

University of Southern California School of Architecture

ARCH 575b Systems: Luminous and Auditory Phenomena in Architecture
3 units

INTRODUCTION / SEMESTER OVERVIEW

Introduction and Purposes

This course is the second in the building systems series and covers topics of lighting and acoustics. The fundamental scientific principles governing light and sound in the built environment will be examined in the context of human physiological, psychological and biological needs. It exposes students to technologies, materials and strategies for control of light and sound in buildings as well as the basic analyses needed to inform design decision-making and examine project performance. The course will continue the themes of resource efficiency and end-user comfort through the examination of emerging metrics for daylight sufficiency, visual and acoustic comfort.

Learning Objectives

- Understanding of the fundamental scientific principles governing the luminous and auditory environments.
- Awareness and ability to implement design strategies and appropriate technologies to utilize daylight effectively.
- Ability to conduct basic analyses using hand calculations and software simulation tools in a design context.

National Architectural Accrediting Board: Student Performance Criterion addressed are in bold.

- A.1 Communication Skills
- A.2 Design Thinking Skills
- A.3 Visual Communication Skills
- A.4 Technical Documentation
- A.5 Investigative Skills
- A.6 Fundamental Design Skills
- A.7 Use of Precedents
- A.8 Ordering Systems Skills
- A.9 Historical Traditions and Global Culture
- A.10 Cultural Diversity
- A.11 Applied Research
- B.1 Pre Design
- B.2 Accessibility**
- B.3 Sustainability**
- B.4 Site Design
- B.5 Life Safety**
- B.6 Comprehensive design
- B.8 Environmental Systems**
- B.9 Structural Systems
- B.10 Building Envelope Systems
- B.11 Building Service Systems**
- B.12 Building Materials and Assemblies
- C.1 Collaboration
- C.2 Human Behavior**
- C.3 Client Role in Architecture
- C.4 Project Management
- C.5 Practice Management
- C.6 Leadership
- C.7 Legal Responsibility**

C.8 Ethics and Professional Judgment
 C.9 Community and Social Responsibility

CALENDAR

Wk	Day	Topic	Assigned	Due	Readings
1	Tues	LIGHTING: The fundamentals of light, color and human visual perception.	Asn#1		Lam. pp. 10-35.
1	Thurs	Light and human psychological and biological needs for visual information.			
2	Tues	The physics of light: terms, physical principles, photometric units.	Asn#2	Asn#1	IES Sect. 1
2	Thurs	Optical properties of materials, implications in simulation and design.			
3	Tues	The design of the luminous environment: objectives and design implications.	Asn#3	Asn#2	Lam. pp. 71-97.
3	Thurs	Energy efficient lighting systems, controls, and design approaches.			
4	Tues	Light from the sun and sky: introduction to climate-based day lighting.	Asn#4	Asn#3	IES Sect. 2
4	Thurs	Software simulation and performance metrics for annual daylight availability.			
5	Tues	Case studies in effective day lighting.	Asn#5	Asn#4	MEEB CH. 14
5	Thurs	Introduction to High Dynamic Range imaging for photometric analysis.			
6	Tues	High-performance glazing and complex fenestration systems for day lighting.	Asn#6	Asn#5	LBNL (website ¹)
6	Thurs	Dynamic facade shading and light-redirecting systems.			
7	Tues	Review for the midterm exam.		Asn#6	
7	Thurs	Midterm exam.	Final project		
8	Tues	ACOUSTICS: Basic physical principles and human perception of sound.	Asn#7		Egan. Ch.1
8	Thurs	Measurement of sound.			
9	Tues	Sound absorption: sound absorbing treatments, reverberation, noise reduction	Asn#8	Asn#7	Egan. Ch. 2
9	Thurs	Strategies for sound absorption.			
10	Tues	The acoustics of rooms: sound paths, ray diagrams, echo control, surface treatments.	Asn#9	Asn#8	Egan. Ch. 3
10	Thurs	Physical experimentation with speech intelligibility and reverberation time.			
11	Tues	Sound isolation in architecture: transmission loss, STC rating system.	Asn#10	Asn#9	Egan. Ch. 4
11	Thurs	Example problems and construction types for			

