

USC School of Architecture

Arch 575b: Systems 11287D

Luminous and Auditory Phenomena in
Architecture

Units: 3.0

Term – Day – Time:

Spring 2021 – Tuesday 6:00 pm – 8:50 pm:

Location: Zoom Online

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Arch Office: Watt Hall 315 (WAH315)

Virtual Office Hours: TBA, posted on Blackboard



Figure 1- *Resonate, an interactive sound and light installation, Frankfurt, Germany Luminale 2012*
(Photo credits: Thomas Wolf, Martina Pipprich) <https://mymodernmet.com/resonate-luminale-2012/>

Course Description

This course is the second in the building systems series and covers topics of lighting, acoustics and building systems. 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 sound and light 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

The USC School of Architecture's five-year Bachelor of Architecture Program and Master of Architecture Program are accredited the National Architecture Accreditation Board (NAAB). Conditions for accreditation can be found here: <https://www.naab.org/wp-content/uploads/2020-NAAB-Conditions-for-Accreditation.pdf>.

Course Responsibilities:

As a required course for an accredited professional degree program, this course holds students accountable for the demonstration of assigned Program Criteria or Student Criteria as defined by NAAB. The accreditation process will require evidence that students achieving a passing grade have attained satisfactory levels of understanding or ability for certain criteria.

Program Criteria: This course has responsibilities within the program to demonstrate the following Program Criteria:

- **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.5 Research and Innovation**—How the program prepares students to engage and participate in architectural research to test and evaluate innovations in the field.

Program Criteria for this course may be demonstrated through curricular activities, course materials (syllabi, lectures, assignments, etc.).

Student Criteria (SC): Student Criteria (SC1.-SC.4) will be evaluated at the understanding level.

Demonstration may include a summary of required readings, lecture materials, field trips, workshop descriptions, and other materials used in the course to achieve the intended learning outcomes.

- **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.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.5 and SC.6. will be evaluated at the ability level. The course must collect all passing student work in which the learning outcomes associated with this criterion are achieved.

- **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.

Course Notes and Logistics

The material will be divided into three basic segments throughout the semester:

- I. Acoustics
- II. Lighting
- III. Building Systems

The class will be primarily a series of lectures, demonstrations, assignments and tests to determine what is being comprehended and what needs more work. Class sessions will typically start with lectures during the first half and lab/ discussions regarding the Group Project during the remaining half. (See Group Project attachment). The group project which will have multi-week assignments. The final project will be presented in groups at the end of the semester. Groups are assigned the first class session.

The homework assignments are not graded, but counted as credit for completion and should be turned in at the subsequent class session. It is beneficial to have done the homework because the quizzes and prelims will be similar in content. Remember, doing and understanding the material will be much more beneficial than just having copied it into your notes.

Preliminary Exams and Final: This course will have two preliminary exams (one for acoustics and one for lighting) and one final.

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.

Time Requirements: This course requires 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 approximately 3 hours each week, you are expected to contribute 6 hours of out-of-class time each week to assignments. Copies of the syllabus, homework, and other announcements may be found on the class blackboard website. We hope to be able to maintain this address throughout the semester.

Technological Proficiency and Hardware/Software Required

All necessary programs and simulations will be provided and taught within the course. A substantial course “handbook” is also provided.

Required Readings and Supplementary Materials

Required “Text”: (... is handed out on the first day of class and is available online through Blackboard. Download an electronic copy to have available in the future.)

- 1.) Arch 575b Acoustics Class Handout

2.) Arch 575b Lighting Class Handout

Supplementary texts (**not required**, purchase one for reference, if you can):

- 1.) Walter T. Grondzik, Alison G. Kwok, *Mechanical and Electrical Equipment for Buildings*, 12th Edition; ISBN: 978-1-118-61590-4, or 978-0-470-19565-9, 1856 pages, September, 2014.
- 2.) Marc Schiler, *Simplified Design of Building Lighting*, ISBN: 978-0471192107 or 0471192104, 1992
- 3.) M.David Egan, *Architectural Acoustics*, ISBN: 978-1932159783 or 1932159789, 2007
- 4.) M.David Egan, Victor Olgyay. *Architectural Lighting*, ISBN-13: 978-0070205871
- 5.) Norbert Lechner; *Heating, Cooling, Lighting: Sustainable Design Methods for Architects*, 4th Edition, ISBN: 978-1-118-58242-8, 720 pages, September 2014
- 6.) Perception and Light as Formgivers for Architecture. Lam. (Free download).
<http://www.wmclam.com/index.php/publications>
- 7.) David K. Lynch, *Color and Light in Nature*, 2nd Edition, ISBN 978-0521775045 or 0521775043.
- 8.) The IES Lighting Handbook, 10th Edition. (Student edition, PDF). ISBN-13: 978-0879950071.
- 9.) IDEO, *The Field Guide to Human-Centered Design*, 1st Edition, 2014, ISBN: 978-0-9914063-1-9
https://bestgraz.org/wp-content/uploads/2015/09/Field-Guide-to-Human-Centered-Design_IDEOorg.pdf
- 10.) The Science of Sound, 3rd Edition. Thomas D. Rossing. Addison-Wesley, 2011. ISBN-13:978-0805385656.
- 11.) Planning and Installing Sustainable Onsite Wastewater Systems. S..M. Parten. McGraw-Hill, 2009. ISBN-13: 978-0071624633.

