

ISC 5935 - Selected Topics in Scientific Computing
Scientific Computing for Fluids
Spring 2016

Instructor:	John Burkardt email: jburkardt@fsu.edu office: 445 DSL
Website:	www.sc.fsu.edu/~jburkardt/classes/cfd_2016/cdf_2016.html
Time and Room:	TBA
Text:)	<i>Finite Difference Methods for Ordinary and Partial Differential Equations</i> , Randall LeVeque.

Course Description: This class introduces the mathematical theory, numerical methods, and computational tools used to model fluid flow. The class will concentrate exclusively on *finite difference methods*.

These methods provide a simple introduction to the approximation of partial differential equations (PDE's), and are relatively easy to program. While most researchers use more advanced methods, finite difference methods will enable us to consider many important ideas, such as consistency, stability, and convergence.

A series of increasingly complex equations will be considered: first in 1D, linear convection, nonlinear convection, diffusion, and the Burgers equation. Thereafter, the 2D Laplace, Poisson, and Navier-Stokes equations will be studied. The final student project will involve modeling 2D fluid flow in a cavity, and in a channel, under the Navier-Stokes equations.

Theoretical topics to be presented include the CFL condition, the Lax equivalence theorem, and von Neumann stability analysis.

This class will rely heavily on an online course developed by Lorena Barba at Boston University, "ME702 Computational Fluid Dynamics". Students will be expected to view the corresponding YouTube videos, available at <https://www.youtube.com/playlist?list=PL30F4C5ABCE62CB61>.

Professor Barba also prepared a set of iPython notebooks, in which students are expected to demonstrate their knowledge by implementing algorithms for the various equations being studied. The notebooks do not assume prior knowledge of Python. They are available at: <http://lorenabarba.com/blog/cfd-python-12-steps-to-navier-stokes/>.

Advanced students may participate in parallel by presenting an independent study plan focussing on an area of scientific computing and fluids, on approval of the instructor.

Assignments for the class will include the completion of the programs studied in the iPython notebooks, as well as several homework assignments on the theoretical material.

Course Objectives: Students completing the course will be able to:

- discretize partial differential equations;
- implement in Python a solution scheme for a discretized PDE;
- determine the order of accuracy of a solution scheme;
- determine the stability of a solution scheme;
- determine space and timestep constraints for a solution scheme;

Grading: The course grade will be based upon:

- completion of the iPython programming assignments (75%)
- homework (25%)

University Attendance Policy: Excused absences include documented illness, deaths in the family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. These absences will be accommodated in a way that does not arbitrarily penalize students who have a valid excuse. Consideration will also be given to students whose dependent children experience serious illness.

Academic Honor Policy: The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of student's 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://academichonor.fsu.edu/policy/policy.html>.)

Americans with Disabilities Act Students with disabilities needing academic accommodation should:

- register with and provide documentation to the Student Disability Resource Center; and
- bring a letter to the instructor indicating the need for accommodation and what type. This should be done during the first week of class.

This syllabus and other class materials are available in alternative format upon request. For more information about services available to FSU students with disabilities, contact the Student Disability Resource Center, sdrc@admin.fsu.edu, web page: <http://www.disabilitycenter.fsu.edu/>.

Syllabus Change Policy Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advance notice.