CIVIL ENGINEERING 731: PROPERTIES OF CONCRETE
CIVIL ENGINEERING 691: PROPERTIES OF CONCRETE

Fall 2017

CLASS INFORMATION:

Class Time:	5:30-8:00 p.m., Wednesdays, KEN 1140
Instructor:	Dr. Konstantin Sobolev
Office:	EMS 939 / W360
Office Telephone:	(414) 229-3198
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Office Hours:	4:15 p.m. – 5:15 p.m., Wednesdays, and by appointment.

COURSE DESCRIPTION:

Properties of fresh and hardened concrete, including rheology, strength, elastic modulus, drying shrinkage, creep, permeability and durability to a variety of aggressive environments depending on the concrete composition and its internal structure.

TEXTBOOKS:

- Concrete: Structure, Properties, and Materials by P.K. Mehta and P.J.M. Monteiro.
- Properties of Concrete by A.M. Neville.

COURSE PREREQUISITES:

Junior Standing

COURSE OBJECTIVES:

The objective of the course is to provide a deeper understanding of the properties of fresh and hardened concrete, such as rheology, strength, elastic modulus, drying shrinkage, creep, permeability and durability to a variety of aggressive environments depending on the concrete composition and its internal structure. It is also objective to acquire a broad view on recent advances in concrete technology, such as high-strength, high-workability, and highly durable concretes; lightweight and heavyweight concrete, fiber-reinforced concrete, self-compacting concrete and roller-compacted mass concrete.

- Students will learn the microstructure - property relations governing the behavior of concrete.
- Students will learn about structure, physical and mechanical properties and design principles of concrete and related materials.
- Students will learn how to conduct the standard tests related to properties of concrete.

LEARNING OUTCOMES:

- Students will have an ability to conduct a literature search regarding recent developments related to concrete.
- Students will have the ability to write and make oral presentations based upon their findings from concrete laboratory experiments and related literature study.
- Students will have the ability to design experiments related to properties of concrete and to conduct experiments, as well as to analyze and interpret data.
- Students will have the ability to know broad range of properties of concrete and related materials.

- Students will have the ability to identify, formulate, and solve engineering experimental design problems related to the specification and properties of concrete.

RELATIONSHIP TO PROGRAM OUTCOMES:

- Graduates will have an ability to function on multidisciplinary teams;
- Graduates will have an ability to communicate effectively;
- Graduates will have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
- Graduates will demonstrate a recognition of the need for, and an ability to engage in life-long learning.

CONTRIBUTION OF COURSE TO MEETING THE PROFESSIONAL COMPONENT:

The microstructure - property relation is the key concept governing the properties and behavior of civil engineering materials, such as concrete. This course is organized to develop the student's abilities for designing the test specimens and determining from the laboratory experiment the most critical properties of construction materials and interpreting the test data. Students work about 5 weeks on their independent study projects and can learn about production and application construction materials (including local needs and local projects) through presentations made by the guest speakers.

COURSE STRUCTURE:

Lectures: There is one 2.5-hour lecture per week.

Projects/Extended Problems: Independent study projects (usually, the literature survey and laboratory experiment (competition on advanced construction material technology) projects are required.

Written Communications: For each literature study and laboratory test project, eight- to twelve-page reports are required.

Oral Communication: At the end of the semester, all students are required to present their literature study or lab project reports to the class. This oral presentation is evaluated and graded by the instructor(s) with the input from the students.

Laboratory Exercises: Minimum of two significant laboratory experiments are required to be conducted by graduate students to determine certain property of a test specimen prepared by the student. These laboratory experiments are demonstrated and taught to students for the correct methodology and practical skills.

Class/Laboratory Schedule: Sixty class hours (each 75 minutes long) per semester are allocated to this class. About 80% of class hours are devoted to lectures by the instructor and/or invited lecturers from the industry; and the remaining 20% are devoted to laboratory/experimental sessions.

Examinations: There will be a total of three examinations (two midterms and a final).

METHODS OF ASSESSMENT:

- Rubrics
- Course Evaluations by Students
- Graded Projects
- Instructor and Peer Judgment
- Structural Division Jury Assessment

RESOURCES COMMONLY AVAILABLE:

- Instructor
- Laboratories: W180, W190, W360

- Departmental library on construction materials (books, journals, educational CDs)
- Data-show projector and/or Smart Board
- Software: MiniTab, Microsoft Office, etc.

