Syllabus of MA428
Introduction to Numerical Analysis, II

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Course Description: Scientific computation has proven to be a major tool for helping this civilization mimic, validate, describe, or predict complicated physical systems. Difficult mathematical problems modeling sophisticated phenomena are more and more understood and solved via numerical calculation which, in turn, allows gaining consistency, precision, control, and, ultimately, making effective decisions. This course aims at exposing post-calculus undergraduates to a variety of numerical techniques in linear algebra that are literally the foundation to every aspect in scientific computation. Essential mathematical theory and practice of computational procedures will be discussed, including solving linear equations, eigenvalue computation, least squares, and application to high-impact modern technologies via projects.

Prerequisites: MA 341 or 301, and programming language efficiency, preferably the Matlab.

Course Structure: Computational techniques will be constructed step by step, both in theory and in implementation. Lectures are built upon elementary skills from calculus and linear algebra. Students will be asked to participate by homework assignments and projects.

Course Materials: Slides of notes will be made available online to students.

Learning Outcomes: Motivate students to dare their creativity. Introduce students to modern world applications through computer-aided calculation, which in addition to advancing knowledge, might lead to higher level of interest in the computational mathematics.

Course Details:

Grading:

- Four computer projects (60%), four homework assignments (20%); and one comprehensive find exam (20%).

References:

- Online lecture notes: `http://mtchu.math.ncsu.edu`
- Tim Sauer, Numerical Analysis, 2nd Edition, Timothy Sauer, Pearson Education, Inc., 2012 ISBN-13: 978-0-321-78367-7.

Date	Hour	Contents	Exercises
		Fundamentals	
01/08	1	Review of Linear Algebra	
01/10	2	Norms	
		Solving Linear Equations	
01/15	3	Triangular Systems	
01/17	4	LU Decomposition	
01/22	5	Conditioning and Error Analysis	Project 1
01/24	6	QR Decomposition	
01/29	7	Householder Transformation	Homework
		Least Squares Techniques	
01/31	8	Least Squares Models	
02/05	9	Least Squares via QR Decomposition	
02/07	10	Geometric Meaning of Least Squares Solution	
02/12	11	Nonlinear Least Squares Problems	
02/14	12	Singular Value Decomposition I	
02/19	13	Singular Value Decomposition II	
02/21	14	Generalized Inverse and SVD	Project 2
		Eigenvalue Computation	
02/26	15	Eigenvalue Problems	Homework
02/28	16	Power Methods	
03/05	17	Inverse Power Methods I	
03/07	18	Inverse Power Methods II	
03/12		Spring Break	
03/14		Spring Break	
03/19	19	QR Algorithm I	
03/21	20	QR Algorithm II	
03/26	21	Shifted QR Algorithm	Homework
03/28	22	Generalize Eigenvalue Problems	
04/02	23	Matrix Polynomials	
		Indirect Methods	
04/04	24	Error Refinement	
04/09	25	Iterative Methods in General	
04/11	26	Stationary Iteration	
04/16	27	Convergence Theory I	Project 4
04/18	28	Convergence Theory II	
04/23	29	Polynomial Accleration	
04/25	30	Krylov Methods in General	
04/30		1:00 PM - 4:00 PM	Final Exam