Colorado State University

Department of Mathematics
College of Natural Sciences

MATH 530 Mathematics for Scientists and Engineers

Fall 2018

Instructor: Dr. Manuela Girotti; office: Weber 111
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Time: Mon-Tue-Wed-Fri 9:00am-9:50am

Location: Engineering E 104

Office hours: by appointment

Textbook: *Partial Differential Equations. Analytical and Numerical Methods*, by Mark S. Gockenbach, 2nd edition, SIAM 2011.
More material (errata, tutorials and solution manual) can be found at: http://pages.mtu.edu/~msgocken/pdebook2/.

Another good reference book:
Partial Differential Equations. An introduction, by Walter A. Strauss, 2nd edition, Wiley 2007.

Catalog description: proof-oriented linear algebra, ordinary and partial differential equations.

Prerequisites: good knowledge of **Calculus I, II and III** (MATH 160, 161 and 261), **Linear Algebra** (MATH 369) and **(Ordinary) Differential Equations** techniques (MATH 340 or 345).

Homework: you will be required to hand in a certain number of assignments along the semester. Homework will consist of (approximately weekly) problem sets (sometimes involving MATLAB), small projects, and reports.

The assignments will be posted on the Canvas website with due dates (please, check the Canvas calendar often!). No late assignments will be accepted. If you are unable to submit a hard copy assignment, you can also scan it and send it to the instructor by email, no later than the due date and due time. Discussions and work group are highly encouraged, however the final submission has to be personal and show understanding of the material. Grades will be posted on Canvas.

Final exam: the final examination will cover material from the entire course and it will be a take-home project.

Grading scheme: The final grade will be built up from the grades coming from the assignments and the final exam. A detailed breakdown of the grading scheme will be posted in due time.

Academic Integrity: this course will adhere to the CSU Academic Integrity Policy as found on the Students' Responsibilities page of the CSU General Catalog and in the Student Conduct Code (http://tilt.colostate.edu/integrity).

Moreover, bear in mind that the consequences for such misconduct (cheating, etc.) will ultimately fall upon you: this course is a precious opportunity for you to learn something new and valuable. It's an investment on your future. Failing to acquire it will sadly be your loss.

Disabilities: Colorado State University is committed to providing reasonable accommodations for all persons with disabilities. Students with disabilities who need accommodations must first contact Resources for Disabled Students before requesting accommodations for this class (http://www.rds.colostate.edu).

Students who need accommodations in this course must contact the instructor in a timely manner (at least one week before examinations) to discuss needed accommodations.

IMPORTANT: note that there is no "100% final exam" option in this course: the term work contributes substantially to the final grade. Therefore, active participation in classes and continuous work on the course material during the semester is essential for success in this course.

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Tentative (and ambitious) outline of the course

We will cover Chapters 1 through 10 of the textbook (plus Chapter 11, time permitting).

1. Classification of differential equations
2. Models in one dimension
   - 2.1. Heat flow in a bar; Fourier's law
   - 2.2. The hanging bar
   - 2.3. The wave equation for a vibrating string
3. Essential linear algebra
   - 3.1. Linear systems as linear operator equations
   - 3.2. Existence and uniqueness of solutions to $A\vec{x} = \vec{b}$
   - 3.3. Basis and dimension
   - 3.4. Orthogonal bases and projections
   - 3.5. Eigenvalues and eigenvectors of a symmetric matrix
   - 3.6. Preview of methods for solving ODEs and PDEs
4. Essential ordinary differential equations
   - 4.1. Converting a higher-order equation to a first-order system
   - 4.2. Solutions to some simple ODEs
   - 4.3. Linear systems with constant coefficients
   - 4.4. Numerical methods for initial value problems
   - 4.5. Stiff systems of ODEs
   - 4.6. Green's functions
5. Boundary value problems in statics
   - 5.1. The analogy between BVPs and linear algebraic systems
   - 5.2. Introduction to the spectral method; eigenfunctions
   - 5.3. Solving the BVP using Fourier series
   - 5.4. Finite element methods for BVPs
   - 5.5. The Galerkin method
   - 5.6. Piecewise polynomials and the finite element method
   - 5.7. Green's functions for BVPs
6. Heat flow and diffusion
   - 6.1. Fourier series methods for the heat equation
   - 6.2. Pure Neumann conditions and the Fourier cosine series

11.3. Fourier series on a disk
11.4. Finite elements in 2 dimensions
11.5. The free-space Green's function for the Laplacian
11.6. The Green's function for the Laplacian on a bounded domain
11.7. Green's function for the wave equation
11.8. Green's function for the heat equation

A diary of the lectures will be regularly kept on the Canvas calendar with the sections covered in each class. Please, refer to that when preparing for the final exam: that will be the official and ultimate syllabus for the class.

Disclaimer: the instructor reserves the right to make changes to the course outline and course content should this be necessary for academic or other reasons. Every effort will be made to minimize such changes.