Department of Physical and Environmental Sciences  
University of Toronto Scarborough  
1065 Military Trail Toronto,  
Ontario Canada M1C 1A4

The VisSim Free Academic Program Team,  
Visual Solutions, Altair Engineering, Inc  
59 Lowes Way, Suite 403  
Lowell, MA 01851

September 20, 2017

To whom it may concern:

This is a letter to verify that ________________ is a student enrolled in a course, “Fundamentals of Ecological Modelling” offered at the Department of Physical & Environmental Sciences, the University of Toronto Scarborough, Ontario, Canada. We have already obtained the Free Academic Program (FAP) for the VisSIM/Embed for our computer laboratory systems, which will be used only for non-profit purpose in the course activities, including in-class work, assignments, and exams.

Students in this course will be often required to work outside of the lab for their assignments throughout the semester. Please provide him/her a FAP VisSIM/Embed licence, so he/she can complete their assignments using his/her personal computer at home.

Sincerely,

George Arhonditsis  
Chair, Department of Physical & Environmental Sciences,  
University of Toronto Scarborough  
Office: 416-208-4858  
E-mail: georgea@utsc.utoronto.ca
Master of Environmental Science Program

FUNDAMENTALS OF ECOLOGICAL MODELLING [EES1118]
Thursday 10:00-13:00 [Computer Lab BV471]
Instructor/E-mail address: Alex Neumann, alex.gudimov@mail.utoronto.ca
Yuko Shimoda, yshimoda@utsc.utoronto.ca
Office hours: Tuesday and Thursday 1:30 pm to 2:30 pm, Office 568

COURSE DESCRIPTION & OBJECTIVES
This graduate course provides an introduction to the rapidly growing field of environmental modelling. Students should become familiar with most of the basic equations used to represent ecological processes. The course will also provide a comprehensive overview of the population and dynamic biogeochemical models; prey-predator, resource competition and eutrophication models will be used as illustrations. Emphasis will be placed on the rational model development, objective model evaluation and validation, extraction of the optimal complexity from complicated/intertwined ecological processes, explicit acknowledgment of the uncertainty in ecological forecasting and its implications for environmental management. The course will also involve practical training in the computer lab. Students will have to develop an intermediate complexity mathematical model, calibrate the model and assess the goodness-of-fit against observed data, identify the most influential model parameters (sensitivity analysis), and present their results.

SCHEDULE
Sep 14  ORIENTATION
Course Outline; Lecture Schedule
INTRODUCTION
Models as a Management Tool
Models as a Scientific Tool
Modelling Elements
The Modelling Procedure
Selection of Model Type
Selection of Model Complexity and Structure
Evaluation of the Current State of Mechanistic Aquatic Biogeochemical Modelling

Sep 21  MODELLING POPULATION DYNAMICS (PART I)
Basic Concepts
Growth Models in Population Dynamics
Single Population Growth
Interaction between Populations
Lotka-Volterra Equations
Interspecific Competition
Prey-Predator Models

Sep 28  MODELLING POPULATION DYNAMICS (PART II)
Minimal Models for Solving the "Paradox of Plankton"

Oct 5  CATASTROPHIC SHIFTS IN ECOSYSTEMS
Theoretical Framework: Ecosystem Response to Gradually Changing Conditions. Examples: (i) Lakes; (ii) Woodlands; (iii) Deserts; (iv) Coral reefs; (v) Oceans. Implications for Management.
Modelling Catastrophic Shifts in Ecosystems

Oct 12  EUTROPHICATION AND STATIC MODELS (PART I)
Simple Eutrophication Models
Oct 19  EUTROPHICATION AND STATIC MODELS (PART II)
Simple Eutrophication Models

Oct 26  EUTROPHICATION MODEL-PROJECT DESCRIPTION
Model Parameterization
Data Description for Model Calibration
Project-Specific Assignments

Nov 2  MASS BALANCE & STREEPER-PHELPS MODEL
Mass Balance
  Mass Balance for a Well Mixed System
  Mass Balance for a Non-Well Mixed System
Streeter-Phelps Model
  The Organic Production/Decomposition Cycle
  The Dissolved Oxygen "Sag"
  Point-Source Streeter-Phelps Equation
Analysis of the Streeter-Phelps Model
Parameterization of Distributed Sources
  Total Streeter-Phelps Model

Nov 9  BASIC MATHEMATICAL TOOLS
Truncation Errors and the Taylor Series
Error Propagation and Total Numerical Error
Ordinary Differential Equations
  Euler’s Method-Runge Kutta Methods

Nov 16  PHYSICAL PROCESSES
Partial Differential Equations
  Space and Time Resolution
Mass Transport
  Advection
  Diffusion & Turbulent Diffusion
  Dispersion
Mass Transfer at a Two-Phase Interface

Nov 23  UNCERTAINTY ANALYSIS OF MATHEMATICAL MODELS
Equifinality and Uncertainty in Mathematical Models:
  A Comparative Analysis of the Generalized Likelihood Uncertainty Estimation and Markov Chain Monte Carlo
  Methodologies

Nov 30  SENSITIVITY ANALYSIS & OPTIMIZATION
Sensitivity Analysis
  First-Order & Monte Carlo Analysis
Optimization
  One-dimensional Unconstrained Optimization
  Multi-dimensional Unconstrained Optimization
  Constrained Optimization

EVALUATION
Modelling Project  30 %
Final Examination  30 %
Mid-Term Project  30 %
Class Participation  10 %

Evaluation will be carried out in accordance with the Graduate Grading and Evaluation Practices Policy (and how that policy is interpreted and applied in this Dept.) The University of Toronto, School of Graduate Studies, 2011-2012 Calendar, pages 56 to 59 explains that policy in detail.

EMERGENCY PLANNING
Students are advised to consult the university’s preparedness site (http://www.preparedness.utoronto.ca) for information and regular updates regarding procedures relating to emergency planning.

ACCESSIBILITY NEEDS
The University of Toronto is committed to accessibility. If you require accommodations for a disability, or have any accessibility concerns about the course, the classroom or course materials, please contact Accessibility Services as soon as possible: http://discover.library.utoronto.ca/services/services-for-people-with-disabilities or http://studentlife.utoronto.ca/accessibility.
PLAGIARISM
University of Toronto code of Behaviour on Academic Matters states that "it shall be an offense for a student knowingly: to represent as one's own any idea or expression of an idea or work of another in any academic examination or term test or in connection with any other form of academic work, i.e., to commit plagiarism."
For accepted methods of standard documentation formats, including electronic citation of internet sources please see the U of T writing website at: http://www.writing.utoronto.ca/advice/using-sources/documentation
The full Code of Behaviour regulations could be found from consulting http://www.sgs.utoronto.ca/current/calendar/regulations16.asp

WRITING AND ENGLISH LANGUAGE
As well as the faculty writing support, please see English Language and writing support at University of Toronto: http://www.sgs.utoronto.ca/english/ and http://www.writing.utoronto.ca/advice Students have commented that they found the latter address extremely helpful for writing term papers.
The following are also useful:

LATE WORK
All assignments are due in class at the specified time and date. Late submission will result in a 5% deduction (of each assignment’s total grade) per business day, excluding weekends. In the case of illness or other special circumstance, notification should be given to the instructors and the Program Office as soon as possible and before the deadline in question. Late work submitted after the final day of classes, is not acceptable without prior written permission from the Instructor.

READINGS
The required textbook for this course is:
Specific readings will also be given out during the lecture and/or practical sessions.

FINAL EXAM DATE
The final examination involves the oral presentation of the modelling projects, i.e., there is no written exam. The date will be decided after discussion in class.