Notes Regarding Physics 247, 248, and 249 (v1.0)

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Abstract

The primary goals of Physics 247, 248, and 249 are to create a stimulating, inviting, yet rigorous environment for first year physics majors. To meet this goal the class emphasizes frequent and positive faculty–student interaction, early and frequent discussion of modern topics in physics, and research proven techniques in teaching and learning. The class was first taught in Fall 2000, and its development is ongoing.

1 Preamble

This document summarizes experiences over the past five years teaching various combinations of Physics 247, 248, and 249 (Physics 247-8-9). In most cases Physics 247 and 248 were co-taught by two faculty. It is hoped that these notes will be continuously updated by faculty teaching these courses, and that they will help make the class easy to organize in the future without getting in the way of positive change. Toward that end, the latex file for this document and its corresponding pdf file are stored in the Physics 247-8-9 online directory at uw.physics.wisc.edu. The username and password are available from the instructional program IT manager (Bill Grogan).

2 Motivation

The original motivation for Physics 247-8-9 was a sense that the traditional route into a physics major was not as efficient as it could be. Perhaps most importantly, many physics majors enter the field because of their interest in modern topics in physics. They have heard of strings, quarks, Bose condensates, and nanoscience, and they want to learn more about these topics.

In order to delve *deeply* into these fields, students need years of study. But in order gain some level of insight, only a few fundamentals are required. Physics 247-8-9 attempts to address this issue by placing modern topics as early in the curriculum as possible (see section 3).

Second, by necessity, many introductory physics classes are large, making it difficult for new physics majors to interact with faculty at the level that is appropriate for students taking a class in their major field of study. Creating a special sequence of courses reserved for students with a strong interest in a physics major solved this problem. It is hoped that the class sequence will be so successful that this particular problem will recur often.

3 Curriculum

The curriculum for Physics 247-8-9 is the standard curriculum for introductory physics, as represented, for example, by Physics 207, 208, 241. However, Physics 247-8-9 offers new opportunities, because the students enrolled are assumed to have a strong interest in physics and a corresponding intention to take all three semesters of the sequence. As a result, there is no barrier to changing the order of the curriculum. For example, in the new sequence, special relativity is typically covered in the first semester, Physics 247, and much of introductory quantum mechanics is covered in Physics 248. Thermodynamics, in contrast, does not appear until the third semester, by which point it can be discussed in the context of much of modern physics. Appendix A contains example syllabi.

4 Contact Hours

Physics 247-8-9 is scheduled with three "lectures," one "laboratory," and one "discussion." These three categories are placed in quotes because they are rapidly changing engines for education at this time. Lectures in Physics 247-8-9 , for example, are typically far more interactive than those in larger classes or in the more traditional small classes of years gone by. This emphasis on interaction makes it appropriate to reduce the number of discussion hours from two to one and to increase the number of lecture hours from two to three. The laboratories have been modified, to this point, only so as to relate to the new ordering of the syllabus. Thus, as shown in appendix B, some of the modern physics labs usually performed in Physics 307 are now part of the Physics 247-8-9 curriculum. Additional modification of the laboratories to take further advantage of the modified curriculum order would

be an important improvement to the course sequence.

5 Grading

Grading is obviously a personal choice for each instructor. Physics 247-8-9 frequently places roughly equal weight on all aspects of the course, with homework assigned every week, including plenty of problems (meaning 10-12 problems about the length of those in Halliday and Resnick). Asking just slightly more of the students than they expect seems to promote a very good *esprit de corps*. Many instructurs have commented on the remarkable lasting friendships the students seem to develop with one another as a result of working together on the homework, frequently in the lobby of the physics department. The following weights serve as an example:

Final	20%
Best Midterm	16%
Second Best Midterm	16%
Third Best Midterm	8%
Homework	20%
Laboratory	20%

A Syllabi

A.1 Physics 247, Fall Semester, 2004

Topic	Reading	Leader	Approx. Weeks
Measurement and 1-D Motion	HRW 1 & 2	Mark	1
1D, 2D, & 3D Motion	HRW 3 & 4	Mark	2, 3
Newtons Laws	HRW 5 & 6	Mark	3, 4
Exam 1, Wed., Oct 6, In Class			
Relativity and Minkowski Diagrams	Kogut 1, 2, & 3	Daniel	5, 6
Lorentz Transformation	Kogut 4 & 5	Daniel	6, 7
Work, Energy, & Consv. Laws	HRW 7 & 8	Mark	8
Multiple Particles and Collisions	HRW 9 & 10	Mark	9
Exam 2, Wed., Nov. 10, In Class			
Momentum and Energy in Relativity	Kogut 6	Daniel	10, 11
Rotation and Angular Momentum	HRW 11 & 12	Mark	12, 13
Exam 3, Wed., Dec. 8, In Class			
Gravity and Static Equilibrium	HRW 13 & 14	Daniel	14, 15

HRW refers to *Fundamentals of Physics*, by Halliday, Resnick, and Walker.
Kogut refers to *Introduction to Relativity*, by Kogut.

