South Dakota School of Mines and Technology

EE 382– Applied Electromagnetics, 3-0 (3 credit hours)
Syllabus, Spring 2018

Instructor:	Mr. Lowell Kolb	**Office Phone:**	**605-394-1221**
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Office Hours: Posted outside office door—changes weekly; typically most of MWF, or by appointment

Catalog Description: EE 382 Applied Electromagnetics

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

Co-requisite: none

Course Objectives: Students should be provided with the working knowledge of the fundamentals of electromagnetic phenomena as characterized by Maxwell's equations and as they apply to electrical engineering.

Instructional Methods: Lecture + Lab; homework, exams, and quizzes

Schedule and Location: Monday, Wednesday, and Friday 3–3:50pm, EEP 254

Use of Electronic Devices in Class: The use of electronic devices during lecture can be very disruptive to your learning, and to others around you. 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 electronic devices during the lecture is 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 D2L web page.

Grading:

		A	B	C	D
18% - Homework and quizzes	Break Points:	90%	80%	70%	60%
50% - Two semester exams					
25% - Final examination					
7% - Special laboratory project (must be completed to pass the course)					

Homework: One homework set will generally be assigned each week, usually on Friday. The homework assignments and their due dates will be distributed through the EE 382 D2L web page. Homework is due **at the start of** class. Late homework is penalized by 10% per day, and **cannot** be accepted after solutions are handed out. If you know you will miss a class, hand in or email your homework early. **Staple your homework** if it runs more than one page. Use 1-side 8.5"x11" engineering graph or plain white paper (no spirals).

- On top of **each page** write the date, course #, homework **#**, your name, and page number (e.g. *x/y*, top-right).
- Write, cut & paste, or paraphrase the problem description at the beginning of each problem.
- Reference the equations you use, which means you must **cite where you got them**, except for fundamental equations, e.g., Ohm's law. For equations derived in the text , you may use their equation numbers.
- Show all steps so that someone besides yourself can follow your solution process.
- Box or double underline your answers. Include practical engineering units (i.e. μF, GHz etc).
- Separate problems with a line.
- Text/figures/graphs must be legible to receive credit. Diagrams/plots/graphs should be readable, titled, labeled (names & units on axes), scaled (numbers on axes), and drawn/plotted/printed clearly.

Quizzes: Quizzes will be given during lecture periods. Unexcused makeup quizzes will be subject to the same late penalty as homework. Quizzes may not be made up after they have been discussed in class.

Exam Policy: The exams will be closed book, closed notes, no formula sheets, and usually no calculators. The exam will provide formulae you need but are not expected to memorize. Computational problems on exams will generally be satisfied by setting up the appropriate equations or simple calculations not requiring a 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. Makeup exams will be given only for excused absences submitted prior to the absence.

Special Laboratory Project: This course does not have an associated lab. However, there will be one special laboratory project during the semester. This laboratory assignment and the open lab hours will be announced during the semester. The special lab project work will be conducted in EEP 127. Lab work will be performed in groups of two students. Use a laboratory notebook for all of your laboratory work. One lab notebook per group is sufficient. Work exclusively in ink and line out mistakes with a ~~single~~ strikethrough so they are clearly legible. Number the front of every page in the upper right corner, and only use the front side of pages. The backs may be used as scratch paper. This project is required to complete the course. Late reports will be penalized with a 10% score reduction per calendar day.

Laboratory Safety Guidelines: See *ECE Lab Safety Policy* posted on the course D2L page.

ADA Policy: Students with special needs or requiring special accommodations should contact the instructor, (Lowell Kolb at 394-1221) and/or the campus Director of Counseling and Disability Services, Ms. Megan Reder-Schopp, at megan.reder-schopp@sdsmt.edu, 394-6988 at the **earliest** opportunity.

