ECE 342: Electromagnetic Fields II

IN

Maxwell's Equations

- Can use Maxwell eqs in integral and differential form, and boundary conditions to solve complex static and dynamic electromagnetic field problems
- Can mathematically model electric and magnetic properties of material media in relation with field eqs
- Understand how electromagnetic material properties can be exploited in engineering applications
- Understand and appreciate EM field theory as a foundation of circuit theory and electrical engineering as a whole

EM waves and Energy

- Understand fundamentals of energy storage and power transfer
- Can apply Poynting's theorem to discuss power balance in electromagnetic systems

EM field computation

- Can solve realistic electromagnetic field problems utilizing physical conceptual reasoning and mathematical synthesis of solutions and not pure formulaic solving
- Can visualize electric and magnetic fields and understand associated abstract field phenomena
- Can analyze time harmonic electromagnetic fields using phasors and complex variables
- Can geometrically represent and spatially visualize three dimension structures

EM devices and systems

- Can compute and analyze potentials and fields in time-invariant and low frequency EM devices and systems of various shapes and material compositions
- Can evaluate capacitance, external and internal inductance, low frequency resistance and leakage conductance of EM structures
- Understand the limitations of circuit theory as an approximation of field theory and can relate them to problems and issues in design of devices and systems

Pre-requisites:

- ECE 341 with a grade of C or better

Concepts:

- Transmission-line equations
- Lossless transmission lines
- Transmission line for communications
  - Frequency domain analysis
  - The lossy line
- Principles of EM propagation. Plane waves
  - Uniform wave propagation
  - Dispersion and group velocity
- Wave propagation in waveguides
  - Transverse electric and transverse magnetic waves
  - Transient response of transmission lines
- Antennas and radiation
- Reflection, transmission and refraction for plane waves

Applications:

- Transmission Lines matching
  - Impulse response
- Transmission line matching
  - The Smith Chart
- Refraction and reflection at oblique incidence
- The dielectric slab waveguide
- The Hertzian dipole antenna

Tools:

- MATLAB (optional)

OUT

Transmission lines

- Can solve for a planar transmission line
- Understands lumped vs. distributed element concept
- Can model the frequency response of transmission lines
- Understands transmission line matching
- Can use Smith Chart to solve transmission line circuits
- Understands and can use concepts of transmission line matching with stubs and quarter-wave transformers
- Can model the behavior of a lossy transmission line

EM waves

- Knows how to express a wave propagating in a medium in an arbitrary direction
- Can use Fresnel Equations
- Understands the concept of dispersion and group velocity

Electrodynamics

- Understands wave propagation in dielectric slab waveguide: TE and TM modes
- Understands behavior of Hertzian dipole antenna
- Wave guides and cavity resonators
- Optical fibers

As of 12/9/08