

CIVIL ENGINEERING 431: MATERIALS OF CONSTRUCTION FALL 2018

CLASS INFORMATION:

Class Time: 2:00 - 3:50 p.m., Tuesdays, EMS E160
Lab Time: 3:30 - 5:20 p.m., Wednesdays, TBA/CHM 195

Instructor: Dr. Konstantin Sobolev
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Office Hours: 1:00 p.m. – 2:00 p.m., Mondays, and by appointment.

Lab Instructor: Clayton James Cloutier
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Office Hours: 2:00 p.m. – 3:00 p.m., Wednesdays (send confirmation email)

COURSE DESCRIPTION:

CivEng 431 introduces civil engineering students to the structure, properties and behavior of construction materials, providing the bridge between engineering mechanics and engineering design. The course is an engineering science course that combines lectures with laboratory experience designed to provide the students with a working knowledge of the nature and engineering properties of construction materials to understand prediction models and statistical variations for quality control. The course provides an introduction to aggregates, concrete, asphalt, timber, steel, structural alloys, and polymers used in the civil infrastructure and in building construction.

TEXTBOOKS:

1. Michael S. Mamlouk and John P. Zaniewski, Materials for Civil and Construction Engineers, 4th ed., Pearson, 2011.
2. Shan Somayaji, Civil Engineering Materials, 2nd ed., Prentice Hall, 2001.

COURSE PREREQUISITES:

Junior Standing

COURSE OBJECTIVES:

Broad Objectives

- Students will learn the microstructure - property relations governing the behavior of civil engineering materials, such as steel, concrete, composites, and plastics.
- Students will learn about structure, physical and mechanical properties and design principles of construction materials.

- Students will learn how to conduct the standard tests related to properties of construction materials.

Learning Outcomes

- Students will have an ability to conduct a literature search regarding recent developments related to materials of construction.
- Students will have the ability to write and make oral presentations based upon their findings from construction materials laboratory experiments and related literature study.
- Students will have the ability to design experiments related to properties of materials of construction and to conduct experiments, as well as to analyze and interpret data.
- Students will have the ability to know basic properties of materials of construction (including steel, aluminum, cement, aggregates, concrete, asphalt, masonry, road base/sub-base materials, composites, and plastics).
- Students will have the ability to identify, formulate, and solve engineering experimental design problems related to the determination of properties of materials of construction.

TOPICS COVERED:

- Principles of materials science
- Microstructure-property relations
- Structural Steel
- Aluminum
- Cement, Aggregates, and Concrete
- Chemical Admixtures
- Asphalt
- Masonry
- Road Base/Sub-base Materials
- New Construction Materials

Projects/Extended Problems: Two independent study projects (usually, the literature survey and students lab competition on advanced construction material technology) and laboratory experiment 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 input by the students in the class.

Laboratory Exercises: Minimum of ten significant laboratory experiments are required to be conducted by all 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.

Students Competition: At the end of the semester, students are encouraged to participate in Students Competition based on the acquired theoretical and practical knowledge. Commonly, students design

the fiber-reinforced concrete beam for the best ultimate bending load and the best deflection. This competition is judged by the jury (three instructors-members of the Structural Division).

Class/Laboratory Schedule: Sixty class hours (each 50 minutes long) per semester are allocated to this class. About half of class hours are devoted to lectures by the instructor and/or invited lecturers from the industry; and the remaining half of the class hours are devoted to laboratory sessions.

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 steel, concrete, composites. 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 presentation made by the guest speakers.

RELATIONSHIP TO PROGRAM OUTCOMES:

- iii. Graduates will have an ability to design and conduct experiments, as well as to analyze and interpret data (ABET b);
- v. Graduates will have an ability to function on multidisciplinary teams (ABET d);
- ix. Graduates will have an ability to communicate effectively (ABET g);
- x. Graduates will have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context (ABET h);
- xi. Graduates will demonstrate a recognition of the need for, and an ability to engage in life-long learning (ABET i).

