University of Southern California Schiler
School of Architecture Fall 2014
Arch 215: Design for the Thermal Environment Course Syllabus

Oberlin College, Environmental Studies Buildings, by William McDonough

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 effect 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.

Course Logistics

The course consists of three parts. The first and largest part 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.

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.

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.

Recommended 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 (or 11th Edidition)*; ISBN: 978-1-118-61590-4, or 978-0-470-19565-9, 1856 pages, September, 2014.

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

3.) Edward Allen & David Swoboda, *How Buildings Work: The Natural Order of Architecture*; Oxford University Press, 2005.

4.) HVAC Analysis and Design 6th ed by McQuiston, Parker and Spitler, Wiley, 2005.

Required "Text":

1.) Arch 215 Class Handout

The only required text is the class handout. But *Mechanical and Electrical Equipment for Buildings* (MEEB) will be used as a reference and a backup for this class and 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. *How Buildings Work* is useful, especially if you have trouble with the class. It explains concepts with many graphic illustrations. The class handout is a large collection of tables and useful graphs and information.

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

There will be homeworks throughout the semester. Material on quizzes, prelims and the final will be heavily related to the homeworks. Thus, though 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**. 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.)

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

3 Pop quizzes @ 10% each	30%
1 Design Analysis @ 20%	20%
1 Midterm @ 20%	20%
1 Final @ 30%	30%

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 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.

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 toteach. 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 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 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 University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

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 can lead to an "F" for that quiz or exam.*

2010 Imperative Statement:

The Architecture Faculty have voted to accept the 2010 Imperative-- to improvement of ecological literacy among the students and faculty and to achieve a carbon-neutral design school campus by 2010. To that end, this class will address issues of carbon neutrality and ***supports*** the following goal for all designs produced in the USC School of Architecture:

> **"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.

Course Outline

Part I:

Logistics and Handout, Basic Physics of Heat Transfer I & II – (Lechner Ch 3)
Conduction, Convection, Radiation, MRT, Latent Heat. Physical Demonstration w/ Steam Iron.

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.
BPAC http://sustainabilityworkshop.autodesk.com/buildings/psychrometric-charts

Climate, and 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 - http://www.energy-design-tools.aud.ucla.edu/For_Tim_Kohut/Climate60b2.dmg
Window - http://www.energy-design-tools.aud.ucla.edu/For_Tim_Kohut/Climate60b2.exe
BPAC http://sustainabilityworkshop.autodesk.com/buildings/climate-analysis

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
https://play.google.com/store/apps/details?id=com.mainelyoffroad.arsuntracker&hl=en
BPAC http://sustainabilityworkshop.autodesk.com/buildings/solar-position
http://sustainabilityworkshop.autodesk.com/buildings/reading-sun-path-diagrams

Solar Design – (Lechner Ch 9)
fin and overhang shadows, profile angle.
Demonstrate complete building in HEED or Sefaira.

Calculations I – (Lechner Ch 15)
q_c, q_s, Degree Days & Design Days

Calculations II - (Lechner Ch 15)
q_i, q_m, q_p, temperature gradients

Calculations III – (Lechner Ch10)
ETD, q_r, Demonstrate thermal mass in HEED or Sefaira.

Pop Quiz
(given at an earlier date, unannounced)

MIDTERM (well before design studio reviews)

Part II:

Site Planning & Regional Vernacular I
Cold & Temperate climate strategies

Site Planning & Regional Vernacular II
Hot Arid & Hot Humid climate strategies

Passive Solar Prototypes
Trombé, super insulated, double envelope, roof pond, earth sheltered

Active Solar Thermal
Collector types, Domestic Hot Water, Space Heating

More Active Systems
photovoltaics, BIPV, principles and examples

Wind Systems and Community Scale Solar Systems
wind generation: individual scale and community scale, Solar One, cogeneration

Planning & Zoning
Shadow plots, Solar access, solar envelopes, Ralph Knowles

Alternate Architecture and Lifestyles
Earthship, Arc and Nader Khalili

Global Warming

Sustainability
Reduce, Reuse, Recycle, Operational Energy, Embodied Energy, Renewable Energy, other resources, LEED

Energy Codes
Title 24, BEPS, HEED

Pop Quiz
(given at an earlier date, unannounced)

2ND "PRELIM or DESIGN ANALYSIS W/ STUDIO

Part III:

HVAC I
Plant & distribution types (VAV etc.)

HVAC II
Duct Sizing

HVAC III
Friction Loss & Fan Sizing

Review

Pop Quiz
(given at an earlier date, unannounced)

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