UNIVERSITY OF SOUTHERN CALIFORNIA

Viterbi School of Engineering

The instructor reserves the right to modify this syllabus. Students will be notified of any changes.

CE 537 – Advanced Reinforced Concrete

Term: Fall 2018
Instructor: Bora Gencturk, Ph.D., P.E.
Office: KAP 234B
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Teaching Assistants:
Amit Jain (amitjn7042@gmail.com), Office Hours: Mondays and Wednesdays 10-11 am, KAP 226.

Lectures: Thursdays, 6:30 – 9:10 pm, KAP 148

Required Textbook:

- *Design of Concrete Structures*, D. Darwin, C. W. Dolan and A. H. Nilson, 15th ed., McGraw Hill, 2016.

Recommended Textbook:

- *ACI 318-14 Building Code Requirements for Structural Concrete and Commentary*, American Concrete Institute (ACI) Committee 318, 2014.
- *Reinforced Concrete: Mechanics and Design*, J. K. Wight, 7th ed., Pearson, 2016.
- *Nonlinear Mechanics of Reinforced Concrete*, Maekawa, K., Okamura, H. and Pimanmas, A., CRC Press, 2003.
- *Reinforced Concrete Structures*, R. Park and T. Paulay, Jonh Wiley & Sons, 1975.
- *Mechanical Behavior of Materials*, N. M. Dowling, 4th ed., Pearson, 2013.

Website: https://blackboard.usc.edu (login with myUSC credentials)
Announcements, notes, handouts, homework assignments and data, etc. will be posted on the Web Site. Students are responsible for checking and downloading the material in a timely manner. Printed copies of certain (but not all) course material will be provided.

Software: Most of the material will be in PDF or will require a Microsoft Office application to open. Adobe Reader may downloaded for free from https://get.adobe.com/reader/ while Microsoft (MS) Office is available free of charge for USC students. Students will need to write simple computer scripts for various assignments. Although the selection of the computer language is up to the students to choose, Matlab is highly encouraged. Use of Matlab will allow the instructor and the TAs help students in coding their assignments. Matlab is available to USC students free of charge. See https://itservices.usc.edu/ for MS Office and Matlab. Additionally, the students will be taught using various reinforced

concrete structural analysis tools including RESPONSE 2000, ZEUS NL, SAP 2000 and ATENA 3D. How to access these computer programs will be communicated to the students during the semester.

Prerequisites: CE457 (or equivalent), and/or any graduate course on concrete
Co-requisites: N/A

Course Objectives and Emphasis: The primary goal of this course is to enrich and expand the knowledge and understanding of the behavior, analysis and design of reinforced concrete structures. This course builds on basic concrete design learned in the undergraduate concrete design course (CE457 or equivalent) and discusses in depth the material behavior of unconfined and confined concrete with and without reinforcement, flexural analysis of beams, flexure-normal force interaction in beam-columns, shear and torsion, and disturbed regions/connections. The course will be balance between behavior, analysis and design and will often refer to American Concrete Institute's Building Code Requirements for Structural Concrete. The constitutive modeling of plain and reinforced concrete and modeling of reinforced concrete elements and frames using various software will be taught.

Course Outcomes of Instruction and Laboratory Sessions:

- Students demonstrate an understanding of the stress-strain behavior of confined and unconfined concrete, plain and reinforced concrete, both under uniaxial and biaxial loading conditions.
- Students demonstrate an understanding of flexural analysis of reinforced concrete beams including moment-curvature relationships, and are able to develop simple algorithms to determine moment-curvature response of singly and doubly reinforced beams with different geometries.
- Students demonstrate an understanding of the flexure-axial load interaction in reinforced concrete beam-columns.
- Students demonstrate an understanding of the concepts of ductility, plastic hinging, stress redistribution, and nonlinear analysis.
- Students are able to design beams and beam-columns under flexural, axial, shear and torsional loading.
- Students are able analyze and interpret the results of beams under shear loading, and moment frames under lateral loading (i.e., pushover analysis).

Course Administration:

- The TA will be holding office hours (2 h/week). Any questions regarding the homework assignments should first be directed to the TAs.
- A grader will be grading the homework. Questions related to homework grades should be directed to the instructor and he will solicit an explanation from the grader. Any questions regarding the exam grades should be directed to the instructor.
- Visit instructor only during office hours or schedule a separate meeting via email.

