MATH 125: Intermediate Differential Equations

Prerequisites: Math 23 and Math 24
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Textbook: no required textbook—instead, lecture notes will be distributed using the UCMCROPS web site.

COURSE GOAL: To provide students with knowledge on how to use a number of different tools to solve ordinary differential equations (ODEs), and to enable students to solve one-dimensional partial differential equations (PDEs).

Learning Outcomes: Confronted with a differential equation (DE), a student who has completed Math 125 should be able to:

1. Recognize the type of equation, including whether it is an ordinary or partial DE and whether it is an initial value or boundary value problem,
2. Choose an effective strategy for solving the equation, using information on the type of equation coupled with knowledge of a breadth of different solution techniques,
3. Carry out the solution strategy, determining either general or particular solutions as appropriate,
4. Check whether their final answers make sense.

Course web site: Please get in the habit of checking both your email and the UCMCROPS web site for this class. Email announcements will alert you to the addition of new material to the web site. The material will include homework assignments, lecture notes, and general announcements regarding office hours and discussion sections.

Expectations: I expect you to attend all lectures and discussion sections, to be in class on time, to show up prepared and able to answer questions, and also to ask questions in class. I expect you to attempt all homework problems shortly after they are assigned (rather than waiting until the night before the due date). Since this is an upper-division course in applied mathematics, I expect you to take more responsibility for your own knowledge and skill level than in lower-division courses. This means that the onus is on you to make use of opportunities to get help outside of class (office hours, email) if you need help. Short, specific email messages to either the instructor or the TA will have a very high probability of being answered quickly.

General Direction: The course is intended to pick up where Math 24 leaves off. We will cover a variety of advanced techniques for dealing with ODEs (including boundary value problems), and then finish with a short introduction to PDEs. Math 126 will pick up where this class leaves off. Our overall goal is that the sequence Math 24-125-126 will give students a very comprehensive background in both ordinary and partial differential equations.

Homework: There will be an assignment handed out on each Friday, due the following Friday. If you can solve most of the homework problems on your own without assistance, then you are in excellent shape. Late policy: without one week prior notice and approval, late homeworks will not be accepted, graded, or noted down for any purpose.

Collaboration Policy: Discussion of homework problems is encouraged. However, when it comes time to write down your actual solutions, you should do this by yourself. To be clear: do not submit any written work unless you are the only author of the work. Identify by name all persons who worked with you or assisted you on the homework. Also identify any books or websites that you used to produce your written work. Do not submit anything that you yourself do not understand in detail. If there are any questions, please ask me.
Testing and Grading: There will be one 50-minute in-class midterm, one take-home midterm, and one three-hour comprehensive final exam. Calculators and other electronic devices will not be allowed during exams. The final grade will be determined by the following weights: $33\frac{1}{3}$% final exam, $13\frac{1}{3}$% for each of the two midterms, and 40% homework.

Tip: Find time to do a little bit of Math 125 every day, or as regularly as you can. Math is learned by doing, i.e., by actually spending your own time to solve problems and understand the solutions. There is no way around this.

Special Accommodations: Student Affairs determines accommodations based on documented disabilities. If you qualify, please submit a letter from Disability Services to the instructor; every effort will be made to accommodate your needs.

We will also make every effort to accommodate students whose religious beliefs/obligations lead to scheduling conflicts with exams, assignments, or attendance. Please speak with the instructor during the first two weeks of class regarding any potential accommodations that may arise due to religious beliefs this semester.

Specific Topics to be Covered:
- Higher-order linear equations
  - General theory
  - Diagonalization and basis of solutions
  - Matrix exponential
  - General variation of parameters formula
- Series solutions
  - Power series expansions, recurrence relations
  - Ordinary singular points
  - Regular singular points
- Boundary value problems and Sturm-Liouville theory
  - Eigenvalues/eigenfunctions
  - Fourier series
  - Orthogonality of eigenfunctions
  - Self-adjointness of a linear differential operator
  - Singular vs. regular Sturm-Liouville problems
  - Eigenfunction expansion
  - Applications
- Transform methods
  - Laplace transform
  - Fourier transform
- Introduction to Partial Differential Equations
  - First-order equations
  - Method of characteristics
  - Transport (linear) and Burgers (nonlinear) equations
  - Heat and wave equations in one spatial dimension
  - Separation of variables and reduction to Sturm-Liouville problem