UNIVERSITY OF OREGON

Syllabus: Passive Heating Seminar

ARCH / ENVS 400M / 500M
Tues / Thurs 12-1:50 (4 credits)
Alexandra Rempel, Instructor **Winter 2018**

Course description

Would it surprise you to learn that passive solar heating can be just as effective in cloudy climates as in sunny ones? In fact, the overcast winters of the Pacific Northwest, the Great Lakes, and northern coastal Europe have among the greatest solar heating potentials on Earth. In this course, we will revise a number of traditional ideas regarding passive solar design in light of contemporary solar radiation modeling, climatology, materials science, soil science, and computational advances. You'll learn how to estimate a location's net solar heating resource; to find the predominant orientation of that resource (it's not always due south!); to select and orient solar-collecting glass optimally; to design thermal mass to store transmitted heat and return it in patterns that match occupant needs; and to estimate passive solar performance with the most accurate methods available. Pair or small-group term projects will develop passive solar designs for diverse building types, incorporating spatial, experiential, and computational components; energy modeling and graphing will be included, but no prior experience is assumed. This course will participate in the Sustainable City Year program, providing opportunities for field work, term projects, and planning input to the City of Albany, OR.

Prerequisite: ARCH 491 / 591: Environmental Control Systems I or permission of the instructor.

Contact information

Instructor: Alexandra Rempel, Assistant Professor, Environmental Studies Program
Office hours: Tuesdays 2-4pm and by appointment, Volcanology 302
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Required materials

1. Course Pack (CP), available at the UO Bookstore
2. Mechanical and Electrical Equipment for Buildings (MEEB), Editions 11 or 12.
3. Access to a computer with Windows 8.x or 10

Website

Assignments, announcements, and grades will be posted on Canvas.

Field work and instruments

One field trip will be required for solar site survey exercises, at a time to be determined.. Sturdy but expensive field instruments will be provided; these will be checked out to individual students who will be responsible for their care and return.

Term projects

Term projects will consist of solar resource studies, conceptual designs, and performance simulations of passive solar heating systems for planned buildings. Through the Sustainable City Year program, the city planners of La Pine, Oregon are particularly interested in a passive solar transit center and city-wide passive solar design guide.

Solar Hotbox competition

In Week 9, we'll let off steam with a fun, silly, agonizing, and inspiring competition to design the Hottest Box, as evaluated by interior surface and air temperatures over a 48h period on the plaza in front of Lawrence Hall.

Content

Week	Topics	Reading / Asg Due*
1a. Call to Action	Introductions; energy use by space heating in buildings; renewable electricity context; graphing and interpretation of visual evidence	---
1b. Solar Site Surveys	Sunpaths; magnetic declination; shading; use of solar pathfinders; tree heights calculation; IDs	Sign up for transportation
Friday January 12: Field trip to La Pine, Oregon		
2a. Precedents	Origins and development of solar architecture in Greece, Rome, and U.S.; conservatories; greenhouses	*A Golden Thread*, Butti, pp. 1-26, 40-46 Critical reflection (500 words)
2b. Climates and Microclimates	Köppen and ASHRAE climate zones; heating season patterns; TMY3 and other weather files; Climate Consultant; DView	*Weather & Climate,* Aguado & Burt, Ch. 15, pp. 474-493 Climate mnemonic (1 page)
3a. Conventional Wisdom	Sunspaces, direct-gain spaces, Trombe walls; mass to glass ratios; problems with performance in all but sunny dry climates	*Passive Solar Energy Book*, Mazria, pp. 28-65 *Sun, Wind, & Light*, Brown, pp. 59-62 Critical reflection (500 words)
3b. Solar Radiation	Quantifying solar radiation intensity; net solar heating resource; plotting solar resources	*Heating, Cooling, Lighting,* Lechner, pp. 140-63 *Sun, Wind, & Light*, Brown, pp. 5-11 Solar geometry problem set
4a. Glass	Solar and visible transmittance; U-factors; modeling; optimizing tilt	*Residential Windows*, Carmody et al., pp. 36-45, 73-79, 90-96 Optimal tilt exercise
4a. EnergyPlus	Introduction to building energy modeling; investigation of a base model for solar hotbox	Downloading and installing of EnergyPlus, Euclid OpenStudio, xESOview
5a. Thermal Comfort	Operative temperatures; Clo; Met; radiant asymmetry; air velocity; implications for passive solar heating design	*ASHRAE Standard 55, Thermal Conditions for Human Occupancy*, pp. 1-26 Graph interpretation problem set
5b. Thermal Delight	Thermal Delights field exercise & poetry / essay composition	*Thermal Delight,* Heschong, Preface & Ch. 2, pp. vii-ix, 18-30 Poem, essay, or interpretive dance
6a. Pinup	Design intent; solar site survey; glazing; optimal tilt; schematic plan, section, 3D; monthly net solar heating resource; next steps	Midterm project presentation
6b. Movable Insulation	Shutters, shades, curtains; vertical and skylight applications; problems; modeling	*Movable Insulation,* Langdon, pp. 18-55 Hand sketches of 3 mechanisms for project
7a. Thermal Mass	Specific heat; heat capacity; heat transfer; phase change materials; internal convection; conventional methods; modeling	*Mechanical and Electrical Equipment for Buildings*, 12th ed., pp. 199-223. Heat transfer problem set

