Physics 5J Syllabus, Winter 2009

The course will consist of weekly lectures, short problem sets (one or two problems per week), and a term project (either a programming project or term paper) of your choice, on a topic of your choice, to be approved by me. I will provide a list of suggestions. The homework should take an hour or less per week; you should expect to spend about three hours per week on the term project in weeks 2-8 of the quarter. The last two classes of the quarter will be spent on student Powerpoint-style presentations of their term projects.

Lecture: Thursday 2:00pm - 3:30pm

Instructor: David Smith, 321 Nat. Sci. II, 9-2183, dsmith@scipp.ucsc.edu

Smith office hours: Tuesday 2-3, Wednesday 10:30-11:30 and by appointment

Textbook: Readings will be distributed weekly. For an advanced treatment of wave topics, see *The Physics of Waves* by Howard Georgi, available free at: http://www.people.fas.harvard.edu/~hgeorgi/new.htm

This syllabus is tentative. I will see what topics work well as we go along:

Wk.	***Date***	***Topics***	***Notes***
1	Jan 8	Lagrangian and Eulerian treatment of fluid flow; Euler's equation; continuity; viscosity, turbulence, Reynolds number	----------
2	Jan 15	Complex number formalism for oscillators; coupled oscillators; chaos	HW 1 due
3	Jan 22	Waves in a solid; dispersion; phase and group velocity	HW 2 due
4	Jan 29	Wakes, shocks, solitons, water waves, tsunamis	HW 3 due
5	Feb 5	Fourier analysis; overtones and tone quality; musical instruments	HW 4 due
6	Feb 12	Fermat's Principle, aberration, real telescopes, thick lenses, Cerenkov radiation	HW 5 due
7	Feb 19	Interferometry, x-ray crystallography, holography	HW 6 due
8	Feb 26	Phase contrast microscopy, Fourier imaging (radio telescopes)	HW 7 due
9	March 5	Student presentations I	----------
10	March 12	Student presentations II	Term project due

Grading:

Term project: 40%	Problem sets: 25%
Term project presentation: 20%	Attendance and participation: 15%

Some suggested topics for **term programming projects:**

Numerical simulation of disturbances in a 3D crystal lattice

Numerical simulation of coupled pendula (e.g. apparatus on wall outside physics office)

Numerical simulation of the spread of a density enhancement in an accretion disk

Numerical simulation of a tsunami wave

Overtone content related to tone quality and identification of instruments (would require synthesizer hardware)

Program to generate diffraction pattern numerically from 2D cutout shape

Some suggested topics for **term papers:**

Development and techniques of x-ray diffraction in biology (protein structure)

Issues related to camera lenses (aberrations and techniques for compensating)

Telescope types / advantages and disadvantages / current and planned telescopes

Survey of waves in plasmas (requires a **lot** of reading ahead in electromagnetism)

Gravitational waves