USC School of Architecture

Arch 215:
Design for the Thermal Environment

Units: 3
Term – Day – Time:
Fall 2021: Tuesday, Thursday, 9:30 am – 10:50 am:

Location: H101 and ZOOM from Blackboard ARCH215

Instructor: Schiler
Office: Watt Hall 315 (WAH 315) / online
Office Hours: Tu, Th 11:00 am -12:00 pm, 2:00 pm – 3:00 pm, Email for a slot or just stop by. Slots have priority.
Contact Info: marcs@usc.edu

Class Assistants: TBA

Figure 1- **Bullitt Center, Miller Hull, Zero Net Energy (ZNE) building, Living Challenge building.**
https://www.seattleu.edu/uploadedImages/Center_for_Environmental_Justice_and_Sustainability/Content/About/Bullitt%20Lovely%20Light.jpg?n=4326

Course Description

"The problem is much more than whether an architect graduating now can detail downpipes or sunshading efficiently, or can properly insert an opening into a wall plane. The loss of basic knowledge and the contemporary disregard for design principles are symptomatic of an enormous general shift in attitudes about what it is appropriate to teach architects." -Glenn Murcutt, Reflecting on architectural education

A building is an intervention in a continuous environment. It creates space, it is a visual object, it imposes an idea on (or responds to) the world around it. It effects the occupant mentally and physically; indeed it is the shelter for the occupant, and as such fulfills needs which are considerably older than recorded history. It responds to natural forces around it (whether well or badly) and even effects the ecology as a whole.

This course deals with the thermal and environmental processes which affect buildings, and how the designer responds to or manipulates the thermal environment. It is necessary for the architect to understand those processes, human response to them, and the materials and tools with which we may work.

Learning Objectives

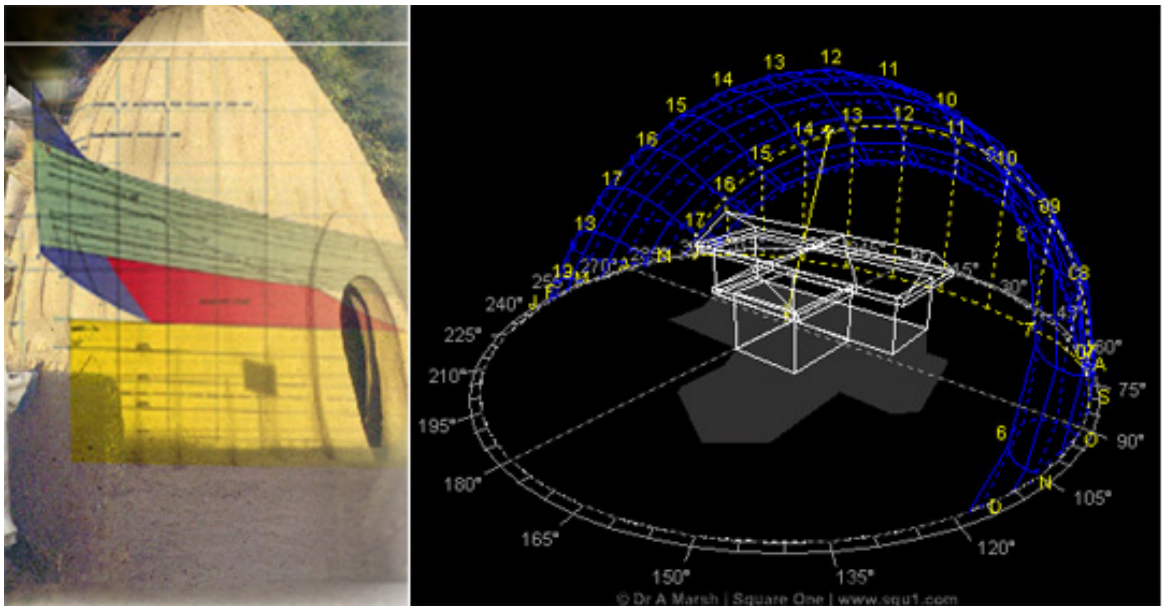
The student will learn how to design environmentally sound, reduced carbon footprint, climate responsive buildings. This will include building physics, calculations, indigenous examples, current examples, codes and standards and typical building equipment (HVAC) used in producing such designs.

For accreditation objectives for this course, see the detailed section at the end.

Prerequisite(s): Physics 125a (or permission of instructor)
Co-Requisite (s): NA
Concurrent Enrollment: NA
Recommended Preparation:

Course Notes and Logistics

The course consists of three parts. The first and largest part of the course deals with the basic physics and concepts which are the core of environmental controls and thermal processes. We will cover the numerical information and tools required to design a reasonable building anywhere in the world, including a numerical understanding of how loads are calculated. Anyone who finds physics and nature to be disagreeable will have difficulty with this part. Please expend the necessary mental effort to understand the material if you don't already know it. You may ask for assistance.