7b. Designing Thermal Mass	Tuning heat delivery from thermal mass through choice of material, configuration, and thickness; implications for course projects	*Thermal Batteries for Buildings*, Rempel, in Geoscience of the Built Environment, pp. 63-101; Graph interpretation (250 words)
8a. Overheating	Turning off a passive solar system: shading; ventilation; movable insulation; thermal mass; scheduling; Hotbox brainstorming	*Optimization of Passive Cooling Control Thresholds*, Rempel, SimAUD, pp. 111-118. Critical summary (500 words)
8b. Unconventional Wisdom	Passive solar resources in cool and cloudy climates; implications for La Pine and Hotboxes	*Unconventional Wisdom from Four Sunspaces in Oregon,* Rempel, BE pp. 158-172. *Solar Arch. in Cool Climates*, Porteous, pp. 1-18 Critical summary (500 words)
9a. Solar Hotbox Competition	Instrument checkout; installation; outdoor setup; security check	Built Hotboxes
9b. Hotbox Judging	Judging; awards; debriefing & discussion; cleanup	---
10. Review Week	No class; office hours by appointment	---
11. Presentations	Presentations to City of La Pine Planners (date and time TBA)	Final presentations

Learning outcomes

By the end of the course, students will be able to:

1. **Gather climate and microclimate information** for a particular location and use it to quantify local heating needs and monthly net solar heating resources.
2. **Select effective glazing, movable insulation, and thermal mass**, as well as optimize glazing tilt and collector configuration, to meet the heating needs of the space to the greatest extent possible, capturing 60-80% of the net solar heating resource.
3. **Simulate the performance** of schematic design-level passive heating systems with EnergyPlus and WINDOW 7.5 software; graph and interpret results.
4. **Present plausible proposals** for such systems, including performance estimates, in a public forum.

Expected student workload

- Undergraduate: A typical week will include 30 pages of reading (3h), a writing, drawing, or calculation assignment (2h), two seminar meetings of 2h each (4h), and work on a project or a project presentation (3h), for an average weekly workload of 12h. Depending on student allocation of project work, however, weekly workloads may vary.
- Graduate: A typical week will include 30 pages of reading (3h), a more extensive writing, drawing, or calculation assignment (4h), two seminar meetings of 2h each (4h), and work on a project or a project presentation (5h), for an average weekly workload of 16h. Depending on student allocation of project work, however, weekly workloads may vary. Graduate student writing assignments will be longer, and Project requirements will be greater than those assigned to undergraduates (particularly for the Hotbox competition), in compliance with University guidelines.

