Math 472
Numerical Methods with Financial Applications

Fall 2008

Course description

This is a survey of the basic numerical methods that are used to solve scientific problems, especially ones arising in actuarial and financial applications.

The emphasis is evenly divided between the analysis of the methods and their practical applications. Some convergence theorems and error bounds are proved. The goals of the course are similar to those of Math 471 but most applications are chosen to be of interest to students in the Actuarial Mathematics and Financial Mathematics programs.

Topics covered are: convergence; root-finding methods; Monte-Carlo simulations; linear systems of equations; interpolation; least squares; parameter optimization; numerical differentiation and integration; numerical methods for ordinary differential equations and partial differential equations; the asset flow differential equations; numerical methods for stochastic differential equations; the Black-Scholes equation; actuarial and financial applications.

Coordinates

- *Time*: T Th 1:10 - 2:30 pm
- *Place*: 130 DENN
- *Instructor*: Ahmet Duran
- *Office*: 2855 East Hall
- *Office hours*: T Th 11:40-1:00 pm
- *Email*: `durana@umich.edu`
- *Phone*: (734) 763-3204
- Course web page: `https://ctools.umich.edu`.

Prerequisites

A four-semester calculus sequence including vector calculus and ordinary differential equations (i.e. Math 216, 256, 286 or 316); one semester of linear algebra (Math 217, 417 or 419); and working knowledge of one high-level computer language. A course in probability (e.g Math 425) is recommended.

Text

T. Sauer: *Numerical Analysis* , ISBN 0-321-26898-9, Pearson Addison-Wesley, 2006. We will cover large parts of Chapters 1-6 and 8-9. Additional course notes on Monte-Carlo simulations, the asset flow differential equations, and the Black-Scholes equation will be provided.

Additional Reference

- Wilmott, Howison and Dewynne: *The Mathematics of Financial Derivatives*

Grading

Your course grade will be determined by the performance on homework (40%), a midterm exam (25%) and a final exam (35%).

Exam dates and policy

Midterm exam	Thu Oct 23 (during class)
Final Exam	Wednesday Dec 17, 1:30-3:30 pm

You will be expected to read each section before it is discussed in class. Exams are closed book. Calculators are not permitted. Our final exam is cumulative. You will be allowed one 3x5" index card with hand-written notes for the midterm exam and two for the final exam. Makeup exams will not be administered.

Homework

There will be approximately ten homework assignments. Your lowest grade will be dropped. In each assignment, a random selection of problems will be graded for correctness and completeness of argument: answers without justification will not earn any credit. You are encouraged to collaborate with other students on homework problems *but* each student must write up his or her assignment independently. I will collect homework at the beginning of class meeting. No late homework will be accepted.

Quizzes

Quizzes will not be administered on a regular basis. However, bonus questions may be given at the beginning of class on a few occasions.

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Schedule (preliminary)

Day	Date	Topic	Book	Assigned	Due
Tu	Sep 2	Convergence	Notes		
Th	Sep 4	Root-finding methods	1.1-1.2	HW1	
Tu	Sep 9	Root-finding methods	1.4-1.5		
Th	Sep 11	Monte-Carlo	Notes		HW1
Tu	Sep 16	Monte-Carlo	9.1-9.2		
Th	Sep 18	Monte-Carlo	Notes	HW2	
Tu	Sep 23	Discrete and continuous Brownian motion	9.3		
Th	Sep 25	Discrete time market models	Notes	HW3	HW2
Tu	Sep 30	Systems of equations	2.1-2.3		
Th	Oct 2	Systems of equations	2.4-2.5	HW4	HW3
Tu	Oct 7	Systems of equations	2.6		
Th	Oct 9	Systems of equations	2.7	HW5	HW4
Tu	Oct 14	Interpolation	3.1-3.2		
Th	Oct 16	Review for midterm			HW5
Tu	Oct 21	*Fall Break*			
Th	Oct 23	**Midterm**			
Tu	Oct 28	Interpolation	3.4		
Th	Oct 30	Least Squares	4.1-4.2	HW6	
Tu	Nov 4	Numerical differentiation	5.1		
Th	Nov 6	Numerical integration	5.2	HW7	HW6
Tu	Nov 11	Numerical integration	5.5		
Th	Nov 13	Ordinary differential equations	6.1, 6.3-6.4		
		Asset flow differential equations	Notes		HW7
Tu	Nov 18	Finite difference methods for partial differential equations	8.1	HW8	
Th	Nov 20	Numerical methods for stochastic differential equations	9.4		
Tu	Nov 25	Option pricing	Notes		
		The Black-Scholes equation	Notes	HW9	HW8
Th	Nov 27	*Thanksgiving*			
Tu	Dec 2	Option pricing by Monte Carlo methods	Notes		
Th	Dec 4	Option pricing by finite difference methods	Notes	HW10	HW9
Tu	Dec 9	Review for Final Exam			
Th	Dec 11	*No class*			HW10
Wed	Dec 17	**Final Exam** 1:30-3:30 pm			