- The students are required to come to class prepared by reviewing the material covered in the previous class and reading the relevant materials from a recommended textbook or provided handouts for the upcoming class.
- Students are encouraged to work together and exchange ideas regarding homework assignments; however, each student is responsible for making a separate submission of his/her own (unless it is a group assignment). Any indication of copying/cheating in the submitted assignments will at a minimum result in a zero grade.
- Unless specifically mentioned by the instructor during the class session, cell phones, smart phones, tablet or labtop PCs, and all other electronic equipment are to be turned off and placed in book bag during the class. First and second noncompliance will result in a warning; third will result in a zero grade for in class-participation. The student(s) will also be dismissed from that day's class.

Course Components:

- If you miss a class, you are responsible for all material covered in class and should get any missed material from a classmate.
- Homework will be assigned throughout the course; the number is to be determined.
- Homework are to be turned in at the beginning of lecture or lab period that they are due.
- Students are required to attend class and participate in the teaching of the material by helping with demonstrations and answering questions of the instructor as well as their peers. Attendance and in class participation will be recorded after each class and will constitute 10% of the total grade.
- Homework constitute 30% of the total grade.
- One midterm exams will be administered. The midterm exam constitutes 30% of the total grade. The midterm exam will be closed notes/books.
- There will be a final project that constitutes 30% of the total grade.
- For the final project, the students will work in groups of 2-3 students to conduct an in-depth analysis of a reinforced concrete element. The students are expected to form their groups early in the semester and provide the instructor with a detailed description of their planned project by the end of the 4th week of classes. The instructor will review their planned project topic and scope and the project topics and scopes will be finalized by the 6th week of classes. The students are expected to submit their final project reports by the last day of classes: Friday, November 30, 2018. Each group will then present their project to the class in a session that will be scheduled during the finals period as determined by the University.

Grading:

Attendance and in class participation	10%
Homework assignments (# TBD)	30%
Midterm exam	30%
Final project	30%

Grade cutoffs are shown in the table below.

A+	**>** 96.67%	**B**	83.33% - 86.67%	**C-**	70.00% - 73.33%
A	93.33% - 96.67%	**B-**	80.00% - 83.33%	**D**	65.00% - 70.00%
A-	90.00% - 93.33%	**C+**	76.67% - 80.00%	**F**	<65.00%
B+	86.67% - 90.00%	**C**	73.33% - 76.67%		

Note: Earning less than 65% on both Midterms and the Final Exam or earning less than 50% on the Final Exam might result in the failure of the course, regardless of your course grade.

Academic Honesty:
USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. Scampus, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A: https://policy.usc.edu/student/scampus/. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The review process can be found at: https://sjacs.usc.edu/students/scampus/.

National Society of Professional Engineers (NSPE) Code of Ethics for Engineers - Preamble and Fundamental Canons:

Preamble
Engineering is an important and learned profession. As members of this profession, engineers are expected to exhibit the highest standards of honesty and integrity. Engineering has a direct and vital impact on the quality of life for all people. Accordingly, the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct.

I. Fundamental Canons
Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.
2. Perform services only in areas of their competence.
3. Issue public statements only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

Visit www.nspe.org/Ethics/ for complete NSPE ethics statement including Rules of Practice and Professional Obligations

Disability Accommodations: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me or the TA as early in the semester as possible. DSP is located in GFS 120 and is open 8:30 a.m. – 4:30 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

Campus Safety: To ensure you receive emergency email notifications and text messages, the students are encouraged to register with the TrojansAlert. The entire emergency management plan as well as instructions on how to register your information in the system can be reviewed here: https://trojansalert.usc.edu.

TOPICS COVERED

- RC history, RC design philosophy
- Concrete and reinforcing steel material behavior and constitutive modeling
- Beam-columns
- Flexural analysis of RC beams: moment-curvature relationships
- Shear behavior of RC members
- Shear and torsional design of RC members
- Analysis and design of RC walls
- Behavior and design of disturbed regions
- Nonlinear behavior of RC systems: pushover analysis
- Seismic load calculations (if time permits)
- Principles of seismic detailing in RC (if time permits)