Syllabus

ECE – 303 ——— Electromagnetic Fields

NC State University – Spring Semester 2013

Class Meeting Times / Location

Lecture Time / Location: Tuesday and Thursday, 9:35 – 10:50 am, EB2 room 1021

Instructor Contact Information

Professor: Dr. Michael Escuti, mjescuti@ncsu.edu

Primary Office / Phone: MRC Bldg room 432 (Centennial Campus), 513-7363

Teaching Assistant: Mohammad Etemadrezaei, metemad@ncsu.edu

Office Hours (for ECE-303)

Professor: Normally, the "flipped"-lecture time serves as the classic office hours. Additional time can be arranged by emailing Dr. Escuti.

Teaching Assistant: Tuesday and Thursday, 11:00 am - 12:30 pm, EB2 1029

Educational Resources (Textbook & Online)

Since active student participation is essential to the impact (and fun!) of this course, we strongly encourage students to take advantage of the "flipped" class perspective, online resources, and your colleagues. We welcome all questions (at least those nominally course or career related) during lecture or by contacting us directly.

Required Textbook: Fundamentals of Applied Electromagnetics, Ulaby, Michielssen, Ravaioli (6th Ed.)

Textbook CD-ROM: http://courses.ncsu.edu/ece303/lec/001/wrap/EmagCD/start.html

(primary) *Moodle*: http://moodle.wolfware.ncsu.edu/course/view.php?id=34254

(opt) *Facebook Group*: http://www.facebook.com/groups/303.ece.ncsu/ (needs @ncsu.edu email listed in FB)

Course Description

This course prepares you to formulate and solve electromagnetic problems relevant to all fields of Electrical and Computer Engineering and that will find application in subsequent courses in RF circuits, photonics, microwaves, wireless networks, computers, bioengineering, and nanoelectronics. Primary topics include static electric and magnetic fields, Maxwell's equations and force laws, wave propagation, reflection and refraction of plane waves, transient and steady-state behavior of waves on transmission lines.

Evaluation and Grading Policy

A weighted average grade will be calculated as follows:

Final Exam = 25 %, In-class Exams (x2) = 22 % (each), Quizzes = 12 %,
Homework = 10 %, Attendance/Participation = 4 %, Oral Presentation = 5 %

It is important to note that the Professor *will not be curving grades in this course*. The good news is that it is theoretically possible for everyone in the class to get an A (or an F). Your performance depends entirely on how you do, and not on how everyone else in the class does. It is therefore in your best interest to help your classmates in every legal way possible.

Overall grade for the course will follow University guidelines:

Score	*Letter Grade*	*Score*	*Letter Grade*	*Score*	*Letter Grade*	*Score*	*Letter Grade*
$97 \leq X$	=> A+	$87 \leq X < 90$	=> B+	$77 \leq X < 80$	=> C+	$67 \leq X < 70$	=> D+
$93 \leq X < 97$	=> A	$83 \leq X < 87$	=> B	$73 \leq X < 77$	=> C	$63 \leq X < 67$	=> D
$90 \leq X < 93$	=> A-	$80 \leq X < 83$	=> B-	$70 \leq X < 73$	=> C-	$60 \leq X < 63$	=> D-

There will be a *gray area* of several points below each of the numerical cutoffs at left (except for A to A+). A student within this gray area may receive the higher grade (e.g. a B+ instead of a B) at the discretion of the Professor. This discretion may depend on several things: steady improvement in your test/homework grades over the semester, strong in-class participation, etc.

Exam Policy

There will be two (2) in-class Exams, in addition to the Final Exam (see Moodle or University Calendar for date/ time). In-class reviews will be organized to provide examples of Exam problems with solutions, and Instructional Objectives will be posted one week prior.

If an Exam is missed without a certified medical excuse or prior instructor approval, a zero will be averaged into your grade. Certified excuses and prior approval will be dealt with individually. A single makeup exam for Exam 1 and/or 2 will be offered, held at a designated time at the end of the semester, and before the Final Exam. This makeup exam will include the contents assessed by both Exam 1 and 2, regardless of which of these two is being "made up". A makeup for the Final Exam will be arranged on a case-by-case basis.