Evaluation

Accomplishment will be evaluated on the basis of class participation, a competition, and a term project, as follows. All grades will be recorded in Canvas. Grade appeals should be made in writing to the instructor.

Class Participation:	25%
Weekly Assignments:	30% (UG: includes Hotbox measurements)
Midterm Pinup:	20%
Final Project & Presentation:	25% (G: includes Hotbox performance)

Letter grades reflect the following:

A: Demonstrates an excellent, thorough, nuanced understanding or accomplishment. Discussion comments and questions are thoughtful and constructive, reflecting careful study of the reading assignments. Group work is active, constructive, collaborative, and shows initiative and resourcefulness. Written work is comprehensive, clear, concise, thoughtful, accurate, and free of grammatical and spelling errors; computational work is complete and accurate; visual work is complete, well-organized, and accessible.

B: Demonstrates a good understanding or accomplishment. Discussion comments and questions are constructive, reflecting good attention to the reading assignments and solid comprehension. Group work is active, constructive, and collaborative, but shows limited initiative and resourcefulness. Written work contains good but not exemplary content, is difficult to follow in places, and/or contains a small number of grammatical and spelling errors; computational work is generally good with minor errors; visual work is complete and of good quality but may be mildly disorganized and/or difficult to interpret in places.

C: Demonstrates an adequate understanding or accomplishment. Discussion contributions are few in number, contain limited constructive content, and/or reflect inattention to reading assignments. Group work is attempted, but shows low energy or effort to collaborate with group members, and/or creates unusual levels of conflict. Written work is incomplete and/or superficial, difficult to follow, and/or contains numerous grammatical and spelling errors; computational work is conceptually adequate but contains significant errors; visual work is mostly complete but with shallow content and/or careless presentation.

D: Demonstrates inferior understanding or accomplishment. Discussion contributions are rare, with minimal content. Behavior in class disrupts others' learning. Group work is inferior, incomplete, or disruptive. Written work contains just enough content to pass, is thoroughly difficult to follow, and/or contains egregious grammatical and spelling errors; computational work is incomplete and contains mis-applied concepts and/or significant errors; visual work is incomplete as well as limited in content and/or presented carelessly.

F: Demonstrates unsatisfactory understanding or accomplishment. Preparation for and/or participation in class is absent. Assignments are missing.

If you are taking this course Pass / No Credit, you must earn a C- to pass as an undergraduate or B- to pass as a graduate student. Grades of Incomplete will only be given for documented, excusable (e.g. medical) situations.

Equity and inclusion

- <u>Equity:</u> Many students in this course have overcome, or are currently overcoming, significant barriers to their education. To ensure that this course is fully accessible to all students, the instructor will respond promptly to requests for additional resources or other accommodation.
- <u>Inclusion:</u> The diversity that students bring to this course is a resource, benefit, and strength. Our collective goal must therefore be to create a classroom environment in which everyone feels welcome and encouraged to share their ideas and perspectives, and to engage in constructive debate, without fear of disparaging or hostile remarks. Mistakes may be made, but the instructor will prevent any such pattern from developing in the class. In addition, any student who feels marginalized or dismissed is urged to speak with her directly so that an effective solution can be developed as soon as possible.

Discussion participation

Students are expected to attend all classes, having carefully read and studied the assignments, and to participate *fully* in discussions and group work, without distracting themselves or others. "Full participation" means devoting one's *full* attention to class: listening attentively, taking notes, asking questions, making thoughtful comments, and working with classmates to complete in-class work. *Texting, emailing, tweeting, snapchatting, instagramming, online shopping, etc. are strictly prohibited*; violations will constitute unsatisfactory class participation.

Illness and absences

Students who are sneezing, coughing, or otherwise clearly ill should stay home to speed recovery and avoid infecting others. The first two absences for illness will be excused with notification by the morning of class; a doctor's note will be required to excuse further absences. Other absences (for example, involving academic or university athletic trips) may be excused with documentation.

