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

## <u>CEE 3369a – Materials for Civil Engineering</u> <u>Course Outline - Fall 2023</u>

#### **Description:**

This course introduces students to the physical properties and engineering characteristics of major civil engineering materials, including portland cement concrete and asphalt concrete. It covers the structural, durability, and sustainability aspects of civil infrastructure, with particular focus on flexible and rigid pavements. The general objectives are for the students to develop the ability to:

**Objectives:** The objectives of this course are for the students to:

- Understand the chemical composition and the hydration process of portland cement and supplementary cementitious materials.
- Recognize the effects of chemical admixtures and mineral additions on the rheological and mechanical properties of concrete mixtures.
- Design a concrete mixture to meet specific design requirements.
- Identify various mechanisms of concrete's deterioration and the actions needed to enhance concrete durability in aggressive environments.
- Recognize the performance, failure criteria and principles of modern design of rigid and flexible pavements.
- Design a flexible and rigid pavement for specific traffic, soil and environmental conditions.
- Incorporate sustainability and environmental considerations in the use of civil engineering materials, develop awareness of modern advances and novel applications involving civil engineering materials, recognize the need for life-long learning to keep abreast of new design and construction methods involving such materials, and to enhance one's design abilities.

<u>Calendar Copy</u>: The consideration of the physical properties and engineering characteristics of materials used in Civil Engineering.

Pre-requisite/s: CEE 2202A/B and CEE 2220A/B.

**Note:** It is the **student's responsibility** to ensure that all Pre-requisite and Co-requisite 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 Anti-requisite. The students may be dropped from the course or not given credit for the course towards their degree if they violate the Pre-requisite, Co-requisite or Anti-requisite conditions.

#### **Contact Information:**

Instructor: Hassan EL-Chabib, PhD, P. Eng., SEB 3029 Email: <u>helchab2@uwo.ca</u>. Office hour: Wednesday, 11:00 am – 12:00 pm or by appointment CEE Administrative Office: SEB 3005 (civil@uwo.ca)

#### **Contact Hours:**

2 lecture hours per week; 2 lab/tutorial hours per week. Attendance is **mandatory.** 

#### **Course Delivery/Notes:**

- Lectures and labs will be delivered in-person. In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, affected course content will be delivered entirely online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will **not** change. Any remaining assessments will also be conducted online as determined by the course instructor.
- When deemed necessary, tests and examinations in this course will be conducted using a remote proctoring service. By taking this course, you are consenting to the use of this software and acknowledge that you will be required to provide personal information (including some biometric data) and the session will be recorded. Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. More information about this remote proctoring service, including technical requirements, is available on Western's Remote Proctoring website at: <a href="https://remoteproctoring.uwo.ca">https://remoteproctoring.uwo.ca</a>
- Class notes for each topic as well as related reference materials (if needed) will be regularly posted on the course website.
- The lectures emphasize on the construction of meaning rather than information transmission. Hence, students shall study the notes for each lecture at home before it is presented by the instructor in class. Home study effort is crucial for the success of students in this course. The class time is dedicated to engaging students in exploring topics in greater depth and applying knowledge to create more meaningful learning opportunities.
- The weekly 2-hour lab/tutorial sessions are crucial to understand the characteristics of the materials and to finish the design project. Students must attend and they are encouraged to seek assistance when needed.

#### **Recommended References:**

(1) Design and Control of Concrete Mixtures, Canadian Edition, Cement Association of Canada.

- (2) Properties of Concrete, by. A.M. Neville, John Wiley & Sons Inc.
- (3) Concrete, by S. Mindess and J. F. Young, Prentice Hall Inc.
- (4) Concrete Pavement Design, Construction, & Performance, by N. Delatte, Taylor & Francis.
- (5) Pavement Analysis and Design, Y.H. Huang, Prentice Hall.

#### Units:

SI units will be generally used in lectures and examinations. Occasionally, Imperial units are used.

