CE 631–102: Advanced Reinforced Concrete Design

(3 credits)

Lectures: Thursday 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. 11:00am-1:00pm
W. 4:00-6:00pm
or by appointment
whenever my office door is open, come in!

Prerequisite: An undergraduate course in theory and design of reinforced concrete

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

Other Recommended Texts & Reading

ACI 318-14, *Building Code Requirements for Structural Concrete and Commentary*

Course Description

Students will learn advanced topics related to the behavior and design of reinforced concrete. The advanced topics include flexural behavior of reinforced concrete, the behavior and design of slender columns and two-way slab systems, the use of strut and tie modeling for design of structural components, frame joints, torsion, and walls.

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 and geometry configurations on concrete design; explain fundamental behavior of structural concrete and principles behind select code provisions.

Flexural Behavior: calculate a moment-curvature diagram for a flexural section with and without compression reinforcement; calculate the cracked stiffness of various concrete components and apply them to frame analyses; perform a plastic collapse analysis on indeterminate concrete beams and plot load-deflection behavior; explain with examples why and when ductility is important in structural design.

Shear and Torsion: describe shear force-transfer mechanisms; calculate shear strength of reinforced concrete systems; identify equilibrium and compatibility torsion in structural systems and explain the significance of each; explain the assumptions and derivations for torsion design and detailing using the plastic space truss analysis; design concrete members of various cross section for torsion using the plastic space truss analogy.

Slender Column Behavior & Design: calculate interaction diagrams for compression and bending in concrete columns; perform a sidesway analysis for a concrete frame; design columns and frames using the moment magnifier method.

Two-way Slab Behavior, Analysis & Design: explain the fundamental behavior and load transfer mechanisms of various slab systems for structural concrete buildings in particular two-way slabs; explain and select design layouts for slab systems; perform a yield line analysis of a two-way slab.

Strut and Tie Modeling and Design: identify "B" and "D" regions in various structural components; sketch the flow of forces in "D" regions; plot principal stresses in concrete members using elastic finite element analyses; create strut & tie models for "D" regions; identify locations and details of reinforcement based on strut & tie models as well as check capacity in compression struts and nodes; give examples of how strut & tie modeling may influence structural form and design decisions; apply strut & tie modeling to the design of deep beams, dapped ends and corbels.

Joints and Walls Joints: describe beam-column joint modes of failure, and necessary design considerations to address these failure modes; evaluate the detailing of various beam-column joint designs for expected performance under monotonic and/or cyclic load; describe different types of walls and their applications in structural systems; calculate the capacity of a bearing wall; calculate the flexural and shear capacity of a shear wall.

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 on a daily basis, 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 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 elementary reinforced concrete design, structural analysis, mechanics of materials, and statics. Assignments may require you to look up relationships (e.g., given f'_c, you can look up the equation used to estimate E_c if E_c is what you need). 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 the assignment is late. After that time, assignments 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.

Exams: There will be one in-class exams held during class time and one exam as scheduled by the University Registrar. All exams count equally.

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 by the end of the day that it is due (i.e., before 11:59:59 PM on the day that it is due).

Homework grades will be assigned in terms of a 5 point scheme:

0 – no submission, or less than 20% on completeness, concept, and execution
1 – (Poor) 20% or better on completeness, concept, and execution
2 – (Below Average) 50% or better on completeness, concept, and execution
3 – (Average) 75% or better on completeness, concept, and execution
4 – (Very good) 90% or better on completeness, concept, and execution

Your course grade will largely be determined by your performance on exams. However, your homework grade will affect your course grade in the following way: homework scores of 3.5 will be "grade neutral", i.e., they will neither increase nor decrease your course grade; scores above 3.5 will tend to increase your grade, whereas scores below 3.5 will tend to decrease your grade.

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 submit it by e-mail. 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:

Homework	25%
Project	25%
Exam 1	25%
Exam 2	25%

The <u>minimum</u> requirements for final letter grades are as follows:

A = 90%, B+ = 85%, B = 80%, C+ = 75%, C = 70%, D = 65%, F < 65%

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 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.

TENTATIVE Course Schedule – *Subject to Change*

Lecture	Date	Lecture Topic	Reading (from Wight)	Notes	HW Assigned	HW Due
1	January 19, 2017	Review of Flexural Behavior and Design	4.1-4.9, 5.1-5.5		**HW1**	
2	January 26, 2017	Moment-Curvature Behavior and Section Ductility	4.1-4.9			
3	February 2, 2017	Serviceability and Load-Deflection Analysis	9.1-9.5,10.1-10.6		**HW2**	**HW1**
4	February 9, 2017	Shear and Torsion	6.1-6.6			
5	February 16, 2017	Shear and Torsion	7.1-7.5		**HW3**	**HW2**
6	February 23, 2017	Slender Columns	12.1-12.7		**HW4**	**HW3**
7	March 2, 2017	Two-Way Slab Behavior and Design	13.1-13.13			**HW4**
-	March 9, 2017	Exam 1		Through Lecture 6, HW4		
-	March 16, 2017	No Class - Spring Recess				
8	March 23, 2017	Yield Line Analysis for Two-Way Slabs	14.1-14.6		**HW5**	
9	March 30, 2017	Strut and Tie Modeling	17.1-17.10	Project Assigned		**HW5**
10	April 6, 2017	Strut and Tie Design	17.1-17.10		**HW6**	
11	April 13, 2017	Joints and Walls	17.11,18.1-18.6			**HW6**
12	April 20, 2017	Joints and Walls	18.7-18.11		**HW7**	
13	April 27, 2017	Design of R/C Structures with Emerging Materials and Systems				**HW7**
-	TBD	Exam 2		Through Lecture 13, HW7		

**Calendar is subject to change by the couse instructor. Last updated 3-January-2017.*