ECE 342: Electromagnetic Fields and Devices II

IN

Maxwell's Equations

- Use Maxwell's equations in integral and differential forms, and boundary conditions to solve complex static and low-frequency electromagnetic-field problems
- Mathematically model electric and magnetic properties of material media in relation with field equations
- 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
- Apply Poynting's theorem to discuss power balance in electromagnetic systems

EM Field Computation

- Solve realistic electromagnetic field problem utilizing physical conceptual reasoning and mathematical synthesis of solutions and not pure formulaic solving
- Visualize electric and magnetic fields and understand associated abstract field phenomena
- Analyze time harmonic electromagnetic fields using phasors and complex variables
- Geometrically represent and spatially visualize three-dimension structures

EM Devices and Systems

- Compute and analyze potentials and fields in time-invariant and low frequency EM devices and systems of various shapes and material compositions
- 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

- ECE341 with a minimum grade of C

Concepts:

- High-frequency electromagnetic field
- Plane electromagnetic waves
- Wave reflection and transmission
- Transmission lines and waveguides
- Circuit analysis of transmission Lines

Applications:

- Indoor and outdoor wireless propagation
- Energy transfer in guided and free-space systems
- High-frequency and high-speed electronic circuits
- Wireline and wireless communication systems

Tools:

- Vector algebra
- Vector calculus
- Complex algebra
- MATLAB – optional

OUT

High-Frequency Electromagnetics

- Perform high-frequency EM field analysis in frequency (complex) domain
- Apply Poynting's theorem and power conservation
- Understand behavior of Hertzian dipole antenna

Plane Electromagnetic Waves

- Relate electric and magnetic properties of material media to EM wave propagation
- Know how to express a wave propagating in an arbitrary direction
- Perform propagation analysis of plane EM waves in the presence of arbitrary boundaries
- Analyze normal and oblique incidence on a perfectly conducting plane and a penetrable planar interface

Transmission Lines and Waveguides

- Perform field analysis of lossless two-conductor transmission lines
- Compute attenuation along low-loss transmission lines
- Evaluate circuit parameters of transmission lines

EM Devices and Systems

- Understand lumped vs. distributed element concept
- Model the frequency response of transmission lines
- Understand transmission line matching
- Use Smith Chart to solve transmission line circuits
- Understand and use concepts of transmission line matching with stubs and quarter-wave transformers
- Perform transient analysis of transmission lines
- Understand the basic performance of antennas and transmission lines in a particular device or system and relate its influence in the acquisition and processing of the signals and the electronic design

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