Freedom In Learning: *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, not on opinions or conduct in matters unrelated to academic standards. Students should be free to take reasoned exception to the data or views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled. Students who believe that an academic evaluation reflects prejudiced or capricious consideration of student opinions or conduct unrelated to academic standards should contact the dean of the college which offers the class to initiate a review of the evaluation.*

Honor System: All work written in the exams, homework, and project must be your own. Failure to abide by these rules will result, at a minimum, in a zero score for the assignment and/or further action following SDSM&T regulations. Homework solutions may be discussed with your colleagues, but all work you submit must be your own. SDBOR Policy 2:33 defines “Academic Misconduct” at length, but it all comes down to cheating, plagiarizing, falsifying, copying, misrepresenting, ‘borrowing’ ideas or information, or helping someone else do any of these things. Your best strategy is to stay far clear of anything that even *resembles* any of these activities. It’s OK to say “NO” if someone presses you to do these actions. You are not being rude; you are being ethical and smart. When deadlines loom and work piles up, cheating is so tempting, but the person you are cheating is you, and the damage you do extends to all your classmates. Instructors are obligated to report dishonesty, and the processes described in the Student Code of Conduct make clear just how seriously dishonesty of all forms is taken at SD Mines.

To be enrolled in this class, you are probably at least half-way through your third year. Juniors already know the consequences of *being caught* at cheating, and that doesn’t stop a few from doing it anyway. Have you ever considered the consequences of *getting away* with cheating? The material being provided in a course like this one consists of tools you are likely to need when you get out into the cruel world where there are no answer databases: One characteristic unique to engineering is that you are frequently expected to design and build things that have never been done before, meaning that the answers aren’t on line or in “the file.” Another unique characteristic of engineering is that if the gizmos you design don’t do what they were expected to do, you get to find another career.

Consider the similarities: “Smokejumpers” are fire fighters who get to forest fires quickly by parachuting close to the conflagration. As part of the job, they are required to pack their own parachutes, and they must demonstrate this skill in order to qualify as a smokejumper. How many of them, do you think, are tempted to cheat on their parachute-packing test so they can get a job jumping out of a perfectly good airplane into a burning forest?

Errors *on the homework* are actually your friend: They identify areas where your understanding is weak, and they do so before an exam, where knowing them really counts. Check out the “Grading” topic on this syllabus: Homework and quizzes only count for 18% of the course grade. Theoretically, you could pass the course with a “B” if you never turned in a homework assignment. Your instructor is counting on 18% being enough additional incentive (besides the parachute thing) that you will actually try your hand at the problems, but no so large a portion of your grade that you will be tempted to use unnatural means to turn in perfect homework assignments and pass up the opportunity to check your true understanding of the material with minimal risk to your final grade.

Exams are your opportunity to prove to yourself and to the School of Mines that you know the material before going out into the cruel world; but it certainly is nice to only have to take a course once. To that end, your instructor intends to be available in office hours so you can get additional help, if you need it, to understand the material. He has also been known to schedule “bonus sessions” when significant numbers of students are struggling with particular concepts. Don’t be reluctant to ask him for help by either method.

South Dakota School of Mines and Technology, Electrical and Computer Engineering Dept.

EE 382, Class Schedule -- Spring 2018 -- (subject to change as needed)

