COURSE ANNOUNCEMENT

PHYSICS 598 CPA

TOPICS IN COMPUTATIONAL PHYSICS AND ASTROPHYSICS

FALL Semester 2010
Call Number: PHYS 42392
Credit: 1 Unit (4 Hours)

Time: MW 1:00 – 2:20 P.M.
Room: 144 Loomis Lab

Professor Stuart L. Shapiro

A numerical laboratory course designed to familiarize students with the use of a computer to solve diverse problems in physics. Problems will be drawn from several different branches of physics and astrophysics. Hydrodynamics, including the physics of shock waves, will be emphasized as the main paradigm for nonlinear phenomena. For the hydrodynamics, the necessary analytic results will be derived in class. Examples drawn from classical mechanics, electromagnetism, quantum mechanics, etc., will already be familiar to students from standard physics courses. Some of the physical systems and equations, together with the numerical methods used to treat them, are listed below.

Students will work on assigned numerical exercises and simulations both individually and in small teams. The results of these simulations will be presented in class periodically and will constitute an integral part of the class development. The emphasis throughout the semester will be on building confidence and expertise at solving physical problems on the computer.

Prerequisites:
No formal requirements other than a working knowledge of some scientific programming language like FORTRAN, C or C++. Graduate students and upper level undergraduates with solid backgrounds in basic physics are welcome. This course should only be taken by students who plan to participate actively, but may be taken on a "credit-noncredit" (i.e. pass-fail) basis.

NUMERICAL METHODS (partial listing)	PHYSICAL SYSTEMS AND EQUATIONS (partial listing)
Roots of transcendental equations	Hydrodynamic equations and shock waves
Integration	Diffusion and heat conduction equations
Ordinary differential equations	Wave and advective equations
Eigenvalue problems	Maxwell's equations
Linear equations and matrices	Schrödinger equation
Partial differential equations (elliptic, parabolic and hyperbolic systems)	Fokker-Planck equation
Finite-difference techniques for PDEs	Collisionless Boltzmann equation
Random number generation	2-D Ising model
Monte Carlo integration and simulation methods	Coupled pendula and dynamical chaos
Spectral methods	
Fast Fourier Transforms	