Sheet 10

1 If any charge is introduced internally within a conducting ıaterial , it arrives to the conductor surface as a surface charge. Starting from the continuity equation of current , derive an expression for the volume charge density as a function of time and the relation time constant of the conductor

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2 Derive the expression of the boundary conditions of the electric field components (normal and tangential) for the interface between two perfect dielectrics having different permittivities

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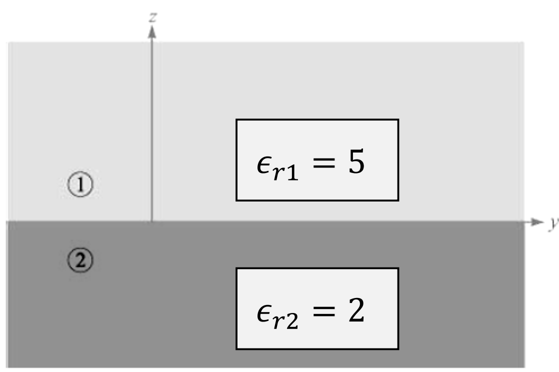
3 In the figure shown, let $\overline{D}_1 = 2\overline{a}_x + 5\overline{a}_y - 3\overline{a}_z$ nC/m^2 .Find

(i) $\overline{D}_{n2}$, $\overline{D}_{t2}$, $\overline{D}_2$

(ii) The energy density in each region

(iii) The angle that $\overline{D}_2$ makes with $\overline{a}_z$



$$[\overline{D}_2 = 0.8\,\overline{a}_x + 2\overline{a}_y - 3\,\overline{a}_z]$$
$$4.29 \times 10^{-7} \quad J/m^3$$
$$3.85 \times 10^{-7} \quad J/m^3$$
$$\theta_2 = 35.68^\circ$$

4 Consider two concentric spheresone has radius a, and a charge $+Q$ is distributed uniformly over its surface. The outer sphere has radius b and a charge – Q is distributed uniformly over its surface. Find the capacitance of the sphere if a dielectric of a dielectric constant ϵ_r has been placed between them

$$\left[\boldsymbol{C = \frac{4\pi\epsilon}{\frac{1}{a} - \frac{1}{b}}} \right]$$

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5 (a) Show that the capacitance per unit length of the coaxial cable is given by

$$C_{\text{per unilt length}} = \frac{2\pi\epsilon}{\ln\frac{b}{a}} \quad \text{F/m}$$

Where a and b are the inner and outer radii

(b) If the thickness between the coaxial cylinders consists of two layers equal in thickness and having ϵ_{r1} and ϵ_{r2} , find the capacitance

$$\left[\boldsymbol{C_T = \frac{2\pi\epsilon_o}{\ln\left(\frac{r}{a}\right)^{\frac{1}{\epsilon_{r1}}}\left(\frac{b}{r}\right)^{\frac{1}{\epsilon_{r2}}}} \quad \text{F/m}} \right]$$

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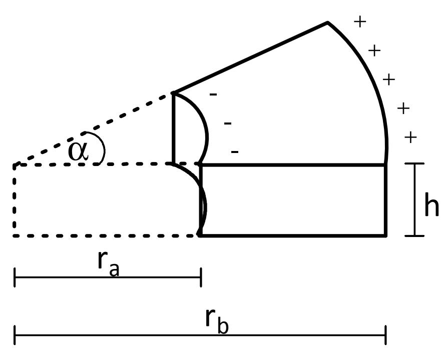
6 Find the capacitance between the curved plates shown in the fig



$$\left[\boldsymbol{C = \frac{\alpha\,\epsilon\,h}{\ln\frac{r_b}{r_a}} \quad F} \right]$$
