TO: The Faculty of the College of Engineering

FROM: Faculty of the Lyles School of Civil Engineering

RE: New Undergraduate Course, CE 33500 Civil Engineering Materials

The faculty of the Lyles School of Civil Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

FROM:

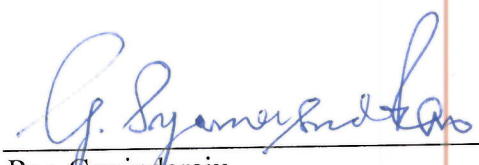
CE 49700 Civil Engineering Materials, Sem. 1, 2, Lecture 3, Lab 3, Cr. 4. Prerequisite: CE 27000 Introduction to Structural Mechanics. Temporary course number. Course was taught in Spring 2020 (51 students) and Fall 2020 (128).

TO:

CE 33500 Civil Engineering Materials
Sem. 1, 2, Lecture 3, Lab 3, Cr. 4.
Prerequisite: CE 27000 Introduction to Structural Mechanics

Description: An introduction to the relationships between fundamental structure of materials and their properties presented through a combination of materials science and engineering approaches. Emphasis on materials of particular interest for civil engineering applications, including metals, aggregates, portland cement concrete, bituminous materials, asphalt binders, asphalt mixtures, wood, polymers, composites and masonry. Laboratory exercises illustrate atomic structure, elastic and inelastic properties, and demonstrate applications of selected principles of mechanics, testing of aggregates, as well as designing and testing of asphalt and concrete mixtures.

Reason: As part of a comprehensive review of the CE undergraduate curriculum, it was determined that the topics covered in CE29700 Statics, CE27000 Structural Mechanics, CE23100 CE Materials I, and CE33100 CE Materials II could be better coordinated and streamlined. CE33500 is the result of consolidating the topics covered in CE23100 and CE33100.



Rao Govindaraju
Bowen Engineering Head of Civil Engineering and Christopher B. and Susan S. Burke Professor of Civil Engineering
Lyles School of Civil Engineering

CE 33500 Civil Engineering Materials

Course Instructor: Pablo Zavattieri and others

Course Description:
The course offers an introduction to the nature and performance of civil engineering materials and evaluation of their properties. It explores the relationships between fundamental structure of materials and their characteristics through a combination of materials science and engineering approaches. This course focUses on materials of particular interest for civil engineering applications, including metals, aggregates, portland cement concrete, bituminous materials, asphalt binders, asphalt mixtures, wood, polymers, composites and masonry. The first part of the course provides general overview of the nature of materials by examining their fundamental (i.e. atomic and molecular level) structure and linking it with such properties as strength, elastic behavior, plastic behavior, yielding, hardening, thermal behavior, viscoelasticity, and fracture. The second part of the course deals with selection, characterization and testing of specific construction materials listed earlier. The laboratory exercises constitute an integral part of the course and are designed to provide hands-on experience with atomic structure of the materials, evaluation of various mechanical and inelastic properties, application of selected principles of mechanics, testing of aggregates as well as designing and testing of asphalt and concrete mixtures.

Upon completion of this course students will develop a strong background in the structure, processing, properties and behavior of engineering materials of interest in civil engineering applications. They should be able to successfully utilize fundamental concepts of materials science and engineering mechanics to understand, explain, and describe the performance of a wide range of civil engineering materials (including metals, particulate materials, portland cement and portland cement concrete, asphalt binders and mixtures, wood, plastics, composite materials and masonry). The student will be able to describe and predict the mechanical response of a material under an arbitrary state of stress. The student will be able to assess the failure behavior of different materials and describe this behavior based on mechanics and material science arguments that will include microstructural evidence, failure theories, and material composition. In the process, the student will be able to connect concepts learned in mechanics (CE27000 Structural Mechanics) with those provided in this course.

The student will achieve these objectives through laboratory and homework exercises that enable them to successfully implement, analyze, and report on laboratory testing procedures. These objectives will be achieved through weekly laboratory exercises, in-class activities and homework exercises.

Learning outcomes from ABET criteria:

-> An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

-> An ability to develop and conduct appropriate experimentation, analyze and interpret data, and Use engineering judgment to draw conclusions.

Specific outcomes:

By the end of the course, the student will be able to:

- Formulate equations that describe the properties of composite materials based on boundary conditions, assumptions and constituent properties.
- Design and conduct experiments, as well as to analyze and interpret data.
- Use non-destructive tests to estimate material properties.
- Use non-destructive tests to locate flaws in engineering systems.
- Compare and contrast strength of materials and fracture mechanics solutions.
- Use mathematics, science and engineering principles to estimate the influence of cracks on the mechanical response of engineering materials
- Use scientific and engineering principles to predict the elastic and viscoelastic response of a material.
- Interpret engineering properties from test data.
- Use standardized test procedures to describe the properties of engineering materials.
- Use mathematical, scientific and engineering principles to compute the influence of material proportions on the structure property relationships for concrete materials.
- Design the proportions for a concrete mixture.
- Explain the relationship between the properties of an asphalt mixture and its performance.
- Select engineering materials for specific applications.
- Communicate effectively using graphs.
- Communicate effectively using an executive summary.
- Communicate effectively using an engineering report.
- Communicate the expected accuracy obtained from engineering data.

