Spring 2019

CE 333-002: Reinforced Concrete Design

Matthew Bandelt

CE 333–002: Reinforced Concrete Design

(3 credits)

Lectures: Tuesday, Thursday 8:30am – 9:50am
Colton Hall, Room 416

Instructor: Matthew Bandelt, Ph.D.
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Office Hours: T. 1:30-3:30pm
Th. 10:00-11:15am
or by appointment
whenever my office door is open, come in!

Prerequisite: CE 332 – The student must have a working knowledge of structural analysis including determinate and indeterminate beams and frame.

Recommend Text: ACI Committee 318 (2014), *Building Code Requirements for Structural Concrete and Commentary (318-14).* Farmington Hills, MI: American Concrete Institute.

Wight, James K. (2015). *Reinforced Concrete Mechanics and Design*. Hoboken, NJ: Prentice Hall; 7th Edition. ISBN-10: 013348596X.

ACI 318-14 can be purchased from the American Concrete Institute at a reduced rate available only to students. Please visit the website below to register as a student. Once you register, you can purchase ACI 318-14 at the ACI bookstore for a reduced rate of $99.
Registration: www.concrete.org/membership/studentmembership.aspx
Store: www.concrete.org/store.aspx

Course Description *(from NJIT's course catalog)*

Primary objectives include the following: to acquaint the student with the properties of concrete and steel and with the behavior of reinforced concrete as a structural material; also, to develop methods for the design of reinforced concrete structural members such as beams, slabs, footings, and columns. Both ultimate strength design and working stress method will be studied.

Course Objectives (General)
By the end of this course, the student will be able to:

General Design: Compare and contrast different methods used for the design of structural concrete; describe the influence of concrete materials on concrete design; explain fundamental behavior of structural concrete and principles behind select code provisions.

Flexural and Shear Behavior and Design: Explain the behavior of a reinforced concrete section at various levels of deformation; calculate the nominal bending strength of a reinforced concrete member with and without compression reinforcement; design a reinforced concrete flexural member with economy and constructability in mind; discuss how shear forces are transferred through a reinforced concrete component; design a reinforced concrete member to resist shear forces.

Slab Behavior and Design: Describe load transfer mechanisms in one-way slabs; design a one-way slab for flexure, shear, temperature, and shrinkage requirements.

Development and Serviceability: Explain the importance of development length as it relates to reinforced concrete member behavior; perform necessary calculations to design a member's development length, bar splices, and bar cutoffs; describe cracking behavior in reinforced concrete members; calculate deflections in a reinforced concrete member.

Short Column Behavior and Design: Explain the difference between short and slender columns; identify the types of transverse reinforcement used in columns and reasons for using them; calculate the capacity of a short reinforced concrete column.

Footing Behavior and Design: Describe limit states used in design of footings; calculate the reinforcement requirements for strip and spread footings.

POLICIES & PROCEDURES

Academic Integrity: Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. *Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university***.** If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu.

Communication: All communication by the Instructor will be done through Moodle. It is your responsibility to check e-mail, and the course page on Moodle regularly.

Lectures/Class: Attendance at all lecture/class periods is expected. During class, I will often ask you to work on a problem or brainstorm ideas with the person or people next to you and you will then be called on to provide one of more of your answers. The goal of this in-class work will be to get you started on a problem (not necessarily finish) that we will then discuss. Please turn all cell phones off during class, keep laptops closed, and be respectful to the course instructor and your classmates.

Handouts: Copies of the notes used in class will be posted on Moodle throughout the semester at least one day before lecture. It is highly recommended that you print out a set of notes to follow along with during lecture, as notes will be filled on these handouts. A "filled in" version of these notes will be posted after class.

Prerequisites: It is assumed that you have a background in structural analysis, mechanics of materials, and statics. These three areas represent the foundation of reinforced concrete behavior and design. For example, if you are asked to design a reinforced concrete member you are expected to know how to calculate the shear force, or moment under a given set of loads. You will not necessarily be given every piece of information you need to solve a problem, but enough to be able to solve it with some looking up of expressions or conducting analyses.

Homework: Homework will be assigned to encourage further reading, to extend the material presented in lectures, and to provide practice in arriving at engineering solutions to problems. Completion of the homework is an essential part of the learning process. All homework is to be

turned in individually unless specified otherwise on the assignment. If you collaborate with a classmate (or two) be sure to state that collaboration and their names at the top of your assignment.

Homework Format: It is expected that all homework be presented in an organized manner; use green, yellow or white engineering paper, one side of each page (clear side, not grid side); begin each problem on a new page and number all pages; staple all homework pages together and have your name written clearly on the front page. An example of an acceptable homework solution is available on Moodle.

