Syllabus of MA427
Introduction to Numerical Analysis, I

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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 that can prove effectual in constructing high-impact modern technologies. Essential mathematical theory and practice of computational procedures will be discussed, including approximation of functions by interpolating polynomials, numerical differentiation and integration, and solution of ordinary differential equations.

Prerequisites: MA 341 or 301 and programming language efficiency

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://www4.ncsu.edu/~mtchu`
- Tim Sauer, Numerical Analysis, 2nd Edition, Timothy Sauer, Pearson Education, Inc., 2012 ISBN-13: 978-0-321-78367-7.

Date	Hour	Contents	Exercises
		Fundamentals	
08/16	1	Source of Errors	
08/18	2	Floating Point Numbers	
08/21	3	Round-off Errors	
08/23	4	Stability of Algorithms	
08/25	5	Conditioning of Problems	Project 1
		Polynomial Approximations	
08/30	6	Polynomial Interpolation	
09/04	7	Lagrange Polynomials	
09/06	8	Examples of Lagrange Interpolation	Homework
09/08	9	Polynomial Evaluation	
09/11	10	Newton Formula	
09/13	11	Implementing Newton Formula	
09/15	12	Errors in Interpolations	
09/18	13	Applications of Interpolations	Project 2
09/20	14	Hermit Polynomials	
		Numerical Integration	
09/22	15	Newton-Cotes Quadratures	Homework
09/25	16	Handling Singularities	
09/27	17	Gaussian Quadratures	
09/29	18	Orthogonal Polynomials	
10/02	19	Deriving Gaussian Quadratures	
10/04	20	Applications of Gaussian Quadratures	Project 3
10/09	21	Numerical Differentiation	
10/11	22	Differential Equations	Homework
		Numerical Ordinary Differential Equations	
10/13	23	Euler Method	
10/16	24	Runge-Kutta Methods	
10/18	25	RKF45 Method	Homework
10/23	26	Deriving RK methods	
10/25	27	Stability of RK Methods	Project 4
10/30	28	Multi-step Methods	
11/13	29	Linear Stability Theory	
11/15	30	Error Analysis of MS Methods	
11/17	31	Predict-Correct Methods	
11/27	32	Nonlinear Equations	
12/02	33	Convergence Analysis	
			Final Exam