ARCH 523b/Structural Design and Analysis

Units: 3

Term: Fall **Day**: Tu **Time**: 1:00 – 3:50 pm

Location: WAH B1

Instructor: Soheil Mohammadi, P.E.

Office: tbd

Office Hours: Thursdays, 5 – 6:30 pm (online via zoom with appointment)

Contact Info: soheilmo@usc.edu

Teaching Assistant: Fatima Zohra Kabbaj

Office: tbd

Office Hours: tbd

Contact Info: Kabbaj@usc.edu

Course Description

Introduction to behavior and analysis of building structures. Structural loading, materials, and element types will be explored to understand the basic building blocks of buildings. Investigation and design of building structural systems for gravity, wind and seismic loading. Comprehensive design exploration of framing type, materials, detailing, layout, form and integration. Introduction to behavior and analysis of façade structural systems. Design exploration of cladding materials and sunshade systems.

Students will develop an understanding of thought process and requirements behind engineering decisions and develop an appreciation of structural design process. Students will develop basic skills including the principals of structural design for various construction materials. This course will familiarize students with modeling simple structures in a computer program, which will provide them with the skillset necessary to analyze and design elements, visualize the structural behavior, and validate hand calculations.

Learning Objectives

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

- Develop informed intuition for structural behavior.
- Develop skills to follow load path from source to foundation.
- Identify relevant loading conditions and methods of assigning them to structural members.

- Analyze simple structures using hand calculation (static equilibrium).
- Use a structural analysis program to analyze simple structures.
- Design structural members for strength and deflection due to various loading conditions.
- Draw comparisons between structural elements used in building structure and façade structure.
- Perform structural design of various materials including steel, wood, concrete, and glass.
- Develop skills to lay out structural systems and design members.
- Develop basic knowledge of various structural details.
- Develop basic skills to choose materials and optimize structural design with the goal of reducing carbon and achieving a more sustainable structure.

Prerequisite(s): ARCH 523aL

Co-Requisite(s): None

Concurrent Enrollment: None

Recommended Preparation: One-semester college-level course in physics or calculus.

Course Notes
The course consists of a combination of lectures and lab sessions. Lectures cover the theory of structures and numerical problems to demonstrate the structural analysis and design process. Lab sessions are designed to familiarize students with the structural analysis process using a Finite Element Analysis (FEA) computer program and with the structural design process using a design computer program.

Technological Proficiency and Hardware/Software Required
- Zoom or Teams for office hours.
- Rhino or AutoCAD for modeling.
- Strand 7 (student version) for structural analysis (https://www.strand7.com/student/). To request access, please complete the PDF form at the link and email student@strand7.com. There is a monthly $10 subscription fee.
- Enercalc or similar structural analysis and design software (student version). No purchase is necessary.

USC Technology Support Links
Zoom information for students
Blackboard help for students
Software available to USC Campus

Required Materials
Text Book: Simplified Engineering for Architects and Builders- 11th or 12th Edition; James Ambrose and Patrick Tripeny. This book can be rented or purchased from major online retailers.

Optional Materials
Book: ASCE 7-16 Minimum Design Loads on Buildings and Other Structure
Book: Structural Glass Facades and Enclosures; Mic Patterson.

Book: Architecturally Exposed Structural Steel: Specifications, Connections, Details; Terri Meyer Boake.
Book: Engineering Nature: Timber Structures; Jacob Schoof

Description and Assessment of Assignments

Homework Assignments

Homework assignments are designed for students to practice the theory learned in class. They are similar to the problems solved and discussed in class. Upon successful completion of the assignments, students will learn the basics of structural performance, analysis, and design in various materials. Assignments are inter-related and each one builds on the previous one in terms of methods of analysis and design, therefore students are highly encouraged to complete each one and to come to class prepared to discuss questions and comments from their peers.

Lab Session

There will be several lab sessions throughout the semester. Students will learn and practice the fundamentals of structural analysis using a Finite-Element-Analysis (FEA) computer program. Students will use the FEA program to validate the problems they solve by hand in the Homework Assignment. Additionally, they will have the ability to expand on their problems using the computer program. One of the lab sessions will be dedicated to a site visit where students will observe an ongoing construction project. One to two of the lab sessions will be dedicated to learning an additional computer program suited for structural design which will be used to complete the final project.

Reading Assignments

Reading assignments will be made throughout the semester. Students are encouraged to read the material before class as it will greatly prepare them for the lecture and help them better follow the theory presented in class.

Midterm and Final Exams

Both the midterm and final exams are in-person at the school. Students are required to complete them independently.

Final Project

The class has a final project that the students will complete in groups. The project is designed so that the students can exercise most of the skills they learned throughout the semester.

Participation

Class attendance and participation are essential for the learning objectives of this class. Read the assigned chapter from the textbook prior to the class. Come to class with questions about the reading materials and homework problems and be prepared to answer questions when called upon. Asking questions, participating in discussions in class, and completing lab exercises will count towards participation.

Grading Breakdown

Table 1 Grading breakdown template

Assignment	% of Grade
Class Participation	15
Homework	20
Mid Term Exam	20
Term Project	20
Final Exam	25
Total	**100**

Grading Scale

Course final grades will be determined based on the following scale:

A 95-100
A- 90-94
B 85-89
B- 80-84
C 75-79
C- 70-74
D 65-69
D- 60-64
F 59 and below

Assignment Submission

Scan the completed assignment into a PDF file and email it to the instructor before the deadline. Pages should be numbered in the lower right corner (format: Page i/total) and have the following information:

- Class number, assignment number, and date on page 1.
- Your name and student ID on each page.
- PDF file name format: Last Name, First Name_HW[insert homework number]

Grading Timeline

Typically, graded homework is returned in about a week. The solutions to the homework and midterm exam will be posted in Blackboard.

