ELECTRICAL ENGINEERING & COMPUTER SCIENCE
COLORADO SCHOOL OF MINES

EENG 386 - Fundamentals of Engineering Electromagnetics

Spring 2017

Course Description: This course provides an introduction to electromagnetic theory as applied to electrical engineering problems in wireless communications, transmission lines, and optics. The theory and applications are based on Maxwell's equations, which describe electric and magnetic fields, the interplay between them, and how they transport energy. We will revisit vector calculus as it describes these scientific concepts, and explore how electromagnetic theory is applied in everyday life. We will also develop the skills of how to model a physical problem using electromagnetic concepts.

Prerequisites: EENG 281, MATH 213, PHGN 200, and/or consent of instructor.

By the end of the course, you will be able to:

1. Solve electromagnetic problems through both pencil-and-paper solutions (for the simpler problems) and computer simulations (for the more complex ones).

2. Explain, using words, a range of electromagnetic phenomena, such as how an electromagnetic wave propagates and what happens to an EM wave at the interface between two materials. Tailor your explanation to your audience (such as a high school student, a peer, your grandmother).

3. Identify applications of electromagnetics in your daily life and your work as an engineer, and employ EM concepts and terminology to explain how these technologies work.

4. Apply course concepts to determine system design parameters on topics such EM wave propagation on transmission lines and simple dipole antennas.

5. Model an electromagnetics problem using a computer program and utilizing the concepts learned in this course. Use the results of your model to assess the feasibility of a design, the optimal choice of design parameters or to solve a relevant question. Communicate your results in the form of a scientific paper.

6. Identify the possible social, economic, global or environmental implications of an electromagnetism-related engineering product or application and explain the potential impacts on stakeholders. Utilize external sources to support your claims.

Brief List of Topics Covered:

- Social impacts of electromagnetic technologies
- Modeling and technical writing

- Electric and magnetic fields and materials
- Coulomb's Law, Gauss' Law, Biot-Savart Law, Ampere's Law, Faraday's Law
- Maxwell's Equations
- Sinusoidal plane waves and electromagnetic wave propagation
- Power Density and Poynting Vector
- Electromagnetic boundary conditions and behavior at an interface
- Transmission lines
- Antennas or waveguides

Instructors and meeting times:

Stephanie Claussen, Ph.D. (sclausse@mines.edu) Office location: BB 251

Office hours: Monday 3-4:30pm, Wednesday 9-10:30am, and Friday 11am-12pm, and by appointment.

My views on teaching and learning:

This semester, I will strive to…

… help you make connections that increase your conceptual understanding. These connections could be to past learning, to the current material, to future applications and fields, and to the broader world around you. Assessment and the classroom environment will be aligned to help accomplish this goal.

… create an interactive learning environment which supports your learning, where you feel comfortable asking questions, exposing any gaps in your understanding and helping each other learn.

…motivate and inspire you. The historical accomplishments of electromagnetism will be woven throughout the class. Real-world examples in homework assignments and course projects will be used to highlight the potential career pathways engineering provides. Applications of electromagnetism in your everyday life will be frequently referenced and discussed.

…remind you that engineering is a human endeavor that can make a positive impact on the world. At its core, engineering leads to products and technologies that affect people world-wide. In engineering, there aren't always right answers. Rather, we have answers we believe are the "most right" at this moment. Engineering always requires tradeoffs, and an engineer's background and values impact how these tradeoffs are made.

Textbook and other required materials:

Fundamentals of Applied Electromagnetics, 7th Ed., by Ulaby, Michielssen, & Ravaioli, Pub. by Prentice Hall (Pearson). (6^{th} edition is ok, too.)

Access to MATLAB

Assignments and assessment:

- *Class preparation:* This class will be taught in a flipped manner: you will be responsible for getting introduced to the content before coming to class. This will be done through assigned reading from the textbook (and occasionally articles and videos) and daily assignments, described below.

- *Class structure:* In-class time will used to work on the hard stuff—solving problems, wrestling with challenging concepts, applying difficult content, and developing engineering skills like model-building, working in teams, and identifying the social implications of our work. The success of this time will rely on the preparation you do before coming to class.

  The course is designed in this way to make the best use of our time when we meet together. As such, you are expected to come prepared to participate in class, by doing the assigned reading and completing the GUIDE assignments.

- *GUIDE Assignments:* Guided Understanding and In-Depth Exploration (GUIDE) assignments will be due before the start of class each day. These could consist of two parts: 1) A portion intended to guide you through the reading which is required for that day, and 2) A problem (or two) which follows-up on the previous class. Late GUIDEs will not be accepted.

  In calculating your final grade, your lowest three GUIDEs scores will be dropped.

