PURDUE
UNIVERSITY

SCHOOL OF ELECTRICAL
AND COMPUTER ENGINEERING
UNDERGRADUATE COUNSELING OFFICE

To: The Engineering Faculty
From: School of Electrical and Computer Engineering
Re: ECE 30411

The School of Electrical and Computer Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ECE 30411 Electromagnetics I
Semesters offered: Fall, Spring
Non-repeatable
Credit 3

Pre/Co-requisites: [ECE 20001 (minimum grade of C) or ECE 20100 (minimum grade of C)] and [PHYS 27200 or PHYS 24100 or PHYS 25100 or PHYS 26100] and [MA 26200 or MA 26600 or MA 36600].

Course Description
This course is a continued study of vector calculus, electrostatics, magnetostatics, and Maxwell's Equations. It serves as an introduction to electromagnetic waves and transmission lines, which is continued in ECE 30412.

Reason
There was a significant gap between the material in ECE 31100 and ECE 44100 causing students who continued into ECE 41100 to lack the background needed to successfully start the course. To fix this, ECE 31100 has been modified and is now ECE 30411 as part 1 of a sequence. ECE 30412 is being developed to become part 2 of the sequence. ECE 44100 will no longer be offered.

History of Previous Offering
This course previously ran as ECE 31100 but this is the first offering of the course under the new format.

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ECE 30411 **Electromagnetics I** **Fall 2019**

Professor: Michael R. Melloch
EE 122D
Phone no. 49-43543
email address: melloch@purdue.edu
Office hours: To be posted on Blackboard

Teaching Assistant: To be posted on Blackboard

Text: Elements of Electromagnetics
by Matthew N. O. Sadiku
Fifth Edition

Schaum's Outlines Electromagnetics
by Joseph A. Edminister

Evaluation Structure:

Reflection Exercise	10 pts
Exam 1	100 pts
Exam 2	100 pts
Exam 3	100 pts
Final	150 pts
Total	460 pts

Blackboard Learn will be used for posting grades, homework assignments, homework solutions, practice exams, announcements, videos, etc.

Exam Schedule: *For exams you will be assigned a seat.*

Exam 1	to be announced
Exam 2	to be announced
Exam 3	to be announced
Final	to be announced

Make-up Exam Policy:

There will be NO written make-up tests. If you have a good excuse for missing a test, you will be either given an oral exam or the other exams will be properly increased in weight.

Homework:

Homework will count as extra credit with a maximum of 30 points. For example, if during the semester there is a total of 60 points on the periodic homework assignments and you achieved 40 points, you will receive 20 points of homework extra credit ($\frac{40}{60} \text{ x } 30 = 20$). Homework assignments will be due approximately each week. Late homework will not be accepted. Please write your solutions legibly and in an organized manner so that the graders can follow your work easily, and where possible, draw a box around your final answer.

You may work together as you solve your homework problems, as this can be an effective means of learning the material. If you do work in a group, **be sure that the solution you turn in is your own work**. This is the only way to learn the material. You will receive reduced or zero credit for homework submissions which appear to be copies of each other.

You will be assigned a number that you will put on your homework instead of your name.

Reflection Exercise

You will submit, by each Monday, a brief written review on Blackboard of what you learned in class during the previous week. Mention any connections you see between the material covered and topics you saw in other courses. Indicate if there were topics with which you are having difficulty and any questions you have. With 15 weeks in the semester, you can acquire all 10 points in ten weeks. I am not looking for length, especially since I will be reading these!

Exam Point Recovery Policy:

Teaching is the best way to learn a subject. So after each exam, I will give you an opportunity to recover points on one problem from your exam. You must have attended at least 80% of the classes since the last exam and received at least half the points on the homework assignments to take advantage of this opportunity. Note there are no excused absences. The 80% attendance requirement is so if you have a legitimate reason to miss a class (illness, family emergencies, other Purdue approved activities) you can still participate in the point recovery opportunity. You will demonstrate your mastery of the problem you missed points on by preparing and presenting to me a no more than ten minute tutorial on the topic of that problem. I will grade your presentation and the points you receive will be anywhere from zero up to the number of points you missed on that problem. Your presentation must be made by the time of the next scheduled exam and you must bring your graded exam to your presentation. After each exam I will email a link to a Doodle poll so that you can schedule your session.

Academic Dishonesty:

Any case of academic dishonesty will result in a grade of F in this course.

Lunch Meetings:

Each week I will meet for lunch with small groups from the class. The purpose is to get to know each other and to answer any questions you have, both specific to ECE 311 and in general. You will be contacted by email to schedule a lunch.

Campus Closing/Disruption of Classes:

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. In such an event, information will be provided through Blackboard Learn.

Class Attendance:

Your class attendance is important. If you must miss class, you are responsible for any material, information, handouts, announcements, etc. you missed. If you are not in class and have someone else sign the attendence sheet for you, you will both receive an F for the class.

Videos

I will post about 50 short videos to Blackboard Learn during the semester. These will be arranged in four folders.

The folder "Demonstrations/Experiments" will show an experiment and explanation of a fundamental concept. I will show some of these demonstrations/experiments in class, but some I may only provide via these videos.

The folder "Lecture Items" will summarize something we covered in class that I feel is extremely critical for you to understand.

The folder "Worked Problems" will be problems I would like to work in class but didn't have the time.

The folder "Interesting Concepts" will be items of interest, but not something that will be specifically covered on an exam.

Course Learning Objectives: A student who successfully fulfills the course requirements will have demonstrated:

(i) An ability to work with electrostatic fields and to be able to find electric and potential fields from charge distributions including the presence of dielectric materials;

1a. To understand the relationship between charge, electric field, and electric flux.

1b To be able to use Gauss' Law and Coulomb's Law to find electric fields and potentials for situations involving charge distributions.

1c To understand what potential difference is and to be able to find potential differences from charge configurations or the electric field intensity.

1d To understand the concept of divergence and to be able to find the charge density from the electric flux density.

1e To understand and determine the energy stored in a collection of point charges or electric fields.

1f To be able to analyze electric boundary conditions between two dielectrics.

1g To be able to use Poisson's equation to find potentials and electric fields.

1h To determine the capacitance of simple geometries.

(ii) An ability to work with magnetostatic fields and to be able to find magnetic fields from current distributions including the presence of magnetic materials;

2a To be able to use the Biot-Savart Law and Ampere's Circuital Law to find magnetic fields from current distributions.

2b To be able to find the forces and torques on moving charges and current carrying wires in magnetic fields.

2c To understand the concept of curl and to be able to find the current density from the magnetic field intensity.

2d To understant the difference between paramagnetic, diamagnetic, and ferromagnetic materials.

2e To be able to analyze magnetic boundary conditions between two materials.

2f To be able to determine the inductance of simple geometries.

(iii) An ability to work with time varying fields including wave propagation;

3a To be able to calculate the displacement current caused by a changing electric field.

3b To be able to calculate the electromotive force caused by a changing magnetic flux.

3c To understand, and know how to represent, a propagating wave.

3d To be able to represent electromagnetic waves in lossless and lossy materials.

3e. To understant Poynting's vector and power flow.

3f To analyze electromagnetic plane waves at normal incident to the boundary between two materials.

(iv) An ability to work with transmission lines in the time and frequency domains;

Come to class on-time!

Class announcements may supersede prior written information

Course Outline

Week	Topics	Sadiku	Schaum's
1	Vector analysis, Coordinate systems, Differential length, volume, and area, Coulomb's law, Electric field intensity (E)	Chapter 1 & 2 3.1, 3.2, 4.1, 4.2	Chapter 2 3.1, 3.2, 3.3, 3.4
2	Electric Field Intenisity continued, Electric flux density, Gauss' law, Divergence	4.3, 4.4, 4.5, 3.4, 3.6, 4.6	3.5, 3.6, 4.1, 4.2, 4.3, 4.4, 4.5, 5.3, 5.5, 5.6, 5.7, 5.8, 5.9
3	Electric Potential, Gradient, Electric Dipole, Energy density in electrostatic fields	4.7, 4.8, 3.5, 4.9, 4.10	Chapter 6, 5.2
4	Current, conductors and dielectrics in static electric fields, boundary conditions	Chapter 5	7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 8.1, 8.7
5	Poisson's and Laplace's equations, Laplacian	6.1, 6.2, 3.8, 6.3, 6.4	Chapter 9

6	Resistance and capacitance, method of images, Biot-Savart Law, Magnetic field intensity (H)	6.5. 6.6, 7.1, 7.2	7.7, 8.2, 8.3, 8.4, 8.5, 8.6, 10.1, 10.2
7	Ampere's Circuital Law, Curl, Stokes Theorem magnetic flux density (B),	7.3, 7.4, 3.7, 7.5, 7.6	10.3, 10.4, 5.10, 10.10, 10.5
8	scalar and vector magnetic potentials, forces and torque	7.7, 8.1, 8.2, 8.3	Chapter 11
9	magnetic dipole, Magnetic materials	8.4, 8.5, 8.6	
10	boundary conditions, inductance, energy	8.7, 8.8, 8.9	10.6, 10.7, 10.8, 12.1, 12.2
11	Faraday's law, Displacement current, Maxwell's Equations, Phasors	9.1–9.5, 9.7	12.3, 13.3, 13.4, 13.5, 13.6, 13.7, 13.8
12	Wave equation, waves, wave propagation	10.1–10.5	14.1, 14.2, 14.3, 14.4
13	Wave propagation, power and Poynting vector	10.6, 10.7	14.5, 14.6, 14.7
14	Reflection of plane waves	10.8	14.8
15	Transmission lines	11.1–11.4	Chapter 15

ECE 30411 Course Outline

Lectures	*Principal Topics*
4	Introduction: Charge; Electric and Magnetic Fields; Units; Vector Analysis; Coordinate Systems; Line, Surface and Volume Integrals; Derivatives
12	Electro Statics: Static Electric Fields; Gauss' Law; Coulomb's Law; Superposition; Applications of Gauss' Law (Continuous Distributions of Charge); Electric Potential; Conductors; Dielectrics; Displacement Field; Boundary Conditions; Capacitance; Electrostatic Energy; Force; Poisson's Equation; Laplace's Equation; Method of Images; Electric Currents; Continuity Equation
7	Magneto Statics: Static Magnetic Fields; Lorentz Force; and Ampere's Law; Vector Magnetic Potential; Biot-Savart Law; Magnetic Dipole; Magnetization; Magnetic Circuits & Magnetic Materials; Boundary Conditions; Inductance; Magnetostatic Energy; Torque
7	Time Dependent Fields: Faraday's Law; Transformers; Generators; Maxwell's Equations; Potential Functions and Boundary Conditions for Time Varying Fields; Wave Equation; Time Harmonic Fields
6	Uniform Plan Waves: Uniform Plane Wave (UPW); TEM Waves; Polarization; UPW in Lossy Media; Power flow; UPW Normal Incidence on Plane Boundary
5	Transmission Lines: Intro Using Parallel-Plate Transmission Line; General Transmission Line Properties; Finite Length Transmission Lines; Transient Behavior; Pulses
3	Exams