METHODS OF ASSESSMENT:

- ABET Rubrics
- Course Evaluations by Students
- Graded Projects
- Instructor Judgment
- Structural Division Jury Assessment
- Mini-FE (CE&M internal) and PE Exams

RESOURCES COMMONLY AVAILABLE:

- Instructor and Teaching Assistant
- Laboratories: W165, W190, W360
- Departmental library on construction materials (books, journals, educational CDs)
- Data-show projector and/or Smart Board
- Software: Microsoft Word, Excel, PowerPoint, etc.

DESIRABLE STUDENT COMPETENCIES:

- Ability to conduct laboratory tests and follow 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 (Microsoft Word, Excel, PowerPoint)

GRADING POLICY:

| | | | |
|---------------|--------|--------------|--------------|
| Three exams: | 3×15 % | A: 96.5-100% | C: 75.5-79% |
| Safety Quiz: | 5 % | A-: 93-96.5% | C-: 72-75.5% |
| Homework: | 15 % | B+: 89.5-93% | D+: 68.5-72% |
| Laboratory: | 20 % | B: 86-89.5% | D: 65-68.5% |
| Presentation: | 15% | B-: 82.5-86% | D-: 61.5-65% |
| | | C+: 79-82.5% | F: <61.5% |

ASSIGNMENT POLICY:

Homework assignments are usually handed out on Mondays, and collected a week later (next Monday). Students who hand in homework two days later (the following Wednesdays) will be penalized 50%. No assignment more than two days late is accepted. No make-up quiz is allowed. The TA will announce the due date of the lab report for each lab. Late reports will be accepted, but 30% will be deducted for every day that the report is late.

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.

MATERIALS OF CONSTRUCTION LABORATORY:

Principal Equipment

- Laboratory bench mixer
- Concrete mixers
- Curing room
- Compression machine
- Flexural and static fatigue test equipment
- Frequency analysis machine
- Concrete abrasion test equipment
- Chloride ion permeability test equipment
- Rapid freeze-thaw machine and freezer room
- L.A. abrasion machine

Supplementary Equipment:

- Air entrainment meters
- Capping equipment
- Cement autoclave
- Cement calorimeter
- Extensometer
- Concrete impact hammer

- Coring drill
- Creep frames
- Gilson mixer
- Hobart mixer
- Scales
- Maturity meters
- Mortar penetrometer
- Resistance thermometer
- Half-cell potential and other test apparatus to measure corrosion potential and carbonation
- Sieves
- Vicat apparatus
- Vibrating table
- Pulse velocity meter
- Windsor probe

TEST PROCEDURES PER ASTM AND/OR AASHTO:

- Cement: T98, T105, T106, T107, T127, T128, T129, T131, T132, T133, T137, T153, T154, T162, T185, T186, T188, T192
- Aggregate: T2, T11, T19, T21, T27, T130, T37, T71, T84, T85, T96, T103, T104, T112, T113, T142, T248, T255
- Concrete: T22, T23, T24, T97, T119, T121, T126, T140, T141, T148, T152, T157, T158, T159, T160, T161, T177, T178, T196, T197, T198, T231, T259, T260, T271, T277, C215, C469, C457, C512, C597, C671, C672, C684, C779, C803, C805, C856, C873, C876, C900, C944, C1064, C1074, C1150

LAB REPORT GRADING:

A general outline for the report is as follows (See the lab manual for detailed description):

1. Title page
2. Abstract (10%)
3. Table of contents
4. Introduction (10%)
5. Procedure and Equipment (10%)
6. Results (20%)
7. Uncertainty analysis (10%)
8. Conclusion (20%)

Other criteria:

1. Organization (5%)
2. Figures (5%)
3. Grammar/Spelling (10%)

LAB: THINK SAFETY FIRST:

You must wear a hard hat and safety glasses at all times when you are in the structures laboratory. Stay away from all active test setups! Request masks and earplugs if you deem it necessary.