Late work

Late assignments are not accepted. Homework shall be submitted at the beginning of the class on the due date. Assignments cannot be redone and returned for grading.

Technology in the classroom

A laptop computer with software listed under the section “Technological Proficiency and Hardware/Software Required” is required. The students should check email every 24 hours during the school week, to be up-to-date on the communications with the instructor.

Academic integrity
The students are expected to work independently on assignments unless otherwise specified by the instructor.

Attendance
Attendance will be in person unless the university announces otherwise. Students are expected to attend every class. If a student needs to miss a lecture for medical reasons, the student should inform the instructor via email or during office hours as early as possible before the class. If a student anticipates conflicts between lecture hours and religious holidays, contact the instructor via email by the end of the second week of class.

Classroom norms
Students are expected to be respectful of their peers and instructor. Laptops are required for the lab portion of each session. The instructor asks that the usage of laptop computers be limited to lab assignments only. Please keep your phones silent and away for the duration of class.

Course evaluation
Student have the opportunity to evaluate the course and submit their feedback on the mid-semester evaluation and the standard USC course evaluation survey at the end of the semester. Your comments are key to improving the course and learning experience, please provide your constructive feedback.

Course Schedule: A Weekly Breakdown
The weekly schedule may change slightly.

Table 2 Course schedule: weekly breakdown

Week	Topics/Daily Activities	Readings	Homework	Assignment Dates
Week 1	**Course Introduction** Objectives, assignments, and policies **Lecture 1**: Review of basic structural concepts: Systems and Elements Basics of structural analysis: Force, Moment, Static Equilibrium, Loads, and Reactive Forces SC.1 – SC.6	Chapter 1	HW-1	1 week to complete.
Week 2	**Lecture 2:** Load Sources: Dead Load, Superimposed Dead Loads, Live Load, Wind Load, Seismic Load, Hydrostatic Load,and Thermal Load Load Combinations Determination of design loads: Tributary area analysis Introduction to ASCE 7 (Minimum Design Loads) **SC.1 – SC.6**	Chapter 1	HW-2	1 week to complete.

Week	Topics/Daily Activities	Readings	Homework	Assignment Dates
Week 3	**Lecture 3:** The Basis of Structural Design: Stress and Strain Structural Elements: Beam and Column, Strength and Deflection Serviceability Requirements **SC.1 – SC.6**	Chapter 2 (2.1, 2.2, and 2.8) Chapter 3 (3.1 through 3.9)	HW-3	1 week to complete.
Week 4	**Lecture 4:** Steel Beam Design **Lab 1:** Strand 7- Introduction to Structural Analysis Computer Program **SC.1 – SC.6**	Chapter 8 Chapter 9 (9.1 through 9.8)	HW-4	1 week to complete.
Week 5	**Lecture 5:** Wood Beam Design **Lab 2:** Strand 7 exercises **SC.1 – SC.6**	Chapter 5 (5.1 through 5.7	HW-5	1 week to complete.
Week 6	**Lecture 6:** Concrete Beam Design **Lab 3:** Strand 7 exercises **SC.1 – SC.6**	Chapter 13 (13.1 through 13.3)	HW-6	1 week to complete.
Week 7	**Lecture 7:** Steel Column Design Wood Column Design **SC.1 – SC.6**	Chapter 10 (10.1 through 10.4) Chapter 6 (6.1, 6.2, and 6.4)		
Week 8 **(10/11/2022)**	**Lecture 8:** Concrete Column Design **Midterm**	Chapter 15 (15.1v through 15.3)	HW-7	HW 1 week to complete. Midterm: In-class exam.
Week 9	**Lecture 9:** Structural Elements: Slab, Deck System, and Foundations Connection Details for Steel, Wood, and Concrete **SC.1 – SC.6**	Chapter 9 (9.11) Chapter 5 (5.10 and 5.11) Chapter 14 (14.1) Chapter 16 (16.1 through 16.3)	HW-8	1 week to complete.
Week 10	**Lecture 10:** The practice of Sustainability and Structural Design **Lab 4:** Site Visit (Location tbd) **SC.1 – SC.6**		HW-9	1 week to complete.
Week 11	**Lecture 11:** Seismic Design: Earthquake Causes, Design Parameters Equivalent Lateral Force Procedure **Lab 5:** Strand 7 exercises **SC.1 – SC.6**			

Week	Topics/Daily Activities	Readings	Homework	Assignment Dates
Week 12	**Lecture 12:** Seismic Design for Architectural Components and Facades Structural Lateral System Layouts: Do's and Dont's **Lab 6:** ENERCALC- Introduction to Structural Member Design Computer Program **SC.1 – SC.6**			
Week 13	**Lecture 13:** Principals of Facade Engineering Facade structural performance criteria. Facade structural systems: medium span and long span systems **Lab 7:** ENERCALC- Introduction to Program **SC.1 – SC.6**		HW-10	1 week to complete.
Week 14	**Lecture 14:** Facade Components and Cladding Materials Structural glass Sunshade systems **Lab 8:** Strand 7 Exercises **SC.1 – SC.6**			
Week 15	Final Project Presentations **SC.1 – SC.6**			Final Project
FINAL 12/8/2022	Final Exam			In-class Exam. 12/8/2022 2-4 pm

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on Research and Scholarship Misconduct.

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press "0" after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086
eeotix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776
osas.usc.edu
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 821-4710
campussupport.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101
diversity.usc.edu
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)
ombuds.usc.edu
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

*Occupational Therapy Faculty Practice - (323) 442-33*40 or otfp@med.usc.edu
chan.usc.edu/otfp
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.