Math 1241
Calculus and dynamical systems in biology

Prerequisites: 4 yrs high school math including trig or satisfactory score on placement test or grade of at least C- in [1151 or 1155]

Credits: 4

Tentative Text: Modeling the Dynamics of Life: Calculus and Probability for Life Scientists, Third Edition, by Frederick Adler

Catalog description: Differential and integral calculus with biological applications. Discrete and continuous dynamical systems. Models from fields such as ecology and evolution, epidemiology, physiology, genetic networks, neuroscience, and biochemistry.

Course objectives:

1. Introduce the connections biological questions and mathematical concepts.
2. Develop the mathematics of calculus and dynamical system 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. *One-dimensional discrete dynamical systems*
cobwebbing, equilibria, long versus short-time behavior
stability of equilibria

2. *Differentiation*
continuity and differentiability
tangent line, limit definition of derivative
derivative of basic functions: polynomials, exponentials, sinusoids
brief overview of methods of differentation: product, chain rules
second derivative
partial derivative of function of two variables

3. *Optimization and root finding*
intermediate and extreme value theorems

4. *Integration*
indefinite integral as solution to ODE
basic anti-derivatives: polynomials, exponentials, sinusoids
definite integral as change in solution to ODE
definite integral as signed area under curve
fundamental theorem of calculus
Euler's method as approximate solution of ODE and numerical integration

5. *1D Ordinary differential equations*

exponential as solution to linear ODE
steady states and stability

6. *Linear algebra*
matricies and determinants
eigenvectors and eigenvalues

7. *Two dimensional dynamical systems*
equilibria and stability
phase plane, direction field, nullclines

8. *Partial differential equations*
recognition of meaning of terms in a PDE