Northeastern University
College *of* Engineering
DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING

ME 6201 Mathematical Methods for Mechanical Engineers 2

CATALOG DESCRIPTION

ME 6201 Mathematical Methods for Mechanical Engineers 2 (4sh)

Focuses on partial differential equations; Fourier Series, function spaces, Sturm-Liouville theory, eigenfunction expansions, special functions, potential theory, solution of elliptic, parabolic, and hyperbolic PDEs using separation of variables, eigenfunction expansions, transform methods and numerical methods. Prerequisite: ME 6200 or equivalent or permission of the instructor.

COURSE DISCUSSION

This is a new course meant to appeal to those students whose undergraduate background provided sufficient expertise in the topics of the companion course ME 6200: ODEs, linear algebra and vector field theory.

The course will begin with a brief review of Fourier Series and then move on to applications in separation of variable solutions of the PDEs used frequently in ME applications: the wave equation, the diffusion equation (1-D unsteady heat transfer), and Laplace's Equation (steady 2- and 3-dimensional heat transfer). We will then review more complicated ODEs, develop the Sturm-Liouville theory, the Sturm separation and comparison theorems, function spaces and eigenfunction expansions. These techniques will then be applied to ODES and to PDEs.

REQUIRED COURSE TEXTBOOK

Advanced Engineering Mathematics 2nd Ed.; M.D. Greenberg (Prentice Hall, 1998) This is the textbook required in the companion course, *ME 6200*. It is a general textbook with something for everyone (almost). It begins at an elementary level and proceeds to progressively more advanced coverage in each topic covered. There are excellent treatments of numerical techniques for ordinary and partial differential equations in parallel with the analytic solutions. In addition there are references to the *Maple* commands to carry out much of the analysis discussed in the text. This book is marked by careful and extensive discussion of all topics. Past generations of students have found it very readable. Chapters 17-20 deal with the bulk of our course. Selected material from these chapters will be used for a brief discussion of finite-difference techniques for elliptic and parabolic PDEs.

SUPPLEMENTARY READING:

Sections devoted to engineering applications of PDEs are given in the following more general references:

Fourier Series and Boundary Value Problems 7th Ed. James Ward Brown and Ruel V. Churchill (Mc Graw-Hill, 2008) This is a standard textbook that has proved very popular over the decades with many generations of engineering students world-wide. The focus is on use of advanced techniques in a variety of solved problems that will appeal especially to ME students, since may of the applications are from fluid and solid mechanics, vibrations and heat transfer. The theory is done honestly and clearly, but the focus is truly on techniques of application. There is no treatment of numerical methods and no discussion of modern software applications.

Advanced Engineering Mathematics 9th Ed., Erwin Kreyszig, (John Wiley and Sons, 2006). See Parts C and E for coverage of our course materials.

There are two older classics which I like as well, each written well before the advent of computer software packages like *Maple, MatLab, Excel* or *Mathematica*:

Advanced Calculus for Applications, 2nd Ed.: F. Hildebrand (Prentice Hall 1976). This is a standard but somewhat dated treatment in its lack of coverage of numerical methods and linear analysis. See Chapters 5, 8 & 9 for coverage of our course materials.

An Introduction to Linear Analysis. Kreider, Kuller, Ostberg and Perkins (Addison Wesley, 1966). This is an excellent treatment of the methods we will cover in our course, but starting with linear algebra as a base. There is no coverage of numerical techniques but the treatment is very nice nonetheless. See Chapters 6, 12-15 for coverage of our course materials.