Software (free download)

- 12.) DIVA plugin for Rhino Day lighting analysis plugin for Rhino (apply for student license)
<http://diva4rhino.com/>
- 13.) DIALux, lighting calculation and visualization software, <https://www.dial.de/en/dialux-desktop/download/>
- 14.) COMFEN (get latest non-beta version) Works on PC only.
<http://windows.lbl.gov/software/comfen/comfen.html>
- 15.) Photosphere (for viewing HDR images) Works on Mac only. Available from Greg Ward's website: <http://www.anywhere.com/>

iOS / Android Apps (free or low cost)

- 16.) SPL meter app for mobile device (Decibel 10th, iOS only)
- 17.) Decibel Meter Pro (by Performance Audio), \$0.99
- 18.) Lux Light Meter Pro
- 19.) Light Meter (lux measurement tool by Vlad Polyanskiy), \$1.99
- 20.) LightMeter (by Whitegoods) (Or comparable pocket light meter for mobile device)

The only required text is the class handout. But *Mechanical and Electrical Equipment for Buildings* (MEEB) is used as a reference and a backup for this class. It is an excellent reference for now, and for the remainder of your career. *Heating, Cooling, Lighting: Sustainable Design Methods for Architects*, is a slightly more accessible book, for those who have trouble with the engineering approach in MEEB. *Simplified Design of Building Lighting* is a book that covers all of the basic lighting principles with extensive examples and review questions. *Architectural Acoustics does the same for Acoustics*. The class handout is a large collection of tables and useful graphs and information, necessary for answering questions on the quizzes and exams, and in your future.

The handouts should always be brought to class, preferably kept in a notebook along with your notes. Again, you will need information from the handouts and notebook for exams, and even for the unannounced pop quizzes.

Description and Assessment of Assignments

Homework and Group Assignments

There will be homework throughout the semester. Assignments will consist of acoustic and lighting calculations, case study research of sound and light environments, and subjective evaluation of lighting and acoustic comfort paired with hand-held physical measurements.

The final project and associated assignments will be provided in a separate class handout.

Test Materials

Material on quizzes, prelims (there are two “midterms”) and the final will be heavily related to the homeworks. All exams will be open book, but limited in time. This means that books and notes may be brought into the exam, **but previous exams, quizzes or finals are not allowed**. You may bring a homework which you have worked out, *but not a homework answer sheet from the web*. Possession of a previous exam or quiz while taking an exam will disqualify the exam. Too many students have counted on these in the past, instead of doing the homework, and the result has been a drop in the average grades! (You are encouraged to study using these materials before the exams, but you may not bring them into the exam with you. If you find that you have such materials among your notes, you must immediately remove them.)

Grading Breakdown

The grade for the semester will be based on the following percentages:

Homework credit	5%
Acoustic Midterm	20%
Lighting Midterm	20%
Final Group Project	20%
Final Exam	35%
Total	100%

Assignment Submission Policy

Assignments issued in class and are due at the beginning of the following class. Assignment grades are used for reference only and as a guide for students. The homework, quizzes, midterms and Final Exam determine the grade, as noted above.

Additional Policies and Support

Disabilities

Over the years we have had many students in the course with various disabilities and have had excellent experiences thus far. 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 Prof. Schiler as early in the semester as early as possible. DSP is located in GFS 120 (Grace Ford Salvatori Hall, 3601 Watt Way. The phone number for DSP is (213) 740-0776. Email is ability@usc.edu. See <https://dsp.usc.edu/contact/>.

Critical Dates and 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.

Disruptive Behavior

Behavior that persistently or grossly interferes with classroom activities is considered disruptive behavior and may be subject to disciplinary action. Such behavior inhibits other students' ability to learn and an instructor's ability to teach. A student responsible for disruptive behavior may be required to leave class pending discussion and resolution of the problem and may be reported to the Office of Student Judicial Affairs and Community Standards for disciplinary action.

Statement on 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 only 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, (www.usc.edu/scampus or <http://scampus.usc.edu>) contains the University Student Conduct Code (see SCampus, Part B, Sections 11.00 – 13.20).