DESIRABLE STUDENT COMPETENCIES:

- Ability to conduct laboratory tests and multi-step test data analysis and interpretation of results;
- Ability to conduct literature research and compile research information into a comprehensive report;
- Basic computer skills (MiniTab, Microsoft Office)

GRADING POLICY:

Course assignments and credit allocation are as follows (UG):

Homeworks:	20%
Discussion (class and D2L):	10%
Three exams:	50%
Presentation (literature):	20%

Course assignments and credit allocation are as follows (G):

Homeworks:	10%
Three exams:	50%
Term research project (lab experiment/case study):	30%
Term paper:	5%
Leading discussions:	5%

Grade assignment:
A: 96.5-100%; A-: 93-96.5%; B+: 89.5-93%; B: 86-89.5%; B-: 82.5-86%; C+: 79-82.5%; C: 75.5-79%; C-: 72-75.5%; D+: 68.5-72%; D: 65-68.5%; D-: 61.5-65%; F: <61.5%

ASSIGNMENT POLICY:
Homework assignments are usually handed out on Wednesdays, and collected a week later (next Wednesday). Students who hand in homework three working days later (the following Monday) will be penalized by 50%. No assignment more than three days late is accepted. No make-up for quiz or presentation is allowed.

CREDITS AND WORKLOAD EXPECTATIONS:

Generally, when a one-credit course is taken, an average of three hours of learning effort per week (over a full semester) is necessary for an average student to achieve an average grade in the course. A student taking a three-credit course that meets for three hours a week should expect to spend an additional six hours a week on coursework outside the classroom.

POLICIES REGARDING SCHOLASTIC MISCONDUCT:

Academic dishonesty in any portion of the academic work for a course shall be grounds for awarding a grade of F or N for the entire course. Scholastic misconduct is broadly defined as "any act that violates the rights of another student in academic work or that involves misrepresentation of your own work." Scholastic dishonesty includes, (but is not necessarily limited to): cheating on assignments or examinations; plagiarizing (i.e., submitting the same project result or substantially similar result); depriving another student of necessary course materials; or interfering with another student's work.

STUDENTS WITH DISABILITIES:

It is the university policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities that may affect their ability to participate in course activities or to meet course requirements. Students with disabilities are encouraged to contact me when possible to discuss their individual needs for accommodations.

UNIVERSITY POLICIES:

The detailed University Policies are here: http://www4.uwm.edu/secu/news_events/upload/Syllabus-Links.pdf

ADDITIONAL READING:

- Design and Control of Concrete Mixtures, S. Kosmatka, B. Kerkhoff, W. Panarese.
- Rheology of Fresh Cement and Concrete by P.F.G. Banfill.
- High-Performance Concrete by P.-C. Aitcin.
- Computer Modelling of Concrete Mixtures by J. Dewar.
- Concrete Admixtures Handbook - Properties, Science, and Technology by V. Ramachandran.
- Lea's Chemistry of Cement and Concrete by F. Lea.
- Advances in Cement Technology Chemistry, Manufacture and Testing by S. N. Ghosh.
- Special Inorganic Cements by I.Odler.
- Binders for Durable and Sustainable Concrete by P.-C. Aitcin.

PREPARED BY: Konstantin Sobolev, April 27, 2010, updated August 27, 2017

TENTATIVE SCHEDULE

Fall 2017

LECTURE 1 Portland cement

- Portland cement and its major constituent phases
- The chemistry of Portland cement manufacture
- Properties of Portland clinker and cement
- Hydration of the calcium silicate phases

LECTURE 2 Cementitious and binding materials of different types

- Mineral additives: natural pozzolanas and industrial by-products
- Blended cements
- High-alumina cement
- Non-Portland cement based binders
- Polymer binders

LECTURE 3 Properties of aggregates

- Classification of aggregates
- Grading requirements
- Alkali-silica and alkali-carbonate reaction

LECTURE 4 Fresh concrete

- Definition and measurement of workability
- Rheological properties
- Effect of vibration
- Pumped and self- compacting concrete

LECTURE 5 Chemical Admixtures

- Types and classification of admixtures
- Accelerating admixtures
- Retarding admixtures
- Water-reducing and superplasticizing admixtures

LECTURE 6 Strength of concrete

- Effect of W/C ratio and porosity
- Influence of aggregates
- Maturity and strength development
- Effect of admixtures

MID-TERM EXAMINATION/RESEARCH SUBJECT DUE

LECTURE 7 Selection of concrete mix proportions

- Standard specifications and concrete mix proportions
- Combining aggregates to meet a type grading
- ACI method

- Case of high-performance concrete

LECTURE 8 Further aspects of hardened concrete
- Fatigue and impact strength
- Electrical properties
- Acoustical properties

LECTURE 9 Temperature effects in concrete
- Effect of curing conditions and different curing methods
- Thermal properties
- Fire resistance
- Effect of low temperatures

MID-TERM EXAMINATION/DRAFT PRESENTATION ON RESEARCH

LECTURE 10 Elasticity, shrinkage and creep
- Stress-strain relation and modulus of elasticity
- Poisson's ratio
- Shrinkage and creep

LECTURE 11 Durability of concrete: chemical attack
- Moisture transport in concrete
- Water and chloride permeability
- Carbonation
- Acid and sulfate attack
- Test procedures

LECTURE 12 Durability of concrete: action of frost
- Action of frost
- Effect of air-entraining
- Effect of de-icing agents
- Test procedures

TERM PROJECT PRESENTATIONS

FINAL EXAMINATION