MATH 132: Numerical Analysis II
Spring 2015

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Lectures: Tuesday/Thursday, 12:00-1:15pm, COB 114
Office Hours: Tuesday/Thursday, 1:15pm-2.15pm, COB 349 (or by appointment)

Discussion-02D: Thursday, 5:30-6:20pm, KL 202
Discussion-03D: Thursday, 6:30-7:20pm, KL 202
Office Hours: Thursday, 2:15pm-4.15pm, COB 396-8

Website: All important course materials will be posted under resources on the ucmcrops course management system. Additionally, you can check my teaching website at: http://faculty.ucmerced.edu/npetra/teaching/math132s15.html.

Course Description: This is the second part of the undergraduate Numerical Analysis course. In this course we will cover approximation theory (e.g., least squares approximations, Fast Fourier Transforms), eigenvalue problems, numerical solutions of nonlinear systems of equations, boundary value problems for ordinary differential equations, and numerical solutions to partial differential equations. To gain practical experience with the numerical methods discussed in class we will use MATLAB, a high-level language and development tool that allows you to quickly develop and analyze algorithms.

Prerequisites: Intermediate Differential Equations (Math 125), Numerical Analysis I (Math 131), or instructor approval

Learning Objectives: Numerical analysis is the area of mathematics that creates, analyzes, and implements algorithms for solving *numerically* the problems of continuous mathematics. Such problems originate generally from real-world applications such as climate, seismology, geodynamics, subsurface flow, etc. It is concerned with approximations (of problems with simpler problems, of a function by a series with finitely many terms, of a derivative by a finite difference, etc.), construction of algorithms, iteration methods, error analysis, stability, etc. The goal of this course is therefore to enable students to design and analyze numerical techniques to approximate solutions to problems for which finding a closed-form (analytic) solution is not possible.

Learning Outcomes: By the end of this course, you should:

1. understand the key ideas, concepts, definitions, and theorems of the subject (e.g., computational algorithms, sources of error, convergence theorems, etc.);
2. be able to choose the best numerical method to apply to solve a given problem and quantify the error in the numerical (approximate) solution;
3. have experience using a professional software package (e.g., MATLAB) and be able to implement, test and validate codes to solve a given problem numerically;
4. have the ability to interpret and discuss the results of computational simulations.

Course Materials:

- **Textbook:** Richard L. Burden and J. Douglas Faires, *Numerical Analysis*, Brooks/Cole, 9th edition (2011)
- If you are looking for an introduction to MATLAB, a good reference is the book by Desmond J. Higham and Nicholas J. Higham: *MATLAB Guide*, SIAM, 2nd edition (2005). Also, I recommend the "Introduction to MATLAB" MITOpenCourseWare.

Grading Policy:

Homework and Quizzes	Midterm Exam	Final Exam	Participation
30%	30%	30%	10%

- The *homework* is weighted as much as an exam, because this is an essential part of learning the ideas discussed in the course. The assignments include computational problems which are designed to help you gain experience with the methods discussed. When reporting on these problems, please follow the handout on "How to report on computational problems". While I encourage discussions and work in groups, you must be the sole author of all work turned in, including computer programs. You must also properly cite any outside sources you used. Late homework will not be accepted.
- The *quizzes* will generally be unannounced and brief. For instance, they may be designed to initiate class discussion or to give me feedback on your learning.
- The *midterm and final exams* are traditional in-class exams. See the detailed schedule for the dates of the exams. *There will be no make-up exams or early exams!* If you are sick during an exam, please bring a note from your doctor. Your grade will be determined by the rest of your course work.
- The *participation* component rewards your professional behavior and active involvement in all aspects of the course. Examples of expected professional behavior include attending class regularly, reading assigned material when requested, submitting assignments on time, and participating actively in class, specifically in group work.

Special Accomodations:

The University of California, Merced is committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design and diversity. I am available to discuss appropriate academic accommodations that may be required for student with disabilities. Requests for academic accommodations are to be made during the first three weeks of the semester, except for unusual circumstances. Students are encouraged to register with the Disability Services Center at UC Merced to verify their eligibility for appropriate accommodations.

Academic Integrity:

Academic integrity is the foundation of an academic community and without it none of the educational or research goals of the university can be achieved. All members of the university community are responsible for its academic integrity. Existing policies forbid cheating on examinations, plagiarism and other forms of academic dishonesty. Further information on the academic conduct policy can be found at studentlife@UCMerced (look under "Student Judiciar Affairs").

Detailed Schedule - Subject to change. Last update: January 16, 2015

Date	Main Topic	Section	HW
Tu 01/20	Class Intro and Overview	8.1	HW1
Th 01/22	Discrete Least Squares Approximation (LSA)	8.1	
Tu 01/27	Orthogonal Polynomials and LSA	8.2	HW2
Th 01/29	Chebyshev Polynomials and LSA	8.3	
Tu 02/03	Trigonometric Polynomial Approximation	8.5	HW3
Th 02/05	Fast Fourier Transforms	8.6	
Mo 02/09	**Last Day to Add/Drop Courses**		
Tu 02/10	Eigenvalue Problems	9.1	HW4
Th 02/12	The Power Method	9.3	
Tu 02/17	Householder's Method	9.4	HW5
Th 02/19	The QR Algorithm	9.5	
Tu 02/24	Singular Value Decomposition (SVD)	9.6	HW6
Th 02/26	Nonlinear systems: Fixed Point Iterations	10.1	
Tu 03/03	Nonlinear systems: Newton's Method	10.2	HW7
Th 03/05	Quasi-Newton Methods	10.3	
Tu 03/10	Steepest Descent Methods	10.4	HW8
Th 03/12	Homotopy and Continuation Method & Review	10.5	
Tu 03/17	Midterm Exam		
Th 03/19	Midterm Discussion		
Tu 03/24	Spring Break		
Th 03/26	Spring Break		
Tu 03/31	BVPs for ODEs:* The Shooting Method	11.1-2	HW9
Th 04/02	BVPs for ODEs: Finite Differences	11.3-4	
Tu 04/07	BVPs for ODEs: The Rayleigh-Ritz Method	11.5	HW10
Th 04/09	Numerical Solution of Elliptic PDEs: Finite Differences	12.1	
Tu 04/14	Numerical Solution of Elliptic PDEs: Finite Differences	12.1	HW11
Th 04/16	Numerical Solution of Parabolic PDEs: Finite Differences	12.2	
Tu 04/21	Numerical Solution of Parabolic PDEs: Finite Differences	12.2	HW12
Th 04/23	Numerical Solution of Hyperbolic PDEs: Finite Differences	12.3	
Tu 04/28	Numerical Solution of Hyperbolic PDEs: Finite Differences	12.3	HW13
Th 04/30	The Finite Element Method	12.4	
Tu 05/05	The Finite Element Method (cont'd)	12.4	
Th 05/07	Review for the final		
Th 05/14	**Final Exam - 8:00-11:00am (COB 114)**		

* Abbreviations: BVPs := Boundary Value Problems, ODEs := Ordinary Differential Equations, and PDEs := Partial Differential Equations