

CIV_ENV 388-2

Building Science: Applications for Sustainable Buildings – part II

Winter Quarter 2023

Course description: This course enriches and applies the concepts learned in Building Science part 1. The course comprises both theoretical and practical sessions. The theoretical sessions introduce the four indoor environmental factors affecting occupants' comfort inside buildings - thermal, visual, acoustic, and indoor air quality – and healthy building concepts. The practical sessions focus on the design of a virtual project consisting of a sustainable student housing, integrating concepts about occupants' comfort, well-being, and health with energy-efficiency principles. The goal of this project is to optimize design features such as orientation, building materials, openings, and shadings to guarantee occupants' needs with the least energy consumption. Quantitative calculations related to energy consumption and visual and thermal parameters are conducted with the help of computer software presented in the practical sessions.

Student learning outcomes: Upon completion of this course students will be able to:

1. Describe the indoor environmental parameters for occupant comfort and health
2. Master sustainable solutions for energy-efficient and healthy design
3. Optimize a design based on trade-offs between energy and human-centric aspects
4. Use computer software for modeling the design project and calculating human-centric and energy metrics
5. Work in a group to iterate design and present design iterations
6. Actively participate in design critiques
7. Present a final project to a potential client motivating design choices
8. Understand scientific literature on the topic

Course goals: The following Course Assessment Table (CAT) relates Student Learning Outcomes to Accrediting Board for Engineering and Technology (ABET) Outcomes as follows:

Student learning outcomes	ABET Outcomes	ABET Outcome Description	Assessment instruments
1, 2	1	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Mid-term exam
3	2	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Final project - content
5, 6, 7	3	An ability to communicate effectively with a range of audiences	All assignments (group and individual) – form Individual questions to group projects

5, 6, 7	5	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Interim presentations – content Final project - content
3, 4, 5	6	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Final project - content
1, 2, 4, 8	7	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Individual exercises – content

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Class times 2-3:20 Tuesday and Thursday

Location Technological Institute LG52

Suggested textbook DeKay, Mark, and G. Z. Brown. *Sun, wind, and light: architectural design strategies*. John Wiley & Sons, 2013. (Available at Northwestern library)

Pre-requisites It is compulsory to attend the first Building Science course offered in the Fall quarter.
However, special requests could be accommodated prior to the start of the course. Please contact the instructor.

Course Assessment Individual evaluation – **20%**
Attendance, active participation to projects' presentations, exercises, and assignments presented during the course. Both the content and form of the assignments will be evaluated, accounting for 80% and 20% of the grade, respectively

Mid-term exam – **20%**
Multiple choices and open questions on the content presented in the first half of the course

Group project – **60%**
Final poster + interim, mid-term and final presentations of a sustainable design for a student housing (grade divided as detailed below). Both the content and form of the project will be evaluated, accounting for 80% and 20% of the grade, respectively

Deliverables Project Presentation and Poster, Canvas Posts, Exercises

Evaluations and expectations

Individual Evaluation

Attendance & Participation

Students will earn 5 points per class for a total of 100 points (20 classes). Students are allowed one "freebie" absence that will not deduct points from the attendance grade. However, students cannot skip the classes in which they are supposed to present their project to the class. Students must inform the instructor of their absence before the start of the class.

Students are expected to actively participate in all classes by asking questions, raising concerns, and facilitating discussions, especially during project critiques. Points will be assigned during project interim presentations if questions will be asked to the other groups (50p/presentation for a total of 100 points). To obtain 50 points, the question(s) must be **challenging** for the group. A more informative question can obtain partial points, based on the evaluation of the instructor.

Besides attendance and participation, the individual evaluation is based on a mix of assignments that will be presented during the course. Two main types of assignments are present: Canvas Post (CP) following a reading, and Individual Exercise (IE) that can span from a presentation to an exercise to understand a new tool. *In the individual evaluations (CP and IE), the content and form of the assignments will be evaluated, accounting for 80% and 20% of the grade, respectively.*

Canvas Post (CP)

Canvas Posts (i.e., discussion threads on Canvas following an assigned reading) are a *critical connection* among students. Hence these posts must be **substantive, insightful, and useful**. Students are supposed to **share their thoughts** on the readings assigned and/or to **provide further examples** and/or **share their own experiences** linked to the topic. Students will be able to see their peers' posts once they will submit theirs. They are then encouraged to comment on some of the posts of their classmates to enrich the discussion.

The quality of posts is much more important than quantity. Posts should be richly developed and take the discussion deeper into the topic or in a new but related and relevant direction.

Posts should average 100 - 150 words each (as a general guideline) and must be well-written, with no spelling, grammatical or punctuation errors.

Based on this, an "average" post will be assigned a maximum of 50 points. To reach the maximum number of points for each post (i.e., 100 points), a student can:

- Build on a colleague's post - provide an example, pose a question for elaboration, develop the point in more detail, apply the point to another situation or personal experiences, etc.
- Consider adding an article or outside reference source (e.g., a video) related to the same issue.

