Introduction to Applied Mathematics

MA 325 Assignment #2

DUE Date: March 18, 2015

A. Successful HCV treatment also called sustained virology response (SVR) is defined as a patient's viral load below the lower limit of quantification at a follow-up evaluation at 24 weeks after the completion of the treatment. On the other hand, patients who do not attain SVR, the viral load either rebounds to pretreatment levels during the therapy (partial virology response (PVR) or breakthrough (undetectable viral load followed by increase during treatment)) or returns to pretreatment levels upon cessation of therapy (relapse).

Consider the following mathematical model for HCV viral kinetic with interferon-α therapy (ϵ) that was discussed in class:

$$\begin{aligned} \frac{dT}{dt} &= s - dT - \beta VT \\ \frac{dI}{dt} &= \beta VT - \delta I \\ \frac{dV}{dt} &= (1-\epsilon)pI - cV. \end{aligned}$$

1. Implement the above model in SimBiology with the initial conditions $T(0) = 1.4984e+06$, $I(0) = 0.4724e + 06$, $V(0) = 4.3881e + 06$ and parameter values $\beta = 4.1684e - 09$, $\delta = 0.1211$, $p = 25.1$, $c = 2.7018$, $\epsilon = 0.61382$, $s = 61.7e + 3$, $d = 0.003$. Simulate the solutions for 336 days and describe the results. Is the treatment successful?
2. Repeat part 1. with the initial conditions $T(0) = 0.9167e + 06$, $I(0) = 0.1009e + 06$, $V(0) = 5.3591e + 06$ and parameter values $\beta = 1.2e - 08$, $\delta = 0.58411$, $p = 25.1$, $c = 0.47268$, $\epsilon = 1.0$, $s = 61.7e + 3$, $d = 0.003$.

B. Write a summary (one to two page) of this module.

Notes:

(i) Your write-up should include, among other things, the differential equations that you exported from SimBiology for each problem, the plots for each simulation, and your responses to the question.

(ii) Since I will be on travel the week of March 16th, please turn in hard copy of your assignment in class on the due date (i.e., do not email me the assignment like you did with the first assignment).