Syllabus
Math 490–3/710–4: Special Topics in Mathematics — Numerical Solution of Partial Differential Equations
Fall 2009, TuTh 1:00–2:15 pm, MP 103

Instructor: Dr. Minkoff
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Office Hours: Tuesday 12:00 noon – 1 pm or by appointment.

Prerequisite: Math 251, Math 341, Math 404 and knowledge of programming in general and MATLAB in particular. Note that we will be using Matlab exclusively in this course. It is unlikely graduate students would have had these courses at UMBC. However, it is expected that all students taking this course will have been exposed to an introductory pde's course and will have a working knowledge of MATLAB.

Texts — Recommended:
(1) *Finite Difference Schemes and Partial Differential Equations*, by Strikwerda. Publisher: SIAM, 2004.
(2) *Numerical Methods for Differential Equations – Fundamental Concepts for Scientific and Engineering Applications*, by Celia and Gray. Publisher: Prentice Hall, 1992.

Note: There are numerous books which cover either finite difference or finite element methods. However, there is no one perfect book covering both methods at an introductory level. I will be using a variety of books for lecture preparation and expect that you should rely on your class notes as your primary "text" for the course.

Useful MATLAB Reference: *Mastering MATLAB*, by Hanselman and Littlefield. Publisher: Prentice Hall, Inc.

Math 490 Grades:

Homework	40%
Midterm Exam	30%
Final Exam	30%
Total	100%

Math 710 Grades:

Homework	30%
Midterm Exam	25%
Project	15%
Final Exam	30%
Total	100%

Homework: There will be one homework due every 1–2 weeks on Thursdays (the length of time will depend on the difficulty of the assignment). Homework is to be turned in at the START of class on Thursday or can be slipped under my office door *prior* to class on Thursday if you must miss class for some reason. *Late homework will not be accepted.*

Please note that the homework constitutes a substantial portion of your overall grade. In order to learn the concepts and be able to apply them to solving problems on exams, etc., you are strongly encouraged to devote as much time as possible to working the homework problems. I encourage you to discuss the homework assignments with other students in the class. However, I expect the homework you submit for grading to be written up by you alone (this includes computer programs which must not be duplicates of programs other students turn in).

Project: In addition to the weekly homework assignments, students taking the class at the 700 level will be expected to do a project of their own choosing preferably related to their thesis work. Detailed instructions to follow.

Tests: No make-up exams will be given except *possibly* in the case of a serious emergency. In such a case I *must* be notified *in advance*. There will be no exceptions to taking the final exam at the date, time, and place specified by the University (Tuesday 12/22/09 from 1–3 pm in MP 103). The final exam will be comprehensive although material covered after the midterm will be emphasized.

Learning Goals and Course Motivation: This course is intended as an introductory course in numerical solution of partial differential equations. It is designed for senior undergraduates or beginning graduate students who have some experience with partial differential equations (through a separation of variables course or an application area).

Many physical phenomena are modeled by differential equations. The canonical models are the heat, wave, and potential equations. When the coefficients in a pde model are not constant or the domain is complex, these pde's cannot be solved via analytic methods (e.g., by writing down a closed form solution). One must resort to *approximating* the solution on a computer. The approximation error in these solutions arises from a variety of sources (including the fact that one cannot take a limit on a computer and must approximate derivatives and integrals by divided differences and finite sums respectively). In this course we will focus on two main ways of solving pde's numerically: finite difference and finite element methods.

We will learn ways to classify pde's and how to determine if a problem (made up of a pde, boundary, and possibly initial conditions) is well posed. We will learn the basic finite difference method for the wave and heat equations and how to analyze accuracy, stability, and order of convergence for finite difference methods. Next we will describe Galerkin finite elements for elliptic and parabolic pde's including how to analyze convergence of the method. Finally we'll discuss ways to efficiently solve the linear system arising from the finite element method solution (multigrid methods).

After taking this course you will have a basic understanding of how to implement and analyze both the finite difference and finite element methods and will be aware of the error in using these methods to approximate solutions to pde's on a computer. You will know which methods to use to best approximate solutions for each type of equation and will be able to modify your pde solution to achieve the desired accuracy needed for your application.

Academic Conduct:
I take academic dishonesty *very seriously* and will not tolerate it in this class in any form. Academic misconduct includes willfully cheating on or giving aid during an exam or copying homework assignments (computer or paper and pencil). Blatant copying on an exam, homework assignment, or computer assignment will result in a grade of zero for that work.

The university now stipulates that the following be included in all class syllabi:

By enrolling in this course, each student assumes the responsibility of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal.

To read the full Student Academic Conduct Policy, consult the *UMBC Student Handbook*, the *Faculty Handbook*, the *UMBC Integrity webpage* www.umbc.edu/integrity, or the *Graduate School website* www.umbc.edu/gradschool.

Class Attendance: I expect students to attend class and to turn up **on time**. Rarely do students do well in classes which they do not attend, and I will be less likely to give outside assistance to students who regularly miss class. Further, students arriving late for class disrupt the entire class. Students who consistently turn up more than a few minutes late for class or who miss more than 3 classes may be docked points from their final grade.

Email: I am happy to answer questions about the class via email. However, I will not respond to email which does not include the name of the sender. Also, students should be aware that discussions of class concepts and involved homework questions are best asked in person during office hours. I reserve the right not to answer an email question if I feel the topic would best be discussed in person.

Important Dates:

Date	Notes
9/1/09	First day of class
9/15/09	Last day to register and last day to add/drop
10/20/09	Midterm Exam
11/10/09	**Absolute Last day to drop class**
12/14/09	Last day of classes
12/22/09	Final Exam