Topics:							
Topic #	Description	Learning Activities	Tentative timeline				
1	Cement manufacturing, cement types and properties	Lectures/Reading material	Week 1				
2	Supplementary Cementitious Materials	Lectures/Reading material	Week 2				
3	Aggregates in concrete	Lectures/Reading material	Week 3				
4	Mixing water and admixtures in concrete	Lectures/Reading material	Week 4				
5	Design of concrete mixture	Lectures/Reading material	Week 5-6				
6	Concrete Durability	Lectures/Reading material	Week 7				

7	Asphalt cement and asphalt concrete	Lectures/Reading material	Week 8
8	Classification and stress analysis of pavement	Lectures/Reading material	Week 9
9	Pavement design consideration	Lectures/Reading material	Weeks 10
10	Design of flexible pavement	Lectures/Reading material	Week 11
11	Design of rigid pavement	Lectures/Reading material	Week 12

#### Specific Learning Objectives: (GA indicators – bold represents evaluated indicators):

At the end of each section, the student should be able to understand:

- 1. Cement Manufacturing, Chemistry and Hydration:
  - a) Recognise the steps involved in manufacturing portland cement and the various reactions occurring in a cement kiln. [IESE1]
  - b) Identify the oxide composition of portland cement and the difference in composition between different types of cements and its effect on the performance of concrete. [IESE1, IESE2, I3]
  - c) Characterise the hydration reactions of the main phases in a cement clinker and the effect on their physical and chemical parameters on cement hydration kinetics. [IESE1, IESE2]
  - d) Identify the major phases in the microstructure of hydrated cement paste. [IESE1, IESE2]
- 2. <u>Mineral Additions and Chemical Admixtures in Concrete</u>:
  - a) Evaluate the effect of using supplementary cementitious materials on the sustainable development of civil infrastructure and the built environment. [IESE1, IESE2]
  - b) Identify the effects of using mineral admixtures such as fly ash, slag and silica fume on the workability, mechanical properties and durability of concrete. [IESE1, IESE2]
  - c) Control the properties of concrete mixtures using chemical admixtures such as accelerators, retarders, superplasticizers and air-entraining admixtures. [IESE1, IESE2, I3]
  - d) Design concrete mixtures involving mineral additions and chemical admixtures to meet specific design requirements. **[IESE2, ET2]**
- 3. <u>Aggregates and their Use in Concrete</u>
  - a) Describe the source and geological classification of aggregates [IESE1]
  - b) Analyse the physical properties and particle size gradation of aggregates. [IESE1, I3]
  - c) Determine the effect of aggregate use in concrete. [IESE1, IESE2]
  - d) Identify harmful aggregates to mitigate their negative effects on the durability of concrete. [IESE1]
- 4. Workability, Mechanical Properties and Durability of Concrete
  - a) Use various tests to characterise the workability of fresh concrete mixtures and recognise the effects of mixture proportions on workability. [IESE2, ET2]
  - b) Appreciate the time and temperature dependence of the properties of fresh and hardened concrete. [IESE1, IESE2]
  - c) Control the mechanical properties of concrete via controlling its mixture proportioning, consolidation, and curing. [IESE2, **ET2**]
  - d) Describe the performance of concrete under compressive and other mechanical loading. [IESE1]
  - e) Learn the development of special concretes such as fibre-reinforced concrete, self-consolidating concrete, and high-performance concrete. [IESE1]
  - f) Identify the mechanisms of deterioration of concrete in different aggressive environments and develop strategies for enhancing the durability of concrete structures. [IESE1]
- 5. <u>Asphalt</u>
  - a) Recognize the chemical composition of asphalt cements, their physical structure, aging, rheological properties, and classification. [IESE1, IESE2]

- B) Recognize the structure of asphalt concrete, ingredients, fillers and additives used in its making, its response to loads, desired properties, effect of temperature and moisture, durability, etc. [IESE1, IESE2, ET2]
- c) Design aggregate mixtures for paving asphalt concrete. [IESE1]
- d) Design asphalt-aggregate mixtures to meet road design specifications. [IESE2, ET2]
- 6. <u>Pavement Design</u>
  - a) Discuss and use the principles of pavement design including the concept of design life and failure criteria. [IESE2, I3]
  - b) Compute stresses and deflections in pavements using linear elastic-layered systems [IESE1, IESE2, 13]
  - c) Rationally design flexible (asphalt) and rigid (concrete) pavements using different methods (e.g. AASHTO, Asphalt Institute, or PCA) given specifications and properties of pavement materials including soil foundation, sub-grade, sub-base, and surface characteristics. **[IESE1,** ET2]
  - d) Evaluate the performance of road pavements. [IESE1, IESE2, I3]

