Boundary conditions:-

Those conditions by which fields must be satisfied at the interface of the media are called boundary conditions.

To find electrostatic boundary condition we use two Maxwell equation.

$$\vec{\nabla}\cdot\vec{E} = \frac{\rho}{\epsilon_0} \Rightarrow \vec{\nabla}\cdot\vec{D} = \rho \qquad (\because \vec{D} = \epsilon_0\vec{E})$$

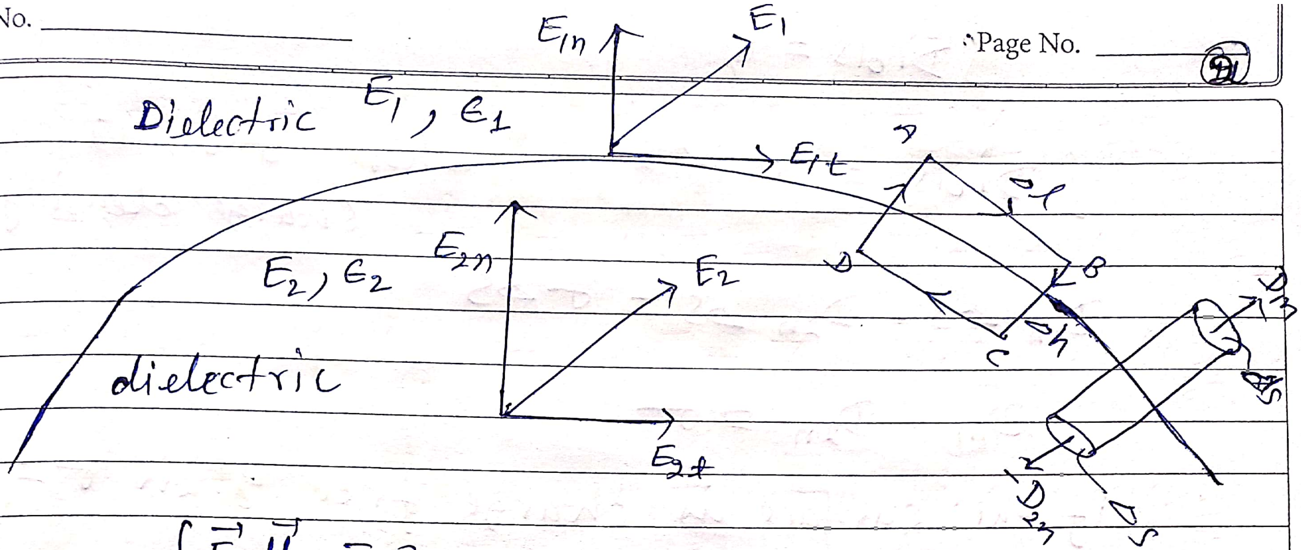
$$\oint \vec{D}\cdot d\vec{s} = Q$$

$$\vec{\nabla}\times\vec{E} = 0 \qquad \oint \vec{E}\cdot d\vec{l} = 0$$

Dielectric-dielectric boundary condition:-

$$E_1 = E_{1t} + E_{1n}$$

$$E_2 = E_{2t} + E_{2n}$$



$$\oint_l \vec{E} \cdot \vec{dl} = 0$$

$$\int_A^B \vec{E} \cdot \vec{dl} + \int_B^C \vec{E} \cdot \vec{dl} + \int_C^D \vec{E} \cdot \vec{dl} + \int_D^A \vec{E} \cdot \vec{dl} = 0$$

$$E_{1t}\,\Delta l + \cancel{E_{1n}\frac{\Delta h}{2}} - \cancel{E_{2n}\frac{\Delta h}{2}} - E_{2t}\,\Delta l + \cancel{E_{2n}\frac{\Delta h}{2}} + \cancel{E_{1n}\frac{\Delta h}{2}} = 0$$

$$(E_{1t} - E_{2t})\,\Delta l = 0$$

$$\Delta l \neq 0$$

$$E_{1t} - E_{2t} = 0$$

$$\boxed{E_{1t} = E_{2t}}$$

Tangential component of $\vec{E}$ is continuous.

$$E_{1t} = E_{2t}$$

$\boxed{\dfrac{D_{1t}}{\epsilon_1} = \dfrac{D_{2t}}{\epsilon_2}}$ Tangential component of $\vec{D}$ is discontinuous across the boundary.

$$\int \vec{D} \cdot d\vec{S} = Q$$

$$\int \vec{D} \cdot d\vec{S} = \sigma \Delta S$$ where σ is the surface Charge density.

$$D_{1n} \Delta S - D_{2n} \Delta S = \sigma \Delta S$$

$$D_{1n} - D_{2n} = \sigma$$

If the surface is charge free then $\sigma = 0$

$$D_{1n} - D_{2n} = 0$$

$$\boxed{D_{1n} = D_{2n}}$$ Normal component of D is continuous if the surface is charge free.

$$D_{1n} = D_{2n}$$

$$\epsilon_1 E_{1n} = \epsilon_2 E_{2n}$$

$$\boxed{\frac{E_{1n}}{\epsilon_2} = \frac{E_{2n}}{\epsilon_1}}$$ Normal component of $\vec{E}$ is discontinuous across the boundary.