

Course Title: PHY 261 Introduction to Modern Physics
Course Instructor: Rob Salgado (3-5982, salgado@suhep)
Office Hours: Wednesday (after class)

Texts: (suggested) Sandin, T.R. Essentials of Modern Physics
(optional) Geroch, R.P. General Relativity From A to B
(optional) Polkinghorne, J.C. The Quantum World
(on reserve) Taylor, E.F. / Wheeler, J.A. Spacetime Physics
(on reserve) Feynman, R.P. Lectures on Physics
(on reserve) Feynman, R.P. QED: The Strange Theory of Light and Matter
(on reserve) French, A.P. / Taylor, E.F. An Introduction to Quantum Physics
(on reserve) French, A.P. Special Relativity
(on reserve) Mermin, N.D. Space and Time in Special Relativity

Purpose:

This course is meant to introduce some of the major themes in physics developed during the last century. Certainly, we cannot expect to do justice to the some of the topics that will be discussed. We will concentrate on RELATIVITY and QUANTUM PHYSICS.

Format:

Daily Lectures. Lecture notes will be available.
Weekly written and reading assignments.

Grades based on

- (30%) weekly homework assignments
([except for the first assignment] assigned on Thursday, due on following Thursday, corrected-and-returned on the following Monday).
- (20%) weekly quizzes (on Thursdays; a slightly-modified problem straight from the homework, open-homework quiz)
- (20%) midterm exam (take-home, open-book/notes/homework)
- (30%) final exam (open-book/notes/homework)

Prerequisites:

I will assume that you have had introductory courses in mechanics and in electromagnetism. In addition, I assume basic mathematical skills

in algebra, trigonometry, and calculus. We will develop some of the mathematics to be used during our course of study. In particular, we will deal with vector spaces (linear algebra).

Philosophy:

Why not follow the (standard) historical presentation?

The historical perspective is confusing.

Confusion arises when we apply Newtonian concepts. Although such concepts are apparently intuitive and logically consistent, they prove to be wrong when applied to the real world. We should overcome such prejudices. [Einstein quote]

Relativity and Quantum Physics should not be made to conform to Newtonian concepts. Instead, one should start from primitive concepts.

Why study mathematics?

Believe it or not, mathematics can simplify a physical discussion. It is a useful tool that helps us actually focus on the true physics as opposed to one's intuition (which may prove to be faulty). Relativity and Quantum Mechanics lie outside one's direct physical intuition.

Mathematics is a bridge that helps us overcome this gap.

Mathematics clarifies the physics, illuminates structure.

Mathematics is the crank that generates predictions which can be compared with experiment.

The effectiveness of mathematics is quite unreasonable [Wigner quote]... but it should be used as a tool for physics so long as it works.

"It will seem difficult at first,
but everything is difficult at first."

Musashi

"It is extreme madness to learn
what then must be unlearned."

Erasmus

"The laws of nature are written in the mathematical language."

Galileo Galilei

"The Unreasonable Effectiveness of Mathematics in the Natural Sciences."

Eugene Wigner

Introduction to Modern Physics
PHY 261: Summer Session I, 1993

Approximate Syllabus

RELATIVITY (May 24-Jun 3)

- Mon, May 24 Homework Assigned (due on Jun 1)
Historical SR
Inertial Observers, Principle of Relativity,
Maxwell Equations
Events and Spacetime, Aristotelian Spacetime, Spacetime Diagrams
- Tue, May 25 Galilean Spacetime-
Invariance
Minkowski Spacetime-the interval (radar measurements), the light-cone
- Wed, May 26 Quiz--Getting-to-know-you-again
(MATH)
Minkowski Spacetime- 4-vectors, dot-products, the metric
projections (time-dilation, length-contraction,
doppler effect, addition of velocities, twin-paradox)
- Thu, May 27 (no class, Rob's away)
- Mon, May 31 (no class, Memorial Day - IF YOU NEED HELP, COME TO MY OFFICE)
- Tue, Jun 1 Homework due
Quiz
(APPLICATIONS)
Minkowski Spacetime- time-dilation, length-contraction,
doppler effect, addition of velocities,
twin-paradox
- momentum and mass-energy, $E=mc^2$, photons $E=pc$
relativistic collision/decay problems
- Wed, Jun 2 (continued)
- Thu, Jun 3 (continued)
Take-Home Midterm distributed (due on Mon, Jun 7)

QUANTUM MECHANICS (Jun 7-Jun 23)

- Mon, Jun 7 Midterm due
Homework assigned (due on Jun 14)
Historical QM - Old QM (Planck Radiation, Bohr Atom)
- Tue, Jun 8 The Two-Slit Experiment, Diffraction/Interference,
Probability Interpretation

Wed, Jun 9 Wave-Particle Duality, deBroglie hypothesis, Uncertainty Principle
Thu, Jun 10 The Schrodinger Equation, the Infinite Square-Well
Principle of Superposition, Vector Spaces II, Linear Operators

Mon, Jun 14 Homework assigned (due on Jun 21)
The Finite Square-Well and relatives. Alpha-decay. Electric wires.

Tue, Jun 15 The Harmonic Oscillator.

Wed, Jun 16 The Hydrogen Atom.

Thu, Jun 17

Mon, Jun 21

Tue, Jun 22

Wed, Jun 23

Thu, Jun 24 In-Class Final.

Homework assigned on May 24, due Jun 1. Quiz Jun 1

Homework assigned on Jun 7, due Jun 14. Quiz Jun 14

Homework assigned on Jun 14, due Jun 21 Quiz Jun 21

Take Home Mid-term: Jun 3-Jun 7

In class Final: Jun 24