ENTOMOL 6704
Systems Analysis, from Molecules to Ecosystems

Coordinating Instructor: Dr. Casey W. Hoy, Professor of Entomology
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Lectures: 1/week, 1 hr lecture
Laboratories: 1/week, 2 hr lab

Prerequisite: A course in Calculus. Credit Hours: 2 semester hours

Course Description and Objectives: This course presents the theory and practice of systems analysis relative to entomology and applied ecology. Systems analysis is an important tool to biologists for two reasons. First, it provides the techniques necessary to construct and test very complex hypotheses about biological processes from molecular levels to population dynamics in managed and natural ecosystems. Because these systems and processes are inherently complex, a well-organized quantitative approach is often required to generate a useful understanding of them. Second, it provides a way to package an understanding of the system in a useful way, a quantitative analysis that can be used to make predictions that help in making management decisions. After taking the course students should:
1.) Understand the systems approach and its use in entomology. Students should be able to use systems analysis to organize their own research.
2.) Be aware of the important literature pertaining to quantitative approaches in entomology, and know where to look for more information.
3.) Have a broad understanding of the important mathematical techniques used in modeling insect sub-organismal, organismal, population, and ecosystem level processes and decision making in insect pest management.
4.) Have a detailed knowledge of, and experience with using, some key mathematical tools such as simulation of population dynamics, agent-based modeling, spatial and long term temporal analysis, and decision support systems.
5.) Be able to communicate more effectively with researchers in quantitative fields.
6.) Gain new insights into their own or other's research.

Course Grading
First Exam 15%
Second Exam 15%
Laboratory Exercises 30%
Systems Analysis Project 40%
100%

No single text, readings to be assigned

Lecture Topics Week (approx.)
1. The Systems Approach in Entomology Rationale, Goals

1
The role of systems analysis in IPM and Agroecosystems Management
Models and the scientific method

2. Qualitative Modeling
   Define the problem (goals)
   Concept and assumptions
   Methods for describing systems

3. Quantitative Modeling
   Defining systems mathematically
   Equations and solutions
   Analysis

4. Parameter estimation
   Curve Fitting and Function Optimization
   Neural Networks

5. Modeling sub-organismal processes
   Enzyme kinetics
   Physiological modeling

6. Spatial Effects and Modeling Individual Behavior
   Individuals/unit area as the state variable
   Location of individuals as the state variable

7. Object-based and Agent-based modeling

8. Modeling Insect Population Dynamics
   Defining states
   Describing rates
   Predicting population change

9. Modeling Insect-Microbe interactions
   Predation
   Parasitism
   Epizootics, plant disease epidemics

10. Modeling Insect evolutionary Processes
    Evolutionary change
    Insecticide resistance

11. Random effects and Monte Carlo methods

12. Insect Pest Management Models
    Economic threshold models
    Optimization models
    Linear Programming
    Dynamic Programming
Heuristic Programming

13. Ecosystem modeling and design

14. Case Studies, Future challenges, and Opportunities

**Laboratory Topics**

In general, laboratories will be designed to give the student hands-on experience with modeling entomological processes at various scales, from molecular to ecosystem. The laboratory section will be used for exercises in constructing, using and analyzing mathematical models and case studies in entomological research. Students will be provided with the necessary software for each of the exercises. Laboratory reports will be required each week consisting, except where otherwise noted, of a written discussion of the laboratory exercise and questions posed by the instructor. Exercises will also serve to assist students with their course project, requiring their own systems analysis applied to a topic of their choice.