MATH 522 Spring 2017 Syllabus,
Apr. 3 Edition*

Prof. Zachariah Etienne

Class meets MWF 10:30PM–11:20PM, ARM 203

Instructor Contact Information

- zbetienne *<at>* mix.wvu.edu
- Office hours:
    - Armstrong Hall 409C
    - Monday and Friday 1:00–2:00PM, or by appointment

Course Website

- http://math.wvu.edu/~zetienne/

Course Preqrequisites

- Good computer programming skills
- Strong background in undergraduate mathematics (this is a *graduate-level Math class*, after all). The below list *is not comprehensive*, but indicative of the types of topics with which you will need to be familiar:
    - Scientific notation/significant figures
    - Basic algebra: Solving Nonlinear Equations and Inequalities
    - Calculus I: Differentiation (chain rule, maxima/minima)
    - Calculus II: Integration (by parts & variable substitution, Taylor Series)
    - Linear Algebra: Basic matrix algebra; computing determinants; properties of determinants; eigenvalues/eigenvectors.
    - Ordinary Differential Equations (ODEs): Series solutions to ODEs, Fourier series
    - Partial Differential Equations (PDEs): Solving PDEs using the Method of Separation of Variables.
- Ability to
    - Read and understand technical writing. You will be expected to study the notes for this class and apply this knowledge to solve homework problems. Homework problems are not obvious extensions to the notes or taken from any textbook; instead they are inspired by real-world problems and build upon material in the notes.
    - Express yourself in a clear, unambiguous way.

Text

- The lecture notes are designed to be self-contained, so there is no required textbook. However, one textbook is recommended:

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*Note that this syllabus is subject to revision, at the option of the instructor. If revised, the new syllabus will not become official until the instructor has distributed it to students over email.

– **"Numerical Recipes: The Art of Scientific Computing"**, by Press, Teukolsky, Vetterling, and Flannery. Any edition except the first should be fine. **Note that Numerical Recipes Second Edition is available for free online at** `http://numerical.recipes` .

Course Objective

- Partial differential equations (PDEs) are used to describe the dynamics of a wide variety of phenomena in many scientific and engineering contexts, though are often difficult or impossible to solve by hand. Motivated by such a wide variety of applications, this course will provide necessary training for analyzing PDEs and solving them *on the computer*, with particular focus on finite difference solutions to hyperbolic, parabolic, and ellipic PDEs. Stability and trustworthiness of the numerical solution will be a central focus, through careful error analysis.

Tentative Course Outline

- Estimating the physical scale of the PDE's solution
- Classification of PDEs
- Finite difference approximations to derivatives, and its relation to interpolation; higher-order approximations.
- Truncation error and convergence
- Finite-precision mathematics on the computer: roundoff error
- Hyperbolic equations; explicit schemes; solving the wave equation
- Stability and Consistency; Lax equivalence theorem
- Parabolic equations; solving the heat equation; exact solutions via Fourier series
- Implicit schemes; algorithms for solving matrices on the computer
- Elliptic equations; solving the Poisson equation

Attendance

- Doing well in this class depends critically on your daily attendance. **Therefore it is expected that you will attend every lecture and arrive on time.**

Grading

Grading will be based on the total number of points earned by a student. The points will be divided as follows:

- Homework Assignments (See **Homework Policy** below): 40%
- Midterm Exams (Fri, Feb 17 and Fri, Mar 17, normal class time/location): 35%
- Comprehensive Final Exam (Thurs, May 4, 2:00PM–4:00PM, normal class location; see the Registrar's website for updates to this time: `http://registrar.wvu.edu/current_students/finals`): 25%

Grading Scale

- A- to A+: 90—100%
- B- to B+: 80—89%
- C- to C+: 70—79%
- D- to D+: 60—69%
- F: Below 60%

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Homework Policy

There will be a total of eight homework assignments given in this class, consisting of four coding assignments and four non-coding assignments. The homework policy is as follows:

- **Coding Assignment** homeworks will consist of two documents handed in separately:
  - The first document will contain handwritten or typewritten answers to each problem (with plots) <u>in order</u> (no Appendices).
  - The second document consists of a printout of all source codes written to answer each problem, again <u>in order</u>. Homeworks without source code *will not be accepted*.
- In **Coding Assignments**, plots will often be requested. All plots must have axes and all data series labeled accurately, or no credit may be given.
- In **Non-Coding Assignment** homeworks, the use of calculators or any electronic computational aides is forbidden, unless the homework problem states otherwise. When computational aides are forbidden, **all work must be shown, or points will be deducted.** Non-coding assignments must be handwritten.
- Bonus credit will be given for professional presentation, as follows:
  - If all problems are handed in <u>in order</u> for a given homework assignment, 2 "In-Order Bonus" points will be awarded toward that homework. (No Appendices allowed.)
  - If each homework assignment document (2 documents for coding assignments and 1 document for non-coding assignments) is properly bound using a single staple, 1 "Staple Bonus" point will be awarded toward that homework.
- The objective of this class is individual proficiency in the subject matter. To this end, **students may not collaborate on homework assignments**; all assignments must be completed ndividually. After completing the assignment, you may compare your solutions with those of other students or against a computer algebra system (e.g., Mathematica or Maple). **However, written solutions or source code listings that are substantially the same will receive zero credit for all students involved.**
- Full solutions will be due at the start of class on the due date; handing in parts of the assignment at different times is forbidden. Students are strongly encouraged to start early, or bugs may prevent them from handing in homeworks on time, and *the standard homework late penalty will be imposed*.
- Turning in homeworks on time is essential for doing well in this class, as homeworks are scheduled according to the lecture material. Late assignments will be penalized as follows:
  - Up to 48 hours late: 20% score reduction
  - 48–96 hours late: 50% score reduction
  - More than 96 hours late: 75% score reduction

Academic Dishonesty

The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, I will enforce rigorous standards of academic integrity in all aspects and assignments of this course. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the Campus Student Code. This Code may be found linked from the Office of Student Conduct web page: `http://campuslife.wvu.edu/office_of_student_conduct`. Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see me [the instructor] before the assignment is due to discuss the matter.

Inclusivity Statement & Accommodations

"The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me [the instructor] and make appropriate arrangements with the Office of Accessibility Services (304-293-6700). For more information on West Virginia University's Diversity, Equity, and Inclusion initiatives, please see `http://diversity.wvu.edu`."

Students requesting special accommodations are required to inform the instructor at least 48 hours in advance of a test.

Electronic Device Policy

During lectures and exams, **cellular phones** and other electronic devices (including but not limited to **calculators**, tablet computers, laptops, PDAs, MP3 players, Blackberrys) are not permitted, except with the consent of the instructor. All forbidden devices must be turned off before the beginning of the class period and placed out of sight (for example, in a backpack or handbag) until the class has concluded.

A student's first violation of this policy **during lectures** will result in a verbal warning (one verbal warning per semester), and each subsequent violation *even during the same lecture* will result in a 1% deduction in the student's overall course grade. Violations of this policy **during exams** will result in a zero grade on the exam and possible expulsion from the course.

Intellectual Property Notice

All course materials, including lectures, class notes, quizzes, exams, handouts, presentations, and other materials provided to students for this course are protected intellectual property. As such, the unauthorized purchase or sale of these materials may result in disciplinary sanctions under the Campus Student Code.