ECE 341 Spring 2019

This course is about electromagnetics (EM), the electrical foundation of Electrical and Computer Engineering, or, how electricity ***really*** works.

- Circuit theory is a simple part of EM, so it was taught first.
- However, there are an increasing number of cases in ECE where circuit theory fails (e.g. faster computers, higher communications frequencies, power electronics, power system transients,), and EM must supplement circuit theory.
- Also EM is the basis for many devices (machinery, antennas, etc.), and one of the physical foundations of any active electronic device.
- Serious hazards for electrical and computer engineers in all areas, such as interference and non-ideal behavior of circuit elements, are increasing with the higher frequencies today for Electrical and Computer Engineers in all areas.

We will tend to avoid some math details and use some software, a modern trend. We will cover only part of the book's material and add some notes, and you must keep up with what material that is.

The text is **Fundamentals of Applied Electromagnetics (7th or 6th Edition)** by Ulaby. ***Solving*** problems is a means to learn principles; problems are ***not*** something to just be memorized. The CD included seems to be helpful; it has some problem solutions, some good moving demonstrations, and some interactive exercises. You will find it useful to read other books, such as Ramo *et al*, *Fields and Waves in Communication Electronics*. Old school: First the "true" field theory and then transmission lines. (You can find similar books in the library, around the call number for the text.) A modern book that teaches in the same order as our textbook: Inan, Inan, and Said, *Engineering Electromagnetics and Waves*. It can give you useful, additional insights. After this course, if you are really into the physics of EM fields, you can venture into Jackson, *Classical Electrodynamics*. A classic for physicists and microwave, optical engineers, this is not an easy book to read. One (actually the smallest) obstacle: We engineers use SI units, but the book uses Gauss units, which the physicists love. That makes some fundamental equations look different. Physicists think those forms are more elegant, but we have different opinions from a practical perspective.

Homework should be finished at the **start of class** on certain days, indicated in the schedule; homework will **not** be collected or graded. **Tests** will *partially* reflect homework and are certification that you have learned what you should. You should try your best to do homework thoughtfully on your own, not just "I got the right answer somehow so I'm finished". Ask "what have I learned form homework? Will I be able to do other problems in this topic?" **Do your homework and then check the answers I put online.** I do NOT collect or grade homework, which is for your own exercise. There will be, however, random, in-class and take-home **quizzes** that I do grade.

There will be two **major tests**, on the days indicated in the schedule. **Make-ups are not given.**

Also a lab schedule will be worked out once the course is under way for the **lab in MK 329.** Completion of all labs is required for course completion.

The **course grade** will be determined using these components: Test 1 15%; Test 2 20%; Quizzes 10%; project 15% lab 10%; final exam 30%.

E-mail will be used for some of my communications, and it's a good way for you to communicate with me.

The most important communication tool is my webpage. Check it often for notes, homework, announcements, office hours, etc. http://web.eecs.utk.edu/~ggu1/files/UGHome.html

Students are expected to adhere to the highest standards of academic integrity at all times.

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Office hours: 10 – 11 am Tue. I also watch e-mail closely (even on weekends).

Graduate student TAs:
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Tips

How to do well in this course (and others) and prepare to be a successful engineer:

- Don't overload your schedule with courses and/or work;
- Aim toward becoming a good engineer;
- Don't miss classes;
- See lab as an inquiry - not following a cook book;
- Don't just do the project; think and get insight.
- Study daily, not just the four nights before tests;
- Ask questions, take notes;
- Don't rely on somebody else (or my posted answers) for homework.
- **Pursue understanding of the principles -** not just memorizing the symbols in some homework problems and equations;
- **Try to visualize phenomena**- don't just manipulate math symbols;
- **Relate this material to other courses**.
- Revisit and reinforce the above three during the course, and, in your future study.
- Read ahead, think in practical terms; see if using the book's CD helps.

Expected schedule (***subject to changes***)

CLASS	MONTH	DATE	DAY	HOME-WORK	ACTIVITY Watch carefully; we don't cover all of each chapter. Numbers in parentheses are main section numbers within chapters.
1	Jan	10	R		**Introduction** (field, wave, lumped components, etc.). Read on your own: Sections 1-1, 1-2 (on units; **important**; read now, will discuss later), 1-3.
2		15	T		CAD tool (ADS) tutorial and clinic. ***Read Section 1-6 on your own if needed*** (brush up your math – complex numbers)
3		17	R		**Generic sinusoidal waves**. Read: 1-3, 1-4, 1-5.
4		22	T		**Waves** continued**. Phasors.** Read: 1-4, 1-7.
		24	R	1	**Transmission lines:** Characteristic impedance (Sections 2-1 thru 2-4 & 2-6 thru 2-9; **lectures take different approach than in book**)
5	Jan	29	T		Transmission lines continued: characteristic impedance continued
6	Jan	31	R	2 (P1-P6)	Transmission lines continued: Standing waves
7	Feb	5	T		Transmission lines continued: Standing waves cont'd
8		7	R	2	Transmission lines continued: Power flow (Section 2-9)
9		12	T	3	CH 2 (Sections 2-10, 2-11; class notes on double stub) – Smith chart for sinusoidal waves.
10		14	R		Z to Y conversion. Lumped component matching.
11		19	T	4	Single stub matching. Double stub matching.
12		21	R	5	Bounce diagram for <u>pulsed</u> waves (e.g. digital signals) **(Section 2-12)**
13		26	T		Bounce diagram. Q&A for Ch. 1 & Ch. 2
14	Feb	28	R	6	**Electrostatics** (**DC electric fields**): CH 4 (Ch 3 embedded) **Charge:** CH 4 sections 4-2.1**. Coulomb's law**: 4-3.
15	Mar	5	T		**Gauss's law:** 4-4. **Dielectrics and polarization:** 4-7.
16		7	R		**TEST 1 (covers generic waves & transmission lines – Ch. 1 & Ch2)**
17		12	T	7	**Dielectrics and polarization, Gauss's law in dielectrics:** 4-7. **Electric scalar potential**: 4-5
17		14	R		**Current:** 4-2.2, 4-6; **Electric boundary conditions** 4-8; **Image method:** 4-11
		19	T		Spring break
		21	R		Spring break
18		26	T	9 (P1-3 & P7)	**Ohm's law** (4-6). **Capacitors & Capacitance** 4-9, 4-10.
19	Mar	28	R	8, 9	**Units** (Section 1-2 of Ch. 1). **DC magnetic fields** (Ch. 5) Section 5-1
20	Apr	2	T		**DC magnetic fields:** 5-1, 5-2
21		4	R		**DC magnetic fields:** 5-3, 5-4 (vector potential), 5-6 (boundary conditions). **Dynamic fields & Maxwell eqs.** (Ch. 6)
22		9	T		CH 6 (Sections 6-1 thru 6-6 in 7/E and 6/E) – **dynamic fields: practical effects of magnetic fields and time-varying fields. Inductance: Sections 5-7, 5-8.**
23		11	R	10	**Practical effects of magnetic fields and time-varying fields. Magnetism of materials**: Section 5-5
25		16	T	11	**TEST 2** (material since Test 1)
26		18	R		**Practical effects of magnetic fields and time-varying fields.** CH 7 (Sections 7-1 & 7-2, same in 5/E) – **electromagnetic plane waves**
27		23	T		CH 7 (Sections 7-1 & 7-2, same in 5/E) – **electromagnetic plane waves**
28	Apr	25	R		**Plane waves**; Review; Q&A
				12	
					Final Exam