¹ <http://lowenergyfacades.lbl.gov/>

		effective sound isolation.			
12	Tues	Acoustic design for assembly spaces.	Asn#11	Asn#10	LATimes articles
12	Thurs	Field trip to Walt Disney Concert Hall.			
13	Tues	ELECTRICAL SYSTEMS: fundamental principles, applications and needs.	Asn#12	Asn#11	MEEB Ch.25,28
13	Thurs	Buildings and the grid: demand response and net-metering.			
14	Tues	WATER: Building / landscape water demand and end-use efficiency.	Asn#13	Asn#12	MEEB Ch. 20
14	Thurs	Storm water control and rainwater harvesting / storage. Green roof systems.			
15	Tues	Net-zero water: sustainable onsite water concepts and systems.	Asn#14	Asn#13	MEEB Ch. 22
15	Thurs	Greywater and blackwater systems. Case study of the Bullitt Center.			
16	Tues	Presentation of final projects		Asn#14	
16	Thurs	Presentation of final projects			

Note: readings should be completed by the date shown on the calendar. All chapter references refer to the required text. [Note: calendar subject to change]

ASSIGNMENTS

Assignments will consist of back-of-the-envelope lighting and acoustic calculations, physical lighting and day lighting analysis using High Dynamic Range (HDR) imaging, case study research of effective day lighting, and subjective evaluation of lighting and acoustic comfort paired with hand-held physical measurements, visualization of quantitative building day lighting performance. The final project will consist of the lighting design and analysis of a net-zero energy residential project (Solar-D applicable) using physical and software modeling.

Assignment #1: Students will research and prepare a short presentation on a phenomenological (observable) dimension of light in the built environment. Presentation of this assignment will be used to stimulate a discussion on appropriate frameworks for quantifying and assessing the use of light in architecture.

Assignment #2: Physical and subjective evaluation of luminous spaces using hand-held illumination measurements. Students will collect personal subjective assessments paired with concurrent physical lighting measurements (illuminance, taken with handheld devices) in a series of spaces on campus. Students will compare/contrast their own observations to engineering industry lighting recommendations and day lighting metrics.

Assignment #3: Physical and subjective evaluation of luminous spaces using High Dynamic Range (HDR) imaging. Students will be trained to acquire calibrated HDR images using digital cameras. Students will take HDR images in a range of spaces on campus and compare their subjective evaluations to the luminance conditions recorded by the HDR images.

Assignment #4: Students will calculate annual daylight availability for a given space type, climate, and solar orientation using the DIVA plugin for Rhino.

Assignment #5: Students will construct a simple large-scale physical model of a single interior space designed to achieve a specific day lighting condition defined by the student in both

subjective and quantitative photometric terms. Students will then analyze the interior luminous environment produced by the physical model under real sun and sky conditions using High Dynamic Range (HDR) imaging and their own visual assessments. Physical outcomes (both subjective and quantitative) will be compared to design intent and discussed.

Assignment #6: Students will use the software tool COMFEN to examine the impact of a range of window glazing and fenestration systems on annual day lighting, energy and visual comfort performance.

Assignment #7: Physical and subjective evaluation of auditory environments using hand-held illumination measurements. Similar to assignment #2, students will collect personal subjective assessments paired with concurrent physical sound measurements (dB, taken with handheld devices) in a series of spaces on campus. Students will compare/contrast their own observations to engineering industry acoustic quality recommendations.

Assignment #8: Case study research and basic problem set on sound absorption in buildings.

Assignment #9: Physical experimentation with speech intelligibility and reverberation time in rooms on campus. Similar to assignment #7, students will conduct physical evaluation of qualitative aspects of the acoustic environment and make judgments for the architectural design choices that lead to acceptable and unacceptable conditions.

Assignment #10: Case study research and basic problem set on sound isolation in buildings.

Assignment #11: Reading response and response to concert experience at Walt Disney Concert Hall.

Assignment #12: Case study and basic annual energy calculations for a CA residential grid-connected PV system with net-metering.

Assignment #13: Annual water footprint calculation and analysis for a typical LA residence.

Assignment #14: Calculation and schematic representation of a net-zero water building concept.

Final Project: The final project for this course will be a schematic environmental design concept for a net-zero residence similar in scale and complexity to the U.S. DOE Solar Decathlon projects. In addition to documentation of schematic design, students will be required to carry out a detailed analysis of the annual performance of lighting and solar control elements. Students will be expected to draw upon their knowledge from the previous semester where appropriate.

