SC528 - Concepts in Physics IV: Waves, Sound, and Geometrical Optics
January – April 2005

Description: For teachers, mastery of concepts including harmonic motion, mechanical waves including sound waves, and geometrical optics. Discussion will include applications such as shock absorbers, musical instruments, rainbows, and corrective lenses. These concepts will also be discussed in a historical and philosophical context to build pedagogical content knowledge, and there will be additional discussion of pedagogy rooted in science education research.

Times: Tuesday 4:30 – 7:30 p.m., Friday 4:30 – 7:30 p.m.

Dates: 13 sessions between January 25th – April 5th (see the attached schedule).

Location: Metcalf Center for Science, 590 Comm. Ave., room 134, 136, or B-25

Instructors:

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Grading Scheme (subject to change):
Homework 10%
Quizzes 7.5%
Midterm test 20%
Final Exam 22.5 %
Portfolio 40%

- Lab Book (10%)
- Presentation (15%)
- History/Philosophy/Physics Education Research Literature analysis (15%)

Lab Book: This should contain class notes, results and analyses of the hands-on activities done in class, and notes you take on the presentations from the other members of the class. Including work you do on homework problems is fine but not necessary.

Presentation : We will use the Active Physics Challenge from Communications, Chapter 1, which is for each group to present a sound-and-light show that builds in many aspects of the physics concepts we discuss in the course. Grading will follow the Active Physics rubric.

Literature Analysis: During the course everyone will be assigned to read the same set of readings and journal articles covering various aspects of history, philosophy, and physics education research. Your individual paper is expected to refer to one or more of these readings, and should also include an analysis of how the readings connect both to this course as well as to activities that you do in your own classroom.

Books and Materials:

1. Knight, Randall (2003). *Physics: A Strategic Approach.* Addison-Wesley.

2. Readings in science education research literature.

3. Readings in history of science.

Course web site: http://physics.bu.edu/~duffy/SC528_Notes.html
(The web site will be accessible once the course starts)

Objectives and Goals

The goal of this course is to support the development of a mastery of fundamental physics with deep pedagogical content knowledge by teachers of physics. The immediate objectives are:

1. Provide a review and instruction in harmonic motion, waves and sound, and geometrical optics.

2. Assist teachers in developing their creativity in the development of laboratory activities to support inquiry-based learning in physics as described in the National Science Education Standards.

3. Offer teachers a historical and philosophical context for the topics covered so as to help them develop the analogies, metaphors, and direct examples that, in part, constitute the basis for a teacher's pedagogical content knowledge.

4. Prepare the teachers for the next course in this sequence.

5. Continue preparing the teachers to take the Massachusetts Teachers Educational Licensure examination in physics.

Curriculum

There will thirteen class sessions, each 3 hours in length. The typical session will be a mix of laboratory experiments, many drawn from the Active Physics curriculum, discussion centered around concepts; a problem-solving session; and either a discussion of the history and philosophy of science, or a discussion of the science education research literature and its bearing on the teaching of physics.

Code for Mastering Physics On-Line Homework System

When you register for the Mastering Physics homework system, at http://www.masteringphysics.com, you will be asked for a course code. Please enter the following code:

MPDUFFY0005

SC528 Course Schedule

Tues. Jan 25 Session 1: Harmonic Motion.
Sections from Knight: 14.1, 14.2, 14.6
Laboratory experiment: "Harmonic motion"
Science Education Literature: Common misconceptions about SHM.
History and Philosophy: Galileo and the pendulum

Fri. Feb. 4 Session 2: Springs; A Pendulum.
Sections from Knight: 10.4, 10.5, 14.3-14.5, 14.7
Demonstrations: Various pendula, Hooke's Law spring; the connection between SHM and circular motion.
Mathematics and Problem-Solving: Applying energy conservation to SHM situations.

Fri. Feb. 11 Session 3: Waves on Strings.
Sections from Knight: 20.1-20.2; 21.1 – 21.3
Active Physics: Communication Chapter 1, Activity 2
Applications: String instruments.
Demonstrations: Standing Waves on a String.
Mathematics and Problem-Solving: Superposition.
History and Philosophy of Science

Tues. Feb. 15 Session 4: Transverse and Longitudinal Waves
Sections from Knight: 20.3-20.4
Active Physics: Communication Chapter 1, Activity 1
Demonstrations: Waves on a long spring.
Mathematics and Problem-Solving: Using the wave equation.
Applications: The recent tsunami.
History and Philosophy of Science

Tues. Mar. 1 Session 5: Waves in Air Columns.
Sections from Knight: 21.4
Active Physics: Communication Chapter 1, Activity 3
Demonstrations: Various instruments.
Applications: Wind instruments.
Science Education Literature

Fri. Mar. 4 Session 6: Making sound electronically.
Active Physics: Communication Chap. 1, Activity 4; Medicine Chap. 1, Activity 5
Laboratory experiment: "Sound"
Science Education Literature

Tues. Mar. 8 Session 7: Midterm test; Ultrasound.
Sections from Knight: 20.5, 20.7
Active Physics: Medicine Chapter 3, various activities
Applications: The Doppler effect, medical imaging
Science Education Literature

Fri. Mar. 11 Session 8: Reflection of light; Spherical mirrors and ray diagrams.
Sections from Knight: 23.1-23.2
Active Physics: Communications, Activities 5 and 6
Computer-Based Activities: Virtual optical bench.
Mathematics and Problem-Solving: Using the mirror equation.
Science Education Literature: Student difficulties with ray diagrams

Tues. Mar. 15 Session 9: Refraction and total internal reflection.
Sections from Knight: 23.3
Active Physics: Communications, Activity 7
Computer-Based Activities: Virtual optical bench.
Applications: Fiber optics
Science Education Literature: Student conceptions of refraction.

Tues. Mar. 22 Session 10: Lenses and ray diagrams.
Sections from Knight: 23.4, 23.6-23.7
Active Physics: Communications, Activity 8
Demonstrations: Various lenses.
Computer-Based Activities: Virtual optical bench.
Applications: A magnifying glass.
Science Education Literature: Student difficulties with ray diagrams

Tues. Mar. 29 Session 11: The human eye and the camera.
Sections from Knight: 23.4, 23.6-23.7
Active Physics: Medicine, Chapter 2, various activities
Student Project Presentations
Computer-Based Activities: Virtual optical bench.
Applications: Corrective lenses.
History and Philosophy: The development of the camera.

Fri. Apr. 1 Session 12: Light, color, and shadows.
Sections from Knight: 23.5
Active Physics: Communications, Activity 9
Applications: Rods and cones in the human eye.

Tues. Apr. 5 Session 13: Final Examination.