Math 414, Numerical Analysis II
Spring 2008

Credit: 3 hours.

Time and place: Tuesday/Thursday, 12:30pm–1:50pm, Jones 306.

Prerequisites: Math 212 or 213 and CSCI 141. Math 413 is NOT a prerequisite. There is some material from Math 413 (e.g., Taylor's formula with remainder) that you will need to pick up, but we will review this material as needed.

Course web site: http://www.math.wm.edu/ buckaroo/classes/math414.

Instructor

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Office hours

Tuesday, Wednesday, Thursday, 11:00am–12:00n, or by appointment.

Typically if you stop by my office and the door is open I will be happy to talk with you.

My office hours may move around during January and February. The Department of Mathematics is interviewing candidates to fill two positions, and my schedule is consequently uncertain because I will need to meet with candidates and listen to their interview talks.

Course texts

Numerical Analysis, by Timothy Sauer, published by Pearson/Addison Wesley. The text is already in its second edition, but either edition is fine for this course. The differences between the two editions lie in corrections.

Matlab

We will use Matlab in this course as our computing platform. Matlab is a high-level language and interactive system that was developed with numerical computing in mind. The College has a campus site license for Matlab which means you can download a copy to your computer(s). I will give you further details about installing and using Matlab in class.

Course description

This course is the second semester of numerical analysis. Numerical analysis is the branch of mathematics that deals with the computational methods for solving problems. Computational efficiency and accuracy in numerical methods are of particular interest. Tools of mathematical analysis are used to understand numerical methods both in terms of practical limitations of computers and also of inherent mathematical limitations. These limitations mean that computed solutions will not be exact, and numerical analysis is concerned with understanding and quantifying the errors in the solution we compute.

This semester I hope to cover Chapters 7 through 12 of the text. Topics include:

- numerical solution of ordinary differential equations,

- numerical solution of partial differential equations,
- Monte Carlo methods,
- trigonometric interpolation, the Fast Fourier Transform, and signal processing,
- data compression,
- Linear and nonlinear least squares.
- numerical computation of eigenvalues.

Course objectives

This course is intended as a broad introduction to numerical analysis. Here are some of the ideas whose understanding are objectives for the course:

- stability, accuracy, and convergence of numerical methods for differential equations,
- how we compute random quantities, and how randomness can help solve problems,
- trigonometric series representations of functions and time series, without which MP3 players would not exist, as well as much of modern mathematics,
- how we compute eigenvalues in practice.

Additional goals of this course are

- hands-on experience with numerical methods using Matlab, and
- practice writing and presenting clear, coherent expositions of mathematics.

Course calendar

For each class you should read the material indicated and come prepared to discuss it. Unless otherwise noted, the section numbers refer to the course text.

This schedule is provisional. During the semester you should refer to the assignments as posted on the course Web site.

		Thu, Jan 17	No class.
Tue, Jan 22	Prologue, IVPs (§§6.1, 6.2)	Thu, Jan 24	Analysis of IVP solvers (§§6.2, 6.3)
Tue, Jan 29	Runge-Kutta methods (§6.4)	Thu, Jan 31	Adaptive and implicit methods (§§6.5, 6.6)
Tue, Feb 5	Multistep methods (§6.7)	Thu, Feb 7	BVPs, shooting (§7.1, 7.2)
Tue, Feb 12	Finite differences (§7.2)	Thu, Feb 14	Collocation and FEM (§7.3)
Tue, Feb 19	Parabolic PDE (§8.1)	Thu, Feb 21	Hyperbolic PDE (§8.2)
Tue, Feb 26	Elliptic PDE (§8.3)	Thu, Feb 28	Catch-up
Tue, Mar 4	Spring break	Thu, Mar 6	Spring break
Tue, Mar 11	Monte Carlo (§§9.1, 9.2)	Thu, Mar 13	Stochastic DEs (§§9.3, 9.4)
Tue, Mar 18	The Fourier transform (§§10.1, 10.2)	Thu, Mar 20	Trig interpolation (§10.2)
Tue, Mar 25	The FFT (§10.3)	Thu, Mar 27	The FFT (§10.3)
Tue, Apr 1	Compression (§§11.1, 11.2)	Thu, Apr 3	Compression (§§11.3, 11.4)
Tue, Apr 8	The power method (§12.1)	Thu, Apr 10	The QR iteration (§12.2)
Tue, Apr 15	The QR iteration (§12.2)	Thu, Apr 17	The SVD (§12.3)
Tue, Apr 22	The SVD (§12.4)	Thu, Apr 24	Catch-up

Course grading

Your final grade will be computed as follows:

Homework and projects	50%,
Mid-term exam (take-home)	15%,
Final exam (take-home)	35%.

Your final grade for the semester will be determined using the following scale:

A	90%–100%
B	80%–89%
C	70%–79%
D	60%-69%
F	$< 60\%$

I reserve the right to relax these standards but I will not make them more stringent.

Absences

Assignments must be turned in to me at the start of class on the day that they are due. Exceptions will be made only under circumstances such as illness, a debilitating accident, or a death in the family. I also make a blanket exception for those prevented from finishing an assignment due to a military obligation to the armed forces of the United States, including the Coast Guard, whether active-duty, reserve, National Guard, or State Defense Force.

Caveat

The schedule and procedures described here may change as the semester progresses.