Syllabus

PHYS 227

Electricity & Magnetism Laboratory for students in the sciences.

Course Description and Course Objectives

Electricity & Magnetism Laboratory for students in the sciences. This is the second semester laboratory to accompany a two-semester course sequence in introductory physics. This class will meet weekly in a 120-minute block to carry out various experiments. Topics include material covered in a typical calculus-based introductory physics course on the principles of electricity and magnetism.

Knowledge to gain: To use laboratory activities to understand the material covered in the accompanying introductory physics course.

Skills to gain: Ability to carry out simple experiments and analyze the data collected to understand a variety of basic physics concepts. Become familiar with a variety of laboratory devices and how to use them to make measurements.

See list of **Learning Objectives**.

Prerequisites

PHYS 218 or 206 and MATH 152 or 172.
You must have a working knowledge of plane geometry, trigonometry, and algebra. You will also be expected to have a working knowledge of derivatives and integrals, and be proficient in the use of vectors (addition, subtraction, dot and cross products).

Co-Requisites

Co-enrollment in PHYS 207.

Text and Required Materials

The text for this lab course is electronic and is hosted on the WebAssign.net website. You will need to purchase an access code for WebAssign for the labs by logging on to the website http://webassign.net/tamu/login.html.

Laboratory Logistics

The lab schedule is attached as well as being posted on the class web-page. The labs consist of three parts, 1) prelab, due before arriving for the lab activity, 2) in-lab, completed as a group assignment during the lab period, and 3) post-lab, due before the next scheduled lab meeting. Each of these assignments will be hosted through the online WebAssign package. Note that while we do not have a formal lab activity scheduled each week, in the weeks without a formal assignment students will be offered a chance to do some exploratory measurements to further enhance their understanding of the principles upon which the physics of electricity and magnetism are based.

Absences

If you miss a lab due to an authorized excused absence as outlined in the University Regulations, you should attempt to contact your instructor to try and arrange to makeup the missed work during the week of your absence. If this is not possible, students will be given the opportunity to make-up the missed work by completing a separate make-up lab at the end of the semester.

For information on university excused absences, see https://student-rules.tamu.edu/rule07/.

Course Topics and Schedule

Week	Topic
Week 1	Exploration of Static Electricity
Week 2	Introduction to WebAssign
Week 3	Electrical Measurements
Week 4	Fields and Potentials
Week 5	Capacitors
Week 6	Exploration of Capacitors in series and in parallel
Week 7	Exploration of the oscilloscope, function generator and DC power supply
Week 8	Oscilloscope and RC Circuits
Week 9	Investigating magnetic fields for permanent and electro-magnets
Week 10	Magnetic Fields
Week 11	Faraday's Law
Week 12	LR, LC & LRC Circuits (part I)
Week 13	LR, LC & LRC Circuits (part II)
Week 14	Make-up lab
Week 15	Make-up lab

Course Grade

The overall course grade is weighted as follows: Each lab will be graded on the basis of 100 points, with 10% of the grade coming from the pre-lab quiz, 70% of the grade coming from the in-lab submission, and 20% of the grade coming from the post-lab quiz.

The semester lab grade will be based on the average of a student's lab grades for the semester.

Grading Scale

A: 90-100
B: 80-89
C: 70-79
D: 60-69
F: <60

Additional grade information: http://student-rules.tamu.edu/rule10

Web Page

www.webassign.net/tamu/login.html – for the electronic lab manual and connection to the lab report system.

ADA Policy

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit http://disability.tamu.edu.

Honor Code

The Aggie Honor Code states, "An Aggie does not lie, cheat, or steal or tolerate those who do." Further information regarding the Honor Council Rules and Procedures may be found on the web at http://aggiehonor.tamu.edu.

