The University of Texas at Arlington
Department of Electrical Engineering

EE 3407 – Engineering Electromagnetics

Course Information Fall 2022

Instructor: Saibun Tjuatja
Room 504 NH
Phone: 817-272-3974
Email: tjuatja@uta.edu

Class time and location:
TTh 12:30 PM – 1:50 PM, WH 404
Office hours for class:
TTh 2:00 PM – 3:30 PM or by appt.

Course Description:

EE 3407 ELECTROMAGNETICS (3-3) Time varying electric and magnetic fields, displacement current, Maxwell's equations and transverse electromagnetic waves; plane waves in an unbounded medium, waves in media with planar interfaces, boundary conditions, reflection and transmission, plane waves in lossless and lossy media; electromagnetic waves in a bounded medium, guided waves, wave guides, propagation modes; transmission lines, circuit models of transmission lines, transmission line equations, reflection at discontinuities, terminations, transient response, steady state waves on transmission lines, open and short circuited lines, power flow, impedance matching and the Smith chart, antennas. Problems and experimental demonstrations will be covered during recitation and laboratory sessions. Prerequisite: C or better in both EE 2347 and PHYS 1444. Co-requisite: EE 3346.

Objective: The objective of this course is to give you an understanding of the basic properties of electromagnetic waves, methods of solution for exterior and interior problems in electromagnetics, and applications of electromagnetic theory. After completing the course, you are expected to have the ability to develop mathematical models of practical EM problems, construct solutions, and analyze the electromagnetic waves inside and outside of a canonical structure.

Required Text: Ulaby, F.T. and Ravaioli, U., *Fundamentals of Applied Electromagnetics*, 7th Edition, Prentice-Hall, 2015.

Reference Text: Pozar, David M., *Microwave Engineering*, 4th Edition, John Wiley & Sons, 2012

Prerequisites: EE 2347 and PHYS 1444

Corequisite: EE 3346

Grading: There will be homeworks, quizzes, labs, and three tests. If you have any question on grading of an assignment or a test, please contact me about your question within one week after the grade is received. The weighting and tentative grading scales are:

Weighting of scores		Scale for letter grade	
Homeworks & Quizes	10%	90—100	A
Average of 3 test scores	70%	80—89.99	B
Lab	20%	70—79.99	C
		60—69.99	D
		<60	F

Tests: All tests will be comprehensive, open book and open notes. The use of computer and calculator is allowed in the exam. No make-up exam unless approval is obtained prior to the scheduled test date.

Assignments: **You must turn in your own work**, not copied from someone else's. Please write (or print) legibly, and make sure that the associated PDF file is readable.

Important Dates:
Test #1: September 22, 2022 (Th)
Test #2: October 25, 2022 (T)
Test #3: December 1, 2022 (Th)

Lecture Topics (plan):

Module #	Topics	Textbook Chapter(s)
1	**Review:** electric charges, current, and voltage (potential difference); Lorentz force; fields & waves; time varying and time-harmonics voltages; time-domain and frequency-domain representations; sinusoidal/time-harmonic travelling waves; complex representation and phasors **Learning outcomes:** compute electric and magnetic fields for a given charge distribution; mathematically formulate time harmonics voltage/current and travelling voltage/current waves; perform complex algebra; formulate time harmonic signal using phasors	1, 4, 5
2	Transmission lines: applications of transmission line; transmission line equations, physical and model parameters, wave propagation on a transmission line, phase velocity **Learning outcomes:** derive the time-harmonic transmission line equation; determine R, L, G, and C of a given transmission line; determine the time-harmonic voltage/current propagation direction, speed, and wavelength on a transmission line	2
3	Finite-length transmission lines: voltage reflection coefficient, standing waves, SWR, wave impedance **Learning outcomes:** for a given transmission line circuit, compute the voltage reflection coefficient, VSWR, and wave impedance	2

4	Lossless transmission lines: short-circuited and open-circuited lines; applications as reactive circuit elements; **Learning outcomes:** compute the input impedance of a transmission with short-circuited and open-circuited loads; design a reactive circuit element using short-circuited or open-circuited transmission line	2
5	Lossless transmission lines: impedance matching; dipole antenna concept; unbounded fields/waves **Learning outcomes:** design a single-stub impedance matching network for a given transmission line circuit; quantify the performance of a transmission line circuit with impedance matching; determine/approximate the current distribution of a dipole antenna; describe the field radiated from the dipole antenna	2
6	**Review:** vector analysis, orthogonal coordinate systems, scalar and vector fields, gradient of a scalar field, divergent and curl of vector fields, Divergence and Stokes' theorem **Learning outcomes:** perform 3D vector algebra; formulate differential length, area, and volume in rectangular, cylindrical, and spherical coordinate systems; determine the gradient of a scalar field; determine the divergent and curl of a vector field; apply divergence and Stokes' theorem in solving problems with contour, surface, and volume integrals	3
7	Differential and integral form of time-varying Maxwell's equations: electromagnetic sources; impressed charge and impressed current distributions; electromagnetic field intensity and flux density **Learning outcomes:** explain the physical phenomena described by Maxwell's equation; explain the relationships between EM sources and fields; describe/formulate the effects of medium on EM intensity and flux densities	6
8	Time-varying and time-harmonic EM fields; Maxwell's equations in source-free region; conduction current and displacement current **Learning outcomes:** convert the time-varying MEs to time-harmonics MEs; apply the source-free formulation for a given EM problem; explain and compute the conduction and displacement currents in a given circuit	6
9	Applications in energy conversion: transformer, Lorentz force, motor and generator **Learning outcomes:** calculate the transformer and motional emf for a given circuit; compute the forces experience by the wire/structure for a given current flow and field configutation; define the basic geometry of a motor and a generator; calculate the torque of a given motor configuration	6
10	Time-harmonic fields; wave equations; propagating waves; non-uniform and uniform plane waves	7

