CE 333–101: Reinforced Concrete Design
(3 credits)

Lectures: Tuesday 6:00pm – 9:05pm (with a 15-minute break mid-way)
Colton Hall, Room 416

Instructor: Matthew Bandelt, Ph.D.
Colton Hall, Room 209
bandelt@njit.edu
(973) 596-3011

Office Hours: M. 1:00-3:00pm
Th. 9:30-11:15am
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.


ACI 318-14 should be purchased from Mrs. Heidi Young in the CE Departmental Office by cash or check made out to “NJIT Civil Engineering Department”. This document is the only resource you are allowed to bring to quizzes and exams in this course.

Additional examples will be used to supplement in-class learning. Many of these examples and additional materials have been developed or acquired through NJIT’s Open Affordable Textbook (OAT) Program.

Other Recommended Texts & Reading

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

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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**: It is expected that NJIT’s University Code on Academic Integrity will be followed in all matters related to this course. Refer to NJIT’s Dean of Students website to become familiar with the Code on Academic Integrity and how to avoid Code violations.

**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 and keep laptops closed.

**Handouts**: Copies of the notes used in class will be posted on Moodle throughout the quarter 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 that time they will not be accepted. Turn in late homework to the Instructor by 5pm the day after the due date – be sure to hand it in by

**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.

**Exams:** There will be five in-class quizzes held during class time and one comprehensive final exam as scheduled by the University Registrar.

**Homework Grading:** All homework will be submitted electronically by students using Gradescope. It is your responsibility to scan your assignment in and upload it to the Gradescope website before 11:59 PM on the day that it is due.

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.

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

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>20%</td>
</tr>
<tr>
<td>In-Class Quizzes</td>
<td>45%</td>
</tr>
<tr>
<td>(Five quizzes that are equally weighted)</td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td>10%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>25%</td>
</tr>
<tr>
<td>(Cumulative final exam)</td>
<td></td>
</tr>
</tbody>
</table>

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 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

As the CEE Department moves into the 21st century, we will continue to build upon our role as an important educator of civil engineers and environmental engineers in the State of New Jersey. Our main vision for the future is continuous quality improvement of students and faculty as NJIT advances in stature both regionally and nationally. Education of bachelor-level civil engineers remains a principal focus of the CEE Department, and to this end, we have established program educational objectives and student outcomes.

Program Educational Objectives

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

1. *Engineering Practice*: Recent 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*: Recent alumni will advance their skills through professional growth and development activities such as graduate study in engineering, professional registration, and continuing education; some graduates transition into other professional fields such as business and law through further education.

3. *Service*: Recent alumni perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, and humanitarian endeavors.

Student Outcomes

Our BSCE student outcomes are what students are expected to know and be able to do by the time of their graduation:

a. ability to apply knowledge of mathematics, science, and engineering
b. ability to design and conduct experiments, as well as to analyze and interpret data
c. ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. an ability to function multi-disciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use techniques, skills, and modern engineering tools necessary for engineering practice
## Course Objectives Matrix – CE 333 Reinforced Concrete Design

<table>
<thead>
<tr>
<th>Strategies and Actions</th>
<th>Student Learning Outcomes</th>
<th>Outcomes (a-l)</th>
<th>Prog. Object.</th>
<th>Assessment Methods/Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illustrate ultimate strength and allowable stress design philosophies.</td>
<td>Learn design concepts and modes of failure.</td>
<td>a, c</td>
<td>1, 2</td>
<td>Homework, projects, quizzes, and exams.</td>
</tr>
<tr>
<td>Formulate the ultimate strength design methodology.</td>
<td>Learn the relationship between theoretical concepts and design procedures.</td>
<td>a, c, e</td>
<td>1</td>
<td>Homework, Projects, quizzes, and exams.</td>
</tr>
<tr>
<td>Discuss the ACI design codes.</td>
<td>Gain professional knowledge required to design safe, serviceable and economical members.</td>
<td>a, c, e, f</td>
<td>1, 2, 3</td>
<td>Homework, Projects, quizzes, and exams.</td>
</tr>
<tr>
<td><strong>Course Objective 2: Apply and enhance knowledge of strength of materials and structural analysis.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incorporate and apply basic knowledge of strength of materials.</td>
<td>Learn the concept of composite sections based on the characteristics of constituent materials.</td>
<td>a, c, e</td>
<td>1</td>
<td>Homework, quizzes, and final exam.</td>
</tr>
<tr>
<td>Incorporate and apply basic knowledge of structural analysis.</td>
<td>Apply knowledge of shear and moment diagrams and influence lines.</td>
<td>a, c, e</td>
<td>1</td>
<td>Homework, quizzes, and final Exam.</td>
</tr>
<tr>
<td><strong>Course Objective 3: Incorporate proper use of modern engineering tools for problem solving and communication.</strong></td>
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<tr>
<td>Introduce state of the art analysis and design software (such as Rivet/Robot, STAAD/Pro, SAP2000 etc.).</td>
<td>Learn how to use the latest technology in solving structural analysis and design problems.</td>
<td>k</td>
<td>1, 2</td>
<td>Homework and projects that are solved using STAAD/Pro.</td>
</tr>
<tr>
<td>Discuss the pitfalls of computerized analysis and design and the need for sound engineering judgement.</td>
<td>Learn how to use modern technology properly and effectively.</td>
<td>k</td>
<td>1, 2</td>
<td>Homework and projects are solved both manually and by STAAD/Pro.</td>
</tr>
<tr>
<td>Place some assignments and course syllabus on the internet. Use e-mail for communications.</td>
<td>Learn how to use information technology.</td>
<td>k</td>
<td>1</td>
<td>None.</td>
</tr>
<tr>
<td><strong>Course Objective 4: Develop decision making skills and provide an environment for independent thinking while encouraging effective teamwork.</strong></td>
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</tr>
<tr>
<td>Demonstrate non uniqueness of design solutions.</td>
<td>Learn how to make design decisions considering realistic constraints such as safety, economy and serviceable.</td>
<td>c, e</td>
<td>1, 2</td>
<td>Design problems.</td>
</tr>
<tr>
<td>Require independent work on homework and projects, and all quizzes and exams.</td>
<td>Learn how to plan and organize work and enhance problem solving skills.</td>
<td>a, e</td>
<td>1, 2</td>
<td>Homework, projects, quizzes, And final exam.</td>
</tr>
<tr>
<td>Require teamwork for some assignments.</td>
<td>Learn the importance of coordination and time management.</td>
<td>d, f, g</td>
<td>1, 2</td>
<td>Homework and Projects.</td>
</tr>
</tbody>
</table>