GENERAL INFORMATION

Midterm and Final

There will be both a written midterm and final for this course.

Extra Credit

There is no extra credit awarded for this course.

Late Work

No late work will be accepted with the exception of extreme circumstances (documented medical or personal emergency). Consequently, if you choose to miss a class, it is your responsibility to determine what assignments you have missed and turn them in before they are due.

Work Requirements

This will be a challenging course that will require consistent engagement throughout the term and timely completion of assignments. This class is designed to require 2 hours of focused out-of-class work for each hour of in class instruction. Because the class meets for 3 hours each week, you are expected to contribute 6 hours of out-of-class time each week to assignments.

CLASS ATTENDANCE

Attendance at all class sessions, including lectures, reviews, and field trips, is required. Not being in class within the first 10 minutes is considered tardy; three tardies constitutes an absence. Failure to be present for the entire class session, unless approved by your instructor, may count as an absence.

Personal illness, family emergency, pre-approved academic reason, or religious observance may be excusable; notify your instructor of such situations as soon as possible and before the affected class session.

Unexcused absences from more than three classes will result in the lowering of your final grade one full letter grade. False representation of your attendance is a violation of the University's ethics policy.

Acceptance of late work may only be considered for excused absences, at the discretion of your instructor.

READINGS

Required Text

- Perception and Light as Formgivers for Architecture. Lam. (Free download). Assigned readings code (Lam).
<http://www.wmclam.com/index.php/publications>
- Architectural Acoustics. M. David Egan. J. Ross, 2007. ISBN-13: 978-1932159783. Assigned reading code (Egan).

Required Text on Reserve (on reserve in library)

- Mechanical and Electrical Equipment for Buildings. Wiley, 2009. ISBN-13: 978-0470195659. Assigned readings code (MEEB).
- The IES Lighting Handbook, 10th Edition. (Student edition, PDF). ISBN-13: 978-0879950071. Assigned readings code (IES).

Reference Texts (not required, but. . .)

These texts will be useful for you to refer to during the semester for additional detail on specific topics.

- The Science of Sound, 3rd Edition. Thomas D. Rossing. Addison-Wesley, 2011. ISBN-13: 978-0805385656.
- Planning and Installing Sustainable Onsite Wastewater Systems. S..M. Parten. McGraw-Hill, 2009. ISBN-13: 978-0071624633.

Required Software (free download)

1. Photosphere (for viewing HDR images)
Works on Mac only
Available from Greg Ward's website
<http://www.anywhere.com/>
2. DIVA plugin for Rhino
Day lighting analysis plugin for Rhino (apply for student license)
<http://diva4rhino.com/>
3. (Optional) DIVA plugin for Grasshopper
No license needed
4. COMFEN (get latest non-beta version)
Works on PC only
<http://windows.lbl.gov/software/comfen/comfen.html>

Required iOS / Android Apps (free or low cost)

- SPL meter app for mobile device
(Decibel 10th, iOS only)
<https://itunes.apple.com/us/app/decibel-10th/id448155923?mt=8>
(deciBel, Android only)
<https://play.google.com/store/apps/details?id=bz.bsb.decibel&hl=en>
- LightMeter (by Whitegoods)
(Or comparable pocket light meter for mobile device)
<https://itunes.apple.com/us/app/lightmeter-by-whitegoods/id501638921?mt=8>

EVALUATION AND GRADING

The grading for the course will be based on the following percentages:

3 quizzes administered randomly throughout the term	10%
Weekly assignments	40%
Midterm exam	30%
Final project	20%

As part of your process this semester, you will demonstrate your ability to integrate the following NAAB Student Performance Criteria. To pass the course, your design work must demonstrate at least a minimum level of competence in each of these aforementioned areas.

You can read more about each criterion at:

http://www.naab.org/accreditation/2009_conditions.aspx.

ACADEMIC INTEGRITY

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. Scampus, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A: <http://web-app.usc.edu/scampus/university-governance/> Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The review process can be found at: <http://www.usc.edu/student-affairs/SJACS/>.

Unsatisfactory performance warnings will be issued when work does not meet minimum requirements. University guidelines relative to plagiarism pertain to original design work; you are expected to do all your own design and presentation work. Receiving substantial assistance, or appropriating another's design work, will be treated as plagiarism.

