ChE 310 S19 Exam 2 **Free Response** **NAME___________________**

[ONLY course webpage should be accessed online. Closed Internet, messaging resources, email, etc.]

Save each as separate m-files. Place name in header comments. Zip all files and submit to course website at end of class as a single file with your name in the filename. Turn in this sheet to the instructor when finished.

Free Response 1: Jared Dopp (one of Dr. Reuel's graduate students) has run experiments to determine the optimal growth time and time exposed to induction[1] agent for a special type of *E. coli* cells to produce high performing cell extract for his graduate thesis work. He fit this data to the following model:

$$Measured\ Output = -6.2 \times 10^6 + (2.2 \times 10^6)x_1 + (4.7 \times 10^5)x_2 - (1.9 \times 10^5)x_1^2 - (1.6 \times 10^5)x_2^2$$

Where x_1 is the cell extract growth time and x_2 is the induction time.

Part 1 – Create a contour plot of this model within the experimental ranges used (5 to 7 hours for growth time and 1 to 2.5 hours for induction time). Don't forget labels!

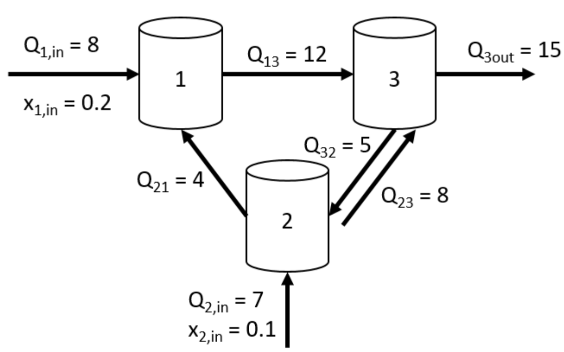
Part 2 – Find the optimal conditions for maximum measured output within the ranges of the data used for the plot above. Display the following to command line with accompanying text:

- Optimal growth time
- Optimal induction times
- Expected measured output at these values

Also plot the optimal point from Part 2 by placing any marker on the contour plot in Part 1.

Free Response 2:

Consider the below series of reactors at steady state:



Total mass flow rates are given by Q_{ij}, and x_i denotes the mass fraction of component x in tank i.

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[1] Induction = adding a small molecule to the cells that triggers them to make an encoded protein, in this case an encoded chaperone protein

(A) Write the mass balance equations for component x in each of the three reactors. Turn these in on paper or as comments in your m-file.
(B) Solve for the mass fractions x_1, x_2, and x_3.
(C) What increase in mass fraction $x_{1,in}$ to tank 1 must be added to increase the steady-state mass fraction x_2 in tank 2 to 0.21?

Free Response 3:

Consider a series reaction in a batch reactor: $A \overset{k_1}{\rightarrow} B \overset{k_2}{\rightarrow} C$ with rate constants k_1 and k_2. We have an old sensor that can only measure component B. The sensor is not very precise, so there is a variance in the measurements.

The concentration of component B (C_B) at a given time t can be derived from a rate expression:

$$C_B = \alpha\left(e^{-k_1 t} - e^{-k_2 t}\right)$$

where α is a constant ($\alpha = -6.25$).

(A) Use the data provided in FR3.xlsx (on the course webpage) to determine the values of k_1 and k_2.
(B) Report the 95% confidence intervals for k_1 and k_2, and the coefficient of determination.
(C) Use your results to determine the two values of t at which $C_B = 1.25$. If you did not obtain an answer for part (A), you may use $k_1 = 0.15$ and $k_2 = 0.03$.