Fall 2024

Arch 545G-003: Graduate Structures I

Rima Taher

NJIT FALL 2024
INSTRUCTOR: Rima Taher, PhD, PE, Senior University Lecturer

ARCH 545G-003: Graduate Structures I

Graduate Course – Lecture Format – 3 Credits

Hybrid Instruction: on campus at Weston 350 on Wednesday from 10 to 11:20 am and online on Monday using Canvas at https://canvas.njit.edu

COURSE OVERVIEW:

This course outlines the fundamental principles of structural behavior and equilibrium in structures. It also covers the traditional structural systems in steel, wood, and concrete along with some of the rules of thumb used in the selection of structural elements. Examples of famous buildings and structures are used to illustrate the various structural systems and concepts. Students will be introduced to BIM through a structural building project using the computer program Revit.

LEARNING OBJECTIVES:

1) Develop the ability to select a structural system for a building, and layout a typical floor or roof framing.

2) Develop the ability to use some established rules of thumb for the selection of structural members.

3) Develop skills for using the methods of statics and structural analysis to analyze structural members.

4) Develop the ability to apply the theoretical concepts and methods using some practical design assignments and a main steel building project.

5) Develop the skills to use computer programs such as Revit to do the work assigned in the main project.

NAAB PROGRAM CRITERIA

The National Architectural Accrediting Board (NAAB) accredits NJIT's architecture program. The NAAB has criteria that must be covered by any architectural curriculum to attain their approval. This course directly addresses (all or in part) the following, as outlined in the 2020 NAAB Conditions for Accreditation:

PC.2 Design—How the program instills in students the role of the design process in shaping the built environment and conveys the methods by which design processes integrate multiple factors, in different settings and scales of development, from buildings to cities.

PC.3 Ecological Knowledge and Responsibility—How the program instills in students a holistic understanding of the dynamic between built and natural environments, enabling future architects to mitigate climate change responsibly by leveraging ecological, advanced building performance, adaptation, and resilience principles in their work and advocacy activities.

PC.6 Leadership and Collaboration—How the program ensures that students understand approaches to leadership in multidisciplinary teams, diverse stakeholder constituents, and dynamic physical and social contexts, and learn how to apply effective collaboration skills to solve complex problems.

PC.7 Learning and Teaching Culture—How the program fosters and ensures a positive and respectful environment that encourages optimism, respect, sharing, engagement, and innovation among its faculty, students, administration, and staff.

NAAB Student Criteria

SC.1 Health, Safety, and Welfare in the Built Environment—How the program ensures that students understand the impact of the built environment on human health, safety, and welfare at multiple scales, from buildings to cities.

SC.2 Professional Practice—How the program ensures that students understand professional ethics, the regulatory requirements, the fundamental business processes relevant to architecture practice in the United States, and the forces influencing change in these subjects.

SC.3 Regulatory Context—How the program ensures that students understand the fundamental principles of life safety, land use, and current laws and regulations that apply to buildings and sites in the United States, and the evaluative process architects use to comply with those laws and regulations as part of a project.

SC.4 Technical Knowledge—How the program ensures that students understand the established and emerging systems, technologies, and assemblies of building construction, and the methods and criteria architects use to assess those technologies against the design, economics, and performance objectives of projects.

SC.6 Building Integration—How the program ensures that students develop the ability to make design decisions within architectural projects while demonstrating integration of building envelope systems and assemblies, structural systems, environmental control systems, life safety systems, and the measurable outcomes of building performance.

LEARNING AND TEACHING CULTURE POLICY

In addition to the overarching values and ethics of the university, the New Jersey School of Architecture (NJSoA) is dedicated to optimism, diversity and solidarity, professional conduct, constructive evaluation and instruction, collaborative community, health and wellbeing, time management and school-lifework balance, respectful stewardship and space management, and well-rounded enrichment. The pedagogy of architecture and design is as complex as it is rewarding, and as dynamically evolving as the people who learn and teach it. This understanding resides at the core of the NJIT Learning and Teaching Culture Policy: https://design.njit.edu/learning-and-teaching-culture-policy

COURSE REQUIREMENTS:

Canvas will be used to deliver some of the course material. Lectures will be on campus at Weston 350 on Wednesday and the asynchronous online lecture on Monday will be posted online on Canvas. Students will be notified when new lectures and course material become available on Canvas. Students will have to submit the course assignments and project using Canvas as well.

The Canvas site is at http://canvas.njit.edu. Students need to login with their UCID and password. Some information regarding lectures and assignments will be sent to the students by email. The information will also get posted to the course Forum. Students must check their NJIT email and the course Forum on a regular basis.

Students are expected to take a test, a mid-term examination, and a final examination, in addition to some homework assignments and a main project. Assignments will be posted to Canvas, and a web link will be created for the students to upload the assignment file by the due date and time. Students must have access to a scanner to scan their solution pages. All pages must be combined in a single PDF and uploaded to Canvas. Students will not be able to post files in formats other than PDF. The instructor must be able to open and read the files. If the file is corrupt or illegible, and the instructor is unable to read the file, the student will receive an F-grade for that assignment. Students are not to email the assignments directly to the instructor. Kepler is now part of Canvas. Work will be automatically archived upon uploading in the Assignments page of Canvas.