	Learning outcomes: derive the time-harmonic wave equation in free space; describe the basic properties of plane, cylindrical, and spherical waves (in terms of propagation direction and power distribution)	
11	Plane wave propagation direction; polarization; Poynting theorem; wave propagation is lossy and lossless media **Learning outcomes:** determine the propagation direction, polarization, and wavelength of a plane wave; quantify the effects of medium on plane wave propagation; calculate the power delivered by a time-harmonic plane wave	7
12	Boundary conditions; wave reflection and transmission, reflection and transmission coefficients, total reflection and Brewster angle **Learning outcomes:** calculate the reflected and transmitted plane waves at the planar interface between two media; analyze and determine the characteristics of reflected and transmitted waves for vertical and horizontal polarizations	8
13	Rectangular waveguides, TM and TE propagation modes, cut-off frequencies, propagation velocities, dispersion **Learning outcomes:** analyze the EM waves inside a rectangular waveguide; calculate the cut-off frequencies, propagation modes, and propagation velocity of a given waveguide	8
14	Cylindrical waveguides and optical fibers, propagation modes, propagation velocities, dispersion **Learning outcomes:** provide basic formulation of EM waves inside a cylindrical waveguide; calculate the cut-off frequencies, propagation modes, and propagation velocity of a given waveguide	8
15	Radiation and Antennas: Hertzian dipole; antenna radiation characteristics **Learning outcomes:** calculate the input impedance, radiation efficiency, and gain/directivity of a Hertzian dipole	9
16	Linear wire and aperture antennas, effective area of receiving antenna, Friis transmission formula; applications in wireless communications, LIDAR, and Radar **Learning outcomes:** define antenna directivity, gain, and effective area; derive and apply Friis transmission formula; perform communication link budget analysis; determine detectability of a target using radar equation	9

---------- **N O T E** ----------

If you require an accommodation based on disability, I would like to meet with you in the privacy of my office (or virtually), during the first week of the semester, to make sure you are properly accommodated.

Student Evaluation of Teaching

Students will be asked to complete online instructor/course evaluation at the end of the semester.

Americans with Disabilities Act

The University of Texas at Arlington is on record as being committed to both the spirit and letter of federal equal opportunity legislation; reference Public Law 93112-The Rehabilitation Act of 1973 as amended. With the passage of new federal legislation entitled Americans with Disabilities Act - (ADA), pursuant to section 504 of The Rehabilitation Act, there is renewed focus on providing this population with the same opportunities enjoyed by all citizens.

As a faculty member, I am required by law to provide "reasonable accommodation" to students with disabilities, so as not to discriminate on the basis of that disability. Student responsibility primarily rests with informing faculty at the beginning of the semester and in providing authorized documentation through designated administrative channels.

Academic Dishonesty – ANY CHEATING WILL RESULT IN SEVERE PENALTIES

It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspension or expulsion from the University.

"Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts." (Regents' Rules and Regulations, Part One, Chapter VI, Section 3, Subsection 3.2, Subdivision 3.22).

Diversity, Equity, and Inclusion

The University is committed to Diversity, Equity, Inclusion (DEI) principles and initiatives to ensure success for all students, staff, and faculty, regardless of identity or cultural background (https://www.uta.edu/about/diversity-equity-inclusion) and highlighted by the following statement in the University's vision statement[1] "The diverse student body shares a wide range of cultural values and the University community fosters unity of purpose and cultivates mutual respect." Following the University, the College of Engineering has developed its own DEI initiatives[2]. As a faculty member and instructor in the College of Engineering, during this course I intend to follow and implement norms in our student faculty interactions that uphold University and College of Engineering DEI principles and initiatives. University values are affirmed by the DEI stance of professional engineering organizations such as, the National Society of Black Engineers, National Society of Hispanic Engineers, Society of Women Engineers, Engineering Accreditation Commission (ABET)[3], and the National Society of Professional Engineers:[4] "Engineers shall be guided in all their relations by the highest standards of honesty and integrity. Engineers shall treat all persons with dignity, respect,

fairness and without discrimination." If you experience a violation of DEI principles in our course, feel free to contact me, or the College of Engineering Student Ombud's-Team[5] , or the Chair of your Department, or the College Associate Dean of Graduate Affairs if you are a graduate student.

1. https://www.uta.edu/strategicplan/about/mission.php
2. https://www.uta.edu/academics/schools-colleges/engineering/about/diversity-equity-inclusion
3. https://www.abet.org/about-abet/diversity-equity-and-inclusion/
4. https://www.nspe.org/resources/ethics/code-ethics
5. https://www.uta.edu/academics/schools-colleges/engineering/students/ombuds-team