ARC 321 I Building Technologies II

Fall 2019
3-credit units: 2-CU Lecture + 1-CU Workshop
Instructors: Altaf Engineer, Assistant Professor, and Valerie Lane, Senior Lecturer

This course is required for the Bachelor of Architecture.

This course focuses on elements of building technology: principles of structural behavior; force and vector analysis; static equilibrium, and environmentally adaptive architectural design.

This course introduces students to the conventions of structural and environmental conditions by isolating system components and analyzing the contributions of individual parts to a greater whole. Structural response to external load and load transfer through elements that make up a system are analyzed in the extreme conditions of long-span horizontal structures, earth retaining elements, and building frames. Fundamentals of environmentally adaptive architectural design are covered, including bioclimatics, electromagnetics, fluid physics, and the related interactions with materials, form, and spatial composition.

Learning outcomes:
Upon successful completion of this course, students will be able to apply basic structural principles and analyze structural stability and static equilibrium with the ability to:

1. Determine the function and categorize fundamental structural elements and systems for force resistance and internal stress distribution.
2. Diagram simple structural conditions using force diagrams and describe load and reaction patterns using appropriate technical terminology.
3. Develop design solutions to abstract structural programs based on geometric stability and form.
4. Visualize methods and systems of notation relevant to depicting, representing, and conveying environmental phenomena in architectural design.
5. Integrate quantitative and qualitative aspects of human comfort, wellbeing, and environmental performance in architectural design.
6. Distinguish between Skin Load Dominated and Internal Load Dominated buildings.
7. Differentiate between passive, active, and integrated building systems and performance.
8. Make appropriate environmental systems and controls selections and apply them in architectural design.
9. Utilize appropriate visualization methods to depict, represent, and convey environmental phenomena, systems, and controls in architectural design.

NAAB performance criteria:
The material covered in this course offers students proficiency (at the indicated level of accomplishment) in the following subject areas as defined by the National Architectural Accrediting Board (NAAB)
http://www.naab.org/wp-content/uploads/01_Final-Approved-2014-NAAB-Conditions-for-Accreditation.pdf1

B.5-p Structural Systems, Principles:
ABILITY to demonstrate the basic principles of structural systems and their ability to withstand gravitational, seismic, and lateral forces.

B.6-p Environmental Systems, Principles:
ABILITY to demonstrate the principles of environmental systems' design, how design criteria can vary by geographic region, and the tools used for performance assessment, for active and passive systems.

Course Structure and Organization:
Through lectures, readings, discussions, and short writing assignments, students will be introduced to principles and mechanisms that relate structural form and patterning and passive design strategies. Students will test their understanding of lecture content through group and individual projects that take place during workshop hours.

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[1]**Understanding:** The capacity to classify, compare, summarize, explain and/or interpret information.
Ability: Proficiency in using specific information to accomplish a task, correctly selecting the appropriate information, and accurately applying it to the solution of a specific problem, while also distinguishing the effects of its implementation.

Students will be asked to develop iterative projects prompted by lecture content and tested in the MaterialsLAB. The iterative process work will be based in the scientific method: the proposal of design responses, articulating hypotheses, testing and experimentation, observation summary, and iterative response.

This course interleaves structural and thermodynamic principles, allocating approximately 50% to the study of structures and 50% to the study of thermodynamic principles.

Course objectives

During this course students will:

1. Diagram vector-active structural components (including trusses, columns, and cables) as they are employed in long-span structural systems.
2. Diagram bulk/section-active structural components, including:
    a. simple beams, cantilevers, continuous beams, and decks, and
    b. concrete and masonry foundation systems and earth retaining strategies.
3. Use studio design projects to identify and diagram:
    a. the coupling nature of compression and tensile forces due to moment-bending action, and
    b. torsion, buckling, and shear forces.
4. Explore wood, steel, and concrete for their material properties, structural capabilities, and assembly requirements as they relate to tectonics, structural stability, and environmentally adaptive systems.
5. Build physical and digital models and use them to test iterative designs.
6. Integrate the fundamental principles of human comfort, health and wellbeing with environmentally sustainability and climatic response in architectural design.
7. Classify the fundamental principles of physics related to environmental performance in design practice, including: thermal (solar), optical (light), kinetic (wind), and acoustic (sound) phenomena.
8. Characterize basic theories and methods for defining relationships between human behavior, human thermal comfort, and the physical environment through proper climatic design response.

The graded components of this course and their criteria of evaluation are currently anticipated to be as follows, but are subject to change as set forth above:

Texts

Readings will be made available through D2L. The order readings are distributed will be in direct relation to lecture content as described in the course calendar. Each reading will be followed by an in-class quiz. Criteria of evaluation will be preparedness, completion of quiz, and accuracy of answers provided. Reading quizzes help instructors to evaluate the depth of understanding of given topics among students.

Reading 1: Structural Patterns / Grids (Structures)
Reading 2: Long Span Structures / Internal Stress Behavior (Structures)
Reading 3: Active / Passive Environmental Design Synthesis (Thermodynamics)
Reading 4: Envelopes / Building Skins (Construction)
Reading 5: Daylighting (Thermodynamics)

Projects:

Precedent study

Students will study an assigned world-class building and describe through written description, physical modelling, and architectural diagramming its architectural strategies for responding to environmental conditions. If the information is not readily available, students will speculate how its systems may work.

Projects 1 & 2

Students will study various structural systems through physical modelling for application to their studio design proposals while simultaneously developing an envelope system that responds to structural bays and environmental conditions. Students will document proposed structural and integral building skin systems through detail drawings and diagrams that associate environmental phenomena to architectural strategies. Project 1 and 2 design project statements will be provided in Studio and will be the catalyst for work completed in this course.

In Project 1, each student's studio design will incorporate studies of long span structures, earth retaining elements, and large open assembly spaces.

Project 1.A – Interim design principles integral to the design studio Project 1.
Project 1.B – Final design principles integral to the design studio Project 1.

In Project 2, the studio design will incorporate studies of various comprehensive building frames and integrated design principles.

Project 2.A – Interim design principles integral to the design studio Project 2.
Project 2.B – Final design principles integral to the design studio Project 2.

In-class Charettes

Students will be asked to participate in short design charettes and various in-class activities providing opportunities for work to be completed on required projects.

Low-stakes Exercises

Students will complete low-stakes writing and sketch assignments. Proof of completion will be done through D2L and review by TA's or instructors. Criteria of evaluation for low-stakes assignments will be proof of completion.

References

Required

Allen, Edward & Joseph Iano. *The Architect's Studio Companion: Rules of Thumb for Preliminary Design.* Wiley, 5th Edition, 2011.

General

Allen, Edward & Joseph Iano. *Fundamentals of Building Construction.* Wiley, 6th Edition, 2014.
Brown, G. Z., and Mark Dekay. *Sun, Wind and Light : Architectural Design Strategies*. Somerset: John Wiley & Sons, Incorporated, 2014.
Ching, Francis D. K. *Building Construction Illustrated*. New York: John Wiley & Sons, Incorporated, 2014.
Deplazes, Andrea. *Constructing Architecture, Materials Processes Structures.* Birkhauser, 2nd Edition, 2005.
Lechner, Norbert. *Heating, Cooling, Lighting: Sustainable Design Methods for Architects.* Wiley, 3rd Edition, 2009.
Millais, Malcolm. *Building Structures: Understanding the Basics*. Routledge, 3rd Edition, 2017.
Salu, Yehuda. *Physics for Architects*. Infinity Publishing, 2nd Edition, 2010.