SAVE ALL FILES FIRST TO YOUR LOCAL HARD DRIVE AND THEN DRAG A COPY TO THE DROPBOX ON THE BIOSERVER. YOU WILL RECEIVE NO CREDIT FOR A QUESTION IF THE FILENAMING CONVENTION IS NOT FOLLOWED EXACTLY. KEEP COPIES OF ALL FILES FOR ONE WEEK IN CASE PROBLEMS WITH THE DROPBOX OCCUR.

1. (16 points) Consider the following biochemical system:

$$\mathbf{A} \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} \mathbf{B} + \mathbf{C}$$

$$\mathbf{C} + \mathbf{D} \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} \mathbf{E} + \mathbf{F}$$

with

$$k_1=0.1\ \text{sec}^{-1}, k_{-1}=1\ \text{M}^{-1}\ \text{sec}^{-1}, k_2=0.2\ \text{M}^{-1}\ \text{sec}^{-1}, \text{and } k_{-2}=0.05\ \text{M}^{-1}\ \text{sec}^{-1}$$

and

$$A(0)=1\ \text{M}, B(0)=0, C(0)=0.4\ \text{M}, D(0)=0.5\ \text{M}, E(0)=0, F(0)=0$$

Using Excel, create a spreadsheet model of the system. Use Euler's method with an integration interval that is constant for all steps.

(a) How did you choose an integration interval? Why?

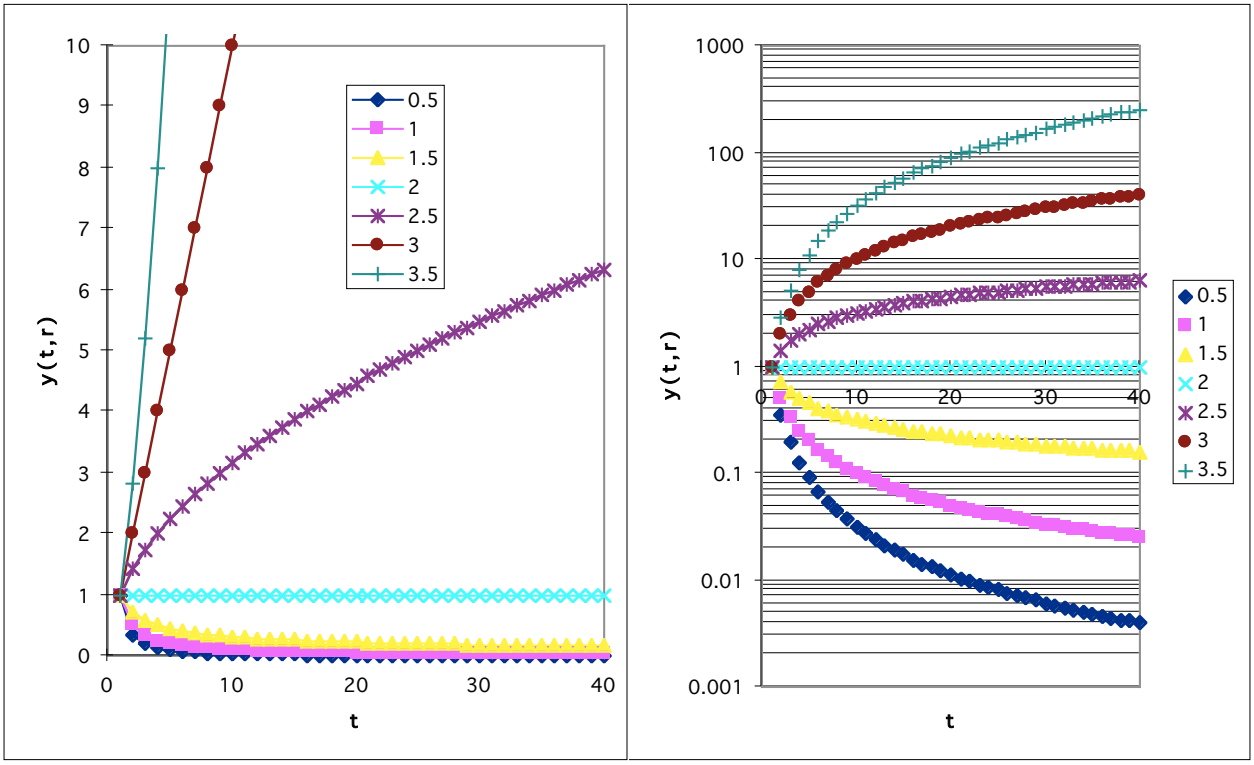
(b) What is A(10), the value of A at 25 sec (to 2 significant digits)?

