PHY 209

Space and Time in Elementary Physics

Syracuse University Summer Session II 1994

Meetings: M-Th 2:00-3:45 pm, 233 Physics Bldg.

**Instructor: Rob Salgado (253 Physics Bldg, 443-3884,
salgado@suhep.phy.syr.edu)**

**Office hours: drop by any time (I usually stay until 2am)
or make an appointment
or catch me logged-on at night (as rbsalgad@rodan or rbsalgad@gamera)
or send me email (salgado@suhep is easy to remember,
and it is the best way to reach me)**

**Prerequisites: High-school Algebra, Trigonometry, and Geometry.
Corequisites: Precalculus (MAT 194).**

**Motivation: Galileo once said "The book of Nature is written in
the mathematical language."**

Physics is not math, and math is not physics. It is important to distinguish between the two. Mathematics is but a very useful tool that helps us describe the physics. When one comes upon a physical situation, one first appeals to one's physical intuition, then uses mathematics to formulate the situation (i.e., to write down a set of equations) and then to calculate (i.e., to solve the equations to obtain a set of numbers). Hoping that one has actually described the physical situation, one appeals again to one's intuition to interpret the results.

Objective: This course is intended to prepare you for the (PHY 211/212) General Physics sequence by helping you develop both your physical intuition and your mathematical intuition.

Method: This is not a lecture course. This is a "hands-on" project-oriented course which will introduce you to some of the basic concepts of physics and to some of the mathematical tools that are useful in studying them.

In the General Physics sequence, one usually follows "the history of physics" trail to introduce the various physical concepts. A basic knowledge of mathematics is usually assumed, and more advanced mathematical techniques are introduced as needed.

Here, we will follow "the history of mathematics" trail to introduce the various physical concepts. The goal is to highlight the connections between mathematics and its application in physics by re-introducing the mathematical concepts with physical models. Hopefully, this will enhance your mathematical intuition with physical analogies, which in turn will enhance your physical intuition with mathematical analogies.

Materials: There is no textbook for this course. On a daily basis, I will distribute a handout which contains the lesson for the day and the assignment due on the next day.

(More details are below.) I will provide materials that are not readily available.

At times, you will be expected to perform some calculations. You may find the need to use a calculator.

Homework: **The assignment will usually be a combination of reading the lesson, performing some task (possibly in the classroom, or in the quad, or at home), explaining what you've learned, and then applying it to a new situation. You are encouraged to work together on the tasks and discuss the write-ups, but it should not deteriorate into one student doing all of the work for another.**

The assignment is due by the start of the next class, when we will be discussing the assignment. This discussion is an essential part of the course. Thus, latecomers will be penalized by one point off their score and no-shows will receive no credit for the assignment. Late assignments will not be accepted.

Grades: Your grade is determined by the quality of the daily assignments you submit.

Each assignment is graded on a 4-point scale: 4 for "mastery of the topic", 3 for "a very good effort", 2 for "a good effort", 1 for "a fair effort", and 0 for "zero effort".

Each assignment also contains a challenging question worth 1 bonus point for a correct answer.

There are approximately 25 class days. So, approximately 100 points will earn a perfect score. There is no final exam. This class is not graded on a curve.

A=90+. B=80+. C=70+. D=60+. F<60.

Schedule Note:

Unfortunately, I will be out of town during WEEK 4 (July 25-28) to attend a physics conference at Stanford. Prof. Eric Schiff (who first taught this course) will substitute for me that week.

Topics to be covered: (very rough outline)

WEEK 1

Euclidean and non-Euclidean geometry

What is pi? How do we know the earth is not flat?

Euclidean geometry: lengths, areas, volumes, angles

Basic measurements. Basic units of the metric system.

Cartesian geometry and graphing functions

Basic graphing of simple functions and taking data from physical situations.

Introduction to kinematics: linear motion. Galilean gravity.

WEEK 2

Equation Solving

Algebraic and geometric interpretations. Colliding trains.

The Triangle

Exploiting scaling symmetry (proportions). How tall is that building?
How big is the moon? The Pythagorean Theorem.
Introduction to geometrical optics (the law of reflection).

Trigonometry and the Circular functions

What does sine, cosine, and tangent mean? More geometrical optics (the law of refraction). Introduction to more kinematics: rotational and oscillatory motion.

WEEK 3

The Vector

What is a vector? Basic algebraic operations and geometrical interpretations.
Introduction to the Newton Laws of Motion.
How does a balance work? How far will this water balloon travel?
Introduction to vector fields. Basic electricity and magnetism.

WEEK 4

More vectors: Statics and Stable Configurations

Center of Mass. Free-body diagrams. The Arch.
Large Numbers, Scientific Notation, and Significant Figures
The Powers of Ten (video).
Introducing some constants of nature (e.g. speed of light, Avogadro number).
The Exponential function
What is e? Growth and decay. How far does a basketball bounce back up?

WEEK 5

Differential Calculus

What is differential calculus about? Linear and projectile motion revisited.
Introduction to energy. Newtonian Gravity.
Making approximations (intuitive introduction to series expansions).

Integral Calculus

What is integral calculus about? Linear and projectile motion re-revisited.

WEEK 6

Solving more-challenging problems we can now tackle

How far is the horizon? How far does the moon fall each second?
Why is there no air on the moon?
The Harmonic Oscillator revisted (the Pendulum).
etc....