CEE 637 – 852: Short Span Bridge Design

(3 credits)

Lectures Online Instruction Using Canvas
http://canvas.njit.edu

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Office Hours: Tuesday & Friday
From 11:45 to 12:45

Prerequisite

undergraduate courses in structural analysis, steel design and reinforced concrete design and some knowledge of prestressed concrete fundamentals.

Required Textbook

Bridge Engineering by Demetrios E. Tonias and Jim J. Zhao, 4th Edition, published by McGraw Hill, 2017, ISBN 978-1-259-64309-5.

An electronic version of the book can be accessed online free of charge through the library.

The library website is at https://library.njit.edu.
Follow these steps:

1. Click on the tab “Databases”
2. Click on “Databases: A to Z”
3. Click on “AccessEngineering” and this will take you to the McGraw Hill “AccessEngineering” database.
4. Login to” AccessEngineering” using your university UCID and password.
5. You can find the book by entering the title or subject into the search box.

The computer program ROBOT of Autodesk is required for some course computer applications. The students can download the free academic version of the program using the university email address. Instructions on how to download the program will be sent to the students.

Other Recommended Texts & Reading

1. AASHTO LRFD Bridge Design Specifications, 9th Edition, American Association of State Highway and Transportation Officials, Washington, D.C., 2020.
2. Building Code Requirements for Structural Concrete and Commentary, ACI 318-19, American Concrete Institute, 2019.
3. Manual of Steel Construction, 15th Edition, American Institute of Steel Construction, 2016.

Course Description

The course covers the engineering process of short-span bridges from design to maintenance and rehabilitation. The various major forms of short-span bridges are presented with an emphasis placed on the most prevalent types and on highway bridges. The structure of a bridge, its superstructure and substructure members and other related elements such as abutments, foundations and retaining walls are discussed. Design procedures are covered based on the requirements of the AASHTO LRFD Bridge Design Specifications. The course includes some computer applications using the Autodesk computer program ROBOT.

Course Objectives (General)

By the end of this course, the student will be able to:

Course Topic 1:

Introduction to Highway Bridge Structures: Use and Functionality, Typical Components, Bridge Terminology – Design Standards and Specifications

Following this topic, students must be familiar with highway bridge structures in general and their various components. They must know the titles of the standards and specifications related to these bridges.

Course Topic 2:

Design Loads: Permanent Loads, Temporary Loads, Deformation and Response Loads,

Following this topic, students must be familiar with the various types of loads used in designing bridges and how to combine the various loads for design.

Course Topic 3:

Superstructure Types - Deck Types: Non-Composite and Composite Decks – Shored and Unshored Construction – Concrete Deck Slabs – Wearing Surface Types

Following this topic, students must be familiar with the superstructure types, deck types and types of construction used.

Course Topic 4:

Concrete Deck Slabs – Detailed Concrete Deck Design Example for a Slab-on-Stringer Bridge

Following this topic, students must be ready to tackle a concrete deck design project.

Course Topic 5:

Bridge Failures – Case Studies – Videos

Following this topic, students must know about some of the most famous bridge collapse cases and the reasons that led to the collapse in each case.

Course Topic 6:

Design of Composite Steel Members - AASHTO LRFD Design Method: Design Truck or Tandem, Wheel Load, Distribution Factors, Effective Flange Width, Dynamic Load Allowance, Placement of Design Truck on a Span, Composite Section Strength, Shear Capacity, Transformed Section, Shear Connector Design, Fatigue, Additional Constraints - Detailed Design Example of a Composite Steel-Concrete Stringer
Following this topic, students must be familiar with the composite girder design for a slab-on-stringer bridge and be ready to tackle the second project which will be on this topic.

Course Topic 7:

Continuous Bridges: Advantages and Disadvantages, Rolled Sections as Continuous Beams, Moment Distribution Method, Examples, Computer Program ROBOT

Following this topic, students must be familiar with continuous bridges and be able to do the structural analysis of a two-span bridge using moment distribution and the computer program ROBOT.

Course Topic 8:

Plate Girders: Elements of a Plate Girder (Flanges, Web, Stiffeners, Lateral Bracing), Hybrid Girders - Detailed Design Example of a Two-Span Continuous Plate-Girder Bridge

Following this topic, students must be ready to tackle Project 3 on the design of continuous bridges.

