Written Homework 3
Rate of Change
Due 10-10-05

Thermic Effect of Food

The metabolic rate of a person who has just eaten a meal tends to go up and then, after some time has passed, returns to a resting metabolic rate. This phenomenon is known as the thermic effect of food. Researchers have indicated that the typical metabolic rate (in kJ/hr) for one person is $F(t) = -10.28 + 175.9te^{-t/1.3}$, where t is the number of hours that have elapsed since eating a meal. Note that kiloJoules (kJ) is a unit of energy where 2100 kJ is equal to 500 calories.

- **a.** Find the average rate of change of F during the first hour after eating. Describe what this means in terms of the thermic effect of food.
- **b.** Use your Matlab program to approximate the instantaneous rate of change of F exactly one hour after eating to an accuracy of at least 0.01 kJ/hr^2. Describe what this means in terms of the thermic effect of food.
- **c.** Answer the 5 Approximation Questions pertaining to part b. Give your answers numerically, symbolically, graphically, and in context.

Electrical Circuits

In a series resistance-capacitance DC circuit, the charge Q on the capacitor as a function of time is given by the equation

$$Q(t) = CV(1 - e^{-t/RC}),$$

where $t = 0$ is the moment the circuit is energized by closing a switch, C is the capacitance of the capacitor, V is the voltage of the power source, and R is the resistance of the resistor. The charging current I_c is the instantaneous rate of change of the charge on the capacitor, or $I_c = dQ/dt$.

- **a.** If $C = 10^{-5}$ farads, $R = 10^7$ ohms, and $V = 10$ volts, find the average rate of change of the charge on the capacitor from $t = 200$ seconds to $t = 201$ seconds. Show your work. Note: when placed into the equation given above, the charge Q will be given in coulombs (C).
- **b.** Use your Matlab program to find the charging current after 200 seconds if $C = 10^{-5}$ farads, $R = 10^7$ ohms, and $V = 10$ volts to an accuracy of three significant digits*. Note: one coulomb per second is one amp (A).
- **c.** Answer the 5 Approximation Questions pertaining to part b. Give your answers numerically, symbolically, graphically, and in context.

*For example, if the current is roughly 30,000 amps, you should determine the value to within 50 amps so that the hundred, thousand, and ten-thousand decimal places are significant. On the other hand, if the current is roughly, 0.001 amps, then you should determine its value to within 5×10^{-6} amps, and so on.