ME 690-001 COMPUTATIONAL NUMERICAL ANALYSIS OF PDEs Spring 2017

J. M. McDonough, RGAN 267
Email: jmmcd@uky.edu

The purpose of this course is to provide to Engineering/Physical Science graduate students a background in numerical methods that will prepare them to at least begin computational work on essentially arbitrarily difficult problems in partial differential equations (PDEs). The course begins with classical, but fairly advanced, material on the solution of both steady-state and time-dependent PDEs (mainly elliptic and parabolic, respectively) with a focus on single linear equations posed on rectangular domains. Following this preparation, *non-linear* problems, and *systems* of PDEs are treated. Finally, the restriction of rectangular domains is removed via an introduction to *grid generation*.

Course Outline

I. Solution of Elliptic PDEs

   A. Basic theory of linear fixed-point iteration
   B. Successive overrelaxation (SOR)
   C. Alternating direction implicit (ADI) methods
   D. Incomplete LU decompositions (ILU)
   E. Preconditioning
   F. Introduction to conjugate gradient methods (Krylov subspace methods)
   G. Multigrid methods
   H. Domain decomposition

II. Time-Splitting Methods for Evolution Equations

   A. ADI methods—again
   B. Locally one-dimensional (LOD) techniques
   C. General Douglas & Gunn time splitting

III. Some Miscellaneous Topics

   A. Discretizations for general self-adjoint form operators
   B. Treatment of mixed derivatives
   C. The “cell-Re” and aliasing problems
   D. Non-linear equations
   E. Systems of PDEs

IV. Introduction to Grid Generation

   A. Basics of (applicable) differential geometry
   B. Grid generation via PDEs
   C. Algebraic grid generation

The course grade will be based on two major homework problems (not necessarily equally weighted) for which Fortran codes will be provided, total 60%, and a comprehensive, closed-book, closed-notes final examination 40%.

There is no required textbook, but course lecture notes will be made available as a downloadable PDF file from http://courses.engr.uky.edu