DO FIRST: Type your name here in place of this line.

MA 261/419/519 Test #1 February 22, 2006

Copy this test, **Test1Spr06.doc**, and the Excel file **drug.xls** from the course website (http://www.math.uab.edu/mayer/Test1Spr06.doc) to your computer and diskette. In responding to the questions below, be sure you follow the previously stated standards for submitting reports and graphs. Problem (1) requires the use of EXCEL; problem (2) requires the use of STELLA. Do not open any files other than those you create as part of this test, or as directed below. The remaining problems refer to STELLA, but do not require you to use it. Insert (copy or type) your responses to the questions in the places provided below in this document. There are five questions on this test. Questions count points indicated [nn]. If you have trouble copying, formatting, or typing anything, ask us for help. When you have completed the test, print it out with your name on it and turn in the paper copy. (Alternately, you may email me your completed test, labeled LastName_Initials_Test1, or copy it to MY diskette.) One hour, fifteen minutes is allotted for the test.

Save your work and test to your computer and diskette often as you work.

(1) [25] Open the Excel speadsheet **drug.xls**. It contains a table of data collected in an experiment with a drug in a person's bloodstream. A quantity of the drug is injected into the bloodstream and the drug concentration in milligrams/liter is measured at the times (in hours) indicated. Use Excel to generate a **disconnected scatter graph** of the data with time on the horizontal axis. Place **three** trendlines, with equations and R^2 values, on the graph: one linear, one quadratic (polynomial of order 2), and one exponential. (a) [10] Copy the graph with trendlines, equations, and R^2 values. (b) [10] Based upon the foregoing, type a paragraph explaining which model (trendline) is the better fit to the data and why. (c) [5] Now suppose you receive additional information: the concentration of the drug is measured at 20 hours and is found to be 2.5 mg/l. Would you change your mind about which model (trendline) is best? Explain your answer.

(a) Paste your graph here. (Format background fill to white in Excel.)

(b) Type your paragraph here.

(c) Type your response here.

(2) [25] Using STELLA, create a model of your choice exhibiting linear growth (or decay). (a) [15] Copy the model diagram, equations with units, and Behavior Over Time graph of the stock into the space below. (Copy from a selection in any STELLA window to the clipboard, and paste the selection into this Word document.) (b) [10] Write a paragraph explaining your model, how it works, and what the numbers mean (paying attention to starting values, calculation of one or two time steps, ending values, and assumptions). Say where the feedback cycle is, if any, what kind of feedback it is (positive or negative), and why the system grows (decays) linearly.

(a) Paste diagram here. (Format background fill to white in Word, if necessary.)

(b) Paste equations and documentation here. (From equation level.)

(a) Paste graph here. (Format background fill to white in Stella. Copy "unpinned" Stella graph window.)

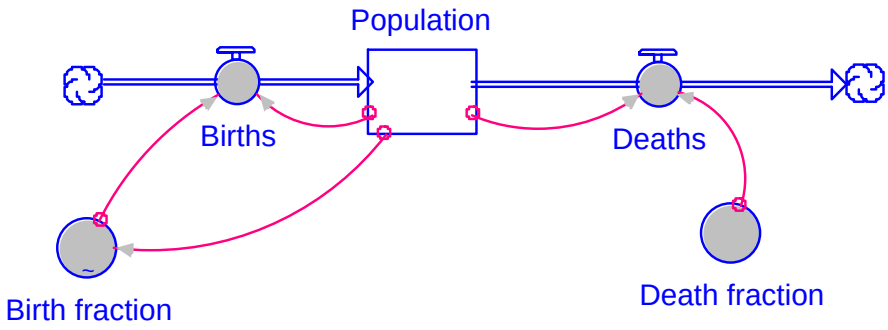
(b) Type your paragraph here.

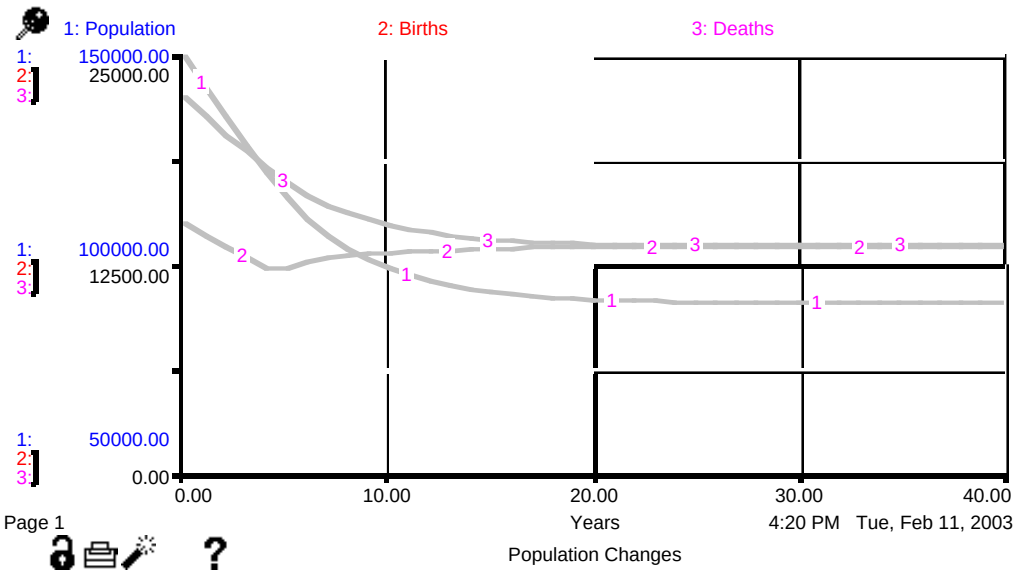
(3) [20] Below is the STELLA diagram of a population model. Accompanying it is the graph of the stock **Population** and the flows **Births** and **Deaths**. It may help you to know that the **Death fraction** is a constant (0.15), but the **Birth fraction** is a graphical converter depending upon Population (with a Birth fraction range of 0.10 to 0.20, decreasing continuously as population increases from 70,000 to 120,000). The flows are defined by the equations:

