ECE 444: Antennas and Radiation

IN

Maxwell's Equations

- Can use Maxwell's equations in integral and differential forms to solve static and dynamic electromagnetic-field problems
- Can use boundary conditions to develop mathematical models of electromagnetic structures
- Can mathematically model electric and magnetic properties of material media in relation with field equations
- Understand limitations of circuit theory as an approximation of field theory

Electromagnetic Waves

- Can analyze uniform plane waves in arbitrary homogenous media
- Can analyze reflection, transmission, and refraction of plane waves at boundaries between diff. media
- Understand skin effect in good conductors
- Can analyze lossless and lossy transmission lines with different terminations
- Can analyze propagating modes in rectangular metallic waveguides

Electromagnetic Field

- Can analyze time-harmonic electromagnetic fields using phasors and complex variables
- Can use vector calculus to solve realistic electromagnetic field and wave problems
- Can geometrically represent and spatially visualize three-dimensional devices and systems

Energy and Radiation

- Can apply Poynting's theorem to discuss power balance in electromagnetic systems
- Understand basics of radiation and energy transfer in guided and free-space systems
- Can use retarded electromagnetic potentials to find electric and magnetic fields due to high-frequency current and charge distributors

Pre-requisites:

- ECE342

As of 3/12/13

Concepts:

- Mathematical solution of Maxwell's equations for radiation problems
- Basic antenna parameters
- Antenna polarization
- Electrically small antennas, wire dipoles, monopoles, and loops
- Theory of receiving antennas based on the reciprocity principle, effective aperture
- Wireless links with nonaligned wire antennas
- Power budget in wireless links
- Friis' transmission formula
- General concept of antenna arraying
- Linear antenna arrays, array factor, pattern multiplication, multidimensional arrays
- Resonant wire and patch antennas
- Fundamentals of broadband and aperture antennas

Applications:

- Antenna Analysis and Design
- Antenna Systems
- Wireless Communications
- Radar Engineering
- Computational Electromagnetics

Tools:

- Complex Algebra and Analysis
- Vector Algebra
- MATLAB
- Graphical Techniques
  - Array pattern plots
  - Impedance Smith chart
- Numerical Techniques

OUT

Radiation Theory

- Can use Maxwell's equations to solve radiation and propagation problems
- Can use retarded electromagnetic potentials to explain radiation phenomena
- Can visualize radiated electromagnetic waves
- Can compute and discuss far fields, radiation patterns, and antenna gain based on antenna current distribution

Antenna Arrays

- Can compute array factor of linear arrays
- Can visualize array patterns in 3-D perspective and in different polar views
- Can design linear antenna arrays to meet specified radiation properties
- Can use pattern multiplication, analytically and graphically

Basic Types of Antennas for Wireless Communication

- Can compute radiation and matching parameters of wire dipole and monopole antennas of arbitrary length, and small loop antennas
- Can evaluate complex wire antennas
- Can analyze radiation of microstrip patch antennas and aperture antennas

Receiving Antennas and Wireless Links

- Can establish relationship between transmitting and receiving properties of a given antenna
- Can compute and use vector radiation function and effective aperture of different antenna types
- Can analyze wireless links with nonaligned wire antennas
- Can compute and discuss power budget in wireless links based on Friis' transmission formula