Learning Objectives

1. Calculate/measure the electric field caused by a continuous distribution of charge
2. Be able to draw and to interpret electric field lines

3. Describe the electric field within a conductor and where the charge is located on a charged conductor.

Electric Potential

4. Articulate the meaning and significance of electric potential
5. Calculate the electric potential due to a continuous distribution of charges
6. Be able to use electric potential to calculate electric field
7. Be able to draw and to interpret equipotential surfaces

Capacitance and Dielectrics

8. Identify the nature of capacitors and be able to quantify their ability to store charge (i.e. the capacitance)
9. Analyze capacitors connected in a network (by determining equivalent capacitance for capacitors connected in series or parallel)
10. Calculate the amount of energy stored in a capacitor
11. Be able to analyze change of charge, voltage, and energy of the capacitor when dielectric is inserted/removed in the presence/absence of the battery

Current, Resistance, and Electromotive Force

12. Calculate/measure the resistance of a conductor from its dimensions and resistivity
13. Articulate Ohm's Law both in terms of the resistivity of a material (the microscopic form of Ohm's Law) and in terms of the resistance (macroscopic form of Ohm's Law)
14. Articulate the concept of electromotive force (emf) and how emf makes it possible for current to flow in a circuit
15. Identify the symbols used in circuit diagrams and be able to construct circuits
16. Calculate/measure terminal voltage of a battery in a circuit
17. Calculate/measure energy and power in a circuit

Direct-Current Circuits

18. Analyze circuits with multiple resistors in series or parallel
19. Apply Kirchhoff's rules to analyze circuits
20. Articulate the functionality of ammeters and voltmeters and be able to use them to make measurements in a circuit
21. Analyze R-C Circuits and be able to measure their time constants using an oscilloscope

Magnetic Field and Magnetic Forces

22. Interpret magnetic field lines and calculate/measure magnetic flux through a surface
23. Be able to measure magnetic fields using a Hall probe

Sources of Magnetic Field

24. Calculate/measure the magnetic field due to a current
25. Calculate/measure the force between two long parallel conductors

Electromagnetic Induction

26. Articulate how Faraday's Law relates the induced emf in a loop to the time-derivative of magnetic flux through the loop and be able to apply it to calculate induced emf
27. Apply Lenz's Law to determine the direction of an induced emf
28. Calculate/measure the emf induced in a conductor moving through a magnetic field
29. Calculate/measure the induced electric field generated by a changing magnetic flux

Inductance

30. Calculate/measure mutual inductance and induced emf due to mutual inductance
31. Articulate the concept of self inductance and be able to relate the magnetic flux and current to the self inductance
32. Calculate the energy stored in a magnetic field
33. Analyze R-L circuits and describe/measure the time-dependence of the current
34. Analyze L-C circuits and describe/measure the time-dependence of the current

Alternating-Current Circuits

35. Analyze/measure the properties of an L-R-C series circuit with a sinusoidal emf
36. Understand the origin of resonances in L-R-C circuits

Learning Outcomes:

For each lab module listed above, the students will

- Demonstrate to the instructor their knowledge of physical laws of motion describing a given lab experiment and a measurement procedure, as based on the pre-lab manual, the textbook, and any supplementary material;
- Apply critical thinking and scientific method in order to build a proper physical model of the experiment, formulate a set of assumptions and approximations behind the model, and identify sources of errors stemming from these approximations and the measurement procedure;
- Develop visual analysis and communication skills in order to
  - Analyze complex graphical information associated with each experiment such as a scheme of the experimental setup, any electric circuits used in the experiment, or a scheme of connection to the measurement equipment;
  - Create scientific graphs based on the experimental data they obtain, including any applicable error bars
  - Use proper graphical information in the lab report.
- Develop oral communication skills in order to
  - Effectively communicate with instructor at the stage of pre-lab testing, preparing the experimental setup, and writing the report;
  - Effectively communicate with team members at all stages of the lab experiment: developing a physical model, taking data, troubleshooting, error analysis, data analysis, and report preparation. Each lab is a team project!
- Develop written communication skills in order to prepare a competent report of their experiment containing the experimental data, error analysis, and assessment of validity of a physical model.