- *Participation*: Active participation in class and in office hours is very important for your learning, and thus is assessed as part of your final grade. This will include working in small groups on short problems, asking questions, brainstorming solutions as a class, and working together and with your instructor outside of class. It is strongly encouraged that you come to office hours at least once in the first two weeks of class, to introduce yourself and help us get to know each other.

  In addition, participation in class discussions via Piazza is encouraged. Questions posted on Piazza will be responded to by the instructor before emailed questions.

- *Modeling final project:* This project will focus on a problem of your own choosing. You will be expected to identify the problem, then use computer simulations (in Matlab or other software packages) to model the problem. You will report your findings in the form of a scientific paper (3-4 page *IEEE Letter*). Instructor support will be provided in all aspects of the project. This assignment will assess your model-building skills.

- *Tests:* There will be three in-class tests throughout the semester, following each of the first three content units.

  From the day that your test is handed back, it can be reworked for an additional 2% of your class grade. This reworking can be done in consultation with the professor but not with your peers. This assignment will also involve a reflection component.

If you choose to not rework your test, you will receive the 2% of your grade weighted by your test score (i.e. the test will be worth a total of 10% (8% + 2%) of your final grade).

- *Self-guided learning and poster session:* For the fourth content unit, you will be able to select between studying antennas and studying waveguides. There will be one day focused on both topics, three days of self-guided learning in small groups, and on the final day, a poster session presented by teams and assessed by your peers.

Course materials will be distributed via Blackboard. All course communications will be done using Piazza (piazza.com/mines/fall2016/eeng386).

The point distribution for these assignments is:

In-class assignments and take-home work	20%
GUIDE assignments	10%
Modeling final project and supporting assignments	25%
Tests 1-3 – 10% each	30%
Tests 1-3 rework/reflection – 2% each	6%
Unit 4 poster session and challenge problems	9%

The letter grades for the course are awarded according to the following criteria:

A	92 - 100%	Exceeds expectations in an outstanding manner.
A–	90 – 92%	Meets expectations.
B+	88 – 90%	
B	81 - 88%	Meets most expectations.
B–	78 - 81%	Meets most expectations, with minor reservations.
C+	76 - 78%	
C	68 - 76%	Meets some expectations
C–	65 - 68%	Meets some expectations with minor reservations.
D+	62 - 65%	
D	57 - 62%	Meets only a few expectations.
D–	55 - 57%	Meets only a few expectations but with reservations.
F	0 - < 55%	Unacceptable performance.

Attendance policy: Attendance in classes is encouraged and is very important. Attending class every day, coming prepared, and participating during class will directly be factored into your grade in the form of an overall participation grade. Attendance is required when we have guest speakers. Official absences will be accommodated.

Late policy: Because the GUIDE assignments are designed to prepare you to be an active and contributing participant during class, late assignments will not be accepted.

Academic Dishonesty Policy: The consequences of academic dishonesty at the Colorado School of Mines are severe and can lead to expulsion. It is imperative that each student take responsibility for their education and adhere to the Academic Dishonesty Policy.

The reading assignments must be done by each student. However, the problems on GUIDE assignments can be worked on in groups. All students must turn in individual homework and they must understand what they turn in. Looking at the solutions manual or solutions to previous semesters' work is considered dishonest. If a student copies a solution and cannot explain it adequately it is considered academic dishonesty. For computer exercises, each student is expected to generate their own solution. One cannot copy another person's computer solution and modify it slightly to make it look like it is their own work. All external sources used must be referenced and cited in their entirety.

Each student should read and abide by the Academic Integrity Policy, provided on-line at: http://inside.mines.edu/UserFiles/File/policies/STU/AcademicIntegrityPolicy.pdf. Each student should also read and abide by the Student Honor Code, provided online at: http://inside.mines.edu/UserFiles/File/policies/STU/Student%20Honor%20Code.pdf

EENG 386 Spring 2017 Course Schedule – Overview (Updated 1/3/2017)

GUIDE assignments are due every day in class (except for test days).

January 11 – February 8: Unit 1: Electrostatics and magnetostatics
Model: e-Ink (Grand Challenge: Advance personalized learning)

February 10: **Test #1**

February 15 – March 15: Unit 2: Maxwell's equations and their application
Model: Solar cells (Grand Challenge: Make solar energy economical)

March 1: **Final project proposals due**

March 17: **Test #2**

March 20 – April 10: Unit 3: Transmission Lines
Model: Power transmission lines (Grand Challenge: Improve urban infrastructure)

April 10: **Final project memo due**

April 12: **Test #3**

April 14 – April 26: Unit 4: Your choice- antennas or waveguides

April 28: **Students' Choice Poster Session**

May 1: Guest speaker.

May 3: Last day of class. **Final projects due, 5pm.**