Written Assignment #2 MAT 294
Due: 9-14-05 Fall 2005

1. The *nominal interest rate* is the simple rate of interest that an investment earns without considering the effect of compounding. This is often given as an APY (annual percentage yield). The *effective interest rate* takes compounding into account. For example at 6% APY, an investment of $500 will earn $500(0.06)=$30 interest in one year. In other words, the investment will be worth $500(1.06)=$530. If however, half of the interest is paid after 6 months and that new amount accrues interest over the remainder of the year, the investment will be worth $500(1.03)(1.03)=$530.45. Now suppose we have an investment of P dollars at a simple interest rate, r. With simple interest, the investment would be worth $P(1+r)$ after one year. Compounded twice per year, it would be worth $P(1+r/2)^2$ after one year. Generalizing this, compounded n times per year, the investment would be worth
$$P(1+r/n)^n$$
after one year. Continuously compounded interest is the result of letting n go to infinity. Pick two nominal interest rates and use your MATLAB program to find asymptotes to determine the corresponding effective interest rates for continuous compounding. Clearly write up your results.

2. A capacitor is an electrical component essentially consisting of two closely placed parallel conductors. When a circuit with a power source is connected, a charge builds up on one of the two plates since the electrons cannot pass across the gap. As this charge differential between the two plates develops, the capacitor generates an electrical force of its own in the opposite direction of the power source. For a direct current (DC) power source such as a simple battery, the force generated by the capacitor will eventually be equal to that generated by the source, and the current will stop flowing. If a capacitor is placed in series with a resistor, the charge differential Q on the capacitor as a function of time is given by the equation $Q(t) = CV(1-e^{-t/RC})$, where C is the capacitance of the capacitor, V is the voltage of the power source, and R is the resistance of the resistor. Use your MATLAB program to find the limiting value of the charge differential in Coulombs (C) for C=20 microFarads (μF), V=12 volts (V), and R=5 Ohms (Ω). Pick another set of values for capacitance, resistance, and voltage, and find the limiting value of the charge differential for this combination. Write up your results.

3. Test your MATLAB program with the function $f(x) = \ln x$. (Note that MATLAB automatically uses base e for logarithms so the function log(x) returns the natural log in MATLAB.) Write up what your program finds and what that means about whether it is working properly.