All students are expected to take the tests in person as indicated below, on the scheduled date and during the scheduled time. No make-up test or exam will be given if students do not show up as scheduled unless the student has a compelling and valid reason that can be substantiated. Proof of hardship must be presented to the Dean of Students.

The use of electronic devices will not be permitted during tests. Only a basic scientific non-communicating calculator will be allowed.

Students enrolled in this course are not to schedule vacation and holiday trips while the course is ongoing and on dates that coincide with test dates. The course will end with the final exam. Airline tickets must not be booked before the final exam date.

Students will have 1 hour and 20 minutes on test 1 and the midterm exam and 2 hours and 30 minutes for the final exam.

This course expects students to work without artificial intelligence (AI) assistance in order to better develop their skills in this content area. As such, AI usage is not permitted throughout this course under any circumstance.

MEANS OF EVALUATION:

The following grades are used for graduate students:

Grade	GPA	Description
A	4.0	Excellent
B+	3.5	Good
B	3.0	Acceptable
C+	2.5	Marginal Performance
C	2.0	Minimum Performance
F	0.0	Failure
I		Incomplete
AUD		Audited (No Credit)

W		Approved Withdrawal
S, U		Satisfactory, Unsatisfactory
P		Passing for Master's Thesis or Doctoral Dissertation

Grading Scale:

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

In this course, students are expected to take a test, a mid-term examination, and a final examination, in addition to some homework assignments and a main project.

Test 1: 20% - Tentative date: Wednesday October 9
Mid-Term Examination: 25% -Tentative date: Wednesday October 30
Assignments: 10% - Due dates will be announced.
Project: 15% - Due Date: Wednesday December 4
Final Examination: 30% - During the final exams' week, December 15 to December 21

REQUIRED TEXTS:

- Simplified Structural Analysis and Design for Architects, Revised Second Edition, by Rima Taher, Cognella, Inc.

  Warning: Students should purchase the revised 2nd Edition of this book. Older editions are outdated and should not be used. The publisher of this book will make it available to the students to purchase online at the best price. Instructions for ordering the textbook online will be posted to Canvas.

- Why Buildings Stand Up – The Strength of Architecture, by Mario Salvadori, W.W. Norton, ISBN # 0-393-30676-3

- The Builders – Marvels of Engineering, by the National Geographic Society, ISBN # 0-7922-7351 – 6 (Winner of the International Architecture Book Award of the American Institute of Architects)

- The Structural Basis of Architecture, by Sandaker, Eggen and Cruvellier, 2nd Edition, published by Routledge, 2011. This book can be accessed online free of charge using the web link below with the NJIT- UCID and password: https://ebookcentral.proquest.com/lib/njit/detail.action?docID=1111702.

USEFUL REFERENCES:

- The Architect Studio Companion – Rules of Thumb for Preliminary Design, by Edward Allen and Joseph Iano, Wiley, ISBN # 0-471-73622-8
- Icons of Architecture – The 20th Century, by Prestel
- Structures – The Way Things Are Built by Nigel Hawkes, Macmillan, USA
- The Tower and the Bridge – The New Art of Structural Engineering, by David Billington, Princeton Press
- Simplified Engineering for Architects and Builders, 11th Edition, by James Ambrose and Patrick Tripeny, Wiley & Sons, 2011, ISBN # 978-0-470-43627-1

- Building Construction Illustrated, 4th Edition, by Francis D.K. Ching, Wiley, 2008
- Shaping Structures – Statics, by Waclaw Zalewski and Edward Allen, Wiley & Sons

INSTRUCTOR:

Instructor will be available for counseling on Tuesday and Friday from 11:45 to 12:45. A phone or a teleconference meeting can also be arranged if needed. Students can contact the instructor for appointments.
Office number: Weston 521 Campus Phone: 973-596-3015.
E-mail address: Taher@njit.edu

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.

ATTENDANCE POLICY

Attendance is critical and an attendance record will be kept. Students need to notify the instructor when unable to attend and explain the reason for not attending. Attendance can also be tracked electronically on Canvas.

The NJIT office of the Dean of Students (DOS) also maintains a way for students to explain absences that instructors can use to regulate absenteeism by providing verifiable documentation through filing an online Student Absence Excuse Request form related to the absences within 14 days. The DOS will communicate with the instructor. Nonetheless, the DOS only verifies documentation, and it remains the instructor's discretion to provide any accommodation and the student's responsibility to follow up with the instructor. Accepted reasons for absence include bereavement, medical concerns, military activity, legal obligations, or university-sponsored events. Additional DOS information is outlined here: https://www.njit.edu/dos/student-excusals

WEEK-BY-WEEK SCHEDULE:

Week 1: 9/2 to 9/7

Lecture 1:
Function and Structure: Architects and Engineers - Development of Structural Materials and Structural Engineering Profession - Selecting a Structural System - Factors to Consider
Design Loads: Dead Loads, Live Loads, Environmental Loads

Lecture 2
Fundamental Principles of Statics and Strength of Materials: Forces and Force Systems – Resultant of a System of Forces

