ECE DEPARTMENT
THE COLLEGE OF NEW JERSEY
Spring 2016
ELC 361 - Engineering Electromagnetics

2015-2016 Course Description:

An integration of theory and practical applications in electromagnetics, transmission lines, and electromagnetic fields and waves. Includes impedance matching, Smith Chart, CAD tools and waveguides.

Text: **Electromagnetics With Applications, by Kraus/Fleisch,** Prentice Hall

Instructor: Dr. Allen Katz, alkatz@tcnj.edu, x2666, 149 Armstrong Hall,
Office Hours: M 02:00 - 03:20 pm and 5:30 - 6:00 pm, W 12:00 - 12:30 pm and TR 5:00 – 6:00 pm.

Week	Lecture Topics	Assignments	Problems
1	Introduction	Chapter. 1	1-3-1, 1-4-1 to 1-4-3, 1-5-1 & 1-5-2, 1-6-1 to 1-6-13, 1-7-1 to 1-7-3
2	Electrical & Magnetic Fields a. Charge, Field Intensity b. Gauss's Law c. Gradient & Divergence d. Capacitance	Chapter. 2 Sec. 1 thru 9 Quiz	2-2-1 to 2-2-3, 2-3-1 to 2-3-5, 2-5-1 & 2-5-2, 2-6-1 & 2-6-2, 2-7-1, 2-8-1, 2-9-1 to 2-9-4
3	Electrical & Magnetic Fields cont'd a. Electric Current b. Ohm's Law c. Power & Joule's Law d. Magnetic Flux	Chapter. 2 Sec. 10 thru 12 Test 1	2-10-1, 2-11-1 to 2-11-6 Computer Design Project 1
4	Electrical & Magnetic Fields cont'd a. Inductance & the Curl b. Changing Magnetic Fields c. Maxwell's Equations d. E&M Simulator	Chapter. 2 Section 13 thru 16 Quiz	2-12-1 to 2-12-9, 2-14-1 to 2-14-9, 2-15-1 to 2-15-4
5	Transmission Lines a. Circuit Concepts b. Characteristic Impedance c. Physical Transmission Lines	Chapter. 3 Section 1 thru 3 Test 2	3-2-1, 3-3-1 to 3-3-10
6	Catch Up & Review		Computer Design Project 2
7	Transmission Lines Cont'd a. Reflection Coefficient b. VSWR	Chapter. 3 Section 4 Quiz	3-4-1 to 3-4-14, 3-5-2 to 3-5-5, 3-6-1 & 3-6-2

	c. Smith Chart		
8	Transmission Lines Cont'd a. Impedance Matching b. Bandwidth c. Transients	Chapter. 3 Section 5 & 6 Test 3	3-6-3, 3-6-4
9	Transmission Lines a. Microwave Office b. S-parameters c. Microstrip Applications	Notes on Microwave Office Quiz	Computer Design Project 3
10	Wave Propagation a. Plane Waves b. Standing Waves in Space c. Conductors and Dielectrics	Chapter. 4 Section 1 thru 6 Quiz	4-2-1 to 4-2-3, 4-3-1, 4-4-1
11	Wave Propagation Cont'd a. Lossey Media b. Phase Velocity c. Group Velocity d. Energy Considerations	Chapter. 4 Section 5 thru 10 Test 4	4-5-1,4- 6-1 to 4-6-3, 4-7-1 to 4-7-9, 4-8-1 & 4-8-2, 4-9-1 & 4-9-2, 4-10-1
12	Polarization a. Basic Concepts b. Linear c. Circular/elliptic forms	Chapter. 4 Section 11 thru 16 Quiz	4-12-1, 4-13-1 & 4-13-2, 4-14-1 to 4-14-3, 4-15-1 & 4-15-2, 4-16-1
13	Waveguides and Fiber Optics a. Line as tuned circuit b. Losses and Q c. Applications	Chapter. 8 Sect 1 thru 12	8-4-1 & 8-4-2, 8-5-1 to 8-5-3, 8-8-1 & 8-8-2, 8-10-1, 8-11-1 to 8-11-3, 8-12-1 & 8-12-2
14	Introduction to Antennas	Chapter. 5 Sect 1 thru 11	

FINAL EXAM

Grading

Quizzes - 20% of the grade
Tests/Projects - 50% of the grade
Final Exam - 30% of the grade

Course Objectives:

Objective 1 To appreciate the electromagnetic model, which includes electromagnetic fields and sources.

