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

CEE 4465a – Environmental Design for Waste Disposal - Course Outline 2016/17

This course is an advanced course in environmental design for waste disposal, and includes a complete preliminary design of a landfill facility. The objectives of the course are for the students:

- To develop an understanding of modern waste management practice and the role of landfilling in this context.

- To recognize the wide range of technical and non-technical considerations associated with site selection, approval, design, construction and operation of a modern waste management facility and understand the impact of the engineering solution in a global and societal context.

- To develop an understanding of the sources and characteristics of municipal solid waste and the chemical and biological characteristics of landfill leachate

- To understand the professional and ethical responsibility of an engineer with respect to waste management including consideration of social, economic, environmental, worker health and safety, and legislative and other regulatory issues.

- To use state-of-the-art computer techniques for assessing the impact of proposed waste disposal sites on groundwater quality.

- To apply mathematical, scientific and engineering knowledge to the design of the preliminary design for a landfill facility to meet specified needs and legislative requirements.

- To improve communication skills by discussing current waste disposal issues and expressing and defending opinions before their peers.

- To obtain experience working as a member of a design team and hence prepare for the engineering workplace.

- To appreciate the rapidly changing nature of knowledge and technology in this field and the need for life-long learning.

Calendar Copy:
Consideration of properties of solid waste, landfill covers, landfill gas, leachate, techniques for disposal, regulations, liner technology, contaminant transport, and impact assessment are examined in the context of the design of solid waste disposal facilities.

Contact Hours:
Average of 3 lecture hours/week; 3 design lab/tutorial hours; (recommended additional personal study – 3 hours/week).

Attendance at the tutorial/laboratory session is **mandatory**

Prequisites: Completion of third year of B.E.Sc. or B.Sc. degree.

Corequisites: None

Antirequisite: CEE 465a/b

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 Faculty. 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.

Instructor:
Shirin Bahrami, Email: sbahram2@uwo.ca, *Administrative Support:* Room 3005, Email: civil@uwo.ca

Textbook:
Prepared class notes should be brought to each class, and may be downloaded from the course website.

Other References:
Geotechnical Aspects of Landfill Design and Construction by Xuede Qian, Robert M. Koerner, Donald H. Gray, ISBN 0-13-012506-7. Published 2002 by Prentice-Hall, Inc. Upper Saddle River, New Jersey 07458

Ontario Regulation 232/98 (key sections in course notes). Available in the Taylor Library and also on the Web at http://www.canlii.org/on/laws/regu/1998r.232/20040802/whole.html.

Landfill Standards: a guideline on the regulatory and approval requirements of new or existing landfill sites, Ontario Ministry of the Environment and Energy (MOE), May 1998, Report PIBS365IE. Web link: http://www.ene.gov.on.ca/envision/land/landfill/

Geotechnology of Waste Management by Oweis, I.S. and Khera, 2nd Edition, PWS Publ. Co., Boston, 1998.

Solid Waste Landfill Engineering and Design by E.A. McBean, F. Rovers & G.J. Farquhar 1995.

Barrier Systems for Waste Disposal Facilities by R.K. Rowe, R.M. Quigley & J.R. Booker 2004, Chapman & Hall.

Computing:

A computer assignment will involve the application of contaminant transport models to landfill impact assessment. Computers will also be used, as required, for the design project.

Units:

SI units will be used in lectures and examinations

Specific Learning Objectives:.

1) Design consideration for landfills. At the end of this section and after completion of section 7 and the Design Project the student should be able to:
   a) correctly use relevant terminology in hydrogeology and waste management;
   b) classify the various phases of the design process and identify the key component of each phase, including the relevant legislation with which the design must comply;
   c) describe the responsibility of a professional engineer with respect to long term health and safety issues and worker safety, education and training related to site investigation, construction and operation of a waste management facility;
   d) describe, in general terms, what is involved in preparing for and obtaining approval of an undertaking under the Environmental Assessment Act of Ontario;
   e) describe the specific design considerations relevant to landfill design and be able to work as a member of a team that can develop a preliminary landfill design that is in compliance with Ontario Regulation 232/98, at a level that could be presented to the MOE for approval under the Environmental Protection Act of Ontario;
   f) prepare well-documented and consistent design calculations, a design and operations report, preliminary design drawings and cost estimates;
   g) describe the role of the engineer and that of other professionals on the design team;
   h) describe the differences between public perception of environmental risks and actual risks
   i) make presentations of engineering projects to the public and be able to present and defend his/her work before his/her peers in a quasi-judicial setting.
2) Solid Waste and Leachate Characteristics. At the end of this section the student should be able to:
   a) describe the nature, sources and composition of solid waste;
   b) describe the difference between in-place, apparent and total average density, calculate each of these and know when to use the different values

c) describe the different solid waste bio-degradation processes and the characteristics of landfill leachate;
d) apply the Ontario "Reasonable Use" Guideline;
e) quantitatively estimate the contaminating life span of a landfill based on the size, infiltration and peak leachate characteristics.