Individual Exercise (IE)

Instructions will be provided in class. Each exercise will be evaluated on a scale from 0 to 100 based on criteria presented for each exercise.

Mid-term exam

It comprises multiple choices and open questions on the content presented in the first half of the course. Questions are associated with points according to their complexity, for a total of 100 points per exam.

The exam will last 60 minutes.

Group project (GP)

Students are requested to work in a group to develop a sustainable design for a student housing. The project will be introduced in the first weeks of the course and explained in a separate document.

Three (graded - g) presentations of the project development (called interim presentations) are scheduled during the course, in which groups must present their project advancements to the instructor and the class. A final presentation to the class (graded - g) is scheduled in the last week of the course. Students are expected to actively participate in other groups' presentations (interim and final) with questions and comments. The participation to other groups' presentations will contribute to the final grade as explained in the "Individual Evaluation" section. Failure to present project advancements in the interim presentations will result in a 0 grade.

Deliverables (to be uploaded on Canvas before the final presentation):

- Final presentation
- Final poster

Both the content and form of the final project will be evaluated, accounting for 80% and 20% of the grade, respectively.

Grade breakdown

Evaluation type	Assignment type	Points	Percentage of the final grade
Individual evaluation	Canvas Post	3 x 100 (80 content, 20 form) = 300 points	20%
	Individual Exercise	4 x 100 (80 content, 20 form) = 400 points	
	Attendance	20 x 5 = 100 points	
	Individual questions to group projects	200 points (50p/presentation)	

Mid-term exam	Quizzes	100 points	20%
First interim presentation	Presentation	100 points (80 content, 20 form)	10%
Second interim presentation	Presentation	100 points (80 content, 20 form)	10%
Third interim presentation	Presentation	100 points (80 content, 20 form)	10%
Group Project (final outcome)	Presentation	50 points (40 content, 10 form)	30%
	Poster	50 points (40 content, 10 form)	

All deliverables are due as indicated on the Syllabus.

Late submissions without prior approval from the instructor will not be accepted and will receive a **grade of zero**.

Grading Scheme

Students will receive A, B or C, No-Pass grades, following this scheme:

A = 93%–100% (Pass)

A- = 90%–92% (Pass)

B+ = 87%–89% (Pass)

B = 83%–86% (Pass)

B- = 80%–82% (Pass)

C+ = 77%–79% (Pass)

C = 73%–76% (Pass)

C- = 70%–72% (Pass)

F < 69% (No-Pass)

Course Syllabus (tentative) - Winter 2023

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Week	Date	Lecture	Topic(s)	Assignment(s)	Assignment due
1	01/05	Course Introduction	<p>Presentation of the course (energy and comfort dichotomy)</p> <p>General presentation of the project</p> <p>In-class exercise: start of case studies analysis</p>	<p>Group project (GP): Group definition and list of students' needs for the project</p> <p>Reading 1: two articles on “beyond green buildings” (CP1)</p> <p>Individual exercise (IE1): analysis of case studies</p>	
2	01/10	<p><u>Practical session:</u> project presentation (+ tool workshop)</p> <p><u>Evaluation: case studies presentation</u></p>	<p>Presentation of case studies by students</p> <p>Project presentation</p> <p>(Rhino + Grasshopper -- pre-recorded videos)</p>	<p>Group project (GP): Site, passive strategies, and example analysis; Shape, structure, program based on students' needs (bubble diagrams), Sustainability diagrams (e.g., passive strategies, sunpaths); Hand calculations</p> <p>Individual exercise (IE2): Watch Rhino+ Grasshopper video and complete exercise 1</p>	<p>GP: Final definition of group members and prepare list of students' needs</p> <p>IE1: Presentation of case study from Transsolar + 1 of choice (comparison across strategies, best strategies, critical analysis) – prepare slides (10 min presentation per student)</p> <p>(Upload slides on Canvas <u>by 11 am</u>)</p>
	01/12	<i>Theoretical session:</i> Thermal comfort	Psychrometrics, heat balance, PMV model, local discomfort, adaptive thermal comfort model, advanced comfort models and indoor factors interactions, local discomfort	Reading 2: two articles on wellbeing frameworks (CP2)	Canvas Post (CP1) - Thoughts on Reading 1 (upload on Canvas discussions <u>by 11 am</u>)
3	01/17	<i>Theoretical session:</i> Visual comfort – part 1	Physics of light, physiology of vision, measuring light with photometric quantities		IE2: exercise 1 (upload on Canvas <u>by 11 am</u>)

