

Homework 4

2.18/2.180

Due Wednesday March 11 at beginning of class

Problems with a star (*) are for graduate students only.

Problem 1: Consider the positive autoregulation circuit of Figure 2.17(a) with no leakiness. For this system, answer the following questions:

- (i) (3 points) Determine the number of equilibria as the key parameters α , K , γ , δ , n are changed.
- (ii) (3 points) Using nullcline analysis, determine the stability of the equilibria.
- (iii) (3 points) This system always has an equilibrium point at zero. Using linearization, determine the stability of this equilibrium and how this stability changes when key parameters are changed.
- (iv) (3 points) (*) Now assume that the mRNA is at the quasi steady state. Repeat (i)-(ii)-(iii) for this case and compare with the above results.

Problem 2 (*): Consider the gene circuit topology (a) in Figure 3.24. Model the system neglecting the mRNA dynamics (QSSA).

- (i) (1 point) Determine the number and stability of steady states and how the parameters control them.
- (ii) (3 points) Include the mRNA dynamics back in the model. How do your answers to the above questions change? Specifically: determine whether this changes the number and stability of the steady states.

Problem 3: (3 points) Exercise 3.1.

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2.18 / 2.180 Biomolecular Feedback Systems
Spring 2015

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