ECE 444: Antennas and Radiation

IN

Maxwell's Equations

- Use Maxwell's equations in integral and differential forms to solve static and dynamic electromagnetic-field problems
- Use boundary conditions to develop mathematical models of electromagnetic structures
- 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

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

Electromagnetic Field

- Analyze time-harmonic electromagnetic fields using phasors and complex variables
- Use vector calculus to solve realistic electromagnetic field and wave problems
- Geometrically represent and spatially visualize three-dimensional devices and systems

Energy and Radiation

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

Pre-requisites

- ECE 342 with a minimum grade of C

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

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

Antenna Arrays

- Compute array factor of linear arrays
- Visualize array patterns in 3-D perspective and in different polar views
- Design linear antenna arrays to meet specified radiation properties
- Use pattern multiplication, analytically and graphically

Basic Types of Antennas for Wireless Communication

- Compute radiation and matching parameters of wire dipole and monopole antennas of arbitrary length, and small loop antennas
- Evaluate complex wire antennas
- Analyze radiation of microstrip patch antennas and aperture antennas

Receiving Antennas and Wireless Links

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

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