ECE 405: Electromagnetic Fields and Waves II

Fall 2015

Lecture: MWF 1:50 - 2:40 2205 EB

Instructor: Prem Chahal
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Office: 2214B Engineering Building
Office hours: 3:00 – 5:00PM Wednesday (2234EB)

Text: Fields and Waves in Communications Electronics, S. Ramo, J. R. Whinnery and T. Van Duzer, 3rd ed., Wiley, New York, 1994.

Suggested References
Antennas, John D. Kraus, 2nd ed., New York, McGraw-Hill, 1988.
Antenna Theory: Analysis and Design, Constantine A. Balanis, 2nd ed., New York, Wiley, 1997.
Antenna Theory and Design, Warren L. Stutzman and Gary A. Thiele, New York, Wiley, 1998.
Microwave Engineering, David M. Pozar, 3rd ed., Hoboken, NJ, Wiley, 2005.

Course Website: The primary web site is via the D2L Course Management System. Please point your browser to the following Course website: Desire2Learn (https://d2l.msu.edu/) and log-in with your MSUNet ID and password.

Grading:

Homework	10%
Quiz:	5%
Midterm Exam:	15%
Final Exam:	20%
Labs:	25%
Design Projects 1&2	15%
Design Project 3	10%

GPA assigned to total score (%):

92.5 -100	85 – 92.5	77.5 – 85	70 – 77.5	62.5 – 70	55 – 62.5	50 – 55	0 - 50
4.0	3.5	3.0	2.5	2.0	1.5	1.0	0.0

THERE IS NO CURVE IN THIS COURSE! The instructor reserves the right to adjust the grading scale.

Important Dates:

10/16,	**Midterm Exam**, 1:50-2:40 pm, 2205 EB
12/18	**Final Exam**: 12:45-2:45 pm (Friday), 2205 EB
09/07	Labor Day (**no class**)
09/30-10/01	Career Gallery (Breslin Center)
11/26-11/27	Thanksgiving Break (**no class**)
12/11	Design Day (**no class**)
12/14-12/18	Final Exam Week

Class outline

ECE405 is a theoretical and experimental study of electromagnetic fields and waves in free- and bound-space.

Notes	Book Chapter	Topics
VI.	11	Microwave networks and circuits: S-parameters, circuit elements
I.	3	EM field equations
II.	3 contd.	Wave equations
III.	6	Waves in unbounded space: Plane waves, spherical waves
VII.	12	Radiation
VIII.		Antenna concepts: Radiated power, impedance, gain, antenna pattern
IX.	12 contd.	Transmitting antennas: dipoles, arrays, microwave antennas
X.		Receiving antennas
IV.	5, 8, 9	Guided waves: Transmission lines, waveguides, microstrip, fiber optics
If time permits **V.**	10	Confined waves: Cavities

University, Department and Instructor Policies

Accommodations for Students with Disabilities*:* Students with disabilities should contact the Resource Center for Persons with Disabilities to establish reasonable accommodations. For an appointment with a disability specialist, call 353-9642 (voice), 355-1293 (TTY), or visit MyProfile.rcpd.msu.edu.

Academic Honesty*:* Article 2.3.3 of the Academic Freedom Report states that "The student shares with the faculty the responsibility for maintaining the integrity of scholarship, grades, and professional standards." In addition, the Department of Electrical and Computer Engineering adheres to the policies on academic honesty as specified in General Student Regulations 1.0, *Protection of Scholarship and Grades;* the all-University Policy on *Integrity of Scholarship and Grades*; and Ordinance 17.00, Examinations. (See *Spartan Life: Student Handbook and Resource Guide* and/or the MSU Web site: www.msu.edu.)

Exam policy: If you must miss an exam, you must contact me **before** the day of the exam to make alternative arrangements. True emergencies will be dealt with on a case-by-case basis.

Homework policy: Homework is due in class on the date given in the assignment, unless other arrangements have been made. You can e-mail it as a **pdf** file, or you can put it in the drop box in the ECE office (2120 EB) prior to deadline. Late assignments will not be accepted unless other arrangements have been made.

Policy on religious observances: If any exam, assignment or project conflicts with a religious observance, let me know **ahead of time** and we will make other arrangements.

Policy on recording lectures**:** You may make audio recordings of the lectures for personal use only. Do not post or otherwise distribute the recordings. Video recordings are not allowed.

