EE 382 *Applied Electromagnetics*
Spring 2017

Instructor: Dr. Keith W. Whites
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Office hours: MWF 11-11:50 AM

Please use e-mail rather than the telephone if you need to contact the instructor. All e-mail will be answered. The instructor will have at least three office hours per week in which to answer any questions you may have on the lecture material, homework problems, and other topics.

Catalog Description: (3-0) 3 credits. Pre-requisite: EE 381. Maxwell's equations for time-varying electromagnetic phenomena are developed and applications including transmission lines, plane waves, and antennas are studied.

Meeting Times: The lecture portion of this course will meet Monday, Wednesday, and Friday from 10:00-10:50 PM in room EEP 208.

Use of Electronic Devices in Class: The use of electronic devices during lecture can be very disruptive to your learning, to those around you, and to the instructor. To maximize your learning opportunity during lecture, laptops may be used for notetaking, but only as a tablet. The use of laptops with the cover open and in the vertical position is not permitted. The use of smartphones and other similar electronic devices during the lecture are not allowed.

Course Reference Materials: The required materials for this course are

- M. N. O. Sadiku, *Elements of Electromagnetics*, sixth edition. New York: Oxford University Press, 2015.
- K. W. Whites, *EE 382 Applied Electromagnetics Lecture Notes*, 2017. Available from the course web page.

Grading: 50 % – Two exams
25 % – Final exam
18 % – Homework
7 % – Special laboratory project (must be completed to pass the course)

Homework Policy: One homework set will generally be assigned each week, usually on Friday. The homework assignments will be distributed through the EE 382 web page accessible from the URL above. Please use engineering paper and write your name and student number on your homework. Please begin each problem on a new sheet of paper and do not write on the back side. <u>On the due date, one problem from this set will be randomly selected for you to turn in at the beginning of class</u>. Late homework will be penalized with a 10 % score reduction per calendar day and will only be accepted when you show the instructor that all of the problems for that set have been completed.

Exam Policy: The exams will be closed book, closed notes, and no formula sheets. Using or referring to equations stored in a calculator is not allowed, even if these equations came pre-programmed in the calculator. If you feel an exam problem was graded incorrectly, it must be resubmitted to the instructor within 24 hours from the time the exam was returned. Failure to write an exam will result in a score of zero. No makeup exams will be given. Upon prior notification of the instructor, allowances will be made under extreme circumstances.

Special Laboratory Project: This course does not have an associated laboratory. However, there will be assigned one special laboratory project during the semester. This laboratory assignment and the open lab hours will be announced during the semester. The special laboratory project work will be conducted in room EEP 127. Laboratory work will be performed in **groups of two** students. Use a laboratory notebook for all of your laboratory work. Only one laboratory notebook needs to be kept between a pair of students. Work exclusively in ink and cross out mistakes, keeping them legible. Number the front of every page in the upper right corner. Late laboratory work will be penalized with a 10 % score reduction per calendar day. This special laboratory project must be completed in order to pass the course.

Honor System: All work written in the exams, homeworks, and the special laboratory project must be your own. Failure to abide by this rule will result, at a minimum, in a zero score for the assignment and/or further action following SDSMT regulations. Homework solutions and the special laboratory project can be discussed with your colleagues that are currently enrolled in EE 382, but ***all work you submit must be your own***.

Course Outcomes: Upon completion of this course, students should demonstrate the ability to:

1. Use magnetic circuits for the calculation of basic magnetic field problems such as solenoids and transformers.
2. Use Faraday's law to calculate problems involving induced emf, such as time-varying magnetic fields, transformers, and moving circuits.
3. Understand the importance of displacement current in electromagnetics, and electrical circuits in general. Calculate displacement current.
4. For lossless and lossy transmission lines, calculate distributed parameters (i.e., R, L, G, and C) and dependent quantities (e.g., characteristic impedance, phase velocity, attenuation constant, and phase constant).
5. Solve time-domain (transient) problems for lossless transmission lines involving unit-step and pulse excitations (i.e., calculate reflection coefficients and determine voltages and currents versus time at fixed positions or versus position at a given time).
6. Solve frequency-domain lossless and lossy transmission line circuits calculating, for example, input impedances, reflection coefficients, VSWR, currents, voltages, and powers.
7. Use Smith charts to calculate lossless transmission line quantities such as reflection coefficients, impedances, locations of voltage maxima and minima, and VSWR.
8. Solve lossless transmission line matching problems (e.g., single-stubs, quarter-wave matching sections, and resistive pads) using both analytical solutions and the Smith chart.
9. Calculate uniform plane wave equations/parameters for propagation through lossless and lossy media.
10. Calculate the Poynting vector and time average power flow for uniform plane waves in lossless and lossy media.
11. Determine the reflection and transmission of uniform plane waves normally incident on a material half space.
12. Apply and calculate fundamental antenna concepts, definitions, and quantities.
13. Analyze a simple Hertzian dipole antenna.

