

# ***Physics 132: Electromagnetism and the Physics of Matter***

## **Spring 2011**

Location: TPL 203                      Instructor: Dr. Frederick W. Strauch  
Time: MWF 11-11:50am              Email: Frederick.W.Strauch@williams.edu  
Office Hours: TBA                      Phone: 413-597-4271  
Office: BSC 088

### **Required Text:**

*Physics: Principles with Applications* (6<sup>th</sup> edition) by Douglas C. Giancoli.

**Recommended:** A good calculator.

### **Course Overview**

This course continues the study of physics in our world. Here we move beyond the study of motion under simple forces and gravity to the most important force in our everyday experience, electromagnetism. This force is in fact dominant at microscopic scales, and accounts for the interactions between atoms and molecules, the building blocks of chemistry and molecular biology. In addition, the design and control of electric circuits is at the foundation of our digital world. Finally, electromagnetism is intimately connected to light and radiation through the electromagnetic spectrum. By thinking about light and matter, we will encounter the frontiers of twentieth century physics: relativity and quantum mechanics.

### **Course Objectives**

At the conclusion of this course you will be able to identify the various concepts and quantities used to (a) describe electric and magnetic forces, fields, and energies, (b) analyze electric circuits and some of their applications, (c) make sense of the strange behavior of light and matter at extreme speeds (relativity) and small scales (quantum mechanics). This understanding will be developed actively through direct observation in laboratories, through demonstrations and discussion in class, and through quantitative reasoning and problem solving.

### **Grading**

<b>Graded Work</b>	<b>Grading Weight</b>
Labs	10 %
Homework	15 %
Quizzes	10%
Hour Tests	15% and 20%
Final Exam / Paper	30 %

*Hour Tests:* The hour tests will be weighted for your maximal benefit. The exam with your higher score will be worth 20%, the other will be worth 15%.

*Final Paper:* You have the option to submit a final paper on the last day of classes in place of the final exam. This would be a 5-10 page descriptive paper on a topic at the intersection of physics and biology, chemistry, neuroscience, or medical technology (more details will be provided by Spring Break).

*Late policy:* Should you be unable to submit an assignment due to a reasonable conflict, let me know at least a week in advance; if due to a serious emergency, documentation may be requested. In all other cases, late homework will be accepted up to 5pm two calendar days after the due date with a 30% penalty; homework turned in more than two days late will receive no credit.

### **Laboratory**

There are three laboratory sections: 132.02 = Mondays, 132.03 = Tuesdays, 132.04 = Wednesdays. Each section will complete six laboratories, meeting from 1:10-3:50pm in TPL 215 or 312 (signs will be posted). These are given by the following schedule:

<b>Lab</b>	<b>Dates</b>	<b>Topic</b>
1	Feb. 14,15,16	Charges, Fields, and Potential
2	Feb. 28, Mar. 1,2	DC Circuits
3	Mar. 14,15,16	Capacitors and RC Circuits
4	Apr. 4,5,6	E/M Ratio
5	Apr. 18,19,20	EM Induction
6	May 3,4,5	Photoelectric Effect

*Please bring a notebook to record your lab work. Problems related to the labs will appear on the exam. NOTE:* It is generally not possible to make up these labs, but in case of a reasonable conflict or an emergency, please contact me as soon as possible so that we can make arrangements.

### **Homework**

A set of problems will be assigned each week, to be due on the following week. These are an essential way to gain problem-solving skills, learn the material thoroughly, assess your understanding, and prepare effectively for exams. Solutions to the homework will be given out (and available on Blackboard) and discussed during the problem-solving sessions (see below).

### **Office Hours**

I will be available often during the semester, so feel free to come by afternoons without lab, or make an appointment. Exceptions: I will not be available during the hours before class.

*Please come by my office or send an email if you find yourself having difficulty with **anything** in this course, big or small: it is my top priority to help you learn physics in any way I can.*

## Resource Center

The Math/Science Resource Center will provide tutors for Physics 132, with a schedule to be determined.

## Exams

There will be two short quizzes, tentatively schedule for Feb. 21 and Apr. 8, and two in-class tests, tentatively scheduled for Mar. 7 and Apr. 22. There will also be a comprehensive in-class final exam during the exam period in May. The hour will be set by the Registrar and cannot be changed. Please plan your travel accordingly, or take advantage of the *final paper option*.