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:

- The Science and Technology of Civil Engineering Materials by F. Young et al.
- Introduction to Materials Science for Engineering by J.F. Shackelford.
- The Science and Design of Engineering Materials by J.P. Schaffer, et al.
- Structure and Properties of Engineering Materials by Henkel and Pense.
- Foundations of Materials Science and Engineering by Smith.
- Engineering Materials: Properties and Selection by K.G. Budinski and M.K. Budinski.
- Concrete: Structure, Properties, and Materials by P.K. Mehta and P.J.M. Monteiro.
- Properties of Concrete by A.M. Neville.
- Design and Control of Concrete Mixtures, S. Kosmatka, B. Kerkhoff, W. Panarese.
- Concrete Admixtures Handbook - Properties, Science, and Technology by V. Ramachandran.
- High-Performance Concrete by P.-C. Aitcin.
- Binders for Durable and Sustainable Concrete by P.-C. Aitcin.
- Special Inorganic Cements by I. Odler.
- Computer Modeling of Concrete Mixtures by J. Dewar.
- Lea's Chemistry of Cement and Concrete by F. Lea.
- Rheology of Fresh Cement and Concrete by P.F.G. Banfill.
- Advances in Cement Technology Chemistry, Manufacture and Testing by S. N. Ghosh.

TENTATIVE SCHEDULE: Fall 2018

| Week | Dates | Topics | Reading | HW |
|------|----------|--|----------------------------|----|
| 1 | Sept 4-5 | L1: Selection of Materials | Ch1 p.1 | 1 |
| 2 | Sept 10 | Introduction/ Safety Quiz/ Lab Tour (Mandatory) | lab #1 | - |
| | Sept 12 | Lab #1: Tensile Strength of FRP | | |
| 3 | Sept 17 | L2: Nature of Materials and Microstructure | Ch2 p.52 Lab #2 | 2 |
| | Sept 19 | Lab #2: Tensile Strength of Heat Treated Steel | | |
| 4 | Sept 24 | L3: Mechanical and Non-Mechanical Properties | Lab #3 | 3 |
| | Sept 26 | Lab #3: Sieve Analysis/Moisture Content of Aggregates | | |
| 5 | Oct 1 | L4: Steel | Ch3 p.85 Lab #4 | 4 |
| | Oct 3 | Lab #4: Virtual Aggregates | | |
| 6 | Oct 8 | L5: Aluminum | Ch4 p.140 Lab#5 | 5 |
| | Oct 10 | Lab #5: Properties of Portland Cement | | |
| 7 | Oct 15 | EXAM 1 | Lab#6 | - |
| | Oct 17 | Lab #6: Fresh Properties of Concrete | | |
| 8 | Oct 22 | L6: Aggregates | Ch5 p.163 Lab #7 | 6 |
| | Oct 24 | Lab #7: SCC | | |
| 9 | Oct 29 | L7: Portland cement | Ch6 p.201 Lab #8 | 7 |
| | Oct 31 | Lab #8: Rheological Properties of Materials | | |
| 10 | Nov 5 | L8: Portland cement concrete | Ch7 p.246 Lab#9 | 8 |
| | Nov 7 | Lab #9: Asphalt Testing | | |
| 11 | Nov 12 | L9: Portland cement concrete | Ch9 p.329 | 9 |
| | Nov 14 | L10: Concrete mixture proportioning | | |
| 12 | Nov 19 | EXAM 2 | - | - |
| | Nov 21 | No class Thanksgiving Recess | | |
| 13 | Nov 26 | L11: Asphalt binders and asphalt concrete | Ch10/11 p.411 Lab#10 | 10 |
| | Nov 28 | Lab #10: FRP | | |
| 14 | Dec 3 | L12: Wood and composite materials | - | - |
| | Dec 5 | FRC Student Competition | | |
| 15 | Dec 10 | Project Presentation | - | - |
| | Dec 12 | Project Presentation | | |
| 16 | Dec 19 | Final Exam 10:00 to 12:00 p.m. | - | - |