



PhD Comprehensive Exam - When Zombies Attack!

Date: Wednesday, May 25, 2022

Time: Distributed at 9:00AM

Duration: 24 hours

Location: Take home exam

Misc: Computer with an installed programming language like Matlab is required

Note: While this is a pharmacoengineering exam, it is structured so as to be more general, with primary coverage focused on basic systems modeling. The expectation is that any engineering student should have the basic mathematical background needed to successfully answer the exam questions.

Materials

The exam is open book and take home. You will need a computer, with a programming language such as Matlab installed, as well as knowledge of how to use this language to solve systems of differential equations and plot results.

General Information

This exam focuses on fundamental modeling concepts and skills. While there will likely be fundamental modeling-related questions on more than one system, the bulk of the exam will focus on the provided paper (When zombies attack!: Mathematical modeling of an outbreak of zombie infection. Munz et al., 2009). This paper includes Matlab code to simulate some of the dynamics described in the paper. You should be able to understand the paper sufficiently such that you can modify or extend the model so that you can simulate new scenarios and/or make new predictions with your own code. While the bulk of the exam focuses on this paper, there is a question (not about zombies) but that still looks at solving basic ordinary differential equations.

You can use Matlab, Python, Mathematica or any other language to solve questions given to you during the exam. Therefore, you will need to have a computer with the appropriate software for the exam. ***You can have whatever code/simulations you want related to the zombie infection paper (or anything else) already completed on your computer before the exam. You will, in part, be expected to be able to use, edit, modify or otherwise use this code to help you answer exam questions.*** Code, diagrams, plots and any text responses will be expected to be turned in as part of your answer. You are encouraged to look up background information on "SIR models", on which the paper is based. Also, feel free to watch a variety of zombie, monster, disaster, or related movies and think about how these scenarios could be modeled.

General topics and concepts that may be of relevance and you should be knowledgeable of include:

- Solving systems of ordinary differential equations Mass action kinetics
- Michaelis Menten kinetics
- Hill functions
- Steady states