14. Apply and use the Friis transmission equation and the radar range equation.
15. Make basic transmission line measurements with RF and microwave test equipment.

Americans with Disabilities Act (ADA) Statement: Students with special needs or requiring special accommodations should contact the campus ADA coordinator, Megan Reder-Schopp, at 394-6988 and/or the instructor at the earliest opportunity.

Freedom in Learning Statement: Students are responsible for learning the content of any course of study in which they are enrolled. Under board of regents and university policy, student academic performance shall be evaluated solely on an academic basis and students should be free to take reasoned exception to the data or views offered in any course of study. Students who believe that an academic evaluation is unrelated to academic standards but is related instead to judgment of their personal opinion or conduct should contact the dean of the college which offers the class to initiate a review of the evaluation.

EE 382 Class Schedule
Spring 2017

Date	Text Section	Topic
1/9	8.10	Introduction to course. Pre-assessment. Magnetic circuits.
1/11	8.10	Magnetic circuits (cont.).
1/13	9.2	Faraday’s law of induction. Lenz’s law.
1/16	–	*No class.*
1/18	Notes	Faraday’s law examples.
1/20	9.3	Faraday’s law and moving circuits.
1/23	9.4	Displacement current and Ampère’s law.
1/25	9.5	Maxwell’s equations, boundary conditions.
1/27	9.7	Sinusoidal steady state, phasors.
1/30	Notes, 9.3	Ideal transformer.
2/1	Notes	Non-ideal behavior of physical circuit elements. Skin effect.
2/3	11.2, 11.3	Transmission lines and distributed l and c.
2/6	–	Review.
2/8	–	**Exam #1**.
2/10	Notes, 11.7	Time domain solutions to TL wave equations.
2/13	Notes, 11.7	TL termination, reflections. Current waves.
2/15	Notes, 11.7	Bounce diagrams.
2/17	Notes, 11.7	Pulse propagation on TLs.
2/20	–	*No class.*
2/22	Notes	Reactive terminations on TLs. Time domain reflectometry.
2/24	11.3	Sinusoidal steady state excitation of lossless TLs.
2/27	11.4	Termination of TLs. Load reflection coefficient.
3/1	11.4	Input impedance of TLs. Excitation and source conditions.
3/3	11.4	Generalized reflection coefficient. Crank diagram. VSWR.
3/6	–	*No class.*
3/8	–	*No class.*
3/10	–	*No class.*
3/13	11.3	Lossy TLs. Dispersionless TLs. Special cases for general TLs.
3/15	11.5	Smith chart.
3/17	11.5	Smith chart (cont.). **(Project assigned.)**
3/20	–	Review.
3/22	–	**Exam #2**.
3/24	Notes, 11.6	TL matching. Quarter-wave transformers. Resistive pads.
3/27	Notes	Single-stub tuner I – Analytical solution.

3/29	Notes, 11.6	Single-stub tuner II – Smith chart solution.
3/31	Notes, 10.2	Uniform plane waves. Infinite current sheets.
4/3	10.3, 10.6	Uniform plane waves in lossy materials. Skin depth. **(Project due.)**
4/5	10.7	Poynting's theorem. Power flow and plane waves.
4/7	10.8	Uniform plane waves normally incident on a lossless half space.
4/10	Notes, 10.8	Example of a normally incident UPW on a lossless half space.
4/12	Notes	Electromagnetic radiation and antennas.
4/14	–	*No class.*
4/17	13.2	Hertzian dipole antenna.
4/19	Notes, 13.2	Near/far fields of the Hertzian dipole antenna.
4/21	Notes, 13.2	Radiation resistance.
4/24	13.6	Antenna radiation patterns. Directivity and gain.
4/26	13.8	Antenna effective aperture. Friis equation.
4/28	–	Review. Post-assessment. Course evaluation.
5/4	–	**Final Exam**, 11:00 AM-12:50 PM, Room EEP 208.