

Syllabus, OPTICS & MODERN PHYSICS, SPRING, 2009

Catalog Description: This is a continuation of the calculus based physics sequence covering optics and the two twin pillars of modern physics: relativity and quantum theory, including simple kinematic and dynamic investigations in special relativity, the twin paradox, a derivation of $E = mc^2$, the historical developments of quantum theory, the Schrödinger equation and the solution to the hydrogen atom. Other topics may include curved space-time, black holes, gravitational waves, elementary particles, topics in solid state, nuclear or molecular physics.

Faculty: Dr. Phillip Broussard, Ph.D., Assoc. Prof. of Physics

Textbooks: *Physics, for Scientists and Engineers* by Paul M. Fishbane, Stephen Gasiorowicz and Stephen T. Thornton, 3rd ed, *Modern Physics* by Paul A. Tipler and Ralph A. Llewellyn 4th ed., and *A Brief History of Time* by Stephen Hawking, 10th ed.

I. Course Objectives

Upon completion of the course, the student will be expected to be able to

- A. demonstrate knowledge of Maxwell's equations and the plane wave solution.
- B. demonstrate the ability to solve problems in geometric optics having to do with reflection, refraction and lenses.
- C. demonstrate the ability to solve problems in physical optics having to do with topics such as interference, diffraction, dispersion.
- D. demonstrate a knowledge of the history of the development of relativity theory and quantum theory and the contrast of these theories to nineteenth century physics.
- E. demonstrate the ability to work problems in special relativity theory.
- F. demonstrate the ability to work problems in introductory quantum theory.
- G. articulate a Christian perspective to developments in modern physics

II. Methods

- A. **Classroom:** The course will be taught using various methods. Often an interactive method will be used, whereby lecture-discussions and video clips are followed by thought questions and student discussion. Other times, historical developments or derivations will be presented with opportunity for discussion throughout. Three 50 minute periods per week.
- B. **Laboratory:** Ten Laboratory experiments will be performed over the course of the semester, each in a three hour period, typically with 2 students working together. Each student will be responsible for his or her own writeup.

III. Means of Assessment

- A. Two two-hour tests (40%). This addresses objectives A-E.
- B. Homework (10%). This addresses objectives A-D.
- C. Labs (25%). This addresses objective A-D.
- D. Final (20%). This addresses objectives F.
- E. Response Paper (5%). This addresses objectives G.

Information and Policy Sheet
OPTICS & MODERN PHYSICS, PHY233

Location: Mills Hall 310, Lab in Mills 310

Time: MWF, 3:00-3:45 PM, Lab: Thursday, 1:00-3:45 PM

Readings: The list of readings below are meant as a guide for what will take place in class. The daily readings are indicated by the title of the sections in the textbook. If no reading is assigned for a particular day, that day has been set aside for continuing on the previous topic. **You should have read each assigned reading before the date it is listed below.** Otherwise you may find it difficult to understand what is done in class.

Grading: The final grade for the course will be based on tests, homework, labs, response paper to Hawking and the final exam, with percentages listed in the Syllabus.

Tests: During the semester, two tests will be given, as well as a final exam. The first test will cover optics, and the second will cover the first half of modern physics. These tests will be given in a multiple choice format and consist of 30 questions. The final exam will serve both as the test over the remaining material covered and a comprehensive exam. It will be in a different format from the first two tests.

Homework: Homework in optics and modern physics will be assigned from time to time, and it should be looked upon as an opportunity to learn. Thus feel free to work together or solicit whatever outside help you need, in order to understand the problems. Homework will be graded, and the answers provided.

Labs: During the course of the semester 10 or more laboratory experiments will be performed. For each lab, a separate lab report will be required. The lab report will consist of reporting the results of following instructions handed out for performing the lab in a manner that is understandable without the aid of prior knowledge of the lab. Lab reports will be due on the day of the next lab session (not counting test days), and should be turned in no later than 5:00 PM on that day. A perfect score for a lab report is 10 points. Reports will still be accepted the day after they are due, but a penalty of one point will be deducted from the grade. *No lab reports will be accepted more than four weekdays late.* If a lab is performed but a report not handed in, 3 points will be awarded for that lab. *No labs may be made up without prior notification of the instructor that a lab will be missed.* Further information concerning labs can be found in the handout for writing lab reports made available in previous semesters. You will typically work in pairs when performing laboratory experiments and calculations, but each person is responsible for his or her own lab write-up. The lab report is expected to be written in \TeX , according to the instructions on the physics website, using the labreport class. Instructions for downloading and installing your own copy are on the website along with appropriate class files.

Response Paper: You will be reading Stephen Hawking's book *A Brief History of Time*. Hawking is a famous physicist who has written extensively on the beginnings of the universe and implications of theories. I want you to read his book and then write a four page paper on the book, with two pages summarizing the physics topics Hawking is interested in, and the remaining part of the paper discussing the philosophical or theological perspective Hawking expresses and the relation of his perspective to his physics interests. Please use 12 pt font! The due date for the paper is listed on the syllabus.

Attendance: Although class attendance is not required as a formal part of the grade, experience shows that there is a very strong correlation between class attendance and grades. In particular, class presentations for the present course may deviate from the book substantially from time to time, and the students are still responsible for the material covered in class. Therefore you would be advised not to miss class unless absolutely necessary.

Office Hours: MWF 10-11 AM and MW 2-3 PM. Also by appointment.

Physics Web Site: The physics web site is <http://huss.covenant.edu/academics/departments/physics/home>. You will find a link to the course web page there, which will have a link to this syllabus and other information related to the course.

