

**ENGINEERING 12
PHYSICAL SYSTEMS ANALYSIS**

SPRING 2008

LABORATORY 5: NUMERICAL ANALYSIS

Objectives

To use numerical methods to approximate the solutions of differential equations.

Apparatus

A PC running Excel.

Procedure

In this laboratory, you will learn two numerical methods to approximate the solution to differential equations. Such methods are especially useful when the number of equations needed to model the system becomes high, or when closed form solutions cannot be found. Generally speaking, in methods of this type, discrete difference equations are found from continuous differential equations that model the behavior of a system. It is important to realize that these numerical methods are approximate. Any results obtained from these methods must be checked to verify that they actually are reasonable results, and error analysis is of particular interest.

Please look over the attached handout from *Applied Numerical Methods*, by Carnahan, Luther, and Wilkes (Wiley, 1969). First (pp. 341-352), an introduction to using numerical method to solve differential equations is provided, and that is followed by a description of Euler's method. The second part (pp. 361-371) provides a description of Runge Kutta methods.

In this lab, you will model the coupled pendulum that we studied in the previous Lab. You will use both Euler's Method and a fourth order Runge Kutta Method, and you can then compare the results from each of these analyses with the exact solutions you obtained analytically in the previous lab exercise. I recommend you use Excel spreadsheets to perform this analysis, but you may also write a program in a computer language of your choice, or use any other.

Include the following in your report

1. Model the coupled pendulum with Euler's method and Runge Kutta method.
2. Qualitatively compare the results obtained from applying the two methods with varying values of h .
3. Qualitatively compare your results to the theoretical results from the previous lab.
4. No formal report is required. Your report should include a brief introduction, results and discussion. Please keep your report short.