Date: 1-8-98
Due Date: 1-15-98

CS 522: Advanced Methods in Scientific Computing

Assignment 1

Note: You can do your programming in Fortran, C, C++, or Matlab. Please thoroughly document your code!

1. Write a program to solve a first order, ordinary differential equation using Euler's method.

2. Solve the *coffee cup* problem using Euler's method and compare your answer with the analytical answer. Initial conditions are $T_s = 22°C$, $T_c = 83°C$, and $r = 0.1$. Try several different values for Δt. The differential equation using Newton's law of cooling is:
$$\frac{dT}{dt} = -r(T - T_s)$$

3. Computational "prove" that the Euler method is order one (i.e. calculate the error as a function of the number of subintervals and show that with a halving of the stepsize, the error reduces by half).

4. Write a program which evaluates a one dimensional integral by the Monte Carlo method.

5. Write a program which generates random numbers on the interval (0,1). Do **not** use the machine's built in random number generator in any way!

6. Use the programs you developed to calculate the following integral. Compare your solution with the analytic answer.
$$\int_0^1 \frac{\ln(1+x)}{x} dx \qquad Answer = \frac{\pi^2}{12}$$

7. Now evaluate the above integral using the machine's built in random number generating function and compare your results.