 Schedule

Wednesday	Jan. 14	Introduction to the Course and From Maxwell's equations to the Wave Equation: EM waves (Read: FGT Sections 34-1 to 34-2)
Thursday	Jan. 15	Lab Reports and Laboratory Techniques
Friday	Jan. 16	Energy and Momentum in EM waves (Read: FGT Sections 34-3)
Monday	Jan. 19	Dipole Radiation and Polarization (Read: FGT Sections 34-4 – 34-5)
Wednesday	Jan. 21	Light, Reflection and Refraction <u>Maxwell HW due!</u> (Read: FGT Sections 35-1 –35.4)
Thursday	Jan. 22	LAB 1: Reflection and Refraction
Friday	Jan. 23	Dispersion (Read: FGT Sections 35-5)
Monday	Jan. 26	Planar and Spherical Mirrors (Read: FGT Sections 36-1– 36-2)
Wednesday	Jan. 28	Lenses (Read: FGT Sections 36-3–36-4)
Thursday	Jan. 29	LAB 2: Dispersion, Light and Color
Friday	Jan. 30	Optical Instruments (Read: FGT Section 36-5)
Monday	Feb. 2	Interference (Read: FGT Sections 37-1 –37-2)
Wednesday	Feb. 4	Interference via Reflection (Read: FGT Section 37-3)
Thursday	Feb. 5	LAB 3: Thin Lenses and Mirrors
Friday	Feb. 6	Interferometers (Read: FGT Sections 37-4)
Monday	Feb. 9	Diffraction (Read: Sections 38-1 –38-2)
Wednesday	Feb. 11	Diffraction II (Read: FGT Sections 38-3 –38-4)
Thursday	Feb. 12	LAB 4: Aberration and Optical Instruments
Friday	Feb. 13	Diffraction III (Read: FGT Section 38-5 – 38-6)
Monday	Feb. 16	Relativity: Historical Introduction (Read: TL Sections 1-1 – 1-2)
Wednesday	Feb. 18	Lorentz Transformation (Read: TL Sections 1-3 – 1-4)
Thursday	Feb. 19	LAB 5: Interference and Diffraction
Friday	Feb. 20	Doppler Effect and Paradoxes (Read: TL Sections 1-5 – 1-6)

Monday	Feb. 23	Relativity, Momentum and Energy (Read: TL Sections 2-1 – 2-2)
Wednesday	Feb. 25	Invariants in Relativity (Read: TL Sections 2-3 – 2-4)
Thursday	Feb. 26	First Test: Optics
Friday	Feb. 27	General Relativity (Read: TL Section 2-5) Hwk Due, Chap. 1: 2,5,12,15,23,29,33,43,45
Monday	Mar. 2	Beginnings of Modern Physics (Read: TL Sections 3-1 – 3-2)
Wednesday	Mar. 4	Blackbody Radiation
Thursday	Mar. 5	LAB 6
Friday	Mar. 6	Photoelectric Effect and Compton Effect (Read: TL Sections 3-3 – 3-4) Hwk Due, Chap. 2: 5,11,17,20,24,29
	Mar. 7-15	SPRING BREAK
Monday	Mar. 16	Atomic Spectra and Rutherford's atom <u>Hawking paper DUE!!!</u> (Read: Sections 4-1 – 4-2)
Wednesday	Mar. 18	Bohr's model and Mosely's vindication (Read: Sections 4-3 – 4-4)
Thursday	Mar. 19	LAB 7
Friday	Mar. 20	More on Chapter 4 Hwk Due, Chap. 3: 3,8,18,27,36,44
Monday	Mar. 23	De Broglie Relations (Read: TL Sections 5-1 – 5-2)
Wednesday	Mar. 25	The Uncertainty Relation (Read: TL Sections 5-3 – 5-5) Hwk Due, Chap. 4: 5,6,14,23
Thursday	Mar. 26	LAB 8
Friday	Mar. 27	Applications of the Uncertainty Relation (Read: TL Sections 5-6 – 5-7)
Monday	Mar. 30	Motivation for Schrödinger's equation (Read: TL Section 6-1)
Wednesday	Apr. 1	Particle in a box (Read: TL Section 6-2) Hwk Due, Chap. 5: 5,8,20,21,30,32,35
Thursday	Apr. 2	Second Test: Relativity and Modern Physics
Friday	Apr. 3	Finite well and Expectation Operators (Read: TL Sections 6-3 – 6-4)

Monday	Apr. 6	Harmonic Oscillator (Read: TL Section 6-5)
Wednesday	Apr. 8	Barriers and Continuity (Read: TL Section 6-6)
Thursday	Apr. 9	LAB 9
Friday	Apr. 10	<i>GOOD FRIDAY-No Class</i>
Monday	Apr. 13	<i>EASTER BREAK-No Class</i>
Wednesday	Apr. 15	3D Schrödinger's equation (Read: TL Section 7-1)
Thursday	Apr. 16	LAB 10
Friday	Apr. 17	Angular Momentum (Read: TL Section 7-2)
Monday	Apr. 20	More Angular momentum Hwk Due, Chap. 6: 3,5,12,13,25,36,38
Wednesday	Apr. 22	Radial part of the Hydrogen atom (Read: TL Section 7-3)
Thursday	Apr. 23	LAB 11: Diode Lab
Friday	Apr. 24	Electron spin (Read: TL Section 7-4)
Monday	Apr. 27	Review for Final Hwk Due, Chap. 7: 3,7,8,10,13,20,23
Wednesday	Apr. 29	Reading/Snow Day
Thursday	Apr. 30	Reading/Snow Day
Tuesday	May 5	Final Exam: 10:30 AM-12:30 PM