ECE 405 Laboratory Policies

Fall 2015

Lab supervisor: Prem Chahal

Lab instructor: Aman Kaur
E-mail: kaurama1@msu.edu
Office hours: Wednesday: 3: 00AM – 5:00 PM

Schedule:	Section 1	Tu 11:30-2:20	2234 EB
	Section 2	Th: 11:30 – 2:20	2234EB
	Section 3	Tu 3:00-5:50	2234 EB

1. Grade breakdown. Your lab grade will be determined from the following breakdown:

Reports	75%
Performance	25% (participation and lab safety)

   The lab instructor will award your performance grade based on his/her observations of your behavior during the lab period. If you are contributing to your group, then you will receive a full 25%. If you are just standing around doing nothing, you will receive 0%.

2. Make-ups. **ALL** labs must be completed for you to receive a lab grade. If you do not complete an experiment, you will receive a "0" for your lab grade. You must be present during lab to get credit. Make-up labs must be arranged either prior to the absence, or afterward with a doctor's excuse. Attendance will be taken during all labs.

3. Preparation. You are expected to be prepared before coming to lab. Read the lab before coming to class, complete the preliminary exercises, if any, and review any topics you are unsure of. The instructor will NOT answer questions during the lab period over topics you should know from the lab manual. The instructor's presence during the lab period is to oversee the lab and help you with any trouble you are having with the equipment. If you do not understand material from the manual, see the instructor **before** the lab period. There may be short quizzes given during the labs to gauge your understanding.

4. Data. All data must be taken in PEN. It must be signed and dated by the instructor before you leave the lab.

5. Lab reports. Lab reports are to be handed in at the beginning of the lab period immediately following the period during which the lab was completed. You will be graded on spelling, grammar, organization and writing style, as well as on content. Each group will turn in one report.

   The outline for the lab reports will be determined by your lab instructor. The following is a suggested outline. Your instructor may deviate as he or she sees fit.

   1. **Title page**. Title of lab, names of students, name of instructor, section number, date of lab, date of report (due date).
   2. **Goals**. One paragraph outlining the goals of the lab.

3. **Accomplishments**. A summary of your accomplishments -- what you have learned during the lab. Discuss discoveries, difficulties, verifications of theory, etc. Relate these to the goals of the lab.

4. **Discussion**. A discussion of your results, which follow in the next section. You must refer to labeled tables and plots. Include answers to questions posed in the lab manual and discuss error, if appropriate. Include all calculations.

5. **Results**. Include your measured and calculated data. Your data must be in either a properly labeled table or graph, or both. When you refer to these, it must be by table or graph number. See the attached pages for examples of a table and graph. For small amounts of data, use a table. For large amounts of data, or when visualization is important, use a graph. Be sure to include units!

6. **Raw data**. Include at the end of your report the raw data you took in lab, including your instructor's signature. Label this data as APPENDIX 1: RAW DATA.

Parts 2 and 3 above are to get you to think about how the lab experience relates to the class material and how the information gained during the lab has helped your understanding of the class topics.

6. Discussion of error. When you discuss error you may, if you wish, blame the equipment. If you do, you must discuss both the source AND RANGE of the error. For example, if you can read a dial to within 5%, this range of error cannot completely explain a difference of 25% between theory and experiment, unless it is compounded. Remember, the most common cause of error is unfamiliarity with equipment.

7. Be nice. Please treat the equipment kindly. Be nice to sensitive things like connectors, switches and dials. To be safe, there will be no food or drink allowed in the lab.

EXAMPLE OF PROPERLY LABELED PLOT

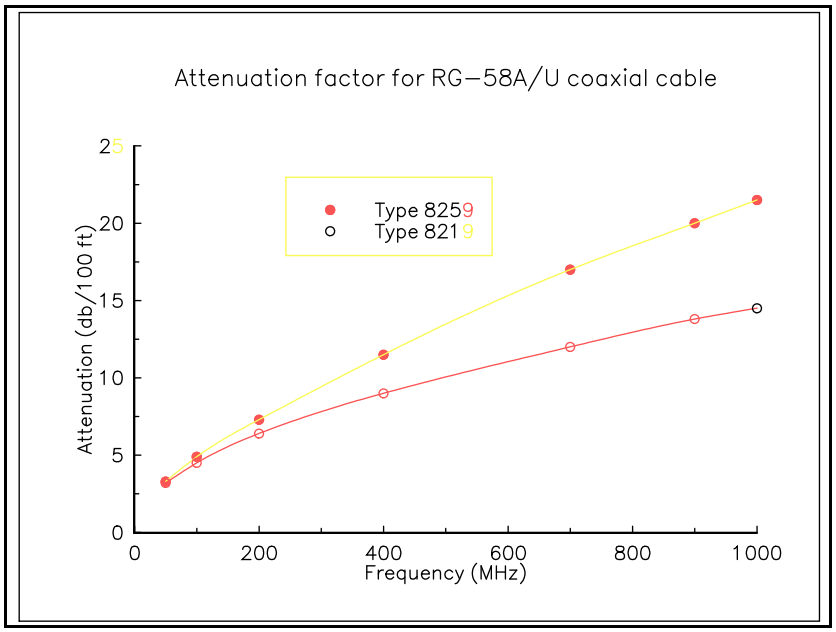

Figure 1.Attenuation factor for RG-58A/U coaxial cable.