The second part of the course deals with historical design strategies and prototypes that respond to environmental issues. Passive solar strategies, active solar panels, wind energy and photovoltaics will be covered. Special attention is given to non-Western solutions and examples.

The third part deals with unusual or recently developed systems and strategies or issues which are being addressed by society at large. This will include community solutions, sustainability issues and the professional knowledge required of an architect currently in practice in the state of California, and dealing with consultants in Heating, Ventilating and Air Conditioning.

Technological Proficiency and Hardware/Software Required

Students must know how to access Blackboard. All necessary programs and simulations will be provided and taught within the course. A substantial course "handbook" is provided..

Required Readings and Supplementary Materials

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

1.) Norbert Lechner; *Heating, Cooling, Lighting: Sustainable Design Methods for Architects, 4th Edition,* ISBN: 978-1-118-58242-8, 720 pages, September 2014

2.) 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.

Required "Text": (… is available online through Blackboard. Download and print.)

1.) Arch 215 Class Handout

The only required text is the class handout. *Mechanical and Electrical Equipment for Buildings* (MEEB) will be used as a reference and a backup for this class and also in the following semester for Arch 315: Design of the Luminous and Sonic Environment. 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. 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 or available during class, preferably kept in a notebook along with your notes or stored online where you can easily access them in the future. Again, you will need information from the handouts and notebook for exams, and even for the unannounced pop quizzes. Lectures are removed during exams. You must have your own copies.

Description and Assessment of Assignments

There will be homeworks throughout the semester. Material on quizzes, prelims (there are two "midterms") and the final will be heavily related to the homeworks. Thus, although the homeworks are not required, it is generally advisable to do them. 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 web pages are not allowed***. You may bring a homework which you have worked out, ***but not a homework answer sheet from the web***. During the COVID pandemic exams will be online you will be expected to conduct yourselves in a professional manner. Possession of a previous exam, quiz or any webpage 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 take them out and place them upside down on the floor in front of you for the duration of the exam.)

Grading Breakdown

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

3 Pop quizzes @ 10% each	30%
2 Midterms @ 20%	40%
Final Exam	30%
	100%

Assignment Submission Policy

Assignments are issued in class and are due at the beginning of the following class. Assignments may be *resubmitted*, once, and will be regraded. Assignment grades are used for reference only. The 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).

Professional Degree:

The USC School of Architecture's five year BArch degree is an accredited professional architectural degree program. 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/2004_Conditions.aspx.

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/department/department-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.

For instructions in an emergency, *USC Emergency Information http://emergency.usc.edu/* will provide safety and other updates.

Course Outline

Lectures (once in each Part will have a pop quiz replacing the lecture)

Part I:

1) August 24, 2021
   Logistics and Handout, Basic Physics of Heat Transfer – (Lechner Ch 3)
   Conduction, Convection, Radiation, MRT, Latent Heat. Physical Demonstration w/ Steam Iron.

2) August 26, 2021
   Human Comfort – (Lechner Ch 4)
   Metabolic mechanisms and resultant Human Comfort ranges, Relative Humidity, condensation problems. Introduce Olgyay and Psychrometric Charts. Introduce Murray's *Psychrometric* tutorial in the first page of the Psychrometric Chart.
   Reference Tutorial at BPAC

3) August 31, 2021
   Climate, Building as Organisms (Lechner Ch 5.1 – 5.8a)
   Climate zones, climate plots on Olgyay and Psychometric Charts, internal loads, skin to volume ratio, building balance point temperatures. Introduce *Climate Consultant*.
   Climate consultant tutorial - https://www.youtube.com/watch?v=7pxpmdZptDM Download Climate Consultant for Mac and Windows - http://www.energy-design-tools.aud.ucla.edu/climate-consultant/request-climate-consultant.php
   Reference tutorial at BPAC http://sustainabilityworkshop.autodesk.com/buildings/climate-analysis

4) September 2, 2021
   Solar Position – (Lechner Ch 6)
   altitude, azimuth, declination, shading masks.
   Introduce MBS and Climate Consultant sunpath apps and Sunpath visualization apps for mobile device
   (Sun Seeker 3d augmented reality viewer, iOS and android)
   https://itunes.apple.com/us/app/sun-seeker-3d-augmented-reality/id330247123?mt=8
   https://play.google.com/store/apps/details?id=com.ajnaware.sunseeker&hl=en
   Demonstrate Solar Tool.

5) September 7, 2021*
   Solar Design – (Lechner Ch 9)
   fin and overhang shadows, profile angle.
   Demonstrate complete building in HEED

6) September 9, 2021*
   Calculations I – (Lechner Ch 15)
   q_c, q_s, Degree Days & Design Days

7) September 14, 2021*
Calculations II - (Lechner Ch 15, Grondzik 7.2)
temperature gradients, condensation, infiltration Q, q_i

8) September 16, 2021*
Calculations III – (Lechner Ch10)
ETD, q_r, Demonstrate thermal mass in HEED or Sefaira.

