

# EE 780 Advanced Engineering Electromagnetics

**Text:** *Advanced Engineering Electromagnetics* (Second Edition), Balanis, Wiley, 2012, ISBN-10: 0470589485, ISBN-13: 978-0470589489.

## **Chapter 1 Time-Varying and Time-Harmonic Electromagnetic Fields**

- Maxwell's equations in differential form
- Maxwell's equations in integral form
- Maxwell's equations for time-harmonic fields
- Continuity equation
- Constitutive equations and parameters
- Boundary conditions
- Power and energy, e.g., Poynting vector and theorem

## **Chapter 2 Electrical Properties of Matter**

- Dielectrics, polarization, & permittivity
- Magnetics, magnetization, & permeability
- Currents, conductors, & conductivity
- AC variations- complex permittivity & permeability, equivalent conductivities, loss tangents

## **Chapter 3 Wave equation and its Solution**

- Wave equations for time-varying and time-harmonic fields- lossy and lossless cases
- Solutions to wave equations- rectangular coordinates (traveling & standing waves)
- Solutions to wave equations- cylindrical coordinates (traveling & standing waves)
- Constraint/dispersion equations and wave constants/numbers

## **Chapter 4 Wave Propagation and Polarization**

- TEM modes and uniform plane waves (UPWs)
- UPWs in unbounded lossless media- principal axis
- UPWs in unbounded lossless media- oblique angle (TE and TM modes)
- UPWs in unbounded lossy media- principal axis
- UPWs in unbounded lossy media- oblique angle (TE and TM modes)
- Polarization

## **Chapter 5 Reflection and Transmission**

- Reflection and transmission coefficients
- UPW at normal incidence- lossless media, planar interface
- UPW at oblique incidence perpendicular polarization with lossless media & planar interface
- UPW at oblique incidence parallel polarization with lossless media & planar interface
- Total transmission/Brewster angle with lossless media & planar interface
- Total reflection/critical angle with lossless media & planar interface
- UPW at normal incidence- lossy-lossy media, planar interface
- UPW at oblique incidence- lossless-lossy media, planar interface
- UPW at normal incidence- multiple interfaces, lossless media, planar interfaces

## **Chapter 6 Auxiliary Vector Potentials, ...**

- (6-59), (6-61), & (6-64) to get fields for rectangular  $TM^z$ ,  $TM^x$ , &  $TM^y$  modes from  $A_z$ ,  $A_x$ , &  $A_y$
- (6-70) to get fields for cylindrical  $TM^z$  modes from  $A_z$
- (6-72), (6-74), & (6-67) to get fields for rectangular  $TE^z$ ,  $TE^x$ , &  $TE^y$  modes from  $F_z$ ,  $F_x$ , &  $F_y$
- (6-80) to get fields for cylindrical  $TE^z$  modes from  $F_z$

## **Chapter 8 Rectangular Cross-Section Waveguides and Cavities**

- Rectangular waveguides- TE modes
- Rectangular waveguides- TM modes
- Power Density, power, attenuation for rectangular waveguides
- Rectangular cavities- TE modes
- Rectangular cavities- TM modes
- Dielectric slab waveguide- modal analysis for TM & TE modes and graphical solution.
- Dielectric-covered ground plane - modal analysis for TM & TE modes and graphical solution.

## **Chapter 9 Cylindrical Cross-Section Waveguides and Cavities**

- Cylindrical waveguides- TE modes
- Cylindrical waveguides- TM modes
- Attenuation for cylindrical waveguides
- Cylindrical cavities- TE modes
- Cylindrical cavities - TM modes
- Cylindrical cavities –  $TM_{010}$  mode quality factor
- Cylindrical dielectric waveguides
- Cylindrical dielectric resonators- PMC assumption TE & TM modes