Course Outline: Schedule for Spring Semester 2020

	Date	Topic Covered
Mon, Tues	13-Jan	Introduction to course
Wed	15-Jan	Review of Stress, Strain, Strength, Extensibility
Fri	17-Jan	Stress-Strain Response - I
Mon	20-Jan	**Martin Luther King Jr. Day**
Wed	22-Jan	Stress Strain Response - II
Fri	24-Jan	Elastic and Inelastic Behavior
Mon	27-Jan	Failure Theories
Labs	28-30 Jan	Lab 1, Machine Operation & Material Variability
Wed	29-Jan	Atoms
Fri	31-Jan	Atomic Structure and Properties
Labs	4-6 Feb	Lab 2, Testing to determine stress, strain and E
Mon	3-Feb	Force-Separation and Theoretical Properties

Wed	5-Feb	Crystal Structure
Fri	7-Feb	Defects, Dislocations and Voids
Labs	11-13 Feb	Lab 3: Tensile testing of steel
Mon	10-Feb	Strengthening Mechanisms in Metals
Wed	12-Feb	Phase Diagrams - I
Fri	14-Feb	Phase Diagrams - II
Labs	18-20 Feb	Lab 4, Hardness
Mon	**17-Feb**	**EXAM 1**
Wed	19-Feb	Kinetics and Time Temperature Transformations
Fri	21-Feb	Fe-C Phase Diagram, Microstructure
Labs	25-27 Feb	Lab 5, Torsion and impact testing
Mon	24-Feb	Fracture Mechanics - I
Wed	26-Feb	Fracture Mechanics - II
Fri	28-Feb	Fatigue
Labs	3-5 Mar	Lab 6, Fracture toughness testing
Mon	2-Mar	Composites I
Wed	4-Mar	Composites II
Fri	6-Mar	Aggregate manufacture
Labs	10-12 Mar	Lab 7, Fiber and particulate composites
Mon	9-Mar	Aggregate Properties
Wed	11-Mar	Viscosity
Fri	13-Mar	Viscoelasticity - I
Mon	16-Mar	**Spring break**
Wed	18-Mar	
Fri	20-Mar	
Labs	24-26 Mar	Lab 8, Gradation and density (aggregates)
Mon	23-Mar	Viscoelasticity - II
Wed	25-Mar	Concrete - Introduction and Production
Fri	27-Mar	Cement and Supplementary Cements
Labs	31 mar-2 apr	Lab 9, Viscoelasticity (creep in polymers)
Mon	**30-Mar**	**EXAM 2**
Wed	1-Apr	Concrete - Mixture Proportioning - Structure
Fri	3-Apr	Concrete - Mixture Proportioning
Mon	2-Apr	Concrete - Fresh Properties
Labs	3-5 Apr	Lab 10, Making Concrete/Heat of Hydration
Wed	8-Apr	Making Concrete/Heat of Hydration
Fri	10-Apr	Concrete - Mechanical Properties
Labs	13-16 Apr	Lab 11, Concrete testing - mechanical properties
Mon	13-Apr	Concrete - Durability and Volume Change

Wed	15-Apr	Polymers
Fri	17-Apr	Asphalt Binders
		Lab 12, Making asphalt concrete
Mon	20-Apr	Bituminous Materials
Wed	22-Apr	Hot-Mix Asphalt
Fri	24-Apr	Asphalt Mixture Performance
		Lab 13, Testing asphalt mixture
Mon	27-Apr	Wood Structure
Wed	29-Apr	Wood Properties and Testing
Fri	1-May	Review
Week of Exams		**Exam 3 (1 hour)**

Suggested Textbooks (Optional): Books are not mandatory. We will follow concepts taken from the following books:

- Shackelford, J., "Introduction to Materials Science for Engineers" 8th edition, Pearson, 2015, ISBN-13 9780133826654
- Calister W.D., Rethwish, D.G., "Materials Science and Engineering: An Introduction"
- Mamlouk, M.S., Zaniewski, J. P., Materials for Civil and Construction Engineers, 3rd Edition, Pearson, Prentice Hall, ISBN -13 978-0-13-611058-3
- Somayaji, S., "Civil Engineering Materials", 2nd Ed., Prentice Hall, © 2001, New Jersey, 07458

Grading:

- Exams (3 exams) 50%
- Homework 10%
- Activities, quizzes & iClicker 10%
- Laboratory Reports 30%

Along with this EFD a signed copy of the Form 40 for undergraduate or Form 40G for graduate courses must be included here. This form must be signed by the authorized individual of the Originating Academic Operating Unit. The Form 40/40G is Used by the Registrar to generate the formal course description documents available to students and to describe the course in the Banner software system.

Following approval of this EFD, the signed Form 40/40G will be routed to the Dean of the College of Engineering by the ECC for additional signatures.

Form 40/40G procedures, instructions and forms can be found at the following web site.

http://www.purdue.edu/Registrar/Forms/Form_40_Introduction.html

When filling out the Form 40/40G pay particular attention to the definitions of requisites, restrictions, and attributes for a course.

***Prerequisite to a course-** is a requisite that has been successfully completed in a prior semester to taking the course, i.e., a course completed the semester before registration or earlier. At registration, most students will not have completed the prerequisite yet -- i.e., students registering for ECE20200 are most likely in ECE 20100 at registration. Students are allowed to register for ECE 20200 if they are currently enrolled in ECE 20100. After the semester (in which they are in 20100) is complete, grades are checked and students who no longer meet the prerequisite are dropped from ECE 20200.*

***Course Attributes** are enumerated by check boxes on the Form 40 and include "Approval by Department" and "Approval by Instructor."*