Late Homework: Homework will be due at the beginning of class on the date it is due. Late Homework will be accepted up to two days after the due date with a 10% reduction for each day that it is late. After forty-eight hours, submissions will not be accepted.

Homework Solutions: Homework solutions will be posted two days after the homework is due. It is your responsibility to make sure you understand how to solve the problems by attending office hours with the instructor and/or asking questions in class. As with many engineering problems, multiple solutions may be possible. This means that all rational solutions to the assignments will be accepted.

Homework Grading: All homework should be submitted electronically by students using Gradescope. It is your responsibility to scan your assignment in and upload it to the Gradescope website before 8:30:00 AM on the day that it is due. You may hand your assignment in to the instructor in person, but homework submissions received after 8:30:00 AM will be marked as late.

Homework questions will be graded in terms of a nine-point scheme based on three categories of format, concept, and execution. All homework questions will be equally weighted in determining your final homework grade.

Format

One (1) point will be awarded if the solution is formatted with a problem statement and a statement on what is required in the solution

One (1) additional point will be awarded if the engineering solution is presented in an organized and neat fashion that is easy to follow along.

One (1) additional point will be awarded if the solution is completed with a boxed-in answer, including a properly formatted drawing if it is requested in the problem statement.

Concept

One (1) point will be awarded if the solution has major errors in the conceptual basis of the solution.

Two (2) points will be awarded if the solution has minor errors in the conceptual basis of the solution.

Three (3) points will be awarded if the solution has no errors in the conceptual basis of the solution.

Execution

One (1) point will be awarded if the solution has two or more math or execution errors.

Two (2) points will be awarded if the solution has one math or execution error.

Three (3) points will be awarded if the solution has zero math or execution errors.

If you believe that an error was made in grading the homework, you should write a short justification of your claim and attach it to the original homework assignment in question. Hand the justification and homework paper (stapled together) to the Instructor during office hours or in class. Your homework will be reviewed to address your concern. The deadline for submitting a re-grade request is one week after the homework is returned.

Quizzes: There will be seven (7) quizzes given throughout the term. These quizzes will be unannounced, and based on homework submissions, in-class exercises, and recent lecture material. Quizzes will begin at the start of class (8:30am) and conclude after twenty minutes (8:50am). Students will not be given extra time if they arrive late to class.

Each quiz will be graded out of four (4) points. Your five (5) highest quiz grades will make up your quiz grade in the calculation of your course grade.

Exams: There will one mid-term examination and a cumulative final exam.

Calculation of Course Grade: A weighted average grade will be calculated as follows:

Homework	20%
Quizzes	20%
Project	10%
Mid-term Exam	20%
Final Exam	30%

The minimum requirements for final letter grades are as follows:

A = 90.0%, B+ = 85.0%, B = 80.0%, C+ = 75.0%, C = 70.0%, D = 65.0%, F < 65.0%

Note: Grades are not curved. It is theoretically possible for everyone in the class to get an A (or an F). Your performance depends only on how you do and how much you learn, not on how everyone else in the class does. It is therefore in your best interest to help your classmates, while acting within the bounds of the stated academic integrity policy (i.e., NJIT's Code of Academic Integrity).

Instructor Commitment: You can expect the Instructor to be courteous, punctual, organized, and prepared for lecture and other class activities; to answer questions clearly; to be available during office hours or to notify you beforehand if he is unable to keep them; to provide a suitable guest lecturer or pre-recorded lecture when they are traveling; and to grade uniformly and consistently.

Students with Documented Disabilities: NJIT is committed to providing students with documented disabilities equal access to programs and activities. If you have, or believe that you may have, a physical, medical, psychological, or learning disability that may require accommodations, please contact the Coordinator of Student Disability Services located in the Center for Counseling and Psychological Services, in Campbell Hall, Room 205, (973) 596-3414. Further information on disability services related to the self-identification, documentation and accommodation processes can be found on the webpage at: (http://www.njit.edu/counseling/services/disabilities.php)

Legal Disclaimer: Students' ability to meet outcomes listed may vary, regardless of grade. They will achieve all outcomes if they attend class regularly, complete all assignments with a high degree of accuracy, and participate regularly in class discussions. This syllabus is subject to change at the discretion of the instructor throughout the term.

CEE Mission, Program Educational Objectives and Student Outcomes

The mission of the Department of Civil and Environmental Engineering is:

- to educate a diverse student body to be employed in the engineering profession
- to encourage research and scholarship among our faculty and students
- to promote service to the engineering profession and society

Our program educational objectives are reflected in the achievements of our recent alumni:

1 – Engineering Practice: Alumni will successfully engage in the practice of civil engineering within industry, government, and private practice, working toward sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.

