**A. NUMBER AND TITLE:** ENV 450 Environmental Computer Applications

**B. DEPARTMENT OF**: Environmental Science and Geography

**C. PREPARED BY**: Dr. R. McCallum
Dr. R. Pardi
Dr. S. Vail

**D. NUMBER OF CREDITS:** 4

**E. REASONS FOR OFFERING COURSE:** The use of computer-based mathematical models and problem-solving methods are ubiquitous in environmental science. All students are briefly introduced to these topics in introductory courses. This course offers a more in-depth experience and development of knowledge at the upper level for students who are likely to use these methods in graduate school or in their professional careers.

**F. PREREQUISITES:** One year of environmental science

**G. COURSE DESCRIPTION:** This course examines the application of mathematical computer simulation to the solution of environmental problems. The general development of computer models is reviewed as well as their specific use. The student employs working simulation models in the analysis of actual case studies while critically evaluating and comparing the results of different models for particular problems. Familiarity with basic principles of computer operation are expected of the student.

**H. COURSE OBJECTIVES:** To give the student working knowledge of the principles of mathematical/computer modeling as applied to the solution of environmental problems. To give the student hands-on experience with the use of various computer applications for this purpose. To develop the student's ability to critically evaluate published analyses of environmental problems involving the use of computer modeling methods.

**I. COURSE CONTENT:**

<u>PART I: Simple Model Equations</u>

1. General principles of mathematical modeling and problem solving
2. Introduction to computer tools: spreadsheet calculations, BASIC programming language, and systems modeling software (e.g., STELLA).
3. Analytical models based on differential equations: simple examples of population growth, Newton's law of cooling, diffusion, chemical kinetics.
4. Analytical models based on stable states: simple equilibrium models in population biology, and environmental chemistry.
5. Estimating model coefficients from experimental data: regression.
6. Principles of computer programming: flowcharting and basic structures

7. Numerical solution of rate equations.

PART II: Models with Multiple Components

8. Chemical kinetics of bimolecular, sequential, and autocatalytic reactions
9. Models of ecological populations and communities
10. Hydrologic models
11. Compartmental models of biogeochemical cycling
12. Diffusion models
13. Stochastic models
14. Advanced topics in modeling
15. Analysis of current environmental problems
16. Analysis of current environmental problems

**J. TEACHING METHODS:** Lecture and computer laboratory exercises, including problem-solving assignments and a longer student project.

**K. EVALUATION OF STUDENTS:** Midterm and final examinations, regular problem-solving assignments, and a longer student project.

**L. ASSESSMENT OF STUDENT LEARNING OUTCOME OBJECTIVES:**

**5b-**demonstrate competency in the use of computer packages for the presentation and analysis of data.

**2-**organize and synthesize scientific information into logical sequence and communicate same.

**M. SUGGESTED TEXTBOOKS**:

Harte, John. 1985. Consider a Spherical Cow: a course in environmental problem solving. W. Kaufmann.

Hannon, Bruce and M. Ruth. 1994. Dynamic Modeling. Springer-Verlag.

Keen, Robert E. and James D. Spain. 1992. Computer Simulation in Biology: a BASIC Introduction. Wiley-Liss.

**N. PERTINENT REFERENCES:**

Arnold, V. I. 1981. Ordinary Differential Equations, 3rd Edition. MIT Press.

Berg, H. C. 1993. Random Walks in Biology, Expanded Edition. Princeton University Press.

Bulmer, M. 1994. Theoretical Evolutionary Ecology. Sinauer Associates.

Campbell, S. L. 1986. An Introduction to Differential Equations and Their Applications,2nd Edition. Wadsworth Publishing Co.

Edelstein-Keshet, Leah. 1988. Mathematical Models in Biology. Random House. New York.

Goel, N. S. and N. Richter-Dyn. 1974. Stochastic Models in Biology. Academic Press.

Hoppensteadt, F. C. 1982. Mathematical Methods of Population Biology. Cambridge University Press.

Jordam, C. 1965. Calculus of Finite Differences. Chelsea, New York.

Murray, J. D. 1989. Mathematical Biology. Springer-Verlag.

Okubo, A. 1980. Diffusion and Ecological Problems: Mathematical Models. Springer-Verlag.

Roughgarden, J. 1979. Theory of Population Genetics and Evolutionary Ecology: An Introduction. MacMillan Publishing Co.

Segel, L. A. 1984. Modeling dynamic phenomena in molecular and cellular biology. Cambridge University Press.

Vandermeer, J. 1990. Elementary Mathematical Ecology. Krieger Publishing Co.

Wilson, E. O. and W. H. Bossert. 1971. A Primer of Population Biology. Sinauer Associates.

Yodzis, P. 1989. Introduction to Theoretical Ecology. Harper and Row Publishers.

Zill, D. 1993. A First Course in Differential Equations with Applications, 5th Edition. PWS Publishing Co.

## O. PROJECTED COSTS:

Software Licenses: $2000