	Date(s)		Text Section [Lecture #]	Topics / Reading and Homework Assignment	Due Today
1	1	08	8.10 [0]	Introduction to course. Pre-assessment. Magnetic circuits.	
2	1	10	8.10 [1]	Magnetic circuits, cont.	
3	1	12	9.2 [2]	Faraday's law of induction. Lenz's law.	
-	1	15		MLK Holiday	
4	1	17	[3]	Faraday's law examples.	HW1
5	1	19	9.3 [4]	Faraday's law and moving circuits.	
6	1	22	9.4 [5]	Displacement current and Ampère's law.	HW2
7	1	24	9.5 [6]	Maxwell's equations, boundary conditions.	
8	1	26	9.7 [7, 8]	Sinusoidal steady state, phasors.	HW3
9	1	29	9.3 [9]	Ideal transformer	
10	1	31	[10]	Non-ideal behavior of physical circuit element. Skin effect.	
11	2	02	11.2, 11.3 [11]	Transmission lines and distributed L and C	HW4
12	2	05	-	Review	
13	2	07	-	Exam #1	
14	2	09	11.7 [12]	Time domain solutions to TL wave equations.	
15	2	12	11.7 [13]	TL termination, reflections. Current waves.	
16	2	14	11.7 [14]	Bounce diagrams.	
17	2	16	11.7 [15]	Pulse propagation on TLs.	HW5
-	2	19		Presidents Day Holiday – No Class	
18	2	21	[16]	Reactive terminations on TLs. Time domain reflectometry.	
19	2	23	11.3 [17]	Sinusoidal steady state excitation of lossless TLs.	HW6
20	2	26	11.4 [18]	Termination of TLs. Load reflection coefficient.	
21	2	28	11.4 [19]	Input impedance of TLs. Excitation and source conditions.	
22	3	02	11.4 [20]	Generalized reflection coefficient. Crank diagram. VSWR.	HW7
-	3	5-9		Spring Break – No Class	
23	3	12	11.3 [21]	Lossy & Dispersionless TLs. Special cases for general TLs.	
25	3	14	11.5 [22]	Smith chart.	
25	3	16	11.5 [22]	Smith chart, cont. **Project assigned.**	HW8
26	3	19	-	Review	
27	3	21	-	Exam #2	
28	3	23	11.6 [23]	TL matching. Quarter-wave transformers. Resistive pads.	
29	3	26	[24]	Single-stub tuner I – Analytical solution.	
30	3	28	11.6 [25]	Single-stub tuner II – Smith chart solution.	HW9
-	3	30		Easter Holiday – No Class	
31	4	02	10.2 [26]	Uniform plane waves. Infinite current sheets.	
32	4	04	10.3, 10.6 [27]	Uniform plane waves in lossy materials. Skin depth.	**Project**
33	4	06	10.7 [28]	Poynting's theorem. Power flow and plane waves.	HW10
34	4	09	10.8 [29]	Uniform plane waves normally incident on a lossless ½ space	
35	4	11	10.8 [30]	Example of a normally incident UPW on a lossless ½ space	
36	4	13	[31]	Electromagnetic radiation and antennae.	HW11
37	4	16	13.2 [32]	Hertzian dipole antenna..	
38	4	18	13.2 [33]	Near/far fields of the Hertzian dipole antenna.	
39	4	20	13.2 [33]	Radiation resistance.	HW12
40	4	23	13.6 [34]	Antenna radiation patterns. Directivity and gain.	
41	4	25	13.8 [35]	Antenna effective aperture. Friis equation.	HW13
42	4	27	-	Review. Post-assessment. Course evaluation.	
				EE 382 Final Exam (comprehensive), tbd	

Prepared by: Dr. Keith W. Whites, 1/5/2017
Extensively edited by: Lowell Kolb, see rev. date at top.

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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 and calculate displacement current in electromagnetics and electrical circuits in general.
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, e.g., input impedances, refection 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 / 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.

RELATION OF COURSE TO PROGRAM OBJECTIVES:

These course outcomes fulfill the following program objectives:
(a) An ability to apply knowledge of mathematics, science, and engineering.
(b) An ability to design and conduct experiments, as well as to analyze and interpret data.
(c) An ability to design a system, component, or process to meet desired needs.
(d) An ability to function on multi-disciplinary teams.
(e) An ability to identify, formulate, and solve engineering problems.
(f) An understanding of professional and ethical responsibility.
(g) An ability to communicate effectively.
(h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
(i) A recognition of the need for, and an ability to engage in life-long learning.
(j) A knowledge of contemporary issues.
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Outcomes / Objectives	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
a.	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
b.		3	3	3			3							4	4
c.		1		2	2	2	3	3		2	2		2	3	3
d.															
e.	2	2	3	2	2	2	4	2	1	2	2	2	2	3	3
f.															
g.															
h.															
i.															
j.															
k.	2	3	3	3	4	3	2	4	3	3	3	2	3	4	3

Prepared by L. Kolb, 7Jan2018

The above table indicates the relative strengths of each course outcome in addressing the program objectives listed above (on a scale of 1 to 4 where 4 indicates a strong emphasis).