EXAMPLE OF PROPERLY LABELED TABLE

Table 1.Properties of various soft ferromagnetic materials.

Material	Initial relative permeability	Coercive force (A/m)	Residual field (Wb/m^2)	Saturation field (Wb/m^2)	density (g/cm^3)
Commercial Iron	150-250	80	0.77	2.15	7.85
Pure iron	10k	4	0.2	2.15	7.85
Silicon-steel	900-1700	35-60	0.62-0.93	1.5-2.0	7.65
Siloctron	1.3k	8-24	1.4	1.5-2.0	7.65
Silicon-iron	400	40	1.2	1.5-2.0	7.65
Deltamax	400-1700	16-32	1.3-1.8	1.35-1.85	8.25
4-79 Mo Perm-Alloy	10k-40k	3-12	0.4-0.55	0.7-0.8	8.74
Supermalloy	50k-120k	0.2-4	0.4-0.55	0.65-0.75	8.77

ECE 405 LABORATORY SCHEDULE

Fall 2015

Note: This schedule is subject to change at the discretion of the ECE 405 instructor. All changes will be announced in class and posted to D2L.

Week of	Experiment	Reports Due
9/7	S-parameter measurements using the vector voltmeter	
9/14	S-parameters of cascaded 2-port networks	Report 1
9/21	Introduction to Network Analyzer	Report 2
9/28	Introduction Network Analyzer – contd.	
10/5	Introduction to HFSS and ADS	Report 3
10/12	Design of microstrip circuits **10/15 : Exam I**	Report 4
10/19	Design of microstrip circuits (Continued)/ Open Lab	
10/26	Network Analyzer measurements of your microwave circuits * & Waveguide components and measurements	Report 5
11/02	Antenna pattern measurements*/ Open Lab	Report 6 **- Project 1**
11/09	Measurement and calculation of antenna impedances	Report 7
11/16	Measurement and calculation of antenna impedances (continued)	
11/23	Open Lab (Thanksgiving Week)	**- Project 2**
11/30	Open Lab	Report 8
12/07	Open project Lab Demonstrate Project 3 – Date TBD	**- Project 3**
12/14	**12/18: Exam II (Final Exam)**	

*Students will be assigned a specific time for these experiments

ECE 405 LABORATORY SAFETY CONSIDERATIONS

Fall 2015

This document addresses safety considerations for students participating in the ECE 405 laboratory. Students should review all safety material provided by previous lab supervisors and be aware of the health effects of electrical shock. This document describes specific potential hazards for ECE 405.

Eye Safety

Eye safety is a serious issue in all ECE laboratories. You are required to wear either goggles or safety glasses at all times while you are in the ECE 405 laboratory. If you wear ordinary eyeglasses, you must also wear safety glasses or goggles that fit on top of them. Safety eyewear must be impact resistant and have a side shield. You can buy glasses at SBS, MSU stores, or the MSU bookstore.

Electrical Shock

Any time students use electrical equipment there is a possibility of electrical shock. In the ECE 405 lab there is little potential for shock since most equipment produces low-voltage, high-frequency signals. By using caution and common sense, a high level of electrical safety can be maintained. Whenever using electrical equipment of any kind, students should be on watch for frayed and broken plugs, wires, and connections. Any potential hazards should be **immediately reported to the lab instructor**.

Microwave Exposure

Several ECE 405 experiments involve using signals at microwave frequencies. Power levels employed are well below those which give rise to electromagnetic heating. However, the subtle physiological effects of microwave energy are still uncertain, and students should take care to minimize their exposure to microwave energy. The following guidelines should be sufficient to provide a safe environment.

1. Never look directly into the open end of a waveguide or transmission line.
2. Never radiate EM fields in the direction of yourself or other people.
3. Never perform measurements while anyone is inside the anechoic chamber.

Note that the measurement software has been written so that RF output is turned off at all times when measurements are not being performed. However, students must be aware of the presence of persons inside the anechoic chamber, and make sure that the measurement process is not initiated when the chamber is occupied.

If students have ANY questions regarding safety, they should immediately discuss them with their lab instructor.