Western University  
Faculty of Engineering  
Department of Civil and Environmental Engineering  

CEE 9576A – BURIED STRUCTURES  
COURSE OUTLINE 2020-2021

DESCRIPTION  
The course introduces the basic principles employed in the structural analysis and design of two categories of buried structures; pipelines and flexible circular/elliptical culverts. Students who successfully complete this course should be able to calculate the loads, analyze and design both flexible and rigid pipelines in addition to flexible soil-steel culvert structures as per the AASHTO-LRFD and CHBDC Codes.

PREREQUISITES  
Soil Mechanics I  
Design of Reinforced Concrete Structures (preferred)  
Design of Steel Structures

<table>
<thead>
<tr>
<th>Topic No.</th>
<th>Description</th>
<th>Learning Activities*</th>
<th>Tentative timeline</th>
</tr>
</thead>
</table>
| 1         | Introduction to buried structures:  
- Introduction to buried pipes  
- Introduction to buried soil-metal culverts/bridges  
- Arching in soil  
- Rigid structure vs flexible one  
- Embankment vs trench conditions and effect of trench width  
- Introduction to using VBA in Excel (to be used in Assignments and Projects) |  
- Four recorded lectures  
- Additional YouTube movies  
- Live help session  
- Upload of Assignment 1 to OWL | Weeks 1 & 2 |
| 2         | Loads on Rigid Pipes  
- Earth loads on rigid pipes  
- Fluid Load on rigid pipes  
- Live loads on rigid pipes  
- Using PipePac software |  
- Three recorded lectures  
- Solved examples  
- Additional reading material (design manuals)  
- Live help session  
- Upload of Assignment 2 to OWL | Weeks 2 & 3 |
| 3         | Design of Rigid Pipes  
- Bedding factors and their classifications  
- Three-Edge bearing strength test  
- D-Load of rigid pipes  
- Pipe Design Criteria (ACPA/CHBDC) |  
- Three recorded lectures  
- Solved examples  
- Live help session  
- Upload of Project 1 to OWL | Week 4 |
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>4</td>
<td><strong>Design of Flexible Pipes</strong>&lt;br&gt;• Different flexible pipe materials&lt;br&gt;• Earth and live loads on flexible pipes&lt;br&gt;• Stiffness of flexible pipes&lt;br&gt;• Stiffness of soil in the pipe zone&lt;br&gt;• Deflection of flexible pipes; Spangler’s Iowa Formula&lt;br&gt;• Buckling of flexible pipes</td>
<td>• Three recorded lectures&lt;br&gt;• Solved examples&lt;br&gt;• Live help session&lt;br&gt;• Upload of Assignment 3 to OWL</td>
<td>Week 5</td>
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<td>5</td>
<td><strong>History of Structural Design of Buried Soil-Metal Bridges</strong>&lt;br&gt;• What is a buried bridge?&lt;br&gt;• Applications of buried bridges&lt;br&gt;• Different structure types&lt;br&gt;• History of design codes&lt;br&gt;• Earth loads&lt;br&gt;• Live loads&lt;br&gt;• Earthquake loads&lt;br&gt;• Design criteria&lt;br&gt;• Force analysis&lt;br&gt;• Deflection, buckling and minimum cover</td>
<td>• Four recorded lectures&lt;br&gt;• Live help session&lt;br&gt;• Upload of Project 2 to OWL</td>
<td>Weeks 9 and 10</td>
</tr>
<tr>
<td>6</td>
<td><strong>Structural Design of Buried Soil-Steel Bridges (Non-seismic)</strong>&lt;br&gt;• Different design methods of soil-steel culverts&lt;br&gt;• Earth loads on soil-steel culverts using CHBDC code&lt;br&gt;• Truck loads as per CHBDC&lt;br&gt;• Ultimate (factored) dead and live loads on soil-steel culverts as per CHBDC&lt;br&gt;• Design soil-steel culverts using CHBDC code</td>
<td>• Three recorded lectures&lt;br&gt;• Live help session</td>
<td>Weeks 11 and 12</td>
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<tr>
<td>7</td>
<td><strong>CANDE Software for the Structural Design of Buried Soil-Steel Bridges (Non-seismic)</strong>&lt;br&gt;• Identify the main inputs and output capabilities of CANDE Software&lt;br&gt;• Discussion of solved examples</td>
<td>• Three recorded lectures&lt;br&gt;• Live help session</td>
<td>Week 13</td>
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**Presentations for Project 1 + One-on-one discussion with each student about his/her work**<br>Weeks 6, 7 and 8

**Presentations for Project 2 + One-on-one discussion with each student about his/her work**<br>Weeks 14, 15 and 16
*Notes:
The lecture schedule (one 3-hour lecture per week) will be agreed upon with students through e-mails and posted to OWL. Lecture-videos will be pre-recorded and posted to the course OWL site one day before the lecture time. The lecture time will be used for help sessions conducted through Zoom software/application and the Zoom-link will be posted to OWL. Students may be split into groups and each group will be assigned a one-hour slot for the online discussions. A forum on OWL will be used for students to post their questions and is open for discussions with the instructor and other students. Effective attendance in the help sessions and participation in the course’s forum contributes towards the total final mark of the course. Review of lecture material and self-study is expected to take, approximately, 6 hours per week.

