

# Bioengineering 498A: Systems and Synthetic Biology

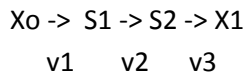
January 23, 2009

Homework Assignment #3

Due: 30<sup>th</sup> January 2009

Points awarded for each question are indicated in square brackets. Return assignment with your name clearly indicated at the top of your answer sheet. [Total points: 100]

[50] **Question 1.** Consider the following network:



Where  $X_0$  and  $X_1$  are fixed species. The rate laws for the three reactions are, respectively:

$$v_1 = k_2 - k_3 * S_1$$

$$v_2 = k_1 * S_1 * S_1 * S_1 - k_0 * S_1 * S_1 * S_2$$

$$v_3 = k_5 * S_2 - k_4$$

The values for the rate constants are:

$$k_0 = 4.2$$

$$k_1 = 1.9$$

$$k_2 = 0.003$$

$$k_3 = 5.8$$

$$k_4 = 4.4$$

$$k_5 = 0.5$$

(a) Write the differential equations for the  $S_1$  and  $S_2$

(b) Find the  $(S_1, S_2)$  values for the two stable steady states and given an estimate of the  $(S_1, S_2)$  values for the unstable state. Hint: they are located somewhere in the range  $S_1 = [0, 4]$  and  $S_2 = [0, 20]$ . Describe the procedure you used (you may use any software that you like).

(c) Change the parameter  $k_0$  and observe changes in the steady states. What is the bifurcation point when you vary the parameter  $k_0$ ? Describe the procedure you.

[50] **Question 2.** Design and simulate a gene network that generates three pulses in sequence (Pulse train) separated by a suitable time interval in response to a step function at an input gene.