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

ME 6200 Mathematical Methods for Mechanical Engineers 1

CATALOG DESCRIPTION

ME 6200 Mathematical Methods for Mechanical Engineers 1 (4sh)

Focuses on ordinary differential equations, linear algebra and vector analysis; topics include Laplace Transform, power series, and numerical methods for ODEs; matrices, finite dimensional linear vector spaces, eigenvalue problems, applications to systems of ODEs; vector field theory, curvilinear coordinates and integral theorems. *Prerequisite: Admission to the Graduate School of Engineering.*

COURSE DISCUSSION

As the catalog description implies this course covers many topics that most of you will already have seen in an undergraduate course. The objective is to consolidate understanding of undergraduate mathematics into a solid base appropriate to a first year graduate level for engineers. The assumption is that in addition to single- and multi-variable differential and integral calculus everyone also has a familiarity ordinary differential equations, vector analysis and linear algebra.

The course will begin with a brief review of 1st and 2nd order ODEs with constant coefficients, and the Cauchy Euler equation with simple non-constant coefficients. Then we will move on to power series solutions of ODEs with variable coefficients, Frobenius' method, Bessel and Legendre functions. Then we will launch into vector field theory, including the differential and integral calculus of vectors and integral theorems, vector spaces and eigentheory for matrix operators

REQUIRED COURSE TEXTBOOK

Advanced Engineering Mathematics 2nd Ed.; M.D. Greenberg (Prentice Hall, 1998)
This 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.

SUPPLEMENTARY READING:

The library is full of books that have coverage similar to Greenberg. My own current favorites, in addition to the required text, are:

Advanced Engineering Mathematics 9th Ed., Erwin Kreyszig, (John Wiley and Sons, 2006). This is the most recent and very modern edition that has become a classic undergraduate-first year graduate level text on topics of interest in many engineering fields. It also integrates the purely mathematical development with computer based systems such as *Mathematica* and *Matlab.*

Advanced Engineering Mathematics 3rd Ed.: Potter, Goldberg and Aboufadel (Oxford Univ. Press, 2005). This is a new edition of an older text that makes an excellent integration of the computer software *Maple* and, to a lesser extent, *Excel* to applications of the mathematical principles.

Mathematical Methods for Scientists and Engineers: Donald A. McQuarrie (University Science Books, 2003) Classical orientation with attention to computer algebra software, mainly *Mathematica.*

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. There is an excellent review of ODEs, treatment of series expansions, Bessel Functions and eigenfunction expansions. It is very applications oriented.

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 not much vector field theory and no treatment of numerical techniques but the treatment is very nice nonetheless.

TOPICAL SYLLABUS AND READING

Week	Topics	Reading
#1	Linear ODEs	2.2, 2.5, 3.2
#2	Constant coefficient and Euler ODEs	3.4, 3.6, 3.7.3
#3	Power series and ODEs	4.1, 4.2
#4	Frobenius Method; Legendre Functions	4.3, 4.4
#5,	Cont'd	Cont'd
#6	Gamma and Bessel Functions	4.5, 4.6
#7	Laplace Transform	Chapter 5
#8	Cont'd	Cont'd
#9	Vectors in 3-Space	14.5, 14.6, 15.2, 15.4-6
#10	Scalar and Vector Field Theory	16.1-16.10
#1*	Cont'd	Cont'd
#12	Matrices and Linear Equations	10.2-10.6
#13	The Matrix Eigenvalue Problem	Chapter 11