2 – Professional Growth: Alumni will advance their skills through professional growth and development activities such as graduate study in engineering, research and development, professional registration and continuing education; some graduates will transition into other professional fields such as business and law through further education.

3 – Service: Alumni will perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, charitable giving and other humanitarian endeavors.

Our Student Outcomes are what students are expected to know and be able to do by the time of their graduation:

1. an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
2. 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
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Revised: 2/13/18

Course Objectives Matrix – CE 333 Reinforced Concrete Design

Strategies, Actions and Assignments	ABET Student Outcomes (1-7)	Program Educational Objectives	Assessment Measures
Student Learning Outcome 1: Apply design methodologies, codes and specifications to the design of reinforced concrete members and elementary structures.			
Illustrate ultimate strength and allowable stress design philosophies.	1, 2	1, 2	Homework, projects, quizzes, and exams.
Formulate the ultimate strength design methodology.	1, 2	1	Homework, Projects, quizzes, an exams.
Discuss the ACI design codes.	1, 2, 4	1, 2, 3	Homework, Projects, quizzes, and exams.
Student Learning Outcome 2: Apply and enhance knowledge of strength of materials and structural analysis.			
Incorporate and apply basic knowledge of strength of materials.	1, 2	1	Homework, quizzes, and final exam.
Incorporate and apply basic knowledge of structural analysis.	1, 2	1	Homework, quizzes, and final exam.
Student Learning Outcome 3: Incorporate proper use of modern engineering tools for problem solving and communication.			
Introduce state of the art analysis and design software (such as Rivet/Robot, STAAD/Pro, SAP2000 etc.).	7	1, 2	Homework and projects that are solved using STAAD/Pro.
Discuss the pitfalls of computerized analysis and design and the need for sound engineering judgement.	7	1, 2	Homework and projects are solved both manually and by STAAD/Pro.
Place some assignments and course syllabus on the internet. Use e-mail for communications.	7	1	None.
Student Learning Outcome 4: Develop decision making skills and provide an environment for independent thinking while encouraging effective teamwork.			
Demonstrate non uniqueness of design solutions.	1, 2	1, 2	Design problems.
Require independent work on homework and projects, and all quizzes and exams.	1, 2	1, 2	Homework, projects, quizzes, And final exam.
Require teamwork for some assignments.	5	1, 2	Homework and Projects.

Week	Date	Lecture	Lecture Topic	Notes	HW Assigned	HW Due
1	January 22, 2019	1	Course Overview and Introduction to Structural Design			
	January 24, 2019	2	Structural Loads and Building Systems		**HW1**	
2	January 29, 2019	3	Introduction to Reinforced Concrete			
	January 31, 2019	4	Reinforced Concrete Material Properties			**HW1**
3	February 5, 2019	5	Flexural Behavior: Stages of Bending			
	February 7, 2019	6	Flexural Behavior: Service Load Stresses		**HW2**	
4	February 12, 2019	7	Flexural Behavior: Nominal Capacity			
	February 14, 2019	8	Flexural Behavior: Doubly Reinforced Members			**HW2**
5	February 19, 2019	9	Flexural Behavior: Doubly Reinforced Members			
	February 21, 2019	10	Flexural Behavior: Section Classification		**HW3**	
6	February 26, 2019	11	Flexural Design: Known Dimensions			
	February 28, 2019	12	Flexural Design: Unknown Dimensions			**HW3**
7	March 5, 2019	13	Flexural Design: Doubly Reinforced Members		**HW4**	
	March 7, 2019	Mid-Term Exam				
8	March 12, 2019	14	One-way Slab Behavior and Design			
	March 14, 2019	15	T-Beam Behavior and Design			**HW4**
9	March 19, 2019	Spring Break				
	March 21, 2019					
10	March 26, 2019	Guest Lec. 1	Guest Lecture			
	March 28, 2019	16	Shear Behavior			
11	April 2, 2019	17	Shear Design		**HW5**	
	April 4, 2019	Guest Lec. 2	Guest Lecture			
12	April 9, 2019	18	Deflections			**HW5**
	April 11, 2019	19	Development Length			
13	April 16, 2019	20	Bar Cutoffs		**HW6**	
	April 18, 2019	21	Short Column Behavior			
14	April 23, 2019	22	Short Column Design		**HW7**	**HW6**
	April 25, 2019	23	Footing Behavior			
15	April 30, 2019	24	Footing Design			**HW7**
	May 2, 2019	25	Course Recap			

**Calendar is subject to change by the couse instructor. Last updated 15-November-2018.*