Numerical Solution of Differential Equations

General Information

Lecture: MWF 1:00PM – 1:50PM, Jan 10 – Apr 26, 2013, Science Center 340.
Lecturer: Guangming Yao, gyao@clarkson.edu, SC363, 315-268-6496.
Office hour: MWF 2:00PM–3:00PM, or any time my door is open.
Course link: `http://people.clarkson.edu/~gyao/ma571_spring2013.html`.
Textbook: A First Course in the Numerical Analysis of Differential Equations, Arieh Iserles.
Recommended Books:
Finite Difference Methods for Ordinary and Partial Differential Equations, Randall J. LeVeque.
Numerical Solution of PDEs in Science and Engineering, Leon Lapidus and George F. Pinder.
Supporting software: Use of MATLAB or suitable substitute software will be required.

Objective This is a course on scientific computing for ODE/PDEs. It includes the construction, analysis and application of numerical methods for ODEs/PDEs. Objects of this course are:

1. to motivate the need for efficient numerical methods for solving differential equations
2. to understand basic finite difference methods for partial differential equations
3. to analyze consistency, stability, and convergence of the methods
4. to implement numerical methods on the computer to solve partial differential equations

Outcomes At the end of the course the students will be able to:

1. make a good choice of methods for a particular ODE problem
2. construct appropriate finite-difference approximations to PDEs
3. show that a finite difference method is consistent
4. find the order of accuracy of a finite difference method
5. examine the stability of a method
6. write programs in high level script languages to solve ODEs/PDEs by finite difference methods
7. verify experimentally the convergence and accuracy of numerical methods

Topics The course is designed to provide a background in numerical solution of differential equations, especially using finite difference methods (FDM). Areas of emphasis include($*$ indicates "if time permits"):

1. Euler methods for ODEs
2. Multistep methods for ODEs
3. FDM for Poisson equation
4. FDM for diffusion equation
5. FDM for hyperbolic equation
6. Multigrid technique*
7. Finite element method*
8. Spectral method*

The material and problems are framed so as to require a background in CU MA 377 Numerical Methods. Approximately two weeks are spent on each topic.

Assessment Your grade will be computed as follows:
40% 4 projects
20% midterm (approximately on Feb 27)
30% final
10% small homework/class assignments

Letter grades will be determined on the following scale:

A(90–100), B+(85-89), B(80–84), C+(75–79), C(70–74), D+(65–69), D(60–64), F(0–59).

Academic Integrity

From the student handbook: *"The Clarkson student will not present, as his or her own, the work of another, or any work that has not been honestly performed, will not take any examination by improper means, and will not aid and abet another in any dishonesty"* Any student violating this regulation will receive a failing grade.

Academic Accommodations

If you require any kind of special accommodation please see your professor. Students must register with the Office of Accommodative Services, located in the Student Success Center, 110 ERC, to verify their eligibility for appropriate accommodations.

Makeup Policy

The right to miss a scheduled exam and take a make up exam can be awarded only by your professor, and will be awarded rarely and only for a serious cause. If for some reason you must miss an exam, you must apply in writing **before** the exam. If you are unable to attend the exam due to an emergency that day you must contact the professor as soon as possible and provide documentation to confirm why you cannot take part in the exam. An unexcused absence will result in a grade of zero on the exam.

Projects

Projects must be typed (in LaTeX, Microsoft Word is OK). All computer code(including comments) **should be** included at the end of the report. The projects are to be thoroughly and neatly organized including a title, a description of the problem and the approach taken to obtain a solution, a brief overview of the numerical method used (what that method does, what kinds of problems it is suitable for, what are its strengths and weaknesses, and how it works), all numerical results presented, and finally, a conclusion that summarizes your findings and explains whether or not your answer makes sense.

You are encouraged to discuss projects with each other, but each student must hand in his or her own project, unless otherwise stated.

Late projects (and homework assignments) lose 10% each day.