

EE 371 Engineering Electromagnetics I

Credits: 3

Categorization of credits: engineering topic

Instructors or course coordinator: Magdy Iskander

Textbook and Other Required Materials: Magdy F. Iskander, “Electromagnetic Fields and waves,” second edition, Waveland Press, 2012, ISBN 1-57766-783-2.

Designation: Required

Catalog Description: Engineering Electromagnetics I (3) Transient and steady-state waves on transmission lines. Plane wave solutions of Maxwell’s equations. Application of Maxwell’s equations under static and time-varying conditions. Pre: 213.

Pre-and Co-requisites: EE 213 (Basic Circuit Analysis II)

Class/Lab Schedule: 3 lecture hours per week

Topics Covered:

- Much of the initial effort will be focused on the development of the basic theory and concepts of electromagnetics and emphases will be placed on describing how these laws were developed from experimental observations by the pioneers in this field. Maxwell’s equations in both integral and differential forms will be developed from experimental observations and solved to describe plane wave propagation in air (Chapters 1&2 in the text).
- Next, electromagnetic interactions with materials will be discussed. More general Maxwell’s equations will then be developed and solved to describe plane wave propagation in lossy material media (Chapter 3 in the text). Polarization of waves and pointing theorem for power consideration are also described in details.
- Plane waves reflections and transmissions at planer boundaries will then be described (Chapter 5 in the text).
- This will lead to the transmission line analysis where both transient and steady state solutions will be developed (Chapter 7 in the text).
- If time permits, applications in antennas design will also be described. As you may know there is a separate antenna course that students can take as a follow up for this introductory one EE371.

Course Objectives and Their Relationship to Program Objectives:

Introduce students to the basic concepts of electromagnetics and illustrate some of its basic applications in wave propagation, communications and transmission lines related technologies. Every effort will be made to describe relevance and practical applications of the developed theory while maintaining strong fundamental understanding of associated physical phenomena. [Program Objectives this course addresses: 1, 3, and 4.]

Course Outcomes and Their Relationship to Program Outcomes:

The following are the course outcomes and the subset of Program Outcomes (numbered 1-7 in square braces "[]") they address:

- Recognize and understand how electromagnetic laws and Maxwell's equations were developed based on simple experiments and interpretation of experimental data. This brings realism and better understanding to the often considered challenging Maxwell's equations and develop appreciation for the role of mathematical expressions and their usefulness in quantifying experimental observations. [1, 6].
- Recognize the connection and relationship between integral and differential mathematical formulation of physical phenomena, in general and Maxwell's equations in particular [1, 6].
- Understand characteristics of wave propagation and relationship to wireless communications and appreciation for the role of polarization in communications and radar applications. When discussing Poynting theorem, students develop appreciation to parameters associated with the development of safety standards for electromagnetic radiation [1, 2, 4, 6]
- Use of microwave engineering design tools such as the Smith Chart to perform impedance matching and evaluate reflections and power transmission on transmission lines [1, 2, 4, 7]
- Apply transmission-line techniques to plane-wave propagation problems, using real-life examples such as hyperthermic treatment of cancerous tumors, radiation hazards of antennas, etc. [1, 2, 4, 7]
- Develop ability to analyze transient response and multiple reflections in digital circuits. This part of the course is considered of interest to computer engineering students [1, 2, 4, 7]

Contribution of Course to Meeting the Professional Component

Physics topics (20%) and Engineering topics: 80%

Computer Usage: Software tools and multimedia modules (CAEME software) are often used in classroom presentations for demonstration of characteristics of wave propagation and interactions with materials, polarization, and virtual participation in experiments that led to the discovery of Maxwell's equations. Students also experience participation in an electronic version of the Smith Chart.

Design Credits and Features:

EE 371 has 0.5 design credit. Exams and homework assignments often involve practical applications including wave polarization, reflection and transmission at multiple interfaces, and use of the Smith Charts for impedance matching design in transmission-line circuit.

Person Preparing Syllabus and Date: Magdy F. Iskander, Jan. 31, 2015. Modified by A. Ohta, Jan. 14, 2021.