		Light sources		
	01/19	<i>Theoretical session:</i> Visual comfort – part 2	Visual comfort Daylight metrics, designing with daylight	Reading 3: two articles on Munger Hall (CP3) Canvas Post (CP2) - Thoughts on Reading 2 (upload on Canvas discussions <i>by 11 am</i>)
4	01/24	<u>Evaluation: First interim presentation</u>	<i>First interim presentation by students (10 min each + 5/8 min discussion) + active participation by other students (Q&A)</i>	GP (g): presentation on site, passive strategies, examples, project shape, orientation, openings, program based on students' needs (bubble diagrams); Sustainability diagrams (e.g., passive strategies, sunpaths); Hand calculations <i>No Canvas uploads</i>
	01/26	<i>Theoretical session:</i> Building standards and certifications	Codes, LEED certification and other energy-centric certifications, WELL certification	Canvas Post (CP3) - Thoughts on Reading 3 (upload on Canvas discussions <i>by 11 am</i>)
5	01/31	<u>Practical session:</u> Work on project	<i>Working session</i> Q&A with instructor (individual groups)	GP (g): implement feedback after first interim presentation <i>No Canvas upload</i>
				GP (g): Definition of design options to be tested (what and why?) Individual exercise (IE3): complete exercise 2 - model in Rhino 2/3 design options of your own project
	02/02	<u>Evaluation: Mid-term exam</u>	<i>Multiple choices and open questions on theoretical sessions weeks 1-4</i>	
6	02/07	<u>Practical session:</u> tool workshop	Intro on computer simulations and results visualization ClimateStudio workshop – part 1 (visual simulation)	GP (g): work on design options after instructor feedback IE3: exercise 2 – model in Rhino 2/3 design options of your own project (upload slides/short report on Canvas <i>by 11 am</i>)

	02/09	<u>Practical session:</u> tool workshop	ClimateStudio workshop – part 2 (thermal simulation and Grasshopper plugin) <i>Exam correction</i>	Individual exercise (IE4): complete exercise 3 – energy modeling	
7	02/14	<u>Evaluation: Second interim presentation</u>	<i>Second interim presentation by students (10 min each + 5/8 min discussion) ± <u>active participation by other students (Q&A)</u></i>	Group project: Calculation of human-centric metrics (visual and thermal) and energy consumption results of design options with ClimateStudio and/or Grasshopper/Ladybug	GP (g): Presentation of entire project and design options to be tested (what and why?) No simulation results! <i>No Canvas uploads</i>
	02/16	<i>Theoretical session & <u>Practical session:</u> tool workshop</i>	Non-image forming effects of light ALFA tool		
8	02/21	<i>Theoretical session:</i> Acoustic comfort	Basic theory of sound, human perception of sound, sound rating Building acoustics (acoustic properties of materials, sound absorbers, room acoustics, sound transmission, and insulation)		IE4: exercise 3 – energy modeling (upload on Canvas <u>by 11 am</u>)
	02/23	<u>Practical session:</u> Project revision	Summary of healthy buildings – group work in class (from readings and lectures) <i>Working session</i> Q&A with instructor (individual groups)		
9	02/28	<u>Evaluation: Third interim presentation</u>	<i>Third interim presentation by students (10 min each + 5/8 min discussion) ±</i>	Group project: additional design iterations to improve energy and comfort – work on the best trade-off.	GP (g): Presentation of human-centric metrics and energy consumption results of design

		<u>active participation by other students (Q&A)</u>	<p>Include design options about the interiors (furniture and finishes), with consideration from ALFA tool</p> <p>Integration of qualitative concepts about acoustic, air quality, biophilic design and healthy buildings in general</p>	options. Conclusions about best design option and/or new design options to test
03/02	<u>Practical session:</u> Project revision	<i>Working session</i> Q&A with instructor (individual groups)	<p>Group project: Calculate WELL and LEED certifications</p> <p>Definition of healthy building strategies in the project</p>	
10	03/07 <u>Practical session:</u> Project revision	<i>Working session</i> Q&A with instructor (individual groups)	Group project: finalize project: presentation and poster	
03/09	<u>Evaluation: Final presentation</u>	<u>Final presentation by students + active participation by other students (Q&A)</u>		<p>GP (g): Presentation of final project with visual, thermal and energy simulation results, presentation of design options, description of qualitative concepts integrated in the design, LEED and WELL certifications, summary of healthy building strategies</p> <p>Upload presentation and poster on Canvas (<i>by 11 am</i>)</p>

Academic Integrity

Students in this course are required to comply with the policies found in the booklet, "Academic Integrity at Northwestern University: A Basic Guide". All papers submitted for credit in this course must be submitted electronically unless otherwise instructed by the professor. Your written work may be tested for plagiarized content. For details regarding academic integrity at Northwestern or to download the guide, visit: <https://www.northwestern.edu/provost/policies-procedures/academic-integrity/index.html>

Accessibility

Northwestern University is committed to providing the most accessible learning environment as possible for students with disabilities. Should you anticipate or experience disability-related barriers in the academic setting, please contact AccessibleNU to move forward with the university's established accommodation process (e: accessiblenu@northwestern.edu; p: 847-467-5530). If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably within the first two weeks of the term, so we can work together to implement your disability accommodations. Disability information, including academic accommodations, is confidential under the Family Educational Rights and Privacy Act.

COVID-19 Classroom Expectations Statement

Students, faculty and staff must comply with University expectations regarding appropriate classroom behavior, including those outlined below and in the [COVID-19 Expectations for Students](#). With respect to classroom procedