

ELEG 3704 – ELECTROMAGNETICS

Credits and Contact Hours

Four credit hours, 45 hours of instructor contact

Instructor's Name

Magda El-Shenawee

Textbook

Fundamentals of Applied Electromagnetics, Fawwaz T. Ulaby, Prentice-Hall, Sixth edition.

Specific Course Information

a. Catalog Description

Analysis of transmission lines with sinusoidal and transient excitation. Development and use of the Smith Chart and methods of impedance matching. Vector analysis, static form of Maxwell's equations, electrostatics, and magnetostatics.

b. Co-requisites: Lab component. Pre- or Co-requisite: PHYS 2074 and MATH 2574.

Prerequisite: ELEG 2114.

Prerequisites by Topics

Integral and differential calculus.

Line, surface and volume integration.

Three-dimensional vector algebra

Circuit lumped elements.

Complex numbers and phasors

c. Required

Specific Goals for the Course:

1. Specific Outcomes of Instructions

After completing this course, electrical engineering students should be able to determine the following:

- Design quarter wave transformers and impedance matching networks for transmission lines
- Use transient analysis of pulses to locate faults on transmission lines
- Electric and magnetic fields produced by simple charge and current distributions

Lecture Topics

- EM spectrum, nature of the electromagnetic field and 1-D wave propagation in lossless media (2 classes)
- Transmission Lines and Smith Chart (8 classes)
- Maximal rate of change of a field, irrotational fields and conservative fields (4 classes)
- Dielectric and magnetic properties of materials (2 class)
- Electric & magnetic fields produced by simple charge & current distributions (8 classes)
- Maxwell's equations (1 class)
- Boundary Conditions on electric and magnetic fields (2 classes)
- Reflection and transmission at planar interfaces (optional)
- Review classes for two midterm examinations (online recordings with access to all students registered in class)
- Two midterm examinations in class (2 classes)
- Comprehensive review of course material before the final examination (1 class)

There are two (2) 80-minute class periods per week for a total of 15 weeks.

Lab Experiments & Objectives

- Introduction to Microwave Kit Overview of a microwave setup: learn how to use the SWR Meter, and assemble an experiment using the microwave kit to measure the frequency and the wavelength of the propagating wave (1 Lab session).
- Conduct the reflection coefficient measurements: assemble an experiment using the microwave kit to isolate the incident and the reflected waves, and measure the voltage standing wave ratio (VSWR) of different loads (1 Lab session).
- Conduct wavelength and VSWR measurements: assemble an experiment using the microwave kit to measure the wavelength of the propagating wave and measure the VSWR of different loads (1 Lab session).
- Unknown load measurements: calculate the impedance of unknown loads using the Smith Chart (1 Lab session).
- Transmission line shunt stub matching network: demonstrate the matching achieved using a single shunt short circuit stub based on only one degree of freedom which the length of the stub assuming that its location from the load is known (1 Lab session).
- Measurement of relative permittivity: measure the relative permittivity of an unknown dielectric. Use MATLAB programming to solve for the nonlinear equation to obtain the solutions (1 Lab session).
- Measurement of Antenna Gain: measure the gain of pyramidal horn antennas versus frequency (1 Lab session for Honors Section).

Computer Usage

Using MATAB programming as an assignment to complete the lab report of experiment # 6

Oral/Written Communications

Students write a 1 page report/essay for the Ethics and Professional responsibility assignment

Design Activities

Design of impedance matching networks and quarter wave transformers using open and short circuit transmission lines

2. Indicate the student outcomes listed in Criterion 3 addressed by the course:

OUTCOME	HOW IT WAS ADDRESSED
(a)	Vector calculus, physical interpretation of gradient, divergence and curl operations on vector and scalar fields, use of phasors to solve transmission line circuits and EM wave propagation problems
(b)	Conducting 6-7 experiments in the lab and collect data to be analyzed in tables and plots. The experiments are based on using the Microwave Kit to clarify and explain the fundamental knowledge of transmission lines, wave propagation, and antenna concepts.
(c)	Design of impedance matching networks to optimize power delivery, design of components that mimic open and short circuits. Conduct lab experiment on designing the shunt stub to achieve impedance matching. Experimental results are validates with analytical results using Smith Chart
(d)	NA
(e)	Ability to use transmission line analogies to solve problems involving 1-D RF, MW and optical signal propagation. Ability to formulate appropriate boundary conditions and solve EM field problems.
(f)	Understand the ethics and the professional responsibility of electrical engineers. The students are asked to attend and submit an essay on the

	Engineering Ethics and Profession. The talk was given by Mr. Ken Vickers who spent 25 years working in the industry at Texas Instrument company.
(g)	NA
(h)	NA
(i)	To help students recognize that they need to keep open minded about the long life learning in the profession, professional activities are organized to be attended. For example, one activity is an organized tour for the whole class to the electromagnetics research labs, where a new technology of terahertz imaging and spectroscopy system is located. Another activity is to bring an engineer or a scientist from the industry or a technology agency to present the numerous applications that an electromagnetic engineer can be engaged in when joins the workforce. The students are required to attend these activities and interact with the presenters.
(j)	NA
(k)	Use of Smith charts to develop physical understanding and simplify problem solution. MATLAB is used to complete lab report of experiment # 6 to solve for the unknown permittivity using experimental data collected in the lab.