James Madison University
Department of Mathematics and Statistics
Math 449 – Numerical Analysis for Differential Equations
Fall 2013

MWF 12:20-11:00-1:10, Burruss 030

Overview: Study and analysis of numerical techniques to solve ordinary and partial differential equations, including Euler, Runge-Kutta, Picard, finite-difference and finite-element methods. Programming using a high-level language and/or software packages. Prerequisite: MATH 237, MATH 238 and MATH 248.

Instructor: Dr. Stephen Lucas.
To contact me: In Person: Roop 112, Office Hours: M 8:30-9:00, 11:15-12:05, Tu 2:30-3:30, W 8:30-9:00, F 8:30-9:00, 11:15-12:05 or by appointment.
Phone: 568-5104, Email: lucassk@jmu.edu

Textbook: Richard L. Burden & J. Douglas Faires, Numerical Analysis, 9th edition, 2011 Thomson Brooks/Cole.

Computing: We will be using Matlab as a programming environment, which can be purchased at the bookstore, or online (student edition) at http://www.mathworks.com/academia/student_version/. Matlab is also available in Burruss 30 & 130, Roop 103, and Miller G080. A flash drive for storing your files is highly recommended. There are a large number of Matlab resources on the web, including the online textbook by Matlab's author, at http://www.mathworks.com/moler/index_ncm.html

Attendance: While I will not be formally taking attendance, it is one of the most important aspects of any mathematics course. In fact, there is a strong correlation between attendance and success. I will **not** accept any late work (i.e. exam, programming assignments, homeworks, etc.) without an exceptionally good excuse. If you miss an exam without first being excused, you will not be allowed to make it up. While my sympathy is directly proportional to your response speed, I do not guarantee sympathy. You or a family member should contact me as soon as possible if you have an extended illness or other extenuating circumstance.

Course grading (approximate): Homework (weekly): 30%, Programming Assignments: 25%, Midterm Exam: 15%, Final: 30%. The final is timetabled for Friday December 13, 10:30-12:30.

- Your weighted average (as a percentage) determines your grade for the course on a scale that will be roughly A=85-100, B=65-84, C=50-64, D=40-49.
- Homework will be assigned weekly, and will be due the following week.
- There will be programming assignments on each topic that are larger scale than the weekly homework. These will be quite challenging and will take **most** students a large block of time to complete properly. It is important to start as soon as possible, and only spend the few days before the due date writing up. Specific instructions will be on the assignments.
- The midterm exam will cover material from the proceeding sections; the final exam will be cumulative. You should expect exams will be more theoretical, while assignments will be more practical.
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Getting Help: While working in groups is encouraged (one of the best ways of learning something is explaining it to someone else), I encourage you to ask a lot of questions, in lectures, by email or by phone. Office hours are an under-utilized resource that is there for you.

Disability and Special Circumstances: I strongly encourage students who require special arrangements to contact me during the first week of class. Students with disabilities need to register with the Office of Disability Services (ODS). Any discussion of special circumstances will remain confidential except for any necessary communication with ODS in case of a disability.

Academic Integrity: Academic integrity is extremely important. Therefore, we will strictly abide by the honor code found at http://www.jmu.edu/honor/printcode.html. Any breach of the honor code results in failure in this course. I encourage working in groups but not copying in groups. Functionally or logically identical programs are considered violations of the honor code to be prosecuted rigorously. If you have any questions about what does or does not fit under the umbrella of academic integrity, please contact me.

Rough Proposed Schedule

1. **Initial Value ode's**: Theory, Euler, Taylor Methods.
2. Runge-Kutta, Multistep Methods.
3. Higher Order and Systems of ode's, Stability.
4. Stiff ode's, Adaptive Runge-Kutta.
5. **Boundary Value ode's**: Theory, Linear Shooting Method.
6. Nonlinear Shooting, Finite Difference.
7. Rayleigh Ritz, Weighted Residuals. **Partial Differential Equations**: Theory.
8. Elliptic, Parabolic (a).
9. Parabolic (b), Hyperbolic, Extensions.
10. **Power Series Method**: Theory
11. Implementation, Examples, Stiffness.
12. **Integral Equations**: Theory, Fredholm, Volterra
13. Element Methods, Nystrom method

MATH/CS 449. Numerical Analysis for Differential Equations.

Goals of the Course

1. To develop an understanding of the logical structure and style of mathematics by
   a) Using reason in an orderly, cogent fashion.
   b) Writing clear, well organized solutions to problems.
   c) Evaluating critically and using mathematical definitions.
   d) Constructing proofs of mathematical theorems using direct and indirect arguments.
   e) Evaluating critically the quality of a mathematical proof by considering such things as completeness, assumptions, precision, and flaws.

2. To develop and ability to use mathematical tools to solve problems and to transfer this knowledge to analogous situations by:
   a) Understanding and applying properties of a continuous probability distribution using its density function.

3. To develop computation skills such as
   a) Constructing an algorithm to perform a specific task.
   b) Writing a computer program in a high-level computer language.
   c) Using matrices to solve systems of linear equations.