MATH 336: Homework #7

Due: Tuesday, November 7, 2017

Solve the below problems concerning ordinary differential equations. A (possibly improper) subset of them will be graded. All calculations should be done analytically, unless marked with an (M). (M) problems require the use of MATLAB. ES denotes the online lecture notes.

1. (30 points) (ES, p.146, #1, **parts (a)-(e) only**) Problem 1 in the ODE6 section of the notes (end of chapter 2), **parts (a)-(e) only**. However, if you'd like to attempt part (f), I will give up to 10 bonus points. However, it is challenging, and a bit more theoretical than what we have covered as of yet.

2. (20 points) (ES, p.146, #2) Problem 2 in the ODE6 section of the notes (end of chapter 2).

3. (15 points) (ES, p.146-147, #3) Problem 3 in the ODE6 section of the notes (end of chapter 2). *Note:* The stoichiometry matrix Γ is quite large here, so if you'd like to use MATLAB to help you for part (b), I'm fine with that.

4. (15 points) (ES, p.148, #6) Problem 6 in the ODE6 section of the notes (end of chapter 2).

5. (20 points) (M) Consider the basic elementary reaction for enzyme-substrate dynamics:

$$S + E \underset{k_{-1}}{\overset{k_1}{\rightleftarrows}} C \xrightarrow{k_2} P + E$$

We will study this reaction (and simplifications) in detail, but for now just consider the full system. Assume that the kinetic rate constants are given by $k_1 = 2/(g/L \cdot s)$, $k_{-1} = 1/s$, and $k_2 = 1.5/s$. Numerically solve (plot the results) the corresponding system of ODEs on the time interval $[0, 10]$ seconds, subject to the initial conditions $S(0) = 8$ g/L, $E(0) = 4$ g/L, and no initial substrate-enzyme complex (C) and product (P). **Describe the behavior you observe from your numerical solution.** *Hint:* Remember, you do NOT need to solve the full four-dimensional system, but instead can use conservation laws to reduce to a planar system (see p.73 of the notes ES for the explicit system). You can use the previous few assignments' MATLAB questions (and solutions) to write ALL of the code. At this point, you should be able to generalize enough to solve an arbitrary system of ODEs.