Late and missing work policy

Studying the reading carefully, completing written or computational assignments for discussion, and arriving at class prepared are central to the learning process for this course. This is a seminar, not a lecture! Incomplete assignments will lower participation grades for the corresponding class, but worse, lateness will circumvent the learning process. Keep up with the reading and weekly assignments at all cost; these may not be "made up" in themselves, but must still be completed for the Midterm Pinup, Hotbox, and Final Presentation deadlines. Late work for the three major deadlines will be graded as missing unless a valid, documented excuse is provided.

Academic integrity

Mutualistic collaboration, which supports the learning of all students involved, is welcome: students are encouraged to discuss reading, field work, and projects outside of class. Full collaboration is, in fact, expected in group work and projects. Parasitic collaboration, however, in which one person (the parasite) represents the work of another (the host) as his/her own, or allows the host to complete the majority of the work while the parasite contributes little, grievously damages the learning process of the parasite and risks harming the host as well. Any activity that *diminishes* the learning of *any* student involved is strictly prohibited. Activities that violate personal and institutional academic integrity include:

1. Fraud: The alteration of documents or data with the intent to deceive groupmates or the instructor.
2. Copying: Creating a submission for a graded exercise by reproducing another student's work.
3. Fabrication: Falsification or invention of information.
4. Plagiarism: Representing the work of another as one's own by omitting acknowledgement or reference.
5. Sabotage: Destruction of another's work.

If academic dishonesty is suspected, the instructor will meet with the student(s) involved to review the evidence and allow student(s) the opportunity to explain. If the instructor concludes that a violation occurred, penalties will be assessed as follows:

1. First or minor violation: Written warning and requirement to re-do the assignment in question.
2. Second or significant violation: A grade of "F" or zero on the assignment in question and requirement to complete a substantial research paper on academic integrity.
3. Third or major violation: Failing grade for the course and referral to the Dean of Students, including the instructor's written summary of events and copies of supporting documentation.

Please refer to the University of Oregon Academic Integrity website (integrity.uoregon.edu) for further details.

Archiving

At the conclusion of the course, students will be required to submit their work digitally for archiving. In addition, students will be asked to remain available to the course Sustainable City Year Program liaison during the Spring Term while the course proposals to the City of Albany are compiled.

Sustainable City Year Program: 2017-18

The Sustainable City Year Program (SCYP), a program through the University of Oregon's Sustainable Cities Initiative (SCI), links the students of the University of Oregon with an Oregon city, county, special district, or partnership of governments for an entire academic year. For the 2016-2017 academic year, the University of Oregon is partnering with the **City of La Pine, Oregon**.

Each year, a partner city receives assistance with their sustainability goals through the work of student classes across the University. In a typical year, **400+ students** from **10-12 disciplines** across **15-25 classes** might work on **20-30 partner-directed projects,** devoting **40,000+ hours of work to helping a local entity** transition to a more sustainable future.

Now in its seventh year, SCYP is providing assistance to La Pine in reaching diverse sustainability goals while creating a forum in which university students can challenge their new knowledge and skills with real-life problems. Students will work with La Pine city staff, local community members, elected officials, and at times, local media. All students will have the opportunity to visit their sites in La Pine; should they desire to take multiple visits, SCI can arrange meetings with city staff and may also be able to reimburse them for transportation costs. We also recommend that students post their work on social media and blogs.

The University of Oregon Library has prepared a research guide for SCYP students. To access resources, data, maps, and other information about Albany, please visit: http://researchguides.uoregon.edu/scyalbany

At the end of the term, students will present their work to the City in professional-quality oral or poster presentations and/or reports. In addition, one student from each class will be hired to work for SCI as a paid report-writer to compile the work of the class into a single final report for the City of La Pine. Class instructors will recommend student report writers, and interested students should contact them directly.

Bibliography

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