Fall 2014 Syllabus

Math 298: Directed Group Study
Fundamental Concepts in Computational and Applied Mathematics

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Lecture time: Monday, 1:30–2:20 pm
Lecture room: SSM 150
Instructor: Juan C. Meza
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Phone number: (209) 228-4487
Office: COB 360
Office hours: M, 2:30-3:30 PM and by appointment.

Course goal and topics

Starting research in applied mathematics can be like learning a new language. There are many new terms and basic facts that must be mastered in order to even start a conversation about one's research. In addition, there are many expectations and new skills beyond those taught in standard undergraduate mathematics courses that must be learned to become a successful graduate student in applied mathematics. This course will introduce the student to some of the fundamental concepts used in computational and applied mathematics. We will not attempt to go into any one area in depth; rather we will present a survey of some of the key ideas and tricks used by practicing computational mathematicians. Along the way, our tour will highlight some of the classic numerical analysis papers and the top algorithms used today including those from linear algebra, nonlinear equations, optimization, discretizations and differential equations, and spectral methods. These ideas will also be highlighted through several case studies taken from real-world applications in computational sciences.

Learning outcomes

Upon completion of this course, students should:

1. Be familiar with key mathematical concepts used in developing numerical algorithms.
2. Understand some of the basic skills and resources necessary to start research in computational and applied mathematics.
3. Be aware of basic communications skills needed to present mathematics clearly to a broad audience in writing and in speaking.

Math 298: Directed Group Study addresses the following two Program Learning Outcomes of the Applied Mathematics Ph.D. and M.S. programs:

PLO #3: Give clear and organized written and verbal explanations of mathematical ideas to a variety of audiences including teaching undergraduate students.

PLO #4: Model real-world problems mathematically and analyze those models using their mastery of the core concepts.

Directed group study meetings

The main vehicle for learning the concepts in this course will be through the class discussions. This is in keeping with the idea that in order to learn a new language, one must practice speaking the language. As such, the class presentations will have a strong element of participation by everybody in the group. It will be expected that all participants will come to class ready to discuss the topic of the week and to present material as needed. As the semester progresses, we will also work on basic communication skills for presentations. The students will then be asked to choose a case-study from computational science or mathematics and lead a discussion during one of the meetings.

Course materials

Textbook. No text or other materials are required for this course. We will make frequent references to some of the major applied mathematics and numerical analysis papers in the literature most of which can be found on the web (see e.g. `http://people.maths.ox.ac.uk/trefethen/classic_papers.txt`). Some familiarity with these papers and their concepts will be useful to the student, but is not required prior to the course. In addition, having access to one or two good numerical analysis books throughout the course will help students in their appreciation of the techniques we will discuss. References to all relevant materials will be provided as needed.

Course webpage. The Math 298 website is part of the UCMCROPS course management system. All important course materials will be posted under RESOURCES on this website.

Grade determination

Your grade in this class will be determined by the following combination:

50% Class participation

25% Reading and writing assignments

25% Presentations at end of the semester

Additional course information

Dropping the course. You may drop this course without paying a fee and without further approval before 5:00 pm on Thursday, September 18 (4:00 PM). Dropping the course after this time requires the signed approval of the instructor, and the confirmation of the Dean of the School of Natural Sciences. Please see the UC Merced *General Catalog* for more details.

Special accommodations. If you qualify for accommodations because of a disability, please submit a letter from Disability Services to the instructor in a timely manner so that your needs may be addressed. Student Affairs determines accommodations based on documented disabilities.

We will make every effort to accommodate all students who, because of religious obligations, have conflicts with scheduled exams, assignments, or required attendance. Please speak with me during the first week of classes regarding any potential academic adjustments or accommodations that may arise due to religious beliefs during this term.

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. The UC Merced Academic Honesty Policy and Adjudication Procedures available on the website: `http://studentlife.ucmerced.edu` by following the link to Student Judicial Affairs.

Math 298 Tentative Class Schedule

Week	Date	Topic
Week 1	Sept. 1 (Labor Day)	No Class
Week 2	Sept. 8	Introduction to Computational Mathematics Motifs
Week 3	Sept. 15	Dense Linear Algebra – Cornerstone of Comp. Math
Week 4	Sept. 22	Sparse Linear Algebra – Taking Advantage of Structure
Week 5	Sept. 29	Structured Grids – Beginning Discretizations
Week 6	Oct. 6	Unstructured Grids – Complexity of Real World Problems
Week 7	Oct. 13	Spectral Methods – Transforming the Problem
Week 8	Oct. 20	N-Body problems – When is Near Near Enough?
Week 9	Oct. 27	Nonlinear Equations and Optimization – Making Optimal Decisions
Week 10	Nov. 3	Monte Carlo Methods
Week 11	Nov. 10	Presentation Essentials
Week 12	Nov. 17	Student Presentations
Week 13	Nov. 24	Student Presentations
Week 14	Dec. 1	Student Presentations
Week 15	Dec. 8	Student Presentations