E}$$

Then

$$\frac{J_c}{J_d} = \frac{\sigma}{\varepsilon(-i\omega)}$$

$$\left|\frac{\vec{J_c}}{\vec{J_d}}\right| = \left|\frac{\sigma}{\omega\varepsilon}\right|$$

for Good conductor, $\frac{\sigma}{\omega\varepsilon} >> 1$

so $\boxed{J_c >> J_d}$

for Poor Conductor, $\sigma$ is less $\frac{\sigma}{\omega\varepsilon} << 1$

so $\boxed{J_c << J_d}$

{e.g. for a metal, $J_c = 10^6 A/m^2$ & $J_d = 10 A/m^2$ then it is Good Conductor.}

If $\sigma \uparrow$ then $J_c \uparrow$ (more)

If $\varepsilon \uparrow$ or $\omega \uparrow$ then $\vec{J_d} \uparrow$

i.e. $J_c \rightarrow$ depend on conductivity

$J_d \rightarrow$ " " permitivity & freq.