Last updated on March 23, 2026

BM5063 Mathematical Physiology and Systems Medicine

Problem Set 4

Instructions

1. You are not expected to submit answers to these problems
2. *How to approach this problem set:* Questions may not have a unique answer here. Try working on them to explore the scenario described by developing a model carefully. Identify the variables and parameters, fast and slow variables, simplifying assumptions, and generalizations.

Questions

1. In class, we used a simplified version of the equations for HPA axis dynamics (we did not consider Hills function based formulation).
   (a) Rewrite all equations using Hill's functions
   (b) Write `Python` program to simulate this detailed model.
2. Using the `Python` program developed in the previous question, simulate the scenario of
   (a) chronic stress
   (b) sudden removal of steroid supplements
3. Using the `Python` program developed in the first question, simulate the dynamics if the external input is time-dependent.
   (a) It is high at morning and low in the evening
   (b) Duration of the day increases over a priod of an year

   Which of the above can have an effect on the gland-size dynamics?
4. In the HPG axis in females, there is a switch of the feedback loop from positive to negative at high estrogen levels. This switch involves two neuronal populations in the hypothalamus. Modify the model to incorporate this effect and write a `Python` program to study this system.
5. For HPS axis, write down equations for changes in the receptor-sensitivity along with hormonal and gland size dynamics.