

Bioengineering 498A: Systems and Synthetic Biology

Mar 6, 2009

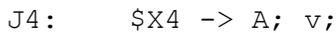
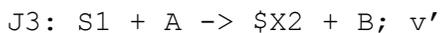
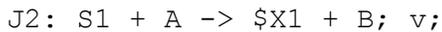
Homework Assignment

Due: 13th March 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]. **All calculations must be shown.**

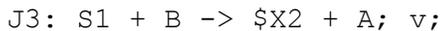
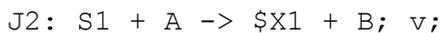
[25] **Question 1.** Prove that (no using Matlab) the following model contains no conserved cycles.

X_0, X_1, X_2 and X_4 are fixed species



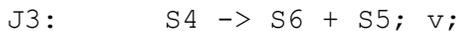
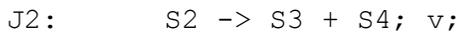
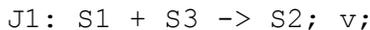
[25] **Question 2.** Derive the N , N_r , L_0 , L and Γ matrices for the following network (without using Matlab):

X_0, X_1 and X_2 are fixed species



[35] **Question 3.**

[25] a) Derive the N , N_r , L_0 , L and Γ matrices for the following network (without using Matlab):



[5] b) From the information you gather on the Γ matrix for the above network, redraw the pathway showing the composition of each species in terms of the elementary subgroups in the pathway (See slide 6 and 39 for examples).

[5] c) Show how you would use Matlab to derive the conservation laws for this pathway.

[15] **Question 4.** QR factorization is a stable way to factorize any matrix into a set of more elementary forms, Q and R . We can use QR to factorize a stoichiometry matrix, that is $N = Q R$, where Q and R have the following structures. The row dimensions of Q_{11} and Q_{21} correspond to the row dimensions of N_r and N_o respectively.

$$Q = \begin{bmatrix} Q_{11} & Q_{12} \\ Q_{21} & Q_{22} \end{bmatrix} \quad \text{and} \quad R = \begin{bmatrix} U \\ 0 \end{bmatrix}$$

Show that the application of QR factorization to the stoichiometry matrix lead to the following result (You can assume that Q_{11} is invertible):

$$L_0 = Q_{21} Q_{11}^{-1}$$