Course Topic 9:

Accelerated Bridge Construction (ABC)

Following this topic, students must watch a video showing an example of ABC and be familiar with the Method and how it is used.

Course Topic 10:

Bridge Inspection and Inspection Programs, Protecting the Superstructures: Inspection, Rehabilitation and Maintenance Issues

Following this topic, students must be familiar with bridge inspections and inspection programs and the issues of rehabilitation and maintenance.

Course Topic 11:

Overview of Concrete Bridges

Following this topic, students must be familiar with the different types of concrete bridges, their advantages and disadvantages.

Course Topic 12:

The Substructure Elements: Abutments, Foundations, Piers and Bearings – Overview of Abutment Design

Following this topic, students must be familiar with the elements of substructure and the general abutment design.

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.

https://www.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf

Communication:

Students may contact the instructor by email or phone. Questions can also be posted to the online Canvas Forum and the instructor will reply to the questions on the Forum as well.

Lectures/Class:

Lectures will be posted online twice per week on Monday and Thursday on the Canvas course-page. The Canvas site is at http://canvas.njit.edu. Students need to login with their UCID and password. An email notification will be sent to the class via email or by posting on the course Forum by the instructor after a new lecture or some new material is posted. Students must login after receiving the notification to watch the lectures and do the related work. Students must check their NJIT email and the Canvas course-page on a regular basis. The instructor will verify the attendance using the features available on Canvas to track the student's attendance and online activity in the course.

Students enrolled in this course should not schedule vacation and holiday trips while the course is ongoing and on dates that coincide with due dates. Airline tickets must not be booked before the end of the course.

Handouts:

Lecture files and handouts will be made available on the Canvas course-page.

Homework:

Students are required to submit three projects in addition to some computer application exercises and a few informal homework assignments.
The project outlines will be posted on Canvas. A PDF file outlining the project will be posted, and a link will be created on Canvas for the students to upload the project file by the due date and time. Students must have access to a scanner to scan their solution pages. All pages must be combined into a single PDF and uploaded to Canvas. Students will not be able to post files in formats other than PDF. Students should not email the assignments directly to the instructor. The student work must be stored on Canvas and any emailed project will be declined and deleted. Tentative due dates are given in this syllabus.

In addition to the formal projects and computer applications, some informal homework problems will be assigned. It is important that students attempt to solve the problems before the solution is posted. Students do not have to upload any informal homework problems but will be required to upload the computer applications. It is necessary for the students to solve the informal assignment problems on their own first because they are an integral part of the course material and are needed for proper learning of the covered topics.

Students who have a conflict with project due times must contact the instructor. Students must have a valid excuse to get an extension on a project deadline. All excuses must be substantiated. Please note that business and vacation trips are not considered as legitimate excuses. Illnesses and other issues must be handled by the Office of the Dean of Students who will determine whether the excuses are legitimate or not and inform the instructor.

Homework Format:

Each project solution must be uploaded as a single PDF by the due time using the link posted for that purpose to Canvas.

Late Homework:

Late projects will not be accepted past the 24-hour grace period following the due time unless the student has a legitimate excuse which can be substantiated. Projects submitted during the 24-hour grace period will be subject to a penalty.

Exams:

This course does not have any exams. The grade will be assigned based on the projects which can be relatively long involving a significant amount of work.

Calculation of Course Grade:

A weighted average grade will be calculated as follows:

Project 1: 20% - Concrete Slab Deck Design for a Slab-on-Stringer Bridge – Tentative Due Date: February 24th

Project 2: 35% - Design of a Typical Composite Stringer for a Highway Bridge –Tentative Due Date: April 13th

Computer Assignment with ROBOT: 10% - Tentative Due Date April 20th

Project 3: 35% - Design of a Continuous Plate-Girder Bridge –Tentative Due Date: Monday April 29th

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.

