

Numerical Solutions of Differential Equations, I
MATH 801, Fall 2003

INSTRUCTOR: Dr. Huanan Yang

TEXTBOOK: Numerical Methods for Ordinary Differential Systems, The Initial Value Problem, by J. D. Lambert, 1991, John Wiley & Sons, ISBN 0-471-92990-5

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SUBJECT: Most natural processes in sciences and engineering are described by differential equations. Very few of these equations can be solved exactly. For some equations, fairly complete qualitative theory has been developed; for others, even such a theory does not exist. In the former case, we are very often not content with the qualitative information but need highly accurate solutions. In the latter case, numerical methods become very useful in the investigations of the qualitative properties as well as in obtaining numerical solutions of high accuracy.

Numerical analysis of differential equations forms a vast field in numerical analysis and applied mathematics. In part I of this course that I teach in the Fall semester, we study the basic theory and applications of numerical solutions of ordinary differential equations. Numerical methods for partial differential equations will be dealt with in part II of this course, Math 802, in the next semester.

We will cover the following topics in this semester (A more detailed outline of the course is attached):

1. Review some preliminary mathematical theory which includes: theory of interpolation, finite difference equations and some basic properties of the solutions of initial value problems of ordinary differential equations.

2. Linear multistep methods and predictor-corrector methods.

3. One step methods, especially Runge-Kutta methods.

In 2. and 3., we will study the concepts of consistency, order of accuracy, stability, convergence, the rate of convergence and the practical implementation of the methods.

4. Stiff problems.

5. Two point boundary value problems.

GRADING: homework 60 %, final 40 %

REFERENCES:

1. *Numerical methods for initial value problems in ordinary differential equations*, by Fatunla

2. *Numerical initial value problems in ordinary differential equations*, by V. G. Gear

3. *Solving ordinary differential equations I, Nonstiff problems* by E. Hairer, S. P. Norsett and G. Wanner