ECE 5105 Electromagnetic Waves (3C)

Maxwell's electromagnetic field theory and its applications to engineering problems. 5105: Fundamental concepts and theorems; elementary wave theory and boundary value problems; applications to radiation, transmission line and waveguide problems. 5106: Analytical techniques (Green's theory, modal analysis, etc.) pertaining to guided wave propagation and to scattering and diffraction by discontinuities and inhomogeneties in metallic and dielectric waveguiding structures.

What is the reason for this course?

The design of microwave and optical components, such as antennas, waveguides, etc., as well as the effective exploitation of diverse types of communication channels, is based upon the theory of electromagnetic fields, expressed most efficiently by Maxwell's equations. However, the solution of these equations requires an in-depth understanding of a number of diverse techniques.

Typically offered: Fall. Program Area: Electromagnetics.

Prerequisites: Graduate standing and ECE 3106.

Why are these prerequisites or corequisites required?

Engineering: Proficiency in undergraduate electromagnetic fields. (Knowledge of the material covered in ECE 3106 is mandatory). Mathematics: Differential equations and Fourier concepts. Also Graduate standing.

Department Syllabus Information:

Major Measurable Learning Objectives:

- Demonstrate facility in using Maxwell's equations to evaluate basic plane wave propagation, interaction with planar surfaces, and energy storage
- Describe the fundamental principles of propagation, particularly with regard to the interaction with obstacles
- Describe the effects of a layered medium on the reflection of a plane wave
- Decompose an arbitrarily polarized incident wave into its perpendicular and parallel vector components and determine the total fields above and beneath a planar interface
- Determine the conditions under which a uniform plane wave will be converted to a nonuniform plane wave upon reflection and refraction at a planar interface
- Compute an equivalent current on the surface of a planar interface due to the action of an incident plane wave and use image theory to account for arbitrary sources

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Course Topics

Topic	Percentage
Maxwell's Equations	20%
Differential and integral forms	
Constitutive relations	
Debye relaxation equation	
Boundary conditions	
Temporal and spatial varying functions	
Uniform and nonuniform plane wave solutions of Maxwell's equations	20%
Polarization & direction of propagation for EM waves	10%

Course Topics

Topic	Percentage
Reflection and transmission of plane waves by planar boundaries	20%
Plane wave and polarization notations	
The sufficiency of TE and TM polarizations	
Plane wave nature of reflection and transmission	
Applying the boundary conditions and Snell's Laws	
The effects of non-zero conductivity	
Evanescent waves	
Infinite conductivity	
Fresnel reflection and transmission coefficients	
Behavior for various media types	
Standing and traveling waves in different directions	
Energy considerations in plane wave propagation	
Applications of plane wave reflection theory	
Solutions of Maxwell's equations in spherical coordinates	20%
Spherical waves	
Comparison of spherical and uniform waves	
Energy and power considerations	
Material Properties	10%