AST 5760: Computational Astrophysics
ISC 5415: Computational Space Physics

This course offers introduction to numerical methods in the context of observational and theoretical astrophysics. The course covers interpolation, approximation, minimization and optimization, solution of linear systems of equations, random number generation, function integration, numerical differentiation, numerical integration of ordinary differential equations, stiff systems of ODEs, survey of methods for partial differential equations (Poisson equation, heat diffusion, hydrodynamics).

Credit: 3 semester hours

Prerequisites: Introduction to Astrophysics (AST 4211), or PHZ 4151C, or CGS 3406, or permission of the instructor

Lectures: MWF 11:15am-12:05pm, 415 DSL

Instructor: Dr. Tomasz Plewa
Office: 415 Dirac Science Library
Phone: (850) 644-1959
E-mail: tplewa@fsu.edu

Office hours: Tuesdays and Thursday, time by appointment, 415 DSL


Course Objectives:

At the end of the course, the student will:

- be familiar with methods and techniques used in numerical computations in astrophysics,

- be able to develop, implement, and use numerical methods in application to problems in theoretical astrophysics;

- analyze and interpret the results of numerical simulations including limitations imposed by observational and numerical discretization errors;

- present the results of computer simulations in form suitable for presentation in literature.
Course Topics:

- Elements of modern science: observations, theory, computations
- The role of scientific computing
- Review of computer models in science and engineering
- Computer code development, programming techniques, code maintenance
- Concepts of verification, validation, sensitivity analysis, and uncertainty quantification
- Elements of numerical analysis: stability, consistency, convergence
- Discretization including adaptive discretization
- Interpolation and smoothing, optimization
- Numerical integration, ordinary differential equations
- Partial differential equations (Poisson, diffusion, Euler and Navier-Stokes equations)
- Monte Carlo, multigrid, matrix-free iterative methods, multipole methods
- Stellar structure calculations

Grading: The course grade will be based on class 2-3 mini-quizzes and 2-3 computational projects. The scale for the grades will be A (90-100%), A- (87-89%), B+ (83-86%), B (77-82%), B- (73-76%), C+ (69-72%), C (63-68%), C- (59-62%), D+ (55-58%), D (50-54%), and F (<50%).

Academic Honor Policy

The Florida State University Academic Honor Policy outlines the University’s expectations for the integrity of students’ academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to “...be honest and truthful and ...[to] strive for personal and institutional integrity at Florida State University.” (Florida State University Academic Honor Policy, found at http://dof.fsu.edu/honorpolicy.htm.)

ADA Statement
Students with disabilities needing academic accommodation should:
(1) register with and provide documentation to the Student Disability Resource Center; and
(2) bring a letter to the instructor indicating the need for accommodation and what type. This should be done during the first week of class.