CHAPTER 4: WAVE PROPAGATION, ATTENUATION, POLARIZATION, REFLECTION, REFRACTION, AND DIFFRACTION

Wave Equation: $\frac{\partial^2 E_y}{\partial t^2} = \frac{1}{me}\frac{\partial^2 E_y}{\partial x^2}$

Characteristic Impedance: $Z = \sqrt{\frac{m}{e}}$ [Ω]

Velocity of an EM Wave: $v = l\,f = \frac{1}{\sqrt{me}}$ [m/s]

Impedance of a Conducting Medium: $Z = \sqrt{\frac{jwm}{s + jwe}}$ [Ω]

Conductive Medium w/ Conductive, Magnetic, & Dielectric Losses: $Z = \sqrt{\frac{wm'' + jwm'}{s + we'' + jwe'}}$ [Ω]

Complex Permittivity and Permiability: $e = e' - je''$ [F/m] ; $m = m' - jm''$ [H/m]

VSWR: $VSWR = \frac{1+|r|}{1-|r|}$; $r = \frac{VSWR-1}{VSWR+1}$

Conductors & Dielectrics:

Conductors $\frac{s}{we} > 100$; $we << s$

Quasi-Conductors $\frac{1}{100} < \frac{s}{we} < 100$; $we \approx s$

Dielectrics $\frac{s}{we} < \frac{1}{100}$; $we >> s$

Attenuation & Propagation Constant: $g^2 = jwms - w^2 me = (a + jb)^2$

For Conductors: $g = \sqrt{jwms} = (1+j)\sqrt{\frac{wms}{2}} = a + jb$

Depth of Penetration (Skin Depth): $d = \frac{1}{\sqrt{fpms}}$; Depth for 1/*e* decrease in *E* in conductor

Loss Tangent: $tand = \frac{s\,'}{we\,'}$

Reflection and Transmission Coefficient: See Table posted on webpage.

Index of Refraction: $n = \frac{c}{v} = \sqrt{m_r e_r}$

Poynting Vector: $\vec{S} = \vec{E} \times \vec{H}$ [Wm^{-2}]

Average Poynting Vector Magnitude: $S_{av} = \frac{1}{2} Re\left\{HH^{*}Z\right\} = \frac{1}{2}\left|H\right|^2 Re\left\{Z\right\} = \frac{1}{2}\left|E\right|^2 Re\left\{\frac{1}{Z}\right\}$

Snell's Law: $n_2\, sin q_t = n_1\, sin q_i$

Critical Angle: $q_{ic} = sin^{-1}\left(\sqrt{\frac{e_2}{e_1}}\right)$

Diffraction from an Edge: $S_{av} = \frac{1}{2}\left(\frac{1}{lka}\right)^2 = \frac{rl}{4p^2 a^2}\,;\, k = \sqrt{\frac{2}{rl}}$

CHAPTER 5: ANTENNAS, RADIATION, AND WIRELESS SYSTEMS

Beam Solid Angle: $$\Omega_A = \iint_{4p} P_n(q, f)\, d\Omega = \int_{f=0}^{2p} \int_{q=0}^{p} P_n(q, f) \sin q \; dq \; df \approx q_{HP} f_{HP}$$

Directivity: $$D = \frac{4p}{\Omega_A} = \frac{4p}{q_{HP} f_{HP}} = \frac{41{,}000}{q^{\circ}_{HP} f^{\circ}_{HP}}$$

Arbitrary Center-Driven Dipole Antenna: $$\vec{E} = \hat{q} Z \frac{j I_{max}\, e^{-jbr}}{2p r \sin q} \left[\cos\left(\frac{bL}{2} \cos q \right) - \cos\left(\frac{bL}{2} \right) \right] \text{[V/m}$$

Total Power Radiated by $l/2$ Center-Driven Dipole: $$P_T = \frac{I_{max}^2 Z\, (2.4376)}{8p} \text{ [W]}$$

Total Power Radiated by Short Dipole: $$P_T = \sqrt{\frac{m}{e}} \frac{(b I_{av} L)^2}{12p} \text{ [W]}$$

Posted Array Antenna Notes