Attendance

Attending classes is a basic responsibility of every USC student who is enrolled in courses at the School of Architecture. Regular and punctual class attendance is considered an essential part of satisfying the NAAB accreditation requirements therefore attendance will be taken at every class session. A student may miss up to two class sessions without directly affecting their grade and ability to complete the course if they provide an excused absence for any confirmed personal illness/family emergency/religious observance. For each absence over that allowed number, the student's letter grade is in danger of being lowered up to one full letter grade. Any student not in class within the first 10 minutes is considered tardy, and any student absent for more than 1/3 of the class time can be considered fully absent. If arriving late, a student must be respectful of a class in session and do everything possible to minimize the disruption caused by a late arrival. It is always the student's responsibility to seek means to make up work missed due to absences. Being absent on the day of a quiz or exam will lead to an "F" for that quiz or exam. Thus missing a quiz drops the final grade by one letter. This is a direct and intentional byproduct of bad attendance.

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 Section 11, *Behavior Violating University Standards* <https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/>. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct/>.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* <http://equity.usc.edu/> or to the *Department of Public Safety* <http://capsnet.usc.edu/departments/departments-public-safety/online-forms/contact-us>. This is important for the safety whole USC community. Another

member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* <http://www.usc.edu/student-affairs/cwm/> provides 24/7 confidential support, and the sexual assault resource center webpage sarc@usc.edu describes reporting options and other resources.

Support Systems

Students whose primary language is not English should check with the *American Language Institute* <http://dornsife.usc.edu/ali>, which sponsors courses and workshops specifically for international graduate students.

The Office of Disability Services and Programs http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations.

If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* <http://emergency.usc.edu/> will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.

COURSE SCHEDULE

Wk	Date	Course Lectures and Description	Issued Group Assign.	Issued HW
Acoustics				
1	Jan 19	Intro to Course and Group Project; Light and Sound Design – Introduction; User centered design, user journey (light, sound, systems) and design goals; innovation. Acoustic Lecture – Fundamentals: Basic physical principles and human perception of sound.	A	1
2	Jan 26	Acoustic Lecture – Physics and Calculations Sound propagation and measurement. Acoustic terms, physical principles, acoustic metrics.	B	2
3	Feb 2	Acoustic Lecture – Sound Isolation and Sound Absorption: Transmission loss, STC rating, building systems noise control. Example problems and construction types for effective sound isolation; Sound absorbing treatments, reverberation, noise reduction; Strategies for sound absorption.	C	3
4	Feb 9	Acoustic Lecture – Room acoustics and performance spaces: sound paths, ray diagrams, echo control, surface treatments. Speech intelligibility and reverberation time; Acoustic design for assembly spaces;	D	4
5	Feb 16	❖ Acoustics Prelim Exam ❖ Group Project Presentation Progress	--	--
6	Feb 23	Acoustic (Guest) Lecture – Acoustic design in practice: Technologies and simulations, immersive audio and multi-sensory environments. Case studies of practical experience and auditory environment. ❖ Group Project Presentation Progress	E	--
Lighting				
7	Mar 2	Lighting Lecture – Fundamentals physics of light, color and human visual perception; Light and human psychological and biological needs for visual information	F	5
8	Mar 9	Lighting Lecture – Physics of Light: Lighting terms, physical principles, photometric units. Optical properties of materials, implications in simulation and design.	G	6
9	Mar 16	Lighting Lecture – Electrical: objectives and design implications. Energy efficient lighting systems, controls, and design approaches.	H	7

Wk	Date	Course Lectures and Description	Issued Group Assign.	Issued HW
	Mar 23	Wellness Day (No Classes)		
10	Mar 30	Lighting Lecture – Daylighting and Facades: Light from the sun and sky; introduction to climate-based day lighting. Case studies in effective day lighting; High-performance glazing and complex fenestration systems for day lighting. Dynamic facade shading and light-redirecting systems.	I	8
		❖ Lighting Midterm Exam		
11	Apr 6	Lighting (Guest) Lecture – Lighting design in practice: Case studies in effective daylighting and electrical lighting; Technologies and simulations for photometric analysis	--	--
Building Systems				
12	Apr 13	Systems Lecture – Power: fundamental principles of electrical power, applications and needs. Codes and standards, responsible performance. Buildings and the grid: demand response and net-metering.	J	9
		❖ Group Project Presentation Progress		
13	Apr 20	Systems Lecture – Water: Building / landscape water demand and end-use efficiency. Storm water control and rainwater harvesting / storage. Codes and standards. Green roof systems. Net-zero water: sustainable onsite water concepts and systems. Greywater and blackwater systems.		10
		❖ Group Project Presentation Progress		
14	Apr 27	Presentation of Final Projects / Last Day of Class	--	--
	May 4	Study Days		
15	May 11	Final Exam	--	--

Note: Group Assignments and individual homework will be assigned at each class session and should be completed by the next class session or otherwise noted.