MATH 368K: Numerical Methods for Applications

Spring 2013 (Section 56760)

General Information

Instructor: Oscar Gonzalez (og@math.utexas.edu) 471-1138

Office hrs: RLM 10.122, W 3-4, Th 9-10

Lecture: RLM 6.120, MWF 11-12

Required text: Numerical analysis, by Burden and Faires (9th Edition, Brooks/Cole, 2011)

Optional text: An introduction to C++ and numerical methods, by Ortega and Grimshaw (Oxford, 1999)

Course webpage: http://www.ma.utexas.edu/~og/TEACHING/M368K/m368k.html

Description

This course is a continuation of M348. It covers a variety of topics in the theory and application of numerical methods and provides practice in computer programming. The main topics include iterative methods for systems of linear and nonlinear equations, least squares approximation and orthogonal polynomials, approximation of eigenvalues, and finite-difference and finite-element methods for ordinary and partial differential equations. The objective is to prepare students for advanced studies in all areas of computational science and engineering. Emphasis will be placed on concepts and algorithms rather than proofs. Prerequisites: M348 with a grade of at least C-; basic programming skills in C++ or a related language.

Policies

Homeworks: Homework sets will be assigned weekly throughout the semester and will contain a mix of analytical and programming problems. It is acceptable for students to help each other with the homework sets; however, each student must write up and submit their own work. Both commented source code and sample output should be submitted with programming assignments. Computers can be found in the Undergraduate Computer Lab, RLM 7.122.

Programming: Computer programming will be necessary to implement various numerical methods and will be a required part of the course. The official programming language will be C++. Some assignments may also require the use of Matlab, which is an easy-to-use software package available in many computer labs around campus. Various sample programs and links to online resources will be provided at the course webpage.

Exams: There will be two midterm exams and a final exam. The tentative dates are

Exam 1 (Feb 22), Exam 2 (Apr 3), Exam 3 (May 14, 9am-12pm).

Exams 1,2 (midterms) will given in class. Exam 3 (final exam) will be given at the date, time and place scheduled by the University.

Course grade: Your course letter grade will be based on your homework and exam grades. The weights are

Homework average (35%), Exam 1 (20%), Exam 2 (20%), Exam 3 (25%).

In the computation of the homework average, one homework grade (lowest) will be dropped.

Grade scale: Homeworks and exams will be assigned grades based on a 100-point scale. The weighted sum of your homework average and exam grades will determine your course letter grade as follows:

A (100-93),	A- (92-90),	B+ (89-87),	B (86-83),	B- (82-80),	C+ (79-77),	C (76-73),	C- (72-70),
		D+ (69-67),	D (66-63),	D- (62-60),	F (59-0).		

Students with disabilities: The University of Texas at Austin provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 TTY.

Drop dates: The last day to possibly get a refund for the course is January 30, 2013. The last day to possibly drop the course for academic reasons is April 1, 2013. After this date, students may go to the Dean's Office to request a drop for urgent non-academic reasons.

Tentative schedule

The following is a tentative schedule for the core topics of the course. Please be aware that material may be reordered, added or deleted.

1. Iterative methods for linear systems (2 weeks)
   - Jacobi, Gauss-Seidel methods
   - Relaxation, SOR methods
   - Conjugate gradient method
   - Condition number, preconditioning
   - Convergence theorems

2. Least squares and orthogonal polynomials (2 weeks)
   - Discrete, continuous least squares problems
   - Optimality conditions, normal equations
   - Orthogonal polynomial bases, conditioning
   - Legendre, Chebyshev and trigonometric bases
   - Fast Fourier Transform (FFT) algorithm

- Approximation theorems

3. Iterative methods for eigenvalue problems (2 weeks)
   - General, symmetric power methods
   - Inverse power method
   - Wielandt deflation method
   - Householder method
   - Jacobi, QR methods
   - Convergence theorems

4. Iterative methods for nonlinear systems (2 weeks)
   - Fixed-point iteration
   - Newton method
   - Quasi-Newton, Broyden methods
   - Steepest descent method
   - Continuation method
   - Convergence theorems

5. Boundary-value problems for ordinary differential equations (2 weeks)
   - Shooting method
   - Finite-difference method
   - Finite-element method
   - Strong, weak formulations
   - Linear, nonlinear problems
   - Convergence theorems

6. Initial-boundary-value problems for partial differential equations (3 weeks)
   - Elliptic, parabolic, hyperbolic equations
   - Finite-difference method
   - Finite-element method
   - Strong, weak formulations
   - Linear, nonlinear problems
   - Convergence theorems, stability conditions