September 21, 2021 - ***Pop Quiz 1**** *(full class period pop quiz, given at an earlier date, unannounced)*

Part II:

9) September 23,, 2021
Lessons from Other Cultures I – (Lechner 5.8b-5.9)
Cold & Temperate Indigenous Strategies.

10) September 28, 2021
Lessons from Other Cultures II – (Lechner 5.8b-5.9)
Hot Arid & Hot Humid Indigenous Strategies.

September 30, 2021
1ST PRELIMINARY EXAM (MIDTERM), covers lectures 1 – 8 will take the entire class period (date may be changed, based on studio reviews)

11) October 5, 2021
Passive Solar Prototypes – (Lechner 7.1-7.13)
Trombé, super insulated, double envelope, roof pond, earth sheltered
Climate Consultant, suggested strategies and Arch 2030 palette examples
http://architecture2030.org/programs/2030-palette/
http://www.2030palette.org/

12) October 7, 2021
Active Solar Thermal – (Lechner 8.20 – 8.26)
Collector types, Domestic Hot Water, Space Heating

13) October 12, 2021*
More Active Systems –(Lechner 8.2 – 8.18)
Photovoltaics, BIPV, principles and examples

October, 14, 2021* **(Fall Recess)**

14) October, 19, 2021*
Wind Systems and Community Scale Solar Systems - (Lechner 2.18, 3.21)
wind generation: individual scale and community scale, Solar One, cogeneration

15) October, 21, 2021*
Planning & Zoning – (Lechner 11.4 - 11.6, USC MBS papers)
Shadow plots, Solar access, solar envelopes, Ralph Knowles

16) October 26, 2021*
Alternate Architecture and Lifestyles – (Lecture references)
Amish, Earthship, Arc, Nader Khalili, BedZED

October 28, 2021**, *Pop Quiz 2** *(full class period pop quiz, given at an earlier date, unannounced)*

Part III:

17) November 2, 2021
Global Warming –
http://www.ipcc.ch/report/ar5/
https://www.c2es.org/content/ipcc-fifth-assessment-report/
http://climate.nasa.gov/causes/
http://architecture2030.org/buildings_problem_why/

18) November 4, 2021
Energy Codes: Title 24, BEPS, HEED
http://www.energy.ca.gov/title24/,
https://www.dgs.ca.gov/DSA/Resources/Page-Content/Resources-List-Folder/Overview-Title-24-Building-Standards-Code?search=Title%2024
http://www.bsc.ca.gov/codes.aspx

November 9, 2021
2ND PRELIMINARY EXAM, covers lectures 9 – 16, will take the entire class period (date may be changed, based on studio reviews)

19) November 11, 2021
Sustainability Metrics and Examples
LEED, Architecture 2030, BREEAM, Oberlin Lewis Center, Bullitt Center

20) November 16, 2021
COVID-19, WELL Buildings, NZE, PassivHaus
Additional considerations, examples of buildings' success and/or failure

21) November 18, 2021*
HVAC I
Plant & distribution types (VAV etc.) – (Lechner Ch 15, Sidebox 16.22)

22) November 23, 2021*
HVAC II – (Lechner Ch 16, esp 16.15)
Duct Sizing

November 25, 2021 **Thanksgiving**

23) November 30, 2021*
HVAC III – (ASHRAE Handbook of Fundamentals (I-P), 2013)
Friction Loss & Fan Sizing

December 2, 2021 - Pop Quiz 3 (full class period pop quiz, given at an earlier date, unannounced)

Final Examination: Thursday, December 9, 2021 11:00 am – 1:00 pm

ACCREDITATION STATEMENT

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 shared values of the curriculum, 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.

Share Values of the Curriculum: This course has a special focus on Environmental Stewardship and Professional Responsibility and a strong attention to Equity, Diversity, and Inclusion, both in recognizing the impact of Environmental Stewaredship on underserved communities and by extolling the architecture, design and lifestyles of other societies and their response to culture and environment.

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.*

The above Program Criteria for this course are demonstrated through curricular activities and course materials (syllabi, lectures, assignments, etc.).

- *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.*

The above Student Criteria SC1.-SC.3 are brought up to the understanding level. See required readings, lecture materials, demonstrations, movies, and other materials used in the course to achieve the intended learning outcomes. There are 3 quizzes, 2 Midterm Exams and a Comrehensive Final Exam.

- *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.*

S.C4 and SC.6 will be evaluated at the ability level. The course will collect all passing student work in which the learning outcomes associated with this criterion are achieved. All student work, verbal, mathematical and graphic will be collected on Blackboard.