Week 2: 9/8 to 9/14

Lecture 1
Fundamental Principles of Statics and Strength of Materials Continued: Moment and Equilibrium of Forces, Tension and Compression

Lecture 2
Introduction to Structural Analysis: Beam Types and Support Types, Support Reactions

Week 3: 9/16 to 9/21

Lecture 1
Fundamental Principles of Statics and Strength of Materials Continued:
Properties of Materials – Thermal Expansion

Lecture 2
Centroid and Moment of Inertia

Week 4: 9/22 to 9/28

Lecture 1 and Lecture 2
Fundamental Principles of Statics and Strength of Materials Continued:
Centroid and Moment of Inertia Continued

Week 5: 9/29 to 10/5

Lecture 1
Structural Analysis: Introduction to Shear and Bending Moment

Lecture 2
Structural Analysis: Introduction to Shear and Bending Moment (Continued)

Week 6: 10/6 to 10/12

Lecture 1
Structural Analysis Continued: Introduction to Shear and Bending Moment (Continued)

Lecture 2
Test 1: Wednesday October 9

Week 7: 10/13 to 10/19

Lecture 1

Steel Structural Systems

Skeleton Framing, Open-Web Steel Joists, Trusses, Rigid Frames, Arches, Domes, Cable-Supported Roofs
Examples of Steel Buildings and Structures

Lecture 2

Layout of Steel Framing Plans

Week 8: 10/20 to 10/26

Lecture 1

Wood Structural Systems

Wood Frame Construction: Platform Frame, Balloon Frame, Light Wood Framing, Ordinary Construction, Heavy Timber Construction
Prefabricated and Engineered Structural Wood: Glulam, Laminated Veneer Lumber (LVL), Parallel Strand Lumber (PSL), Structural Insulated Panels (SIP) – Wood Connections – Wood Trusses – Wood Arches and Rigid Frames
Examples of Wood Structural Systems

Lecture 2

Layout of Wood Framing Plans

Week 9: 10/27 to 11/2

Lecture 1

Reinforced Concrete: Properties of Reinforced Concrete – History of Concrete Construction

Lecture 2

Mid-Term Examination: Wednesday October 30

Week 10: 11/3 to 11/9

Lecture 1

Traditional Concrete Structural Systems

Conventional Frame and Deck Systems: Flat Plate, Flat Slab with Shearheads, Flat Slab with Beams, Waffle Slab, One-Way Slab, Pan-Joists
Lateral Resistance and Shear Walls - Reinforced Concrete Walls
Concrete Shell Structures: Folded Plate, Barrel Shell, Short Shell, Dome of Revolution, Hyperbolic Paraboloid

Lecture 2

Layout of Reinforced Concrete Framing Plans

Week 11: 11/10 to 11/16

Withdrawal Deadline: Monday, November 11

Lecture 1
Precast and Prestressed Concrete
Project Assigned: Modeling of a Steel Building Using Revit.

Lecture 2
Examples of Concrete Uses in Buildings and Structures: Frank Lloyd Wright: Guggenheim Museum, Johnson Wax Building and Tower, Fallingwater

Week 12: 11/17 to 11/23

Lecture 1
Bridges and Bridge Types: Beam Bridge, Cantilever Bridge, Arch Bridge, Suspension Bridge, Cable-Stayed Bridge – Examples of Bridges - the Brooklyn Bridge

Lecture 2
Gothic Cathedrals: Brief History, Plan of the Gothic Cathedral, Structure of the Gothic Cathedral - Examples: Notre Dame de Paris, Chartres, Saint Pierre at Beauvais.
Monuments and Towers: Gateway Arch, Eiffel Tower, CN Tower

Week 13: 11/24 to 12/30

Tuesday November 26: Thursday Schedule
Wednesday November 27: Friday Schedule
Thanksgiving Recess: Thursday November 28 and Friday November 29 – No Class

Lecture 1 (Monday)
Tall Buildings: History, Overview of Structural Systems, Lateral Stability, Examples of Skyscrapers (Fuller Building, Sears Tower, Hancock Building, Hong Kong & Shanghai Bank, Petronas Tower, Marina Towers, Taipei 101)

Week 14: 12/1 to 12/7

Lecture 1
Domes: Examples of Ancient and Modern Domes: Hagia Sophia, Nervi (Rome Olympic Games Complex), Louisiana Superdome
Exhibition Halls: Crystal Palace, Pompidou Center

Lecture 2
Concrete Shells and Complex Roofs: Examples of Concrete Shells and Complex Roofs: Sydney Opera House, TWA Terminal, and Other Examples

Project Due: December 4

Week 15: 12/8 to 12/14

Lecture 1: Last Lecture on Wednesday December 11
Cable Roofs and Light Tensile Structures: Cable Systems, Examples of Cable Roofs and Hangars with Cantilevered Cable Roofs, Examples of Tensioned Fabric Structures

Review for the Final Exam

Wednesday, December 11: Last Day of Class
Thursday, December 12: Reading Day 1
Friday, December 13: Reading Day 2

Final Exam Week: 12/15 to 12/21