# MATH 709

## Foundations of Computational Mathematics II

### *Spring 2016*

**Meeting times**: TTh 11:40 AM - 12:55 PM at **LeConte 303B**

**Instructor**: Dr **Peter G. Binev**
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**Office hours**: TTh 10:30 - 11:30 AM and 2:00 - 2:30 PM at LeConte 425 or by appointment.

**Text**: ***Numerical Linear Algebra*** by Lloyd N. Trefethen and David Bau III, Sixth Edition, Paperback - SIAM, 1997. The course will cover the entire material considered in the book.

**Credits**: 3

**Prerequisites**: MATH 544 or 526, or equivalent upper level undergraduate courses in Linear Algebra (Note: All Non-degree students should request permission to register from the Graduate Director in the Mathematics Department).

**Bulletin Description**: Vectors and matrices; QR factorization; conditioning and stability; solving systems of equations; eigenvalue/eigenvector problems; Krylov subspace iterative methods; singular value decomposition. Includes theoretical development of concepts and practical algorithm implementation.

**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 Linear Algebra;
- use facts, formulas, and techniques learned in this course to apply algorithms and theorems to find numerical solutions, bounds on their errors, and investigate the stability of the corresponding algorithms to various types of problems including QR factorization and least squares minimization, eigenvalue/eigenvector problems, and iterative methods for linear systems;
- understand the theoretical derivation of the basic results in the above topic areas.

**Outline**: Numerical Linear Algebra studies the practical algorithmic idea,s which every mathematical scientist needs to work effectively with vectors and matrices. The course will give an introduction to general ideas in Numerical Linear Algebra 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 (not necessarily in the order they will be considered): orthogonality, norms, orthogonal and affine projections, Singular Value Decomposition (SVD), matrix factorizations, finite precision arithmetic, stability, least squares, systems of equations, direct and iterative methods, pre-conditioning, eigenvalue/eigenvector problems, and conjugate gradient methods. Both theoretical development of concepts and constructive methods realized in terms of practical algorithm implementation are considered. The plan is to consider two lectures from the textbook at each regular class meeting.

**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**: The textbook offers several homework problems after each lecture. Be sure to solve these problems (and write some of them) before the next class. Some of the problems will be discussed and/or presented by a student at the beginning of the next. Such a presentation should not last more than five minutes, so make sure to have the calculations done before class and present only the basic ideas. Occasionally, solutions for particularly assigned problems will be collected and graded. 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.

**Midterm Exam**: There will be one exams in a form of a test during the semester. The tentative day of the exam is March 31, 2016. The problems on the tests will be similar to the ones from the homework and the discussions in class.

**Projects**: The students have to choose projects motivated by the computational or theoretical problems discussed in the course but are not covered by the textbook. Make sure to discuss your topic with the instructor before starting to work on it. Every student should prepare a two-page abstract describing the project and present a 10-15 minutes talk or a poster at the end of the semester. The abstract should be submitted on or before April 14, 2016.

**Final Exam**: The final exam in a form of a test will take place on **Thursday, April 28, 2016 at 9:00 AM**. 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 midterm exam (25%), the project (25%), 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%.