Births = Birth_fraction*Population

Deaths = Death_fraction*Population

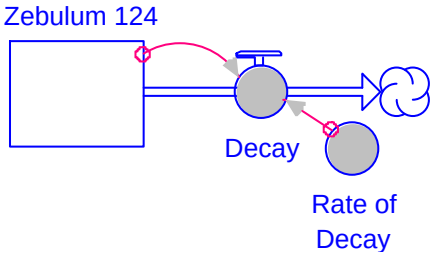
Based on your understanding of the diagram, the equations, and the graph, write a paragraph addressing what happened to the population over time, why it leveled off, and what the leveling-off means. What does it mean that the Births and Deaths graphs coincide over the last 15 years or so? What does it mean that the Population graph crosses the Births and Deaths graphs?





Type your response here.

(4) [20] Refer to the STELLA diagram and equations below. (a) [15] Given the equations and constants in the model, the Behavior Over Time graph of the stock **Zebulum 124** will exhibit which of the following shapes: increasing at a constant rate, increasing at an increasing rate, increasing at a decreasing rate, decreasing at a constant rate, decreasing at an increasing rate, or decreasing at a decreasing rate? Explain your answer in terms of the feedback loop(s), mathematical relationships, and specific numbers in the model. What kind of feedback (positive or negative) is exhibited by the outflow of this model? Explain your feedback answer. (b) [5] From the Stella difference equation in the model, derive the differential equation that Stella numerically simulates (more and more closely as **dt** goes to 0). State, but do not solve, the differential equation.



Zebulum_124(t) = Zebulum_124(t - dt) + (- Decay) * dt
INIT Zebulum_124 = 100 {grams}

OUTFLOWS:
Decay = Rate_of_Decay*Zebulum_124 {grams/year}

Rate_of_Decay = 35/10000 {grams/gram/year}

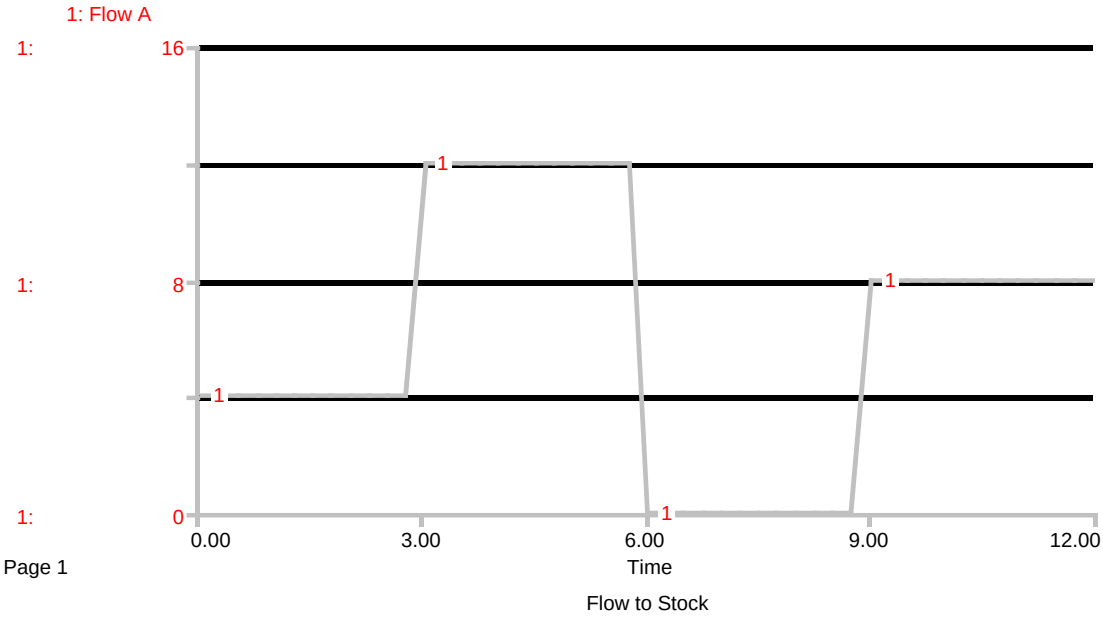
(a) Type your response here.

(b) Type your derivation here.

(5) [10] Below is the graph of the flow (Flow_A) into a stock (Stock_A). The equation that defines the flow is

Flow_A = 4 + STEP(8,3) - STEP(12,6) + STEP(8,9)

You are given that the initial value of Stock_A is 12. Carefully sketch the corresponding graph of Stock_A on the axes below. You will need to sketch the stock graph on a paper copy of the flow graph. Be sure to put an appropriate scale for the stock on the vertical axis.


1: Flow A
1:
16
1:
8
1:
0
1
1
1
1
0.00
3.00
6.00
9.00
12.00
Time
Page 1
Flow to Stock