## Tentative Schedule

<u>Date</u>	<u>Topic</u>	<u>Reading(Giancoli)</u>	<u>Laboratory</u>
Feb. 4	Overview, Electric charges	16.1–16.4	
Feb. 7	Coulomb's law	16.5–16.6	
Feb. 9	Electric fields	16.7-16.9, 16.12	
Feb. 11	Electric potential	17.1–17.3	
Feb. 14	Potential for point charges	17.4-17.6	L1. Feb. 14,15,16
Feb. 16	Capacitors and capacitance	17.7	
Feb. 18	<i>NO CLASS: Winter Carnival</i>		
Feb. 21	Dielectrics and Energy in the E-field; <b>Quiz 1</b>	17.8-17.9	
Feb. 23	Current and Resistivity	18.1-18.4	
Feb. 25	Power, Alternating Current, Intro to circuits	18.5-18.7	
Feb. 28	Ohm's Law, Series and Parallel Resistors	19.1-19.2	L2. Feb.28, Mar.1,2
Mar. 2	More DC circuits	19.1-19.2	
Mar. 4	Kirchhoff's laws	19.3-19.4	
<b>Mar. 7</b>	<b>HOUR TEST 1</b>		
Mar. 9	Series and Parallel Capacitors	19.5	
Mar. 11	RC circuits; wrap-up electricity	19.6-19.7	
Mar. 14	Magnets and magnetism	20.1-20.2	L3. Mar. 14,15,16
Mar. 16	Magnetic forces and magnetic fields	20.3-20.4	
Mar. 18	Magnetic fields from wires, loops, and coils	20.5-20.7	
<b>SPRING BREAK</b>			
Apr. 4	Magnetic induction; Faraday's Law; Lenz's Law	21.1-21.3	L4. Apr. 4,5,6
Apr. 6	Electric generators, transformers, and power	21.4-21.5, 21.7	
Apr. 8	Inductors; <b>Quiz 2</b>	21.9	
Apr. 11	Energy and LR circuits	21.10-21.11	
Apr. 13	Resonance and LC circuits	21.14	
Apr. 15	Electromagnetic Waves	22.1-22.3	

Apr. 18	Light as an EM wave; Energy, power, intensity	22.4-22.5	L5. Apr. 18, 19, 20
Apr. 20	Medical Imaging; X-Rays and MRI	25.11-25.12, 31.9	
<b>Apr. 22</b>	<b>HOURLY TEST 2</b>		
Apr. 25	Relativity: Galileo, Einstein, and Simultaneity	26.1-26.3	
Apr. 27	Time dilation and Length contraction	26.4-26.5	
Apr. 29	Speed limits and relativistic momentum	26.6-26.8	
May 2	Relativistic energy (rest, kinetic....)	26.9	
May 4	Early Quantum Theory	27.1-27.4	L6. May 2,3,4
May 6	Wave-particle duality; light and matter	27.7-27.9	
May 9	Bohr model of the atom; atomic structure	27.10-27.12	
May 11	Uncertainty and measurement	28.1-28.5	
May 13	CONCLUSIONS		
TBD	Final Exam		

### Honor Code

Every work that is done by you and your fellow students is subject to the honor code. Students should be aware of the College's statement on "Academic Honesty and Honor Code" (pp. 136-137 in the Williams College Student Handbook 2008-2009).

Note that the honor code is not just about cheating: all activities in class are to be undertaken with honesty and integrity. However, this should not be pursued at the expense of learning.

For homework, it is expected that discussions with another student, with a Resource Center tutor, or with the professor will enhance your understanding of a problem. However, you must write the final solution in your own words; it is not acceptable to simply transcribe someone else's work and present it as your own. *You should note on your paper the names of the people you conferred with.*

For laboratories: Each lab group will consist of two or three students. Within your group, you may share data, but the data should be entered into each student's notebook. You are encouraged to cooperate within your group on calculations and data analysis. Each student should write his or her conclusions in his or her own words.

No collaboration is permitted during the hour tests, or the final exam. These tests are "closed book." On the hour tests and on the final exam you may consult your own handwritten notes on a single 3"x 5" card. You may use an electronic calculator, but may not use formulas or any other notes stored before the test in the calculator.

If you are in doubt as how the Honor Code applies to any aspect of this course, please ask the instructor.

### Final Disclaimers

All contents of this syllabus are subject to revision by the instructor. While physics is not usually a politically charged topic, passionate discussion may occasionally occur. Please do not take any perceived offense personally, and please see me if you have any concerns.