JOHN A. REIF, JR. DEPARTMENT OF
CIVIL AND ENVIRONMENTAL ENGINEERING

NJIT New Jersey Institute of Technology

CE 333–002: Reinforced Concrete Design

Lectures: Monday, Wednesday 11:30am – 12:50pm
Tiernan Hall, Lecture Hall 1

Instructor: Matthew J. Bandelt, Ph.D., P.E.

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Office Hours: Mon. 9:00-11:00am (Colt. Hall)
or by appointment
in person or via Zoom (link below)
https://njit-edu.zoom.us/my/bandelt

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

(2 credits, 3 contact hours)

Recommend Texts: ACI Committee 318 (2019), *Building Code Requirements for Structural Concrete and Commentary (318-19).* Farmington Hills, MI: American Concrete Institute.

McCormac, James C, and Brown, Russel H. (2016). *Design of Reinforced Concrete*. Hoboken, NJ: Wiley; 10th Edition. ISBN-10: 1118879104.

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

ACI 318-19 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 318-19 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.

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 Course Instructor will be done through Canvas. It is your responsibility to check e-mail, and the course page on Canvas regularly.

Lectures/Class: Attendance at all lecture/class periods is expected. Students are expected to participate through the class period. During class, I will often ask you to work on a problem or brainstorm ideas 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 be respectful to the course instructor and your classmates. You should always bring a pencil and calculator with you to class.

Handouts: Copies of the notes used in class will be posted on Canvas 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 in 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 at a particular location along the length of a beam 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.

Modular Grading: This course will use a modular grading methodology whereby you will be given up to two assessment opportunities for the different course modules described below. These modules represent the main topics covered in this course and align with the learning objectives for the course and lectures.

Course Modules: There are seven course modules outlined as follows:

Module 1 – Structural Loads and Building Systems
Module 2 – Flexural Behavior: Service Limit State
Module 3 – Flexural Behavior: Ultimate Limit State
Module 4 – Flexural Design
Module 5 – Shear Design
Module 6 – Development and Anchorage
Module 7 – Short Column Interaction Diagrams

Assessment Opportunities: For each module, you will be given one in-class assignment, and one exam opportunity to determine your score for that module. The score from your last attempt at a module will be your score for that module. As a result, you may decide to not attempt a module after one attempt if you do well on the first assessment opportunity, or you may decide to attempt to repeat a module if you do poorly on the first assessment opportunity. The assessment opportunities are summarized in Table 1. In-class assignments will be twenty (20) minutes in length. You may decide not to take an assessment opportunity (in class, exam). If you take an exam you may answer as many, or as few questions as you would like.

Table 1: Assessment Opportunities

Module	Topic	In Class Assignments	Exam 1	Exam 2	Exam 3
1	Structural Loads and Building Systems	X	X		
2	Flexural Behavior: Service Limit State	X	X		
3	Flexural Behavior: Ultimate Limit State	X		X	
4	Flexural Design	X		X	
5	Shear Design	X			X
6	Development and Anchorage	X			X
7	Short Column Interaction Diagrams	X			X

Project: A course project will be assigned in the middle of the semester related to computer applications of the topics covered in this course. Details of the project will be assigned approximately half-way through the term.

Absence Policy: If you miss an assessment opportunity, you will be unable to make it up. The only exception to this is if you had a serious medical issue, death in the family, or other excusable emergency absence. In this case, you are required to obtain an excused absence from the Dean of Students prior to asking for a make-up.

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

Module 1 – Structural Loads and Building Systems	10%
Module 2 – Flexural Behavior: Service Limit State	10%
Module 3 – Flexural Behavior: Ultimate Limit State	10%
Module 4 – Flexural Design	10%
Module 5 – Shear Design	10%
Module 6 – Development and Anchorage	10%
Module 7 – Short Column Interaction Diagrams	10%
Final Exam	15%
Homework	5%
Course Project	10%
Total	100%

Each module will be scored out of ten (10) points. In order to receive a passing grade for the course, you must pass five (5) out of the seven (7) modules. A passing score for a module is defined as a score of six (6) points out of the ten (10) points. Additionally, in order to receive a passing grade for the course you must have a score of least three (3) points out of ten (10) points on all modules.

If you meet the requirements to receive a passing grade for the course, your course letter grade will be calculated based on the minimum requirements as follows:

A = 90.0%, B+ = 85.0%, B = 80.0%, C+ = 73.0%, C = 65.0%, D = 60.0%, F < 60.0%

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). **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 optional. All homework is to be turned in individually unless specified otherwise on the assignment. If you collaborate with classmates, 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; have your name written clearly on the front page. An example of an acceptable homework solution is available on Canvas.

Homework Solutions: Homework solutions will be posted three 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, many solutions may be possible and will be accepted if they follow logical engineering judgement.

