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

# CEE 3369b – Materials for Civil Engineering
## Course Outline – Winter 2019

This course trains students to incorporate knowledge of the physical properties and engineering characteristics of major civil engineering materials, including portland cement concrete and asphalt concrete, in the structural, durability and sustainability design of civil infrastructure, with particular focus on flexible and rigid pavements. The general objectives of the course are for the student to become able to:

- Relate the manufacturing of portland cement, its chemical composition and hydration reactions to the engineering properties of cement-based materials.
- Recognize the effects of chemical admixtures and mineral additions on the short- and long-term performance of concrete structures.
- Conduct the mixture design of concrete to meet specific design requirements.
- Identify various mechanisms of degradation of concrete structures and the actions needed to enhance the durability of concrete structures in aggressive environments.
- Perform the mixture design of paving asphalt concrete to meet design specifications; recognize the performance, failure criteria and principles of modern design of rigid and flexible road pavements.
- Carry out the thickness design of flexible and rigid pavements considering 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.

**Pre-requisites:**
Completion of the second year of the Civil and Environmental Engineering program or permission of the Department.

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

**Anti-requisites:**
The former ES 369a/b and CEE 369a/b.

**Contact Hours:**
2 lecture hours/week; 2 lab-tutorial-design hours/week.

**Instructor**
A.R. Suleiman, MESc, Office: SEB 2020, Email: asuleim3@uwo.ca, Administrative Support: SEB 3005.

**Class Notes:**
Class notes for each chapter of the course will be regularly posted on OWL. These notes should be brought to each class. Additional reference materials will also be posted on the OWL course website.

**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.
(6) Materials for Civil and Construction Engineering, by M.S. Mamlouk and J.P. Zaniewski, Prentice Hall.

**Units:**
SI units will generally be used in lectures and examinations.

**Specific Learning Objectives:**

1. Cement Manufacturing, Chemistry and Hydration: At the end of this section the student should be able to:
   a) Recognise the steps involved in manufacturing portland cement and the various reactions occurring in a cement kiln.
   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.
   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.
   d) Identify the major phases in the microstructure of hydrated cement paste.

2. Mineral additions and Chemical Admixtures in Concrete: At the end of this section the student should be able to:
   a) Evaluate the effect of using supplementary cementitious materials on the sustainable development of the cement and concrete industry.
   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.
   c) Control the properties of concrete mixtures using chemical admixtures such as accelerators, retarders, superplasticizers and air-entraining admixtures.
   d) Design concrete mixtures involving mineral additions and chemical admixtures to meet specific design requirements.

3. 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.
   b) Appreciate the time and temperature dependence of the properties of fresh and hardened concrete.
   c) Control the mechanical properties of concrete via controlling its mixture proportioning, consolidation, and curing.
   d) Describe the performance of concrete under compressive and other mechanical loading.
   e) Learn the development of special concretes such as fibre-reinforced concrete, self-consolidating concrete, and high performance concrete.
   f) Identify the mechanisms of deterioration of concrete in different aggressive environments and develop strategies for enhancing the durability of concrete structures.

4. Asphalt
   a) Recognize the chemical composition of asphalt cements, their physical structure, aging, rheological properties, and classification.
   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.
   c) Design aggregate mixtures for paving asphalt concrete.
   d) Design asphalt-aggregate mixtures to meet particular road design specifications.

5. Pavement Design
   a) Discuss and use the principles of pavement design including the concept of design life and failure criteria.
   b) Compute stresses and deflections in pavements using linear elastic-layered systems
   c) Rationally design flexible (asphalt) and rigid (concrete) pavements using different methods (AASHTO, Asphalt Institute, PCA) given specifications and properties of pavement materials including soil foundation, sub-grade, sub-base, and surface characteristics.
   d) Evaluate the performance of road pavements.

**General Learning Objectives**

E=Evaluate, T=Teach, I=Introduce

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

**Evaluation:**

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| **Quizzes** | **10%** |
| **Midterm Test** | **15%** |
| **Design Project** | **25%** |
| **Final Examination** | **50%** |
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| **Total:** | **100%** |

**Important Notes:**

- Faculty policy states that **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 cannot be resubmitted for grading by the student in subsequent years.
- Should a quiz 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: http://www.uwo.ca/univsec/handbook/appeals/religious.pdf

**Quizzes and Examinations**

**Four Quizzes** will be conducted during lectures and/or tutorials with a one week notice. The quizzes will be **closed book**. Hence, students shall be up-to-date with the course material coming into each lecture and tutorial. Students who are absent will get a mark of zero, unless the absence has been reported and documented **before** the quiz. The **closed book midterm test will be immediately after the reading week**. The **final examination will be 3 hours,** and will be **OPEN BOOK** in which class notes and approved handheld calculators may be used. Students should consult the list of approved calculators posted outside the Civil and Environmental Engineering Department Office.

**Tutorials and Laboratories:**

Tutorial problems may be assigned, but will not be marked. Solutions will be posted on OWL to assist students in their learning. Students must attend laboratories. **Lab reports should be integral part of the final design project report**. Lab data and knowledge should be used in the design project.

Lab and project group membership will be assigned by the instructor, and may be revised during the term. All group members must sign the cover page of group submissions. The instructor will designate the group member responsible for preparing each group submission. Late project submissions will receive a mark of zero. Extensions are to be negotiated with the instructor, not with the teaching assistants.

**Use of English:**

In accordance with Senate and Faculty Policy, students may be penalised up to 10% of the marks on all assignments, projects, reports, tests and examinations for the improper use of English. Additionally, poorly written work with the exception of final examinations 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.

**Cheating:**

University policy states that cheating, including plagiarism, 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:**

**The instructor may take attendance in any lecture without notice.** Any student who, in the opinion of the instructor, is absent too frequently from class 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 examination in the course.

**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.

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 or 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

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

**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 × 82147 for any specific question regarding an accommodation.

**Notice:**
Students are responsible for regularly checking their email, the OWL course site, and notices posted outside the Civil Departmental Office.

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

The document "INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED" and on ADMINISTRATION OF EXAMINATIONS is considered part of this outline.