SPECIFIC LEARNING OUTCOMES

<table>
<thead>
<tr>
<th>Degree Level Expectation</th>
<th>Weight</th>
<th>Assessment Tools</th>
<th>Outcomes</th>
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<tbody>
<tr>
<td>Depth and breadth of knowledge</td>
<td>25%</td>
<td>• Assignments • Project</td>
<td>• Understanding of advanced concepts and theories • Awareness of important current problems in the field of study • Understanding of computational and/or empirical methodologies to solve related problems</td>
</tr>
<tr>
<td>Research &amp; scholarship</td>
<td>15%</td>
<td>• Project</td>
<td>• Ability to conduct coherent and thorough analyses of complex problems using established techniques/principles and judgment</td>
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<tr>
<td>Application of knowledge</td>
<td>30%</td>
<td>• Assignments • Project</td>
<td>• Ability to apply knowledge in a rational way to analyze a particular problem • Ability to use coherent approach to design a particular engineering system using existing design tools</td>
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<tr>
<td>Professional capacity / autonomy</td>
<td>5%</td>
<td>• Project</td>
<td>• Defends own ideas and conclusions</td>
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<tr>
<td>Communication skills</td>
<td>15%</td>
<td>• Project</td>
<td>• Ability to communicate (oral and/or written) ideas, issues, results and conclusions clearly and effectively</td>
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<tr>
<td>Awareness of limits of knowledge</td>
<td>10%</td>
<td>• Assignments • Project</td>
<td>• Awareness of the need of assumptions in complex scientific analyses and their consequences • Understanding of the difference between theoretical and empirical approaches • Ability to acknowledge analytical limitation due to complexity of practical problems</td>
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### ASSESSMENTS

<table>
<thead>
<tr>
<th>Assessment Type</th>
<th>Material Covered</th>
<th>Tentative Due Date</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Homework Assignments (three; equally weighted)</td>
<td></td>
<td></td>
<td>30%</td>
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<tr>
<td>Project 1</td>
<td>Topics 1, 2, 3, and 4</td>
<td></td>
<td>25%</td>
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<tr>
<td>Project 2</td>
<td>Topics 5, 6 and 7</td>
<td></td>
<td>40%</td>
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<tr>
<td>Participation (synchronous)</td>
<td>Attendance of, at least, 50% synchronous class help sessions and participation in the course’s forum</td>
<td></td>
<td>5%</td>
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**Activities in which collaboration is permitted:**
- Projects; collaboration between members of the same team is allowed; collaboration between members of different teams is not permitted

**Activities in which students must work alone (collaboration is not permitted):**
- Assignments; collaboration in not permitted unless specifically allowed by the instructor

### CONTACT INFORMATION
Course instructor: Khaled El-Sawy
Email address: kelsawy2@uwo.ca

Contact policy:
- Contact instructor via email (above)
- Weekly Office hours are held via Zoom
- A general FAQ section on the ‘forums’ section of OWL will be used for students to pose course-related questions so that all have the same information.

### REQUIRED TEXTBOOK
- Lecture notes by the instructor

### COURSE CONTENT
The lecture notes and online lecture videos are copyrighted to the instructor and legally protected. Do not post these videos and lecture notes on any other website or online forums. The recording of the live/synchronous sessions of the course without the permission from the instructor is prohibited. The illegal posting and sharing of the copyrighted course content could be subjected to legal actions.
UNITS
Both SI and Imperial units will be used (depending on the design code)

LABORATORY
NA

COMPUTER USAGE
Students are expected to:
• Develop Excel sheets and VBA code for the design of pipes under different burial conditions
• Use PipePac to design pipes
• Using CANDE to model the behavior of and design buried steel culverts

CHEATING, PLAGIARISM/ACADEMIC OFFENCES
Academic integrity is an essential component of learning activities. Students must have a clear understanding of the course activities in which they are expected to work alone (and what working alone implies) and the activities in which they can collaborate or seek help; see information above under “Assessments” and ask instructor for clarification if needed. Any unauthorized forms of help-seeking or collaboration will be considered an academic offense. University policy states that cheating is an academic offence. If you are caught cheating, there will be no second warning. Students must write their essays and assignments 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. Plagiarism is a major academic offence. Academic offences are taken seriously and attended by academic penalties which may include expulsion from the program. Students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence (see Western's scholastic discipline regulations for graduate students).

SYNCHRONOUS LEARNING ACTIVITIES
Students are expected to participate in synchronous learning activities as outlined in the course syllabus and/or described by the instructor. If you have issues that will impede your ability to participate in synchronous activities, please discuss with the course instructor at the beginning of the course.

CONDUCT
Students are expected to follow proper etiquette during synchronous and asynchronous activities to maintain an appropriate and respectful academic environment. Any student who, in the opinion of the instructor, is not appropriately participating in the synchronous and asynchronous learning activities and/or is not following the rules and responsibilities associated with the online learning activities, will be reported to the Associate Dean (Graduate) (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Associate Dean (Graduate), the student could be debarred from completing the assessment activities in the course as appropriate.
HEALTH/WELLNESS
As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several health and wellness related services (remotely accessible) to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. Information regarding health- and wellness-related services available to students may be found at http://www.health.uwo.ca/.

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Campus mental health resources may be found at:

http://www.health.uwo.ca/mental_health/resources.html
https://www.uwo.ca/health/psych/index.html

SICKNESS
Students should immediately consult with the Instructor (for a particular course) or Associate Chair (Graduate) (for a range of courses) if they have problems that could affect their performance. 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. Obtaining appropriate documentation (e.g., a note from the doctor) is valuable when asking for accommodation due to illness.

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 Accessible Education for any specific question regarding an accommodation at:
661-2111 x 82147 or
http://academicsupport.uwo.ca/accessible_education/index.html,