Math 2241: Mathematical Modeling of Biological Systems

Prerequisites: Math 1241, 1271, or equivalent

Credits: 4

Catalog description: Development, analysis and simulation of models for the dynamics of biological systems. Mathematical topics include discrete and continuous dynamical systems, linear algebra, and probability. Models from fields such as ecology, epidemiology, physiology, genetics, neuroscience, and biochemistry.

Course objectives:

1. Introduce the connections between biological questions and mathematical concepts.
2. Develop the mathematics of dynamical systems, linear algebra, and probability through modeling biological systems.
3. Explore the utility of using mathematical tools to understand the properties and behavior of biological systems.
4. Develop facility in interpreting mathematical models and the conclusions based on the models.

Course topics:

1. *Class-structured models*
multi-dimensional linear discrete dynamical systems
matrix equations and eigenvalues of matrices
age-structured models for population dynamics

2. *Two-dimensional continuous dynamical systems*
equilibria and nullclines
phase plane analysis
stability of equilibria
partial derivatives
models of infectious diseases, neurons, competition and predation

3. *Diffusive processes*
interpretation of partial differential equations
the diffusion equation
models of dispersal

4. *Networks*
metabolic networks or genetic networks

5. *Probabilistic modeling*
probability distributions, independence, conditional probability, random variables
probabilistic inference
population genetics

6. *Modeling philosophy*
development of a mathematical model
appropriate use and limitations of mathematical models