#### **General Learning Objectives**

*E*=*Evaluate*, *T*=*Teach*, *I*=*Introduce* 

Problem Analysis	Т	Teamwork	Т	Ethics and Equity	-
Investigation	E(A	)Communication	-	Economics and Project Management	-
Design	Т	Professionalism	-	Life-Long Learning	-
Engineering Tools	E(A	Impact on Society	E(D	Knowledge Base	-

#### Assessments:

The final course mark will be determined as follows:

Midterm Exam:	25%
Attendance/Participation:	10%
Design Project:	25%
Final examination:	40%
Total:	100%

#### **Quizzes and Examinations**

- **Midterm Exam**: A two-hour midterm exam is tentatively scheduled for Tuesday **October 24** during the lecture period. The exam could be entirely closed book or 2 parts (closed and open book). Classroom will be announced in due course if needed.
- **Final Exam:** A 3-hour open book final examination will be held during the final examination period
- Missed Quiz or Midterm

The policy of the department of Civil and Environmental Engineering is that there will be **no make-up for missed quizzes or midterms**. For those that do legitimately miss a quiz or midterm and provide the required supporting documentation, the standard practice will be that the weight of the missed quiz/midterm will be reassigned to the final exam.

#### Notes:

- 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.
- 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, if applicable, cannot be resubmitted for grading by the student in subsequent years.

Should a quiz or test conflict with a religious holiday that a student wishes to observe, the student must inform the instructor of the conflict no later than one week before the scheduled test. For further information on Accommodations for Religious Holidays see:

https://www.eng.uwo.ca/undergraduate/academic-consideration-for-absences.html

#### **Activities in Which Collaboration Permitted:**

- Group project
- Labs and lab reports

#### Activities in Which Collaboration is Not Permitted:

- Examinations
- Ouizzes

Tutorial and laboratories: Tutorial problems may be assigned but will not be marked and solutions will be posted on the course website. Groups for labs and the design project will be assigned by the instructor and may be revised during the term. Students must attend all laboratories and submit a group report for each lab with the cover page signed by all group members. Late submission will not be accepted, and all group members will receive a grade of zero unless an extension is pre-approved by the instructor. Lab data as well as lab reports should be used as an integral part in the final report of the design project.

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, except for 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: Western University uses software for plagiarism checking. Students are required to submit their Laboratory Reports (if applicable) in electronic form for plagiarism checking.

Academic Integrity: 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.

#### Accommodation and Accessibility:

Students are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students can be found at: https://www.eng.uwo.ca/undergraduate/academic-consideration-for-absences.html

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. Latecomers 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 and refrain from using electronic devices. On the premises of Western University or at a University-sponsored program, students must abide by the Student Code of Conduct: http://www.uwo.ca/univsec/board/code.pdf

<u>Sickness and Other Problems</u>: Students should immediately consult with the instructor if they have any problems that could affect their performance in the course. The student should seek advice from the instructor regarding how best to deal with the problem. Failure to notify the instructor immediately (or as soon as possible thereafter) will have a negative effect on any appeal. If you are unable to meet a course requirement due to illness or other serious circumstances, please follow the procedures below.

## • Assessments worth less than 10% of the overall course grade:

For work worth less than 10% of the total course grade, academic consideration might be granted by the instructor to students with a legitimate reason. If approved, student will be given extension to submit any missing work. In such a case where documentation is required, it can *only* be collected by the student's Dean's Office Academic Counselling unit.

## • Assessments worth 10% or more of the overall course grade:

For work totaling 10% or more of the final course grade, students must provide valid medical or supporting documentation to the Academic Counselling Office of your Faculty of Registration as soon as possible. For further information, please consult the University's medical illness policy at

https://www.uwo.ca/univsec/pdf/academic\_policies/appeals/accommodation\_medical.pdf.

The Student Medical Certificate is available at https://www.uwo.ca/univsec/pdf/academic\_policies/appeals/medicalform.pdf.

### **Absences from Final Examinations**

- If you must miss the Final Exam, please contact Western Engineering Undergraduate Services as soon as possible. They will assess your eligibility to write the Special Examination.
- You may also be eligible to write the Special Exam if you are in a "Multiple Exam Situation" (e.g., more than 2 exams in 23-hour period, more than 3 exams in a 47-hour period).

**Note:** missed work can *only* be excused through one of the mechanisms above. Being asked not to attend an in-person course requirement due to potential COVID-19 symptoms is **not** sufficient on its own.

**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.

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

Course Breakdown: Engineering Science = 50% = 18.9 AU's, Engineering Design = 50% = 18.9 AU's