# CAAM 336

# DIFFERENTIAL EQUATIONS IN SCIENCE AND ENGINEERING

Fall 2013 · Rice University

---

| | |
|---|---|
| Lectures: | MWF 1:00-1:50pm, Herzstein 212 |
| Web Site: | http://www.caam.rice.edu/~caam336 |
| Instructor: | Richard Rankin (Richard.A.Rankin@rice.edu), Duncan Hall 2037, (713) 348-5724<br>Office hours: Monday 2-2:50pm, Monday 4:10-5pm, Tuesday 4-6pm.<br>In Duncan Hall 3092 (except the 29th of October when room is to be decided) |
| Teaching Assistant: | Yingpei Wang (Yingpei.Wang@rice.edu), Duncan Hall 2104<br>Office hours: Wednesday 2-4pm in Herman Brown 22 |
| Recitations: | Monday 7-9pm in Sewall 307 (except the 16th and the 23rd of September when room is Baker Hall 116) |

---

**Absence Policy:** Students are strongly encouraged to contribute to our class community by attending and participating in lectures. Failure to turn in a homework or an exam because you were not at the lecture where it was announced that this was due is not an acceptable reason.

**Text:** The content of this course is based on material from:
Mark S. Gockenbach, *Partial Differential Equations: Analytical and Numerical Methods*, 2nd ed., SIAM, Philadelphia, 2011.

**Grade Policy:** Homework accounts for 50% of the final grade and exams account for the remaining 50%. Your five lowest homework question scores will not count towards your final grade.

**Matlab:** Most homework questions will require some MATLAB programming. Any MATLAB codes that you write for the homework must be printed out and attached to the corresponding homework. It is an honor code violation to consult another student's code while writing your own code. It is an honor code violation to consult a transcription of any part of another student's code while writing your own code. It is an honor code violation to turn in codes which have been written by another student. For assistance with the parts of the homework that require you to code in MATLAB, you are encouraged to refer to matlabPrimer.pdf and the MATLAB codes for the demos shown in class, which can be found on the MATLAB page of the class website. You may also consult the MATLAB Documentation.

**Homework:** Homework questions will be posted to the homework section of the class website. You will have at least one week from when they are posted to do them. Mathematically rigorous solutions are expected and you must document your calculations clearly. You may discuss the homework questions with other students in the class but the solutions that you turn in should be written independently. It is an honor code violation to consult another student's solutions while writing your own solutions. It is an honor code violation to consult a transcription of any part of another student's solutions while writing your own solutions. On each homework that you turn in clearly state your name and which homework question it is. All of the pages associated with a particular homework question should be stapled together. However, pages associated with different questions should not be attached to each other, even if you are turning in the questions at the same time. This is to allow each question to be graded by a different grader simultaneously. You may hand your homework to Richard Rankin in class. Alternatively, you can turn your homework in by placing them in Richard Rankin's mailbox, which is located in Duncan Hall 1092. Homework will not be accepted late without what is judged by the instructor to be a good reason. We adhere to Student Health's "No Note" policy. Failure to be honest about why homework is turned in late is an honor code violation. It is an honor code violation to consult solutions to the homework or exams from previous sections of this class.

**Exams:** Two exams will each account for 25% of the final grade. The first of these will be in October. More details will be given nearer the time.

*Any student with a disability requiring accommodation in this course is encouraged to contact the instructor during the first week of class, and also to contact Disability Support Services in the Ley Student Center.*

---

| | |
|---|---|
| Prerequisites: | CAAM 210 (Introduction to Engineering Computation) and MATH 212 (Multivariable Calculus), or permission of the instructor. Less formally: you should be able to write elementary MATLAB programs, and be comfortable with vector calculus and basic vector and matrix operations. |
| Course Objectives: | CAAM 336 students learn to identify partial differential equations and solve canonical cases using both analytical and computational techniques. |
| Course Outcomes: | Upon completing this course, students should be able to:<br>1) explain the concept and computation of a best approximation from a subspace;<br>2) identify linear operators and compute their spectra in basic cases;<br>3) apply these concepts to obtain exact series solutions to differential equations;<br>4) develop finite element approximations to the exact solutions;<br>5) assess the stability requirement for time-dependent approximations;<br>6) create MATLAB programs that compute and visualize series and finite element solutions. |

---

CAAM 336 · Manifesto and Outline

Differential equations form the heart of applied mathematics: they capture an amazing variety of phenomena in fields ranging from physical science and engineering to biology, from financial derivatives to traffic flow. As useful as these equations are, in practice they can be quite difficult to solve: as you read these words, many of the world's fastest computers are busily calculating solutions to such equations. Though the roots of this field reach back to the 18th century, many important, fascinating problems remain for you to tackle. Nearly all disciplines in science and engineering rely fundamentally on differential equations.

This course focuses on the three most famous partial differential equations: the Poisson (diffusion) equation, the heat equation, and the wave equation. There are two main approaches to solving these equations: one that constructs the exact solution as an infinite series (the 'spectral method') and another that uses numerical methods to quickly build approximations to the solution. For historical reasons these two approaches are usually taught in distinct courses—an unfortunate fissure that masks beautiful and deep connections. This course will emphasize these connections. By mastering these ideas you will not only learn elegant techniques for solving classical problems; you will also develop tools to solve the problems you will discover for yourselves as professional scientists and engineers.