Objective 2 To apply vector calculus concepts.

Objective 3 To understand static electric field concepts and calculations.

Objective 4 To understand steady magnetic field concepts and calculations.

Objective 5 To understand transmission line and wavequide theory.

Objective 6 To understand matching techniques and of S-parameters.

Performance Criteria:

Objective 1 The student will be able to apply a mathematical structure and field equations to relate fields to their sources.

Objective 2 The student will be able to apply vector algebra (orthogonal coordinate systems, and scalar and vector products) and calculus of scalar and vector fields (surface and volume integrals, vector differential operations, vector integral identities, and Helmholtz theorem) to electromagnetic problems.

Objective 3 The student will be able to apply Coulomb's law, Gauss's flux theorem, and Boundary conditions to electromagnetic problems.

Objective 4 The student will be able to apply the Biot-Savart law, magnetic dipole field theory, and magnetic field boundary conditions to electromagnetic problems.

Objective 5 The student will be able to apply electromagnetics theory to transmission lines and wavequides.

Objective 6 The student will be able to S-parameters in the solution general electromagnetic problems.

Educational Objectives:
The School of Engineering at The College of New Jersey seeks to prepare its graduates:

- To contribute to the economic development of New Jersey and the nation through the ethical practice of engineering;
- To become successful in their chosen career path, whether it is in the practice of engineering, in advanced studies in engineering or science, or in other complementary disciplines;
- To assume leadership roles in industry or public service through engineering ability, communication skills, teamwork, understanding of contemporary global and socio-economic issues, and use of modern engineering tools;
- To maintain career skills through life-long learning and be on the way towards achieving professional licensure.

Electrical and Computer Engineering Student Outcomes
(What TCNJ Electrical and Computer Engineering students are expected to know and be able to do at graduation. What knowledge, abilities, tools and skills the program gives the graduates to enable them to accomplish the Educational Objectives). The following Student Outcomes listed on the following page are expected of all graduates of the Electrical or Computer Engineering Program.

ECE graduates will have:

- **an ability to apply knowledge of mathematics, science and engineering**;
- an ability to design and conduct experiments, as well as to analyze and interpret data;
- **an ability to design a system, component, or process to meet desired needs;**
- an ability to function in multidisciplinary teams;

- **an ability to identify, formulate and solve engineering problems**;
- an understanding of professional and ethical responsibility;
- an ability to communicate effectively;
- the broad education necessary to understand the impact of engineering solutions in a global and societal context;
- a recognition of the need for and an ability to engage in life-long learning;
- a knowledge of contemporary issues;
- **an ability to use the techniques, skills and modern engineering tools necessary for engineering practice;**
- an ability to analyze and design complex electrical and electronic devices;
- an ability to analyze and design software and systems containing hardware and software components.

Specific to this course

- **an ability to apply knowledge of mathematics, science and engineering**;
  Vector calculus, multivariable calculus, field theory, Maxwell's Equations.
- **an ability to design a system, component, or process to meet desired needs;**
  Home work problems involve design (Power & RF transmission lines, impedance matching) and a project requiring the design of an impedance matching network
- **an ability to identify, formulate and solve engineering problems**;
  Electrical and magnetic field intensity, transmission lines, matching
- **an ability to communicate effectively;**
  Aural presentation of home work problems, written design report
- **an ability to use the techniques, skills and modern engineering tools necessary for engineering practice;**
  MATLAB used for many homework problems, Microwave Office used for design project

DESCRIPTION OF DESIGN ACTIVITY
Design of related home work problems and matching network design project using Microwave Office.