3) Advective-Diffusive Contaminant Transport. At the end of this section the student should be able to:
a) describe the key contaminant transport and retardation mechanisms (advection, diffusion, dispersion, sorption and radioactive and biological decay);
b) describe the governing differential equations and typical boundary conditions;
c) calculate the percolation through a landfill cover, based on the water balance method and estimate leachate volumes;
d) describe the basic features of the HELP model and discuss its strengths and limitations.

4) Technique for Waste Diversion and Disposal. At the end of this section the student should be able to:
a) incorporate the 3R's (Reduce, Reuse and Recycle) in the design of a waste management strategy and be familiar with the advantages and limitations of recycling;
b) describe alternative techniques for waste treatment (incineration and energy from waste; composting; bioconversion; waste processing and landfilling);
c) describe the different landfilling techniques (trench method; area method).

5) Landfill Design. At the end of this section and after completion of the design project, the student should be able to:
a) describe the available design options for barrier systems;
b) design barrier systems that comply with the Ontario Regulations 232 (§10) for both standard design and site specific alternatives to the standard designs;
c) design the base contours of a landfill;
d) design the leachate collection system;
e) describe the general characteristics of the three main groups of clay liners (re-compacted active soil; soil-bentonite mixtures; geosynthetic clay liners) and their strengths and limitations;
f) describe the main types of geomembranes and the key design considerations associated with selection of a suitable geomembrane
g) describe the typical landfill development and operations consideration and, as part of a design team, develop a preliminary design and operations (D&O) report.

6) Environmental Impact Assessment and Regulations. After completion of this section and the design project the student should be able to:
a) discuss the different types of environmental regulatory systems, the requirements of a landfill approval process, and the advantages and limitations of prescriptive and performance based regulations;
b) discuss the broad consideration of the Environmental Assessment Act.

7) Landfill gas. After completion of this section the student should be able to:
a) estimate the quantity and composition of gas that will be generated by a MSW landfill;
b) describe and be familiar with typical gas recovery and migration control systems.

Instructor may expand on material presented in the course as appropriate.

General Learning Objectives

E=Evaluate, T=Teach, I=Introduce

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

Evaluation:

The final course mark will be determined as follows:

Assignments and quizzes	20%
Design Project	25%
Mid-term Test	15%
Final Examination	40%

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 assignments and achieve a passing grade in this component, 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 assignment or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted.

(d) Should conflicts arise 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 http://www.uwo.ca/univsec/handbook/appeals/accommodation_religious.pdf)

1.Quizzes and Examinations:

One 3-hour final examination.

2.Design Project

The design project is a major component of the course. You will be asked to form "design teams" of 4 or 5 students (the actual number will be specified when the number of students in the course is known). You will be assigned a site that has previously been considered for landfilling during or following an extensive EAA investigation. You will have access to key hydrogeologic data arising from these studies. The site boundaries of the area investigated will be shown on the drawing, however, you may select your own footprint subject to the requirement that the landfill must be located within the boundaries shown. You are to design the landfill subject to a number of constraints that will be specified (in addition to those arising from the Environmental Assessment Act, the Environmental Protection Act, 1998 Landfill Standard Guidelines (Ontario Regulation 232/98) MOE and MOE Guidelines for EPA Submissions and Government waste diversion targets).

Although basic information concerning the site is provided for your assistance, this information is not complete and it will be necessary for you to obtain additional information. The submission should be sufficiently detailed such that it could be presented to the MOE for review and approval of the undertaking.

Your submission should clearly indicate the name of the individual who undertook prime responsibility for each aspect of the work and the name of the individual who reviewed that aspect of the work. All hand calculations are to be on squared paper and must be organized and presented in a neat, clear and professional manner. All pages of calculations must have the date, initials of the originator and initials of the checking engineer. All calculations are to be checked. All drawings are to be of professional quality with the name of originator and checking individual shown.

Your group will be required to make an oral presentation of your design and will be expected to defend your design (which will be reviewed by the instructor, teaching assistants, and a peer review group).

Of the marks assigned for the oral presentation and defence of your project 10% will be assigned for your critical review of the other groups' submissions and 80% will be assigned for the final design submission. Each student will be required to submit a written and signed assessment (with reasons) of how, in their opinion, the marks for the design project should be divided between team members (the instructor will make the final allocation after considering the opinion of all group members and reviewing the work done by each student).

3.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.

Plagiarism Checking:

The University of Western Ontario uses software for plagiarism checking. Students are required to submit their Laboratory Reports in electronic form to Turnitin.com for plagiarism checking.