RELIGIOUS OBSERVANCES

The University recognizes the diversity of our community and the potential for conflicts involving academic activities and personal religious observation. The University provides a guide to such observances for reference and suggests that any concerns about lack of attendance or inability to participate fully in the course activity be fully aired at the start of the term. As a general principle students should be excused from class for these events if properly documented and if provisions can be made to accommodate the absence and make up the lost work. Constraints on participation that conflict with adequate participation in the course and cannot be resolved to the satisfaction of the faculty and the student need to be identified prior to the drop/add date for registration. After the drop/add date the University and the School of Architecture shall be the sole arbiter of what constitutes appropriate attendance and participation in a given course. Any student concerned about missing class for a recognized religious holiday should bring this matter up with your instructor in the first week of classes. A list of recognized religious holy days may be found at: <http://orl.usc.edu/religiouslife/holydays/>.

DISABILITY ACCOMMODATIONS

The University of Southern California is committed to full compliance with the Rehabilitation Act (Section 504) and the Americans with Disabilities Act (ADA). As part of the implementation of this law, the University will continue to provide reasonable accommodation of academically qualified students with disabilities so those students can participate fully in the University's educational programs and activities. Although USC is not required by law to change the "fundamental nature of essential curricular components of its programs in order to accommodate the needs of disabled students," the University will provide reasonable academic accommodations. The specific responsibility of the University administration and all faculty serving in a teaching capacity is to ensure the University's compliance with this policy.

The general definition of a student with a disability is any person who has "a physical or mental impairment which substantially limits one or more of such person's major life activities," and any person who has "a history of, or is regarded as having, such an impairment." Reasonable academic and physical accommodations include but are not limited to: extended time on examinations; substitution of similar or related work for a non-fundamental program requirement; time extensions on papers and projects; special testing procedures; advance notice regarding book lists for visually impaired and some learning disabled students; use of academic aides in the classroom such as note takers and sign language interpreters; early advisement and assistance with registration; accessibility for students who use wheelchairs and those with mobility impairments; and need for special classroom furniture or special equipment in the classroom.

Obtaining Accommodations:

General: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to your studio instructor as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

Physical Accommodations: DSP will work with classroom scheduling, the course instructors and their departments, and the students to arrange for reasonable accommodations.

Academic Accommodations: Students seeking academic accommodations due to a physical or learning disability should make the request to the course instructor prior to or during the first week of class attendance, as well as registering with DSP as early in the semester as possible. Course instructors will require that a student present verification of documentation when academic accommodations are being requested.

WRITING CENTER

For assistance with academic writing, students may wish to take advantage of the Writing Center maintained by USC. Evaluation of paper clarity, organization, syntax and grammar is available by appointment, free of charge. If you'd like to improve your writing and your ability to communicate your ideas, consider using this valuable resource. See their website at:

<http://dornsife.usc.edu/writingcenter/> for more information.

SUSTAINABILITY INITIATIVE

The School of Architecture has adopted the 2010 Initiative for Sustainability, which includes the following language:

“The design should engage the environment in a way that dramatically reduces or eliminates the need for fossil fuel.”

This does not mean that no other issues are to be addressed. Precisely to the contrary, all design issues are fair game, but in the background, all will be considered within the generalized goal of reducing or eliminating the need for fossil fuel.

This intention impacts our design process in a number of ways, including:

- orientation of buildings and site development to minimize negative environmental force impacts and take advantage of positive ones
- building modestly: providing the minimum space necessary to handle required programmatic needs
- maximum practical use of day-lighting; careful use of orientation and provision of control/shading mechanisms to handle associated heat loads
- maximum practical use of passive solar techniques for heating and cooling
- maximum practical use of natural ventilation techniques; selection of hybrid systems for ventilation, heating and cooling which permit this

No school can lay a claim to sustainability sensitivity that does not institute and vigorously pursue a recycling program. This recycling program is in force at all times. We pledge to provide adequate, well-marked recycling containers for each section and to provide a posted, printed recycling protocol so you know what goes where.

ACCREDITATION STATEMENT

The USC School of Architecture’s five-year Bachelor of Architecture program and the Master of Architecture program are accredited professional architectural degree programs. All students can access and review the NAAB Conditions of Accreditation (including the Student Performance Criteria) on the NAAB Website, http://www.naab.org/accreditation/2009_conditions.aspx.