ECE 341: Electromagnetic Fields I

IN

Mathematics

- Can solve integrals, take derivatives, and solve differential equations by classical analytical techniques
- Can use vector algebra in three-dimensional problems in space
- Can use standard orthogonal coordinate systems
- Has working knowledge of geometry and trigonometry
- Understands basics of vector calculus
- Has command of complex algebra

Circuit Theory

- Can analyze linear circuits with time-invariant currents
- Can analyze RLC circuits in time-harmonic regime
- Has command of power and energy relations for circuit elements, in both instantaneous and time-average forms
- Can analyze electric circuits with time-harmonic currents using phasors and complex variables

Physics and Engineering

- Understands basics of electricity and magnetism
- Can use Coulomb's law and Biot-Savart law to compute electric and magnetic fields due to simple charge and current distributions
- Can use Maxwell's equations in integral form to solve simple electric and magnetic field problems
- Has command of basic mechanical principles and relations in motion, force, energy, work, rotation, torque, and equilibrium
- Has engineering problem-solving skills
- Understands algorithmic and modular approach to problems in engineering

Pre-requisites:

- MATH 340 or 345 and PHY142

Concepts:

- Electric and magnetic fields in free space
- Maxwell's equations in integral form and applications
- Maxwell's equations in differential form and applications
- Electromagnetic boundary conditions and applications
- Electromagnetic potentials
- Electromagnetic energy storage and power transfer, Poynting's theorem
- Fields in arbitrary electromagnetic media
- Analysis and characterization of time-invariant and low-frequency electromagnetic devices and systems
- Evaluation of capacitance, external and internal inductance, low-frequency resistance, and leakage conductance

Applications:

- Electronics
- Power systems
- Electromagnetic compatibility
- Modeling of transmission lines
- Communications
- Computer engineering
- Computational electromagnetics

Tools:

- Vector algebra
- Vector calculus
- Complex algebra

OUT

Maxwell's Equations

- Can use Maxwell's equations in integral and differential forms, 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 equations
- Understands how electromagnetic material properties can be exploited in engineering applications
- Understands and appreciates EM field theory as a foundation of circuit theory and electrical engineering as a whole

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-dimensional structures

EM Energy and Power

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

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
- Understands limitations of circuit theory as an approximation of field theory, and can relate them to problems and issues in designs of devices and systems

As of 12/9/08