Homework Submission and Grading: All homework should be submitted electronically by students using Gradescope. It is your responsibility to scan your assignment (or take a high-quality image of it) and upload it to the Gradescope website before 11:00:00 AM on the day that it is due. Homework submissions received after 11:00:00 AM will not be graded. Homework will be graded based on completeness, format, and execution. Each assignment will be counted equally, but not all individual questions will necessarily be graded. The selection of which question(s) are graded is subjected to the discretion of the instructor on each individual assignment.

Instructor Commitment: You can expect the Course 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.

Generative AI: Student use of artificial intelligence (AI) is permitted in this course when explicitly stated on assignments. Additionally, if and when students use AI in this course, the AI must be cited as is shown within the NJIT Library AI citation page for AI. If you have any questions or concerns about AI technology use in this class, please reach out to the Course Instructor prior to submitting any assignments.

In all instances when the use of AI is not permitted, it is expected that students work without AI assistance to better develop their skills in this content area.

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: https://www.njit.edu/accessibility/requesting-testingaccommodations

Tentative Course Schedule

Week	Date	Module	Lecture Topic	Notes
1	January 22, 2025	1	Course Overview and Introduction to Reinforced Concrete	
2	January 27, 2025		Introduction to Structural Design and Structural Loads	
	January 29, 2025		Structural Loads and Building Systems	
3	February 3, 2025	2	Flexural Behavior: Stages of Bending	
	February 5, 2025		Flexural Behavior: Service Load Stresses	
4	February 10, 2025		Flexural Behavior: Service Load Stresses	Module 1 - In Class Assignment
	February 12, 2025		Flexural Behavior: Serviceability	
5	February 17, 2025		Flexural Behavior: Serviceability	
	February 19, 2025	3	Flexural Behavior: Nominal Capacity	
5	February 24, 2025		Flexural Behavior: Nominal Capacity	
	February 26, 2025		Flexural Behavior: Section Classification	Module 2 - In Class Assignment
6	March 3, 2025		Flexural Behavior: Doubly Reinforced Members	
	March 5, 2025	*Exam 1: Topics 1 to 2*		
7	March 10, 2025	4	Flexural Design: Known Dimensions	
	March 12, 2025		Flexural Design: Known Dimensions	
8	March 17, 2025	*No Class - Spring Recess*		
	March 19, 2025			
9	March 24, 2025	4	Flexural Design: Unknown Dimensions	Module 3 - In Class Assignment
	March 26, 2025		Flexural Design: T-Beams and One-Way Slabs	

10	March 31, 2025	*Guest Lecture - Computer Tools for Structural Design*		Meet in Colton Hall Computer Lab
	April 2, 2025	4	Flexural Design: T-Beams and One-Way Slabs	
11	April 7, 2025	5	Shear Behavior	
	April 9, 2025		Shear Design	Module 4 - In Class Assignment
12	April 14, 2025	6	Development Length in Reinforced Concrete Members	
	April 16, 2025	*Exam 2: Topics 3 to 4*		
13	April 21, 2025	6	Development Length in Reinforced Concrete Members	Module 5 - In Class Assignment
	April 23, 2025	7	Short Columns and Interaction Diagrams	
14	April 28, 2025		Short Columns and Interaction Diagrams	Module 6 - In Class Assignment
	April 30, 2025		Short Columns and Interaction Diagrams	Module 7 - In Class Assignment
15	May 5, 2025	*Exam 3: Topics 5 to 7*		
	May 7, 2025	Course Wrapup and Exam Review		
16	TBD	*Final Exam*		

**Calendar is subject to change by the couse instructor. Last updated 6-January-2025.*

CEE Mission, Program Objectives and Student Outcomes

The *Mission* of the John A. Reif Jr. Department of Civil and Environmental Engineering is to:

- Educate a diverse student body to be employed in the engineering profession
- Encourage research and scholarship among our faculty and students
- Promote service to the engineering profession and society

The Department of Civil & Environmental Engineering also shares the four-pronged mission of New Jersey Institute of Technology: education, research, service and economic development.

Program Educational Objectives

Our *Program Educational Objectives* are reflected in the achievements of our recent alumni:

- *Engineering Practice*: Alumni will successfully engage in the practice of civil engineering within industry, government, and private practice, working towards safe, practical, resilient and sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.
- *Professional Growth*: Alumni will advance their technical and interpersonal 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 academia, business, and law through further education.
- *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.

Student Outcomes

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

- an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
- 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 communicate effectively with a range of audiences
- 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

- 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
- an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusion
- an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Course Objectives Matrix – CE 333 Reinforced Concrete Design – Section 002

Strategies and Actions	Outcomes (1-7)	Prog. Object.	Assessment Methods/Metrics
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, 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 properuse 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 computer software.
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 using computer software.
Place some assignments and course syllabus on the internet. Use e-mail for communications.	7	1	None.
Student Learning Outcome 4: Develop decisio n making skills and provid e an environmental 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.