EN.580.441/EN.580.641 Cellular Engineering HW #2
Assigned: Sept. 18 **Due: Sept 27**

Question #1

Instructions:
In this homework you will reproduce a classic cellular engineering model used to analyze ultrasensitivity, a key cellular process that enables a switch-like response. The article is: "Ultrasensitivity in the mitogen-activated protein kinase cascade" by Huang CF and Ferrell JE in PNAS 93: 10078-10083, 1996. The article PDF and main code to implement the model are provided, but you need to add a section to make plots and to determine Hill Coefficients. By implementing and perturbing this computational model, you will be able to simulate biomolecular kinetic phenomena. The perturbation is a modification that you make to the code to see how it changes the model. Your perturbation could be something such as changing rate constants, changing concentrations, altering a pathway, adding a new pathway, adding new inhibitors, deleting an enzyme, etc. Your perturbation is your choice and creativity is encouraged.

Submit through blackboard:

1. A 1-1.5 page write up (single spaced, 12 pt font, not counting figures) that includes the following:
   a. Brief Introduction – What was the experiment and why is it important?
   b. Model – What are the biological reactions and how are they implemented as a computational model? What are the assumptions?
   c. Reproduction of Figure 2 – Including a text description of what the graphs demonstrate and the calculated Hill Coefficients / curves overlaid.
   d. Species vs. time – Including a text description of how the concentration of the main enzymes (MAPK-PP, MAPKK-PP, MAPKKK*, MAPK, MAPKK, MAPKKK) change over time.
   e. Modification(s) to the model – What did you change and why?
   f. Results – What do your perturbations show?
   g. Conclusions – How good is the model? What are its limitations?

2. Plots/graphs (On extra pages after the write-up)
   a. Both graphs reproducing Figure 2 from the paper
   b. Species vs. time graph
   c. Between 1-5 additional graphs depending on your perturbation(s)
   d. A figure caption under each graph that fully describes the figure

3. Commented MATLAB code so that the TAs may execute it and read it.