PHYS 360: Modern Physics
Fall 2018

Course Syllabus

Lectures:	10:20-11:55 TTh Mainiero 60	Labs:	2:00-5:20 pm Thursday Mainiero 60
Instructor:	Dr. David Chappell	email:	dchappell@laverne.edu
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Phone:	909-448-4598		
Office Hours:	MTW 1:30-3:30 or by appointment		

Course Description

This course follows the development of two revolutions in physics that took place at the beginning of the 20th Century: relativity and quantum mechanics. We will survey the experiments whose surprising results shook the foundation of classical, Newtonian Physics and forced physicists to adopt counter-intuitive views of the nature of space, time, matter and energy.

Overview

Relativity was developed almost entirely by Albert Einstein. The Special Theory of Relativity, published in 1905, states that space and time (and matter and energy) are interconnected and may be transformed into one another. The effects of Special Relativity are largest when speeds approach the speed of light and subtle effects can be measured for even for more modest motions. General Relativity extends Special Relativity to accelerating reference frames and provides a theoretical explanation of gravity.

Quantum Mechanics was developed by dozens of physicists over several decades to explain the behavior of matter and energy on an atomic scale. It is the most successful and far-reaching theory of all of physics, and has been estimated to drive approximately 1/3 of the U.S. economy. Applications of quantum mechanics include lasers, semiconductors, solar cells, the atomic bomb, atomic energy, medical imaging, superconductors and particle physics.

Quantum Mechanics was extended to include Special Relativity by Paul Dirac (and as a result lead to the discovery of anti-matter). The most promising attempt to unite General Relativity with Quantum Mechanics is String Theory, however, much work remains to be done.

You will study many of the theories and experiments covered in this class in more detail in classes such as Quantum Mechanics, Thermal Physics, Solid State Physics and Astrophysics.

Prerequisites:

PHYS 203, PHYS 204, MATH 202

Required Text:

K.S. Krane, *Modern Physics*, (John Wiley & Sons, 2012), 3rd ed.

Supplemental Texts:

H.T. Milhorn, *The History of Physics,* (Virtual Book Worm, College Station, TX, 2008).

P.A. Tipler and R.A. Llewellyn, *Modern Physics,* (W.H. Freeman and Company, New York, 2012), 5th ed.

Evaluation

Your course grade will be based on the following:

homework, quizzes and participation	20%
labs	15%
3 exams (15% each)	45%
final exam (cumulative)	20%

Letter grades will be assigned as follows:

A	90-100
B	80-89
C	65-79
D	55-64

Quizzes

A 5-minute quiz will be given at the beginning of most classes. The quiz will cover the assigned readings for that day. It is very important that you read the book and lecture notes before coming to class. No makeup quizzes will be given, but the lowest *two* quiz scores will be dropped.

Participation

A large part of this class will involve the discussion of new ideas in physics that arose during the 20th century. Students are expected to read the assigned readings before coming to class and participate in the class discussions.

Homework

Homework will be assigned each class period. Assignments are due at the beginning of class. You are expected to write your solutions neatly and in an organized fashion that conveys your reasoning and provides a complete picture of how you arrived at your results. Homework problems that are illegible or excessively disorganized will be given zero credit. You are encouraged to work with your classmates on homework assignments, but you are expected to write up you final solutions on your own. Homework will be graded and returned the next class session. If you are not satisfied with your grade, you may rework your solutions using the feedback provided and resubmit your work to be regraded. You may repeat this process as many times as you like up until the next exam.

Exams

Exams will be conducted in-class and will cover all the material in the course including lectures, assigned readings in the textbook, homework, and labs.

Famous Physicists

This course follows the historical development of modern physics. We will get to know a number of famous physicists whose names are now associated with pivotal experiments and theories. Understanding the context of these revolutionary ideas and discoveries will be of the utmost importance. *Why* were the results of a particular experiment so unexpected and confusing at the time? *What* did classical physics predict should happen? *How* did these experiments lead to a new theoretical understanding of our universe?

Labs

You will conduct six labs throughout the semester. During lab you will record your data and calculations in a bound lab book. Lab reports will be prepared electronically and have a standardized format similar to the labs you did in PHYS 203 and 204. Lab reports are due two weeks after the date when the lab is assigned. Lab reports turned in after the due date will be marked down 5% for each day they are late. As in a professional research report, the discussion and interpretation of results is of the utmost importance, as is the careful presentation of data.

Modern Physics in the News

I encourage you to keep your eyes and ears alert for news articles related to modern physics. The following websites have weekly news articles related to research in the high tech world, quantum physics, particle physics, astrophysics, etc.

> http://physicsworld.com/
> http://www.rdmag.com/

"If you aren't confused by quantum mechanics, you haven't really understood it." — *Neils Bohr.*

"The physicist's greatest tool is his wastebasket." — *Albert Einstein*

“Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution. It is, strictly speaking, a real factor in scientific research.”

— *Albert Einstein*

I hope you enjoy this class!

Class Schedule (Subject to Change)

Week of	Lectures	Labs
Aug 28	Overview Chapter 2: Relativity	
Sept 4	Chapter 2: Relativity	Lab 1: Cosmic Ray Muons (part 1)
Sept 11	Chapter 2: Relativity	Lab 1: Cosmic Ray Muons (part 2) Field trip to Mt. Baldy
Sept 18	Chapter 2: Relativity **Test 1**	
Sept 25	Evidence of subatomic structure: electrons and radioactivity	Lab 2: Millikan Oil Drop Experiment
Oct 2	Chapter 3: Particle-like properties of light	
Sep 9	Chapter 4: Wave-like properties of particles	Lab 3: Photoelectric Effect
Oct 16	Chapter 6: Rutherford-Bohr Model of the Atom	
Oct 23	**Test 2** Chapter 5: The Schrödinger Equation	Lab 4: Double Slit Experiment
Oct 30	Chapter 5: The Schrödinger Equation	
Nov 6	Chapter 5: The Schrödinger Equation	Lab 5: Computer Lab (part 1) – Wave Functions
Nov 13	Chapter 7: The Wave Model of the Atom	Lab 5: Computer Lab (part 2) – Hydrogen Wave Functions
Nov 20	**Test 3** **Thanksgiving (Nov. 22)**	
Nov 27	Chapter 14: Elementary Particles	Lab 6: Cloud Chamber
Dec 4	Chapter 15: Cosmology and the Fate of the Universe	
Dec 11	**Final Exam - 12:45 - 3:25 pm**	

A current and more detailed version of the schedule complete with homework assignments and readings may be found at www.david-chappell.com/phys360