ECE 6010: Electromagnetic Field Theory I

Course Description

Maxwell's Equations; plane waves; field representations and solutions in unbounded space; waveguides and cavities; elements of Green's Functions; cylindrical and spherical waves; electromagnetic theorems.

Prior Course Number: ECE 719, 810, and 811
Transcript Abbreviation: EM Theory 1
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Graduate
Student Ranks: Masters, Doctoral
Course Offerings: Autumn
Flex Scheduled Course: Never
Course Frequency: Every Year
Course Length: 14 Week
Credits: 3.0
Repeatable: No
Time Distribution: 3.0 hr Lec
Expected out-of-class hours per week: 6.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: Prereq: 5010 (713), and 5011 or 613; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.
Exclusions: Not open to students with credit for 719, 810, or 811.
Cross-Listings:

Course Rationale: Existing course.

The course is required for this unit's degrees, majors, and/or minors: No
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.1001
Subsidy Level: Doctoral Course

Course Goals

Learn some fundamental laws of electrodynamics based on Maxwell's equations.
Learn electrical properties of materials, solutions of the wave equation as plane waves in source free regions
Learn about wave polarization, and reflection/transmission of plane waves
Learn about modal solutions in waveguides and cavities
Learn about cylindrical and spherical waves in the context of canonical scattering problems
Learn about electromagnetic theorems such as duality, uniqueness, reciprocity, and conservation laws

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Maxwell's equations: Differential and integral forms; continuity equation; constitutive relations; media classification; boundary conditions; Poynting theorem; time harmonic fields; complex Poynting vector, homogeneous wave equation and its solution	9.0							
Plane waves: Polarization, attenuation, reflection, and refraction	5.0							
Field representations and solutions in unbounded space: Electromagnetic sources, solutions of 2D and 3D inhomogeneous wave equation, vector and scalar potentials, Hertz potentials, potentials for static fields, near zone and far zone representations	5.0							
Waveguides and cavities: Parallel plate waveguide, grounded dielectric slab, rectangular waveguide and cavity	7.0							
Elements of Green's functions	2.0							
Cylindrical waves and structures: Cylindrical wave functions, circular metallic guide, dielectric rod, cylindrical wave transformations, scattering by metallic cylinder	5.0							
Spherical waves: Plane wave scattering by spheres, radar cross section	3.0							
Electromagnetic theorems: Duality, uniqueness, image theory, equivalence principle, reciprocity and reaction theorem, conservation laws	6.0							

Representative Assignments

Homework
Midterm exam
Final Exam
Term project with written report and oral presentation.

Grades

Aspect	Percent
Homework	25%
Midterm exam	20%
Final exam	30%
Term project	25%

Representative Textbooks and Other Course Materials

Title	Author
Advanced Engineering Electromagnetics	C. A. Balanis

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
***	a	An ability to apply knowledge of mathematics, science, and engineering.
	b	An ability to design and conduct experiments, as well as to analyze and interpret data.

Course Contribution		College Outcome
	c	An ability to design a system, component, or process to meet desired needs.
	d	An ability to function on multi-disciplinary teams.
*	e	An ability to identify, formulate, and solve engineering problems.
	f	An understanding of professional and ethical responsibility.
**	g	An ability to communicate effectively.
	h	The broad education necessary to understand the impact of engineering solutions in a global and societal context.
*	i	A recognition of the need for, and an ability to engage in life-long learning.
	j	A knowledge of contemporary issues.
	k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Additional Notes or Comments

Updated abbreviation, prereqs, exclusiong, goals and topics to match university format.

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