A.2 Physics 248, Spring Semester, 2005

Topic	Reading	Lectures
Waves	HRW 16-18	1-4
DeBroglie Waves, Uncertainty Principle	T&L 5	5-7
Experimental Basis of QM	T&L 3	8-10
Exam 1, Wednesday, February 16, In Class		
Schrodinger Waves	T&L 6	11-12, 14-18
Electrostatics	HRW 22-26	19-24
Exam 2, Wednesday, March 16, In Class		
Bohr Model	T&L 4	26-28
DC Circuits	HRW 27-8	29-30
Magnetic Fields and Induction	HRW 29-31	31-34
Exam 3, Wednesday, April 20, In Class		
Hydrogen Atom	T&L 7	35-36, 38-44

HRW refers to *Fundamentals of Physics*, by Halliday, Resnick, and Walker.
T&L refers to *Modern Physics*, by Tipler and Llewellyn.

A.3 Physics 249, Fall Semester, 2005

Topic	Reading	Lectures
ac Circuits	HRW 32 & 33	1-4
Maxwell's Equations	HRW 34-37	5-11
Thermo. and Stat. Mech.	HRW 19-21 & T&L 8	12, 13
Midterm 1	October 5	14
Thermo. and Stat. Mech.	HRW 19-21 & T&L 8	15-20
Molecular Physics	T&L 9	21, 22
Solid State Physics	T&L 10	23-28
Midterm 2	November 9	29
2DEGs and Quantum Dots	Special Handout	30
Nuclear Physics	T&L 11 & 12	31-34
Particle Physics	T&L 13	35-39
Midterm 3	December 7	40
Cosmology	T&L 14	41-43

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B Laboratories

B.1 Physics 247, Fall Semester, 2004

Lab	Physical Location	Documentation Location
MC1 (errors and motion)	Phys. 207/208 Lab Storage	207/208 Lab Manual
MPC1a&b (radiation)	Phys. 207/208 Lab Storage	207/208 Lab Manual
M5 (projectile motion)	Phys. 207/208 Lab Storage	207/208 Lab Manual
Relativity 1	uw.physics.wisc.edu	uw.physics.wisc.edu
Relativity 2	uw.physics.wisc.edu	uw.physics.wisc.edu
M6 & M10 (circ., P, frict.)	Phys. 207/208 Lab Storage	207/208 Lab Manual
M14a (collision with carts)	Phys. 207/208 Lab Storage	207/208 Lab Manual
MC7 & MC8 (pendula)	Phys. 207/208 Lab Storage	207/208 Lab Manual
Rotation Lab	Phys. 207/208 Lab Storage	uw.physics.wisc.edu
M3 (statics)	Phys. 207/208 Lab Storage	207/208 Lab Manual

B.2 Physics 248, Spring Semester, 2005

Lab	Physical Location	Documentation Location
SC1, S2 (waves)	Phys. 207/208 Lab Storage	207/208 Lab Manual
E6 (e/m ratio)	Phys. 207/208 Lab Storage	207/208 Lab Manual
QM Computer Lab 1	Physics 248 Lab Computers	uw.physics.wisc.edu
QM Computer Lab 2	Physics 248 Lab Computers	uw.physics.wisc.edu
EC2 (Electric Fields)	Phys. 207/208 Lab Storage	207/208 Lab Manual
EC3 (Capacitors)	Phys. 207/208 Lab Storage	207/208 Lab Manual
L5 (Balmer Series)	Phys. 207/208 Lab Storage	207/208 Lab Manual
Frank-Hertz	Phys. 307 Lab Storage	Physics 307 Lab Room
EC7 (Induction)	Phys. 207/208 Lab Storage	207/208 Lab Manual
Photoelectric Effect	Phys. 307 Lab Storage	Physics 307 Lab Room
E8, E9 (AC Circuits)	Phys. 207/208 Lab Storage	207/208 Lab Manual