(c) Create a graph within your spreadsheet showing A(t) vs. t and E(t) vs. t on the same axes for t=0 to 25 sec.

Save your spreadsheet with a filename consisting of the characters "Q1" followed by the code number shown below and your full name (e.g., Q1 707 John Public). Drop a copy in the dropbox on the BioServer.

Code Number _____

2. (5 points) Consider the following plots describing a system of one state variable (y) that is a function of time (t) with one parameter (r). Each line shows the behavior of y for a different value of r, as shown in the legend. Both plots are for the same system: the plot on the left has a linear vertical scale, while that on the right has a logarithmic scale.



Show below a parameter line summarizing the behavior of the system with respect to changes in r.

3. (8 points) Consider the following 3 x 3 image filtering kernel.

1	1	1
1	4	1
1	1	1

(a) How would you describe this kernel?

(b) What will be the value of the highlighted pixel (location 2,2) below if the kernel is passed over the following 4 x 4 image?

0	1	2	3
0	2	4	6
0	3	6	9
0	4	8	12

4. For each statement, write True or False with a brief explanation (1 point for correct answer, 2 points for correct explanation).

(a) A parameter line can be used to summarize the behavior of a biochemical system with two rate constants.

(b) In compartmental analysis, a compartment is defined to be a volume that can receive material from or transfer material to other volumes.

(c) In the Hodgkin-Huxley model of a squid neuron, the m gate opens before the n gate during an action potential.

(d) Displaying an image with contrast stretching (contrast enhancement) requires altering the image in memory.

(e) When using Euler's method to model a biochemical system, the concentrations of reactants whose derivatives increase with time are consistently underestimated.

(f) The Hogkin-Huxley model is based on an accurate biochemical description of the mechanism of neuron firing.

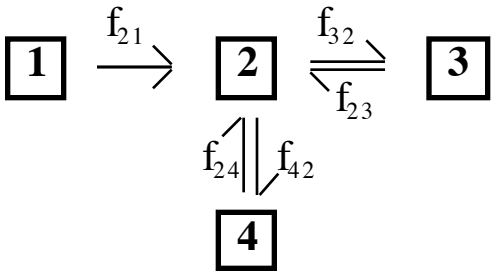
(g) An analytical solution to a single differential equation can be found by Excel if it the equation is linear.

5. You are given two protein sequences, "pakvf" and "grsipy".

(**a**) (6 points) Use the blanks below to carry out a dynamic programming alignment using the PAM250 similarity matrix and no gap penalties.

(**b**) (4 points) What is the optimal alignment between the two sequences according to the assumptions above?

6. (20 points) Consider the following compartmental system:



with

$$f_{21} = 1,\ f_{32} = 0.1,\ f_{23} = 0.2,\ f_{24} = 0.02,\ f_{42} = 0.1$$

and

$$q_1(0) = 1,\ q_2(0) = 0,\ q_3(0) = 0,\ q_4(0) = 0$$

Create a Maple worksheet that

(a) contains the differential equations describing this system

(b) solves the system numerically

(c) plots $q_1(t)$ vs. t and $q_2(t)$ vs.t on the same axes for t=0 to 10

(d) Write the value of $q_3(3)$ here.

Save your worksheet with a filename consisting of the characters "Q7" followed by the code number shown at the bottom of page 1 and your full name (e.g., Q6 707 John Public). Drop a copy in the dropbox on the BioServer.