Boundary Conditions for Electromagnetic fields

The differential forms of Maxwell's equations are used to solve for the field vectors provided the field quantities are single valued, bounded and continuous. At the media boundaries, the field vectors are discontinuous and their behaviors across the boundaries are governed by boundary conditions.

The integral equations are assumed to hold for regions containing discontinuous media as shown in figure 1.1.Boundary conditions can be derived by applying the Maxwell's equations in the integral form to small regions at the interface of the two media. The procedure is similar to those used for obtaining boundary conditions for static electric fields (chapter 2) and static magnetic fields (chapter 4). The boundary conditions are summarized as follows

With reference to fig 4.3

$$\widehat{a_n} \times \left(\overrightarrow{E_1} - \overrightarrow{E_2}\right) = 0 \qquad 4.27(a)$$

$$\widehat{a_n} \cdot \left(\overrightarrow{D_1} - \overrightarrow{D_2}\right) = \rho_S \qquad 4.27(b)$$

$$\widehat{a_n} \times \left(\overrightarrow{H_1} - \overrightarrow{H_2}\right) = \overrightarrow{J_S} \qquad 4.27(c)$$

$$\widehat{a_n} \cdot \left(\overrightarrow{B_1} - \overrightarrow{B_2}\right) = 0 \qquad 4.27(d)$$

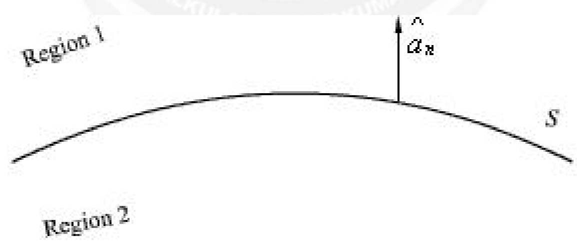

Fig 1.1 Boundary conditions of electromagnetic fields
(www.brainkart.com/subject/Electromagnetic-Theory_206/)

Equation 4.27 (a) says that tangential component of electric field is continuous across the interface while from 4.27 (c) we note that tangential component of the magnetic field is discontinuous by an amount equal to the surface current density. Similarly 4.27(b) states that normal component of electric flux density vector $\overline{D}$ is discontinuous across the interface by an amount equal to the surface current density while normal component of the magnetic flux density is continuous.

If one side of the interface, as shown in fig 4.4, is a perfect electric conductor, say region 2, a surface current $\vec{E}$ $\vec{J_S}$ $\sigma = \infty$ can exist even though is zero as .

Thus eqn 4.27(a) and (c) reduces to

$$\widehat{a_n} \times \vec{H} = \vec{J_S} \qquad (4.28(a))$$

$$\widehat{a_n} \times \vec{E} = 0 \qquad (4.28(b))$$