

Homework #9
Due: Feb 3, 2015

1. (M) pg 241 ex. 10
2. Consider the specific neutrophils-G-CSF model :

$$\frac{dg}{d\tau} = \frac{a_1}{n+0.1} - \left(a_2 + \frac{a_3 \cdot n}{n+0.1}\right) \cdot g,$$
$$\frac{dn}{d\tau} = a_4 \cdot \left(\frac{1+0.01 \cdot a_5 \cdot g}{1+0.01 \cdot g}\right) - n.$$

where $a_1 = 0.5, a_2 = 1.4, a_3 = 0.5, a_4 = 1, a_5 = 6$

- (a) Find the qualitative behavior of the null-clines: show that they are monotone and can cross only once. Discuss the robustness of this statement as the parameters are varied.
 - (b) Find the fixed point and its stability - this fixed point corresponds to homeostasis.
 - (c) Prove that there can be no limit cycles in this system.
 - (d) Bonus: See Shochat et al. 2007 and 2008 and Malka et al. 2012 for axiomatic model construction, motivation, analysis and implications. By now there are new variants to the G-CSF injections - find how the model parameters should be changed to reflect their properties. Find how circadian oscillations in G-CSF change the systems behavior.
3. Bonus: pg 240 ex 9