To request an excused absence, 1) write a formal hard copy letter to me (yes, real paper), dated and signed, stating your specific request and the reason you are asking for an excused absence; 2) provide documentation supporting your request; 3) bring this letter and the documentation to me in person before the requested date (if an absence is foreseeable) or within one day after the absence (if it is of unforeseeable nature), at which time we will discuss your request. Special cases will be dealt individually.

Online Lecture Process and Policy ("flipped class")

Most lectures will be pre-recorded and distributed online, to be viewed before the scheduled class. The scheduled class time will include additional demonstrations, active learning activities, and open tutorial time.

Normally, the active learning activity will involve a group or individual discussion and/or calculation that will be handed in by the end of class. This will be graded, and integrated into the participation score.

Quiz Policy

Each recorded lecture will be followed by one or more brief online quizzes, primarily for immediate feedback.

The lowest three quiz scores will be dropped. Unexcused absences will result in a zero score for the missed quiz.

Homework Policy

The lowest grade in homework assignments will be dropped (therefore, one homework during the semester can be missed without loss of credit). No late homework will be accepted.

Homework assignments will be posted on the course website, and are due at the *end of class or TA office hours*, whichever is later.

Oral Presentations Policy

All students will be asked to present a short (~5 min) oral presentation about a suitable electromagnetics topic of their choice. For example, one of the Technical Briefs in our textbook, or another device, effect, or idea.

This will be recorded in the Hunt Library presentation practice rooms. The grade for these presentations will be composed of a score from the instructors and your student peers. Detailed guidelines will be provided mid-semester.

Instructors' Commitment

We aim to provide you with the best course materials and to go out of our way to assist you in learning the material. You can expect your instructors to be courteous, respectful, and punctual; to be well organized and prepared for lectures; to answer questions clearly and in a non-negative fashion; to be available during office hours or notify you beforehand if we are unable to kept them; to grade uniformly and consistently according to posted guidelines.

For Students with Disabilities

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at the Student Health Center. For more information on NC State's policies on working with students with disabilities, see this link. You instructor and TAs have been and will continue to be as flexible as possible.

Academic Integrity

University policy will be followed. Note that teamwork is strongly encouraged (as it is an important part of being a successful engineer), but plagiarism/cheating is not be tolerated at all. You are expected to fully understand and author any assignments even though you may work on them with your classmates on out-of-class assignments. If

you do not meet this standard, it is far better to discuss the situation with the professor than to dig yourself into a hole (i.e. cheating) that will have significant long-term consequences.

Instructional Objectives

We aim to produce students with a foundation and working knowledge of basic electromagnetic phenomena. In order to do well in this course, students must demonstrate the ability to:

1. **Determine** when a circuit must be analyzed with transmission line (TL) principles or when it can be considered as a lumped-element circuit.
2. **Explain** the following concepts: transmission line, phase velocity, phase constant beta, attenuation constant alpha, complex propagation constant gamma, characteristic impedance, wave (input) impedance, voltage reflection coefficient, traveling vs standing waves, and standing-wave-ratio.
3. **Calculate** the characteristic impedance, capacitance, inductance, resistance, and conductance of TLs (coaxial, two-wire, parallel-plate) when given their phase velocity and geometry, and visa versa.
4. **Write** the steady-state solution equations for voltage and current, which **solve** the general transient traveling-wave equations.
5. **Calculate** the input impedance, reflection coefficient, and standing-wave-ratio of a TL terminated by an arbitrary load, including open/short-circuit, resistive, and reactive loads.
6. **Match** a TL operating in sinusoidal steady state mode to arbitrary load impedance, using quarter-wave-matching and impedance-matching with lumped elements principles.
7. **Calculate** power consumed in transmission line circuits.
8. **Sketch** the voltage and current phasor amplitude along a TL terminated by an arbitrary load.
9. **Convert** a wave solution equation from phasor-domain to time-domain notation.
10. **Explain** the concepts of permittivity, permeability, electric field (E-field), electric flux density field (D-field), magnetic flux density field (B-field), magnetic field (H-field), divergence operator, and curl operator – with equations where appropriate.
11. **Determine** the electric field (Coulomb's Law) and potential from discrete charges.
12. **Apply** Gauss's Law (integral and differential forms) relating electric flux density and charge.
13. **Apply** Kirchhoff's Voltage Law (integral form) relating voltage potential and electric field.
14. **Explain** and **calculate** capacitance, resistance, conductivity, and conduction current.
15. **Employ** electrostatic boundary conditions to find E- and D- fields across dielectric and metallic interfaces.
16. **Calculate** the force and torque on charges and steadystate currents within magnetic fields, and the force between two current-carrying circuits.
17. **Apply** Biot-Savart Law to find the H-field from steadystate currents.
18. **Apply** Ampere's Circuital Law (integral and differential forms) relating the magnetic flux density and current.
19. **Apply** Faraday's Law (integral and differential forms) to determine the induced voltage in a circuit due to a time-varying magnetic field.
20. **Explain** the concepts of induced voltage (ie, electro-motive-force), inductance, total magnetic flux, flux linkage, ideal transformer, magnetic dipole, plane wave, spherical wave, intrinsic impedance, refraction, critical angle – with equations where appropriate.
21. **Discuss** Maxwell's equations and recognize the difference between electrodynamics and statics.
22. **Determine** electromagnetic plane wave parameters, including propagation direction, wavenumber (ie, propagation constant), absorption coefficient, frequency, wavelength, polarization state (ie, linear, circular, elliptical) – from both phasor- and time-domain representations.
23. **Calculate**, for a plane wave normally incident on a dielectric boundary, the reflection coefficient, transmission coefficient, total E- and H-field wave equations on both sides of boundary, absorption loss, skin depth, and power density.
24. **Apply** Snell's Laws to find the refracted and reflected angles at a dielectric boundary, as well as when total-internal-reflection occurs.
25. **Explain**, in the context of an oral presentation, how an electromagnetic device or system works, and evaluate peers doing the same.

Class Schedule and Topics (*tentative and subject to changes)*

Class	Date	Lecture	Topic
1	1/8/13	1a	Intro to Course via Syllabus, Waves, Phasors
2	1/10/13	1b	Waves, Phasors
3	1/15/13	2a	Transmission Lines
4	1/17/13	2b	Transmission Lines
5	1/22/13	2c	Transmission Lines
6	1/24/13	2d	Transmission Lines
7	1/29/13	2e	Transmission Lines
8	1/31/13	2f	Transmission Lines
9	2/5/13	2g	Review (etc)
10	2/7/13	**Exam 1**	
11	2/12/13	3a	Vectors
12	2/14/13	3b	Vectors
13	2/19/13	4a	Electrostatics
14	2/21/13	4b	Electrostatics
15	2/26/13	4c	Electrostatics
16	2/28/13	4d	Electrostatics
Spring Break	3/5/13		
	3/7/13		
17	3/12/13	5a	Magnetostatics
18	3/14/13	5b	Magnetostatics
19	3/19/13	5c	Magnetostatics
20	3/21/13	5d	Review (etc)
21	3/26/13	**Exam 2**	
Spring Holiday	3/28/13		
21	4/2/13	6a	Time Varying EM
22	4/4/13	6b	Time Varying EM
23	4/9/13	6c	Time Varying EM, Plane Wave Propagation
24	4/11/13	7a	Plane Wave Propagation
25	4/16/13	7b	Plane Wave Propagation, Wave RX TX
26	4/18/13	8a	Wave RX TX
27	4/23/13	8b	Wave RX TX, guest lectures
28	4/25/13	8c	Review (etc), guest lectures
-	5/2/13	Final Exam (8-11 am)	

Attendance Policy

Full participation in lectures and examinations is expected of all students. An attendance record will be kept and used to assess student participation where necessary. Certified excuses and prior approval will be dealt with individually, and can be easily arranged via email beforehand. University rules and regulations available at http://www.ncsu.edu/policies/academic_affairs/pols_regs/REG205.00.4.php will be closely followed.

Policy on Auditing and Satisfactory/Unsatisfactory

University policy will be followed for those taking the course with the satisfactory/unsatisfactory or the audit classifications. In simple terms, satisfactory or audit credit will only be given to those students who have a C- or higher final grade and who have followed the regulations in the "Evaluation and Grading Policy" section above.