Cheating:

University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties that might include expulsion from the program. If you are caught cheating, there will be no second warning.

For more information on scholastic offenses, please see:
http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf

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

Notice:

Students are responsible for regularly checking their email, course website (https://owl.uwo.ca) and notices posted outside the Civil and Environmental Engineering Department Office

Consultation:

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

Course breakdown:

Engineering Science = 86% = 39 AU's; Complementary Studies= 14% = 6.5 AU's.

The document "INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED" is part of this course outline.

Western University
Faculty of Engineering
2016-2017

INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED

If, on medical or compassionate grounds, you are unable to write term tests or final examinations or complete course work by the due date, you should follow the instructions listed below. You should understand that academic accommodation will not be granted automatically on request. You must demonstrate to your department (or the Undergraduate Services office if you are in first year) that there are compelling medical or compassionate grounds that can be documented before academic accommodation will be considered. Different regulations apply to term tests, final examinations and late assignments. Read the instructions carefully. (see the 2016 Western Academic Calendar).

A. *GENERAL REGULATIONS & PROCEDURES*

1. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.

2. Bring your request for academic accommodation to the attention of the Chair of the department (or the Undergraduate Services office if you are in first year) prior to the scheduled time of the test or final examination or due date of the assignment. If you are unable to contact the relevant person, leave a message with the appropriate department (or Undergraduate Services office, if you are in first year). The addresses, telephone and fax numbers are given at the end of these instructions. Documentation must be provided as soon as possible.

3. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or exam reweighted on a retroactive basis is not permitted.

B. *TERM TESTS*

1. If you are unable to write a term test, inform your instructor and the Chair of your Department (or the Undergraduate Services Office if you are in first year) prior to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office and inform the Chair of the Department (or the Undergraduate Services Office if you are in first year).

2. Be prepared to provide supporting documentation to the Chair and the Undergraduate Services Office (see next page for information on documentation).

3. Discuss with the instructor if and when the test can be rescheduled. **N.B.** The approval of the Chair (or the Undergraduate Services Office if you are in first year) is required when rescheduling term tests.

C. *FINAL EXAMINATIONS*

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number (please spell your full name).

2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, sleeping in, misreading timetable and travel arrangements.

3. In order to receive permission to write a special examination, you must obtain the approval of the Chair of the Department **and** the Associate Dean and in order to apply you must sign a "Recommendation for a Special Examination Form" available in the Undergraduate Services Office. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

N.B. **It is the student's responsibility to check the date, time and location of the special examination.**

D. *LATE ASSIGNMENTS*

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Associate Dean if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4. i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean. Documentation is mandatory.
   ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean.

SHORT ABSENCES

If you miss a class due to a minor illness or other problems, check your course outlines for information regarding attendance requirements and make sure you are not missing a test or assignment. Cover any readings and arrange to borrow notes from a classmate.

EXTENDED ABSENCES

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You may want to seek advice from the academic counsellor in your Department or the counsellors in the Undergraduate Services Office if you are in first year.

DOCUMENTATION

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, you must provide the doctor with a Student Medical Certificate to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office if you are in first year). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence.**

In Case of Serious Illness of a Family Member: Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

In Case of a Death: Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

For Other Extenuating Circumstances: If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

ACADEMIC CONCERNS

You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).

You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.

If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your academic counsellor.

Calendar References: Check these regulations in your 2016 Western Academic Calendar available at www.westerncalendar.uwo.ca.

Absences Due to Illness - page 117
Academic Accommodations for Students with Disabilities - page 118
Academic Accommodations for Religious Holidays - page 119
Incomplete Standing - page 104
Scheduling of Term Assignments – page 97
Scholastic Offences - page 113
Special Examinations - page 132

Note: These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

***Drop Deadlines*:**		
	First term half course (i.e. “A” or “F”):	November 5, 2016
	Full courses and full-year half courses (i.e. “E”, “Y” or no suffix):	November 30, 2016
	Second term half or second term full course (i.e. “B” or “G”):	March 7, 2017

Undergraduate Services Office:	SEB	2097	telephone: (519) 661-2130	fax: (519) 661-3757
Dept. of Chemical and Biochemical Engineering:	TEB	477	telephone: (519) 661-2131	fax: (519) 661-3498
Dept. of Civil and Environmental Engineering:	SEB	3005	telephone: (519) 661-2139	fax: (519) 661-3779
Dept. of Electrical and Computer Engineering, Software Engineering Mechatronics Engineering	TEB	279	telephone: (519) 661-3758	fax: (519) 850-2436
Dept. of Mechanical and Materials Engineering:	SEB	3002	telephone: (519) 661-4122	fax: (519) 661-3020