Example: Design two different networks to match two 50 ohm patch antennas to a common 50 ohm feed point. Evaluate the relative bandwidths.

REALISTIC CONSTRAINTS
Economic: Discuss relative costs and manufacturing considerations of different designs.

PROFESSIONAL ENGINEERING TOOLS
MATLAB and Microwave Office packages are widely used in industry for the design of RF and microwave hardware.

COMPUTER USAGE
About thirty percent of the homework problems involve the use of a computer. The design project requires computer use.

FEEDBACK MECHANISM
The homework problems are presented using Power Point by the students in class and discussed.

FOURTH HOUR EDUCATIONAL ACTIVITIES
Forth hour meetings are regularly required of students with the instructor to discuss and present results of intensive design projects (Computer Design Projects 1 & 2) and special home work assignments required by this course. These projects require each student to significantly increase out-of-class learning.

SELECTED TCNJ POLICIES

TCNJ's final examination policy is available on the web:
http://www.tcnj.edu/~academic/policy/finalevaluations.htm

Attendance

Every student is expected to participate in each of his/her courses through regular attendance at lecture and laboratory sessions. It is further expected that every student will be present, on time, and prepared to participate when scheduled class sessions begin. At the first class meeting of a semester, instructors are expected to distribute in writing the attendance policies which apply to their courses. While attendance itself is not used as a criterion for academic evaluations, grading is frequently based on participation in class discussion, laboratory work, performance, studio practice, field experience, or other activities which may take place during class sessions. If these areas for evaluation make class attendance essential, the student may be penalized for failure to perform satisfactorily in the required activities. Students who must miss classes due to participation in a field trip, athletic event, or other official college function should arrange with their instructors for such class absences well in advance. The Office of Academic Affairs will verify, upon request, the dates of and participation in such college functions. In every instance, however, the student has the responsibility to initiate arrangements for make-up work.

Students are expected to attend class and complete assignments as scheduled, to avoid outside conflicts (if possible), and to enroll only in those classes that they can expect to attend on a regular basis. Absences from class are handled between students and instructors. The instructor may require documentation to substantiate the reason for the absence. The instructor should provide make-up opportunities for student absences caused by illness, injury, death in the family, observance of religious holidays, and similarly compelling personal reasons including physical disabilities. For lengthy absences, make-up opportunities might not be feasible and are at the discretion of the instructor. The Office of Academic Affairs will notify the faculty of the dates of religious holidays on which large numbers of students are likely to be absent and are, therefore, unsuitable for the scheduling of examinations. Students have the responsibility of notifying the instructors in advance of expected absences. In cases of absence for a week or more, students are to notify their instructors immediately. If they are unable to do so they may contact the Office of Records and Registration. The Office of Records and Registration will notify the instructor of the student's absence. The notification is not an excuse but simply a service provided by the Office of Records and Registration. Notifications cannot be acted upon if received after an absence. In every instance the student has the responsibility to initiate arrangements for make-up work.

TCNJ's attendance policy is available on the web:
http://www.tcnj.edu/~recreg/policies/attendance.html

Academic Integrity Policy

Academic dishonesty is any attempt by the student to gain academic advantage through

dishonest means, to submit, as his or her own, work which has not been done by him/her or to give improper aid to another student in the completion of an assignment. Such dishonesty would include, but is not limited to: submitting as his/her own a project, paper, report, test, or speech copied from, partially copied, or paraphrased from the work of another (whether the source is printed, under copyright, or in manuscript form). Credit must be given for words quoted or paraphrased. The rules apply to any academic dishonesty, whether the work is graded or ungraded, group or individual, written or oral.

TCNJ's academic integrity policy is available on the web:
http://www.tcnj.edu/~academic/policy/integrity.html.

Americans with Disabilities Act (ADA) Policy
Any student who has a documented disability and is in need of academic accommodations should notify the professor of this course and contact the Office of Differing Abilities Services (609-771-2571). Accommodations are individualized and in accordance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1992.

TCNJ's Americans with Disabilities Act (ADA) policy is available on the web:
http://www.tcnj.edu/~affirm/ada.html