## CEE 9695B SPECIAL TOPICS IN CIVIL & ENVIRONMENTAL ENGINEERING: DATA ANALYSIS AND MODELLING ENVIRONMENTAL SYSTEMS

**Description**

This case study-format course demonstrates the application of theory to environmental and chemical engineering. Students will learn an approach and a set of practical steps that will allow them to address environmental engineering problems where data analysis and modelling are key components of successful solutions. The course aims to emphasize an interdisciplinary and interconnected approach to analyzing environmental systems. Emphasis also will be placed on quantitative results interpretation and reporting.

**Prerequisites**

1) Graduate student status or permission of the department
2) Undergraduate-level, basic knowledge in statistics and/or modelling.

Unless you have either the prerequisites for this course or written special permission from your instructor to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

**Note:** It is the student's responsibility to ensure that all Prerequisite and Corequisite conditions are met or that special permission to waive these requirements has been granted by the Program. It is also the student's responsibility to ensure that they have not taken a course listed as an Antirequisite. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

**Corequisites**

None.

**Antirequisites**

None.

**Contact hours**

1 lecture hour and 2 tutorial hours per week, 0.5 course.
We will meet twice a week, once in lecture and once in a seminar/workshop during which

we focus on discussions and on the advancement of your practical skills in quantitative analysis and modelling.

**Instructor**

Dr. K.Kreyman (CMLP 1331), e-mail:   kkreyman@uwo.ca

**Reference texts**

1.Selected chapters from the following textbooks:

C. Reimann, et. al, Statistical data analysis explained, Wiley, ISBN 978-0-470-98581-6 (H/B).

E. Holzbecher, Environmental modelling using MATLAB, Springer. ISBN978-3-540-72936-5.

2. Collection of selected research papers.

**Course notes**

Course notes will be available to students in a printed version or on-line.

**Laboratory**

None.

**Units**

SI units will be used.

**Computing**

The course will require the processing of data using the numerical calculation toll(s) of your choice such as Excel, Matlab or Minitab.

**General Learning Objectives**

The learning objectives of this course are

- to better understand of the basic concepts and applicability of data analysis and modelling when solving environmental engineering problems
- to develop knowledge and skills related to practical analysis of datasets to solve environmental engineering problems

| Knowledge Base | x | Individual work | x | Economics and project management | n.e. |
|---|---|---|---|---|---|
| Problem analysis | x | Communication | x | Life-long learning | x |
| Investigation | x | Professionalism | x | | |
| Design | x | Impact to society | n.e | | |
| Engineering tools | x | Ethics and Equity | n.e. | | |

n.e.: not evaluated

**Specified Learning Objectives**

The course is developed so as to provide students with the opportunity to use data analysis and mathematical models to explore physical and chemical processes associated with common environmental engineering problems and phenomena. The examples of data analysis and modelling discussed through the course are based mostly on the results of groundwater quality monitoring and contaminant transport in shallow water bodies. However, the methods taught can be applied to solve a broad range of engineering problems.

To apply the theory and to interpret the results students will be supplied with time series data sets of monitoring of the physico-chemical parameters of groundwater; alternatively, students are allowed to select data of their choice (with approval of the instructor). Upon successful completion of this course, students should be able to:

- formulate the purpose of data exploration and to examine the data with the aim of both understanding their general character and spotting problems by applying basic statistical techniques that are important, when first confronted with a new dataset,

- recognize and correct datasets problems/errors such, for example, like data gaps, inconvenient units of measurement and others,

- identify the benefits and limitations of modelling methods in searching for solutions to environmental problems, formulate objectives the modelling can achieve,

- characterize a given system in terms of its essential elements, that are, purpose, parameters, constraints, subsystems, interconnections and environmental context,

- understand principles of model development, solution, calibration and validation, get practice in applying these principles to develop system models searching for solutions to environmental engineering problems,

- understand the various types of models, their applicability and choose mathematical equations to build an appropriate model meeting the established goals,

- apply a set of data analysis and modelling methods and techniques to construct relevant models of environmental systems to propose viable solutions,

- interpret the results of mathematical modelling within the context of its capabilities and limitations to address critical issues in an engineering project,

- judge the practical application of data analysis and modelling environmental system methods and techniques.

**Topics**

The following main topics will be discussed during the course:

- Quantitative vs qualitative methods of research, combination of qualitative and quantitative forms of analysis, building an effective problem statement.

- Analysis of environmental field and laboratory data sets: a process, conceptual foundations, types of data, primary data and secondary sources, application of analytical and statistical approaches to the data analysis including the multivariate statistical and Fourier analysis, developing mathematical models from data.

- Application of system approach to field and laboratory data studies: elements of engineering system analysis and terminology, demarcation of system boundaries, specification of state variables and parameters.

- Describing system mathematically: models and modelling, types of models, stages of modelling, initial and boundary conditions, assumptions in modelling.

- Model results interpreting and reporting: general practices, relational tables and quantitative results presenting.

## Participation

This course is taught interactively. All students should participate in seminars and to help lead discussions.

## Evaluation

2 assignments - 5% each
Seminar presentation - 15%
Modelling project - 25%.
Classroom workshops/seminars - 15%
Exam - 35%

The project requires students to conceptualize, develop, build and test a model, or module for an existing model and interpret the results obtained. Students will be supplied with time series data sets presenting the results of groundwater quality field monitoring or allowed to examine their own data sets (with approval of the instructor).

## Note

(a) Students must receive a passing grade on the final examination to pass this course.
(b) Assignments are to be handed in during class on the specified due date provided by the Instructor.

## Repeating all components of the course

In accordance with Senate and Faculty Policy, students who have failed an Engineering course (i.e. <50%) must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted for grading by the student in subsequent years.

## Use of English

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

## Attendance

Any student who, in the opinion of the instructor, is absent too frequently from class or laboratory periods in any course, will be reported to the Associate Chair (Graduate) (after due warning has been given). On the recommendation of the Department concerned, and

with the permission of the Associate Chair (Graduate), the student will be debarred from taking the regular examination in the course.

### Cheating

University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning (see Scholastic Offence Policy in the Western Academic Calendar).

### Plagiarism

Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar). The University of Western Ontario has software for plagiarism checking. Students may be required to submit their work in electronic form for plagiarism checking.

### Sickness and other problems

Students should immediately consult with the instructor or Associate Chair (Graduate) if they have problems that could affect their performance in the course. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

### Notice

Students are responsible for regularly checking their Western email and notices posted on their Instructor's doors. Course cancellations will also be sent out via Twitter.

### Consultation

Students are encouraged to discuss problems with their teaching assistant and/or instructors in tutorial sessions. Office hours will be arranged for the students to see the instructor and teaching assistants. Other individual consultations can be arranged by appointment with the appropriate instructor.

### Accreditation (AU) breakdown

Engineering Science = 50%  Engineering Design = 50%