

Syllabus, Fall 2010

*Online syllabus:* Throughout the entire semester, this syllabus will be online at the URL

<http://www.mgnet.org/~douglas/Classes/na-sc/2010f-notes/syllabus.pdf>

*Course Description:* This course will comprehensively cover algorithms for numerically solving partial differential equations using multigrid methods (or multilevel methods when applied to a problem that is not grid based). Theory and how the algorithms really work in practice will be emphasized equally for a wide range of problems. Geometric and algebraic multigrid algorithms will be included. We will also cover multiscale methods as a form of a multilevel algorithm for problems in which different scales provide different and useful information about the solution to a problem. For example, many problems in energy are multiscale problems primarily and may also use traditional multigrid methods as well. This course is open to Graduate and Undergraduate students. Depending on the background of the students, we may study nuclear reactor core designs for third+ and fourth generation reactors. This is an emerging research area again due to the large number of reactors that are in the process of being approved in various countries (U.S., China, India, etc.) and the almost complete lack of trained people in the field.

*Prerequisites:* Permission of the instructor.

*Classrooms:* Ross Hall 247 (TR, 1:20-2:30)

*Class web page:* <http://www.mgnet.org/~douglas/Classes/na-sc/2010f-index.html>

*TA:* none

*Office hours:* Tuesday 2:30-3:30, Wednesday 11:00-12:00, Thursday 2:30-3:30, and by appointment (send me email or call for an appointment). Please call 766-6580 before coming to Ross Hall 227.

*Textbook:* None

*Suggested Readings:*

- C. C. Douglas, G. Haase, U. Langer, A Tutorial on Elliptic PDE Solvers and their Parallelization, vol. 16, Software, Environments, and Tools (SET) series, *Society of Industrial and Applied Mathematics* (SIAM), Philadelphia, 2003.
- W. L. Briggs and V. E. Henson and S. F. McCormick, A Multigrid Tutorial, 2<sup>nd</sup> ed., *Society of Industrial and Applied Mathematics* (SIAM), Philadelphia, 2000.
- W. Hackbusch, Multi-Grid Methods and Applications, *Springer*, Heidelberg, 1986.
- P. Wesseling, An Introduction to Multigrid Methods, *R.T. Edwards*, 2004.
- U. Trottenberg and C. W. Oosterlee and A. Schüller, Multigrid, *Academic Press*, London, 2000.
- Y. Efendiev and T. Y. Hou, Multiscale Finitel Element Methods: Theory and Practice, *Springer*, New York, 2009.

*Homework:* This is going to resemble a seminar course. I will assign topics and expect students to present lectures using the LCD projector. You can scan handwritten notes for the lectures.

*Exams/Projects:* There are no any exams in this course. There will be at least one project that the whole class will work on cooperatively in the standard way all large scale parallel applications are developed. The students will divide the project(s) up into pieces that will allow individual students to apply their own strengths to.

*Grading:* 100% of the grade will come from the class lectures (50%) and the project (50%). You cannot pass this course by only doing one half, but not the other half.

*Advice:*

- It is a good idea to already know Matlab to prototype algorithms and at least one legacy programming language (e.g., C, C++, or Fortran). The class should decide to use a single programming language to facilitate cooperation.

- Do not be late to class. Do not leave early, either. This is the most important class you are taking this term no matter how many other professors say the same thing.
- Take notes in class. My lecture notes will not be online during the semester.

*Learning objectives:* Both theoretical and practical uses of multigrid should be learned equally throughout the course. Students should know the limits and uses of the algorithms taught in the course. Students should know which ones are useful computationally given a problem to solve for which multiple algorithms taught in this course are applicable.

*Cheating Policy:* Getting caught cheating or plagiarizing will result in a failing grade and possibly much worse, including expulsion from the university and legal proceedings against you. I have zero tolerance for cheaters. I will enforce whatever the latest university policy is. When in doubt, ask me first. Life is too short to experience the penalties of getting caught cheating.

*Disability Policy:* It is University of Wyoming policy to accommodate students, faculty, staff, and visitors with disabilities. If you have a physical, learning, sensory, or psychological disability and require accommodations, please let me know as soon as possible. You will need to register with University Disability Support Services (UDSS) in the Student Educational Opportunity offices, Room 330 Knight Hall, and provide UDSS with documentation of your disability. See the university handbook for more details.