ISC 5227: Survey of Numerical Partial Differential Equations

This course provides students with high-performance computational tools necessary to investigate important problems requiring numerical solutions of PDEs arising in basic science and engineering, with an emphasis on combining them to study real world problems. A combination of course work and practical computation lab assignments provides the proper blend of theory and practice with problems culled from the applied sciences.

Credit

4 semester hours

Prerequisites

ISC 5305: Scientific Programming, or the permission of the instructor.

Prerequisites for this course include programming skills in Fortran 77/ Fortran 90, C, or C++ as well as basic knowledge in calculus, linear algebra, and numerical methods for solving linear and nonlinear systems of algebraic equations. If you do not meet these requirements, please obtain consent of instructor.

Course Objectives

At the end of the course, the student will be able to

- to develop, analyze, and efficiently implement the three numerical methods for partial differential equations;
- to understand the advantages and limitations of each method for various types of problems;
- carry out solutions of partial differential equations in multidimensions computationally,
- visualize and analyze simulation results.

Course Topics

Topics include discretization, mesh generation and adaptation, stability including CFL and TVD conditions, operator splitting, coupling between PDEs and ODEs, and solution accuracy and convergence, finite difference methods, finite volume methods, spectral methods.

Contact Information

Instructor: Tomasz Plewa
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Office phone: 850.644.1959
E-mail: tplewa@fsu.edu
Office hours: by appointment.

Teaching Assistant: Brian Bartoldson
E-mail: bb11t@my.fsu.edu
Office hours: by appointment.

Homework Submission

Each homework assignment or project must be submitted as a single pdf document via email to TA (bb11t@my.fsu.edu) with a copy to the Instructor (tplewa@fsu.edu).

Grading

The course grade will be based on class tests (3 in total, 40%), computer laboratory homework assignments (50%), and ad hoc essays (10%). Because the laboratory and homework effort is substantial, no mid-term or final exams will be given.

Late homework submissions will be subject of 10% points reduction per day, with maximum of 50% points reduction. Homework submissions will be accepted through the last day of classes.

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%).

Textbooks

Required: E. Ward Cheney, David R. Kincaid, *Numerical Mathematics and Computing* (Cengage Learning), 2012, 7th edition, ISBN-10: 1133103715, ISBN-13: 978-1133103714

Choice: Michael T. Heath, *Scientific Computing: An Introductory Survey* (The McGraw-Hill Companies, Inc.), 2002, 2nd edition, ISBN-10: 0072399104, ISBN-13: 978-0072399103

Choice: R. J. Barlow, Statistics: A Guide to the Use of Statistical Methods in the Physical Sciences (Wiley), 1993, ISBN-10: 0471922951, ISBN-13: 978-0471922957

Website

https://canvas.fsu.edu/courses/118505

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 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.)

Americans with Disabilities Act

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.

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
874 Traditions Way 108
Student Services Building
Florida State University
Tallahassee, FL 32306-4167
(850) 644-9566 (voice) (850) 644-8504 (TDD)
sdrc@admin.fsu.edu
http://www.disabilitycenter.fsu.edu/

Free Tutoring from FSU

For tutoring and writing help in any course at Florida State University, visit the Academic Center for Excellence (ACE) Tutoring Services' comprehensive list of tutoring

options - see http://ace.fsu.edu/tutoring or contact tutor@fsu.edu for more information. High-quality tutoring is available by appointment and on a walk-in basis. These services are offered by tutors trained to encourage the highest level of individual academic success while upholding personal academic integrity.

List of Topics

1. Scalar advection equation (1/8—1/31; T1)
Finite difference method; reconstruction-evolution algorithm; Courant-Friedrichs-Lewy condition; solution error, error norms and convergence; numerical flux; finite volume method.

2. Advection-diffusion (2/5--2/28; T2)
A one-dimensional finite volume solver for a coupled system of hyperbolic and parabolic PDEs; stability restrictions due to diffusion; nonlinear diffusion.

3. Advection-diffusion-reaction (3/5—3/28)
Flows driven by local source terms; time-resolved reactive flows; cooling due to radiative losses.

4. Multidimensional problems (4/2—4/25; T3)
Strang splitting and directional splitting; iterative solvers for elliptic and nonlinear diffusion PDEs.