MATH 708

Foundations of Computational Mathematics I

Fall 2015

Meeting times: MWF 12:00 - 12:50 PM at **Sloan College 103**

Instructor: Dr **Peter G. Binev**
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Office hours: MWF 10:45 - 11:45 AM at LeConte 425 or by appointment.

Text: *An Introduction to Numerical Analysis* by Endre Süli and David F. Mayers, Cambridge University Press, 2003.

Credits: 3

Prerequisites: Math 554 or equivalent upper level undergraduate course in Real Analysis.

Bulletin Description: Approximation of functions by algebraic polynomials, splines, and trigonometric polynomials; numerical differentiation; numerical integration; orthogonal polynomials and Gaussian quadrature; numerical solution of nonlinear systems, unconstrained optimization.

Learning Outcomes: Upon the successful completion of this course students will be able to:

- read, interpret, use vocabulary, symbolism, and basic definitions and theorems from Numerical Analysis;
- use facts, formulas, and techniques learned in this course to apply algorithms and theorems to find numerical solutions and bounds on their errors to various types of problems including root finding, polynomial interpolation and approximation, fast Fourier transform, numerical differentiation and integration, and spline approximation;
- understand the theoretical derivation of the basic results in the above topic areas.

Outline: Computational Mathematics is build upon the understanding of computational processes provided by Numerical Analysis that studies the algorithms for the problems of continuous mathematics. The course will give an introduction to general ideas in Numerical Analysis and will discuss different aspects of the performance of the numerical procedures involved. In addition to the theoretical material, some numerical implementations in MATLAB will be considered on an elementary level. Topics include:

- number representations and loss of significance (handouts) – 0.5 weeks;
- nonlinear equations and systems of equations (chapters 1, 2, and 4) – 2.5 weeks;
- polynomial interpolation, divided differences and numerical differentiation (chapter 6 and handouts) – 2.5 weeks;
- polynomial approximation in the infinity norm (chapter 8) – 1.5 weeks;
- polynomial approximation in the 2-norm, trigonometric polynomials and Fast Fourier Transform (chapter 9 and handouts) – 2 weeks;
- numerical integration (chapters 6 and 10, handouts) – 3 weeks;
- spline functions and computer aided geometric design (chapter 11 and handouts) – 2 weeks.

ADA: If you have special needs as addressed by the Americans with Disabilities Act and need any assistance, please notify the instructor immediately.

Academic Dishonesty: Cheating and plagiarism will not be allowed. You are expected to practice the highest possible standards of academic integrity. Any deviation from this expectation will result in a minimum academic penalty of your failing the assignment, and in additional disciplinary measures including referring you to the Office of Academic Integrity. The University of South Carolina has articulated its policy governing academic integrity and the students are encouraged to carefully review it: http://www.housing.sc.edu/academicintegrity/violations.html.

Homework: A number of homework problems will be assigned during the course. Be sure to solve and write these problems before the next class. Some solutions will be collected and graded. Particular homework problems will be discussed and/or presented by a student in class. Both the written solutions and the participation in the discussions will be taken into account in forming the homework grade.

Discussions: The homework and the projects will be discussed in class. The participation in the discussions will be taken into account as part of the homework grade.

Exams: There will be two exams both in a form of a test during the semester. The tentative dates of the exams are September 25 and November 4, 2015. The problems on the tests will be similar to the ones from the homework and the discussions in class.

Projects: Every student has to choose a project motivated by the computational or theoretical problems discussed in the course. Several possible themes for the projects will be suggested by the instructor in the length of the course. The project in a form of a poster, slides/presentation, or a short paper should be submitted on or before November 30, 2015.

Final Exam: The final exam in a form of a test will take place on **Friday, December 11, 2015 at 12:30 PM**. The problems will be from the entire material covered in the course.

Grading: The final grade will be determined from the homework grade (25%), the two exams during the semester (15%+15%=30%), the project (20%), and the final (25%). The letter grades will be assigned as follows: **A** for at least 90%; **B+** for at least 86%; **B** for at least 80%; **C+** for at least 76%; **C** for at least 70%; **D+** for at least 66%; **D** for at least 60%; **F** for less than 60%.