The minimum requirements for final letter grades are as follows:

A:	100-90
B+:	89-85
B:	84-80
C+:	79-75
C:	74-70
D:	69-60
F:	Below 60

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 office hours are moved; 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)

Course Schedule

Week	Date	Topic/*Assignment*
1	1/14 to 1/20	Introduction to the Course and Course Requirements – Introduction to Highway Bridge Structures: Use and Functionality, Typical Components, Bridge Terminology – Design Standards and Specifications
2	1/21 to 1/27	Design Loads: Permanent Loads, Temporary Loads, Deformation and Response Loads
3	1/28 to 2/3	Bridge Design Methods Group Loading Combinations
4	2/4 to 2/10	Load Distribution on Bridges Superstructure Types - Deck Types: Non-Composite and Composite Decks – Shored and Unshored Construction Concrete Deck Slabs – Wearing Surface Types
5	2/11 to 2/17	Concrete Deck Slabs – Detailed Concrete Deck Design Example for a Slab-on-Stringer Bridge **Project 1 Assigned**
6	2/18 to 2/24	Bridge Failures – Why Bridges Collapse Case Studies – Videos: The Tacoma Narrows Bridge Collapse, the Collapse of the Silver Bridge, The I-85 Bridge Collapse, Other Case Studies **Tentative Project 1 Due Date: February 24th**

7	2/25 to 3/2	Design of Composite Steel Members - AASHTO LRFD Design Method: Design Truck or Tandem, Wheel Load Distribution Factors, Effective Flange Width, Dynamic Load Allowance, Placement of Design Truck on a Span, Composite Section Strength, Shear Capacity, Transformed Section, Shear Connector Design, Fatigue, Additional Constraints - Detailed Design Example of a Composite Steel-Concrete Stringer
8	3/3 to 3/9	Detailed Design Example of a Composite Steel-Concrete Stringer (Continued)
9	3/10 to 3/16	**Spring Recess – No Class**
10	3/17 to 3/23	Detailed Design Example of a Composite Steel-Concrete Stringer (Continued) **Friday 3/19: Good Friday – No Class**
11	3/24 to 3/30	Detailed Design Example of a Composite Steel-Concrete Stringer (Continued) **Project 2 Assigned**
12	3/31 to 4/6	Plate Girders: Elements of a Plate Girder (Flanges, Web, Stiffeners, Lateral Bracing), Hybrid Girders Continuous Bridges: Advantages and Disadvantages, Rolled Sections as Continuous Beams, Moment Distribution Method, Examples, **Last Day to Withdraw: Monday April 1st.**
13	4/7 to 4/13	**Tentative Project 2 Due Date: April 13th** Computer Program ROBOT **Computer Assignment Using ROBOT Assigned**
14	4/14 to 4/20	**Computer Assignment Using ROBOT Tentative Due Date: April 20th** Detailed Design Example of a Two-Span Continuous Plate-Girder Bridge **Project 3 Assigned**
15	4/21 to 4/27	Accelerated Bridge Construction (ABC) Bridge Inspection Overview of Concrete Bridges Protecting the Superstructures: Inspection, Rehabilitation and Maintenance Issues

16	4/28 to 5/4	**Tentative Project 3 Due Date: Monday April 29** The Substructure Elements: Abutments, Foundations, Piers and Bearings **Last Day of Class at NJIT: Tuesday 4/30 – Friday Schedule** **Reading Day 1: Wednesday May 1st** **Reading Day 2: Thursday May 2nd** **Last Lecture: Monday 4/29**
		Final exams start on 5/3 and end on 5/9

CEE Course Objectives Matrix – CE 637– 852

Strategies and Actions	Course Student Learning Outcomes	ABET Student Outcomes (a-k)	Program Educational Objectives	Assessment Methods/Metrics
Course Objective 1: Introduce the students to the various types of bridges, the related engineering codes and standards and the types of loads used to design bridges				
Present Highway Bridge Structures: Use and Functionality, Typical Components, Bridge Terminology – Design Standards and Specifications – Design Loads and Group Loading Combinations	1,2,4,6,7	1,2,4,6,7	1, 2	Lectures and discussions
Course Objective 2: Present the various deck types in bridges and how to design a typical concrete deck slab				
Present the Superstructure Types - Deck Types - Concrete Deck Slabs – Detailed Concrete Deck Design Example Explain the Elements of the Substructure Introduce the Issues of Bridge Inspection, Maintenance, Rehabilitation and See cases of Bridge Failures	1,2,4,6,7	1,2,4,6,7	1,2	Projects, class lectures and discussions

Course Objective 3: Learn how to design composite steel members for a slab-on-stringer bridge and steel plate girders for continuous bridges				
Design of Composite Steel Members - AASHTO LRFD Design Method: - Detailed Design Example Design of Plate Girders for Continuous Bridges – Detailed Design Example	1,2,4,6,7	1,2,4,6,7	1,2	Projects, class lectures and discussions

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 safe, practical, 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 technical and interpersonal skills through professional growth and development activities such a 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