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 Gauss' law and Ampère's law in integral form to solve simple electric and magnetic static 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, PHY142, and ECE 202

Concepts:

- Electrostatic field in free space
- Electrostatic field in dielectrics
- Capacitance
- Electric energy
- Steady electric currents
- Magnetostatic field in free space
- Magnetostatic field in material media
- Electromagnetic induction
- Inductance
- Magnetic energy

Applications:

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

Tools:

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

OUT

Maxwell's Equations

- Can use Maxwell's equations in integral and differential forms, and boundary conditions to solve complex static and low-frequency 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 static and low-frequency 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 geometrically represent and spatially visualize three-dimensional structures

EM Energy and Loss Power

- Understands concepts and is able to evaluate electric and magnetic energy densities and total electric and magnetic energies of different structures
- Understands concepts and is able to evaluate Joule loss power density and total dissipated power of different 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, inductance, resistance, and 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 3/12/13