Physics C: Electricity and Magnetism Syllabus

Overview of Course:

Class Meeting Time: Four 45 minutes periods and one 90 minute period per week.

Physics C: E&M is taught as the second half of a second year physics course. Students in the class have previously completed a year of algebra-based physics with a comprehensive hands-on laboratory component. Students are required to have completed or be concurrently taking a calculus course. The extended period each week is normally used for a laboratory experiment which consists of an inquiry based challenge to evaluate a variable or function. Students complete a lab report for each experiment that stresses scientific conclusions and validity of results. Exams in the course are designed along the lines of the free response section of the AP exam. Quiz grades are based on an in class multiple choice quiz based on the AP exam (no calculators or equation sheets allowed). Quizzes are given during weeks in which there is no exam. Students are additionally expected to complete an assigned set of homework problems for each quiz and exam. Selected students will present their solution to an assigned problem to the class each week, with extra credit being awarded based on the presentation.

Text

Serway, Raymond A., and John W. Jewett. Physics for Scientists and Engineers. 8th ed. Belmont, CA. Brooks/Cole, 2010.

Grading:

Exams	60%
Labs	20%
Quizzes	20%

Course Structure:

The Physics C: E&M course is taught with the understanding that many students are just beginning the study of integrals as the semester starts. For that reason the more calculus intensive topics are reserved for the end of the course. This also allows the students to firmly establish a basic understanding of major concepts before revisiting them at the end of the course and allows them to develop appropriate math skills before tackling these topics. Additionally as the Physics C: E&M course shares laboratory space with a Physics B course and a first year physics course this course structure allows for the lab experiments in the courses that use the same equipment to be conducted at the same time.

Instructional Approach

The instructional approach of the Physics C: E&M course is to provide students with many opportunities to discover basic concepts on their own. Typically when a new topic is to be introduced the students are first allowed to explore the topic through a "Quick Lab" or computer simulation that will allow the students to determine the relationships between the variables involved in the concept. The students then discuss their findings as a group before the teacher begins a presentation on the topic. Connections between the students' findings and the accepted physics of the topic will be made during the presentation and an analysis of the equations governing the topic will be made to see if the students' findings follow the presented equations. Additionally, many of the labs are timed to occur before the main concept of the experiment is covered in the class. This forces students to apply knowledge of similar situations to the new concept and create their own approach to the problem, rather than simply doing it the way it is presented in the textbook.

Exam 1: Electrostatics (10 instructional periods)

Assigned Readings:
- Ch 23 Sections 1 – 4, 6 - 7
- Ch 24 Sections 1 – 2, 4
- Ch 25 Sections 1 – 4, 7 - 8
- Ch 26 Sections 1 – 4

Electrostatics
Electric fields and Gauss' Law
Coulomb's Law
Electric potential
Potential difference
Electrostatic conductors and capacitors

Exam 2: Circuits (10 instructional periods)

Assigned Readings
- Ch 27 Sections 1 - 2, 4 – 6
- Ch 28 Sections 1 – 8

Electric circuits
Current and resistance
Ohm's Law
Resistors in series and parallel
Kirchhoff's Rules
Capacitors in circuits
RC circuits

Exam 3: Magnetism and Induction (13 instructional periods)

Assigned Readings
- Ch 29 Sections 1 – 6
- Ch 30 Sections 1 – 6
- Ch 31 Sections 1 - 6

Magnetism basics
Magnetic field
Force on charge
Force on wire
Fields around wires
Biot-Savart and Ampere's Laws
Gauss' Law
Induction
Faraday's Law
Lenz's Law

Exam 4: Extended Topics: Electrostatics (10 instructional periods)

Assigned Readings
- Ch 23 Section 5
- Ch 24 Section 3
- Ch 25 Sections 5 – 6
- Ch 26 Sections 5 – 7

Potential by integration
More Gauss' Law applications
Fields and potentials of charge distributions
Charge on a conductor and shielding
Charge and energy density
Dielectrics

Exam 5: Extended Topics: Circuits and Magnetism (15 instructional periods)

Assigned Readings
- Ch 27 Section 3
- Ch 30 Sections 1, 3
- Ch 32 Sections 1 – 5
- Ch 33 Sections 1 – 9
- Ch 34 Sections 1 – 2

Current density and drift velocity
Meters with resistance and circuits
Combinations of resistors and capacitors
More situations involving Biot-Savart and Ampere's Laws
Magnetic flux through integration
Self-inductance
LR circuits
LC circuits
Maxwell's Equations

Review and AP exam (10 instructional periods)

Selected Topics and Student Presentations (20 instructional periods)

Labs

Labs are categorized as follows:
Hands-on − Students perform an experiment using physical apparatus. All hands-on experiments are open ended where students are provided with an objective and equipment but are left to devise an appropriate experimental procedure.
Virtual − Students manipulate a computer "experiment"

Laboratory Experiment	Exam	Type	Time Required
Experiment 1 – Coulomb's Law Video analysis of the repulsion between two charged objects	1	Hands-on	90 minutes
Experiment 2 – Electric fields A computer simulation is used to examine the electric fields around charges <http://phet.colorado.edu >	1	Virtual	45 minutes
Experiment 3 – Millikan's Experiment The charge on an electron is determined using a computer simulation <physic313.50webs.net/ejsweb/simulations/_apps/millikan_lab.app/millikan2.html >	1	Virtual	90 minutes
Experiment 4 – Capacitors in Series and Parallel Rules for capacitors in combination are discovered	1	Hands-on	90 minutes
Experiment 5 – Wheatstone's Bridge An unknown resistance is determined	2	Hands-on	90 minutes
Experiment 6 – Ohmic and Non-Ohmic Materials The voltage and current curves of various conductors are investigated	2	Hands-on	90 Minutes
Experiment 7 – Ampere's Law The magnetic field of a current carrying wire is examined	3	Hands-on	90 minutes
Experiment 8 – Induction A magnet is dropped through coils of wire to examine flux and induction	3	Hands-on	90 minutes
Experiment 9 – Variable Capacitor and Dielectrics The effects of distance and dielectrics on capacitors are investigated <Exploration of Physics>	4	Virtual	45 minutes
Experiment 10 – Meters in DC circuits Examining the resistances of voltmeters and batteries and their effects on DC circuits	5	Hands-on	90 minutes
Experiment 11 – RC Circuit Calculating the time constant of RC circuits	5	Hands-on	90 minutes
Experiment 12 – RL Circuit Writing the differential equation for a RL circuit and finding the time constant	5	Hands-on	90 minutes
Experiment 13 – LC Circuit Examining the oscillation of an LC circuit <http://phet.colorado.edu >	5	Virtual	90 minutes