

**Western University - Faculty of Engineering**  
Department of Civil and Environmental Engineering

CEE 9535B – Advanced Methods in Hydrosience: Applications and Design  
Course Outline – Winter 2018

**Objectives:**

Design, planning, and management of civil infrastructure require understanding, simulation and prediction of hydrological and environmental components. This course gives students a working knowledge of probabilistic and statistical approaches to analyze and interpret growing observed and simulated spatial and temporal data (e.g. climate, hydrology, environment, ecology, geology, population etc.). The emphasis will be on developing analytical skills to simulate and predict natural disasters including floods and droughts in an uncertain and changing climate. Topics covered in this class will be supplemented with computer exercises, which will use graphical and statistical software packages such as Excel, R, MATLAB, and ArcGIS to perform numerical analysis of real-world data.

**Topics:**

Note that all topics may not be covered due to time constraints.

1. Fundamentals of probability and Statistics in Water Resources and Environmental Engineering
  - Random variables
  - Discrete and continuous probability distribution functions
  - Some common applications of probabilistic and statistical methods
  - Estimation of distributional parameters
2. Spatial Data Analysis
  - Point pattern analysis
  - Spatial autocorrelation
  - Spatial regression
3. Bayesian Inference Framework
  - Formulating the model hypothesis
  - From prior to posterior
  - Scrutiny of the model hypothesis
  - Markov Chain Monte Carlo sampling
4. Risk and Reliability
  - Understanding uncertainty, risk and reliability
  - Measures of reliability
  - Ways to handle the reliability
  - Decision making under uncertainty
5. Design Rainfall
  - Purpose of design rainfalls
  - Comparison of annual maximum series and partial duration series
  - Appropriate probability distributions

- Regionalization
  - Deriving sub-daily and sub-hourly IDF relationships
  - Design spatial patterns
6. Flooding; Flood Frequency Analysis
    - Flood characteristics
    - Flood processes
    - Flood hydrograph estimation
    - Describing the chance of flood
    - Description of flood risk
    - Models of flood peaks
    - Index flood method
  7. Low Flow and Drought Analysis
    - Significance of low flows in ecology and environmental flow management
    - Factors affecting low flows
    - Low flow indices
    - Drought, aridity, and water scarcity
    - Causes of drought
    - Drought properties based on statistical techniques
    - Indices for drought characterization
    - Statistical methods for drought forecasting
  8. Inverse Problem Theory and Its Application in Model Optimization
    - General formulation of inverse problem
    - Hydrologic model calibration using global optimization
    - Shuffled complex evolution algorithm
  9. Future Engineering Challenges in an Uncertain and Changing Climate

**Prerequisite:**

This course is designed for graduate students (MEng, MEng, PhD) enrolled in civil engineering, environmental science, statistics and geography with an interest in data analysis, interpretation, and modelling. It is expected that students will have basic understanding of hydrology and statistics by taking suitable courses at the undergraduate or graduate levels. Students without a suitable background in these topics should consult with the instructor prior to registering for the course.

**Corequisites:**

None.

**Antirequisites:**

None.

Note: It is the student's responsibility to ensure that all Prerequisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. It is also the student's responsibility to ensure that he/she has not taken a course listed as an Antirequisite.

The student may be dropped from the course or not given credit for the course towards his/her degree if he/she violates the Prerequisite, Corequisite or Antirequisite conditions.

**Instructor:**

M. Reza Najafi, Ph.D.  
Spencer Engineering Building, Room 2053a  
Email: mnajafi7@uwo.ca

**Contact Hours:**

3 lecture hours per week.

**Course Materials:**

Prepared class notes by Dr. Najafi covering the material will be posted on OWL

References:

- Handbook of Applied Hydrology, by Vijay P. Singh
- Fundamentals of Statistical Hydrology, by Mauri Naghettini
- Statistical Methods in Water Resources, U.S.G.S, by Helsel and Hirsch  
(<https://pubs.usgs.gov/twri/twri4a3/pdf/twri4a3-new.pdf>)
- Statistical Methods for Geography, by P. Rogerson
- Rainfall-Runoff Modelling: The Primer, by Keith Beven

**Computing:**

Assignments and term project will require the processing of observations and simulations using graphical and data-analysis software such as R, MATLAB, ArcGIS or similar, and the students will be assumed to be proficient in the use of the software of their choice.

**Units:**

SI units will be used in lectures and examinations.

**General Learning Objectives**

E=Evaluate, T=Teach, I=Introduce

Problem Analysis	E	Team Work	I	Ethics and Equity	I
Investigation	T	Communication	I	Economics and Project Management	
Design	T	Professionalism		Life-Long Learning	I
Engineering Tools	E	Impact on Society	T	Knowledge Base	E

**Assignments and Project**

There will be four assignments spaced throughout the course. The project will span the length of the course, and will involve critical review of some technical papers, programming, a report, and a class presentation.

**Examination**

A 3-hour examination is held during the examination period on all work covered during the course. The examination is an Open Book, and a calculator is allowed.

**Evaluation:**

The final course mark will be determined as follows:

Final Exam:	50%
Assignments:	10%
Project:	40%
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Total	100%

**Note:**

- (a) **Students must pass the final examination to pass this course.** Students who fail the final examination will be assigned the aggregate mark, as determined above, or 48%, whichever is less.
- (b) **Students must turn in all individual assignments and projects to pass this course.** Students who do not satisfy this requirement will be assigned 48% or the aggregate mark, whichever is less.
- (c) **Students who have failed this course previously 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.
- (d) Should any of the quizzes conflict with a religious holiday that a student wishes to observe, the student must inform the instructor of the conflict no later than two weeks before the scheduled test.  
(For further information on Accommodations for Religious Holidays see [https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_religious.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf))

**Use of English:**

In accordance with Senate and Faculty Policy, students may be penalised 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.

**Scholastic Offences:**

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: [http://www.uwo.ca/univsec/handbook/appeals/scholastic\\_discipline\\_grad.pdf](http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_grad.pdf).

**Plagiarism:**

University policy states that plagiarism, defined as the “act or an instance of copying or stealing another’s words or ideas and attributing them as one’s own.” (excerpted from Black’s Law Dictionary, West Group, 1999, 7th ed., p. 1170) is a scholastic offence. In submitting any written work as part of the coursework requirements for this course students must ensure that this work is written in their own words. Whenever students take an idea or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations.

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

A student who is found guilty of plagiarism in respect of any written work submitted as part of the coursework requirements for this course will be given a grade of zero for the submitted work. Repeated acts of plagiarism, either in this course or any other course subsequent to a first offence, will result in the student being given a failing grade for the course in which the subsequent offence occurs, and may also incur further penalties such as requiring the student to withdraw from the program in which they are enrolled in.

**Attendance:**

Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

**Accessibility:**

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

**Conduct:**

Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others. Late comers may be asked to wait outside the classroom until being invited in by the Instructor. Please turn off your cell phone before coming to a class, tutorial, quiz or exam.

On the premises of the University or at a University-sponsored program, students must abide by the Student Code of Conduct: <http://www.uwo.ca/univsec/board/code.pdf>.

**Sickness and Other Problems:**

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

For more information concerning medical accommodations, please see:  
[http://www.uwo.ca/univsec/handbook/appeals/accommodation\\_medical.pdf](http://www.uwo.ca/univsec/handbook/appeals/accommodation_medical.pdf).

**Notice:**

Students are responsible for regularly checking their email, and the course OWL site for new notices related to the course.