GEO 5500 Numerical Methods in the Geosciences
Computer Assignment #7
Ordinary Differential Equations

Assigned: February 24, 2005
Due: March 3, 2005

Relevant reading: Lindfield and Penny, Chapter 5.1 – 5.5; 5.10, 5.12

1. Lindfield and Penny, problem 5.14 (cases (i), (ii), and (iii) only)

2. Consider a simple ecosystem consisting of rabbits that have an infinite food supply and foxes that prey on the rabbits for their food. A classical mathematical model describes this as a system of differential equations.

$$\frac{dr}{dt} = 2r - \alpha rf$$
$$\frac{df}{dt} = -f + \alpha rf$$

f is the number of foxes, **r** is the number of rabbits, **t** is time, and α is a constant. When $\alpha = 0$, the two populations do not interact, so the rabbits do what rabbits do best and the foxes die off from starvation. When $\alpha > 0$, the foxes encounter the rabbits with a probability that is proportional to the product of their numbers. Such an encounter results in a decrease in the number of rabbits and in increase in the number of foxes.

Investigate the behavior of this system for $\alpha = 0.01$ and various initial values of rabbits and foxes. Construct plots of interesting solutions. Include a plot of rabbits and foxes versus time as well as a plot of just rabbits and foxes. Run at least these two simulations: (1) rabbits = 300 and foxes = 150 and (2) rabbits = 15 and foxes = 22. Comment on the population dynamics in both of these scenarios.