MATHEMATICAL MODELING OF INFECTIOUS DISEASES

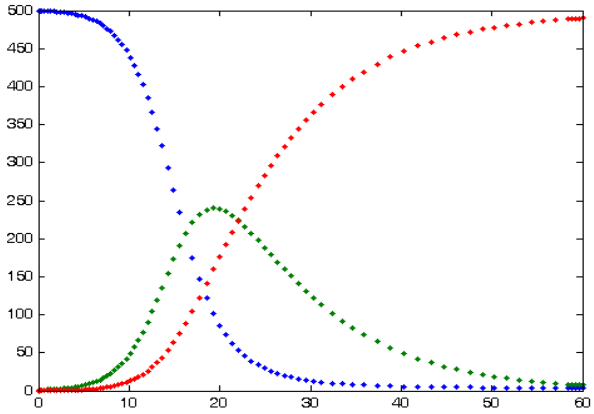
MATH-290-OL, Summer 2008

Instructor: Daniel Maxin

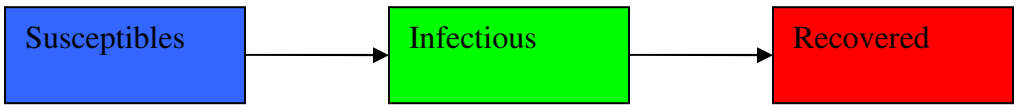
Prerequisites: Calculus 1

Course Description: An application of mathematical methods and concepts to biological processes. The mathematical content is based on differential equations that will be introduced as needed. Topics to be covered include:

- **Single-species population models**. We introduce the exponential and the logistic model and discuss their advantages and limitations. Typical examples are population models with births and deaths and harvest models used in fisheries and invasive species control strategies.
- **Interacting population models:** epidemic models and their role in predicting the outcome of infectious diseases. We will focus on establishing conditions for preventing or eliminating an epidemic and correlate them with several disease-specific assumptions: recovery, immunity, disease-induced mortality, and treatment. Examples of non-recoverable infections are given by HIV, or the genital herpes strain HSV-2, while diseases such as influenza provide recovery but may also increase the mortality depending on the infectious strain.



Example: *A standard model of an infectious disease that provides complete recovery. The peak of the epidemic is represented by the maximum size of the infectious class (the green graph).*
One typical question that we will address in this class is: **Under what conditions the epidemic occurs and how many individuals are affected by the disease?**



Class interaction:

- The student-instructor interaction will be entirely online mainly through CourseVU, e-mail and, possibly, voice-chat.
- Your presence in campus will not be necessary or required although you are welcome to set up appointments with me if you happen to be on campus.
- Any work that you turn in (HW, project, etc…) should be sent to me electronically as file attachment to an e-mail. If you really want to work the HW by hand you can send the assignments through US-mail (instructions will be provided)
- No textbook is required although I will recommend several books when the class starts for those who want to go deeper in the subject area. The study material will be uploaded through CourseVU and it will provide the theoretical background for you to study together with a set of solved examples. A Calculus Textbook might be also helpful as a reference during the course especially for those of you who need a refresher on derivatives and integration techniques.

Technical requirements

- Computer access with an Internet connection (required)
- Scanner, printer, speakers and a microphone (optional)

I intend to keep these requirements to a minimum. Although the class requires a computer system to analyze differential equations systems, these programs will be available for free from the Internet (details will be provided). You do, however, need a reliable Internet connection. Also helpful, but not required, is a set of speakers and a microphone in case I decide to hold an online voice chat

Mathematics Content

- Calculus, Differential Equations and some elementary matrix algebra.

Although Calculus 1 is a prerequisite I will set aside the first week or two for an extensive review of the most important concepts from Calculus that you will need in this course. Ordinary Differential Equations and Systems will be introduced as needed throughout the course in the context of modeling population and epidemic models.

Grade

Your grade will be based on weekly homework assignments and, possibly, a final project.

Recommended books:

(for those of you who wish to study more on this subject)

- Any Calculus Textbook, especially those designed for Life Science majors such as: ***Modeling the Dynamics of Life*** by F.R. Adler.
- ***Elements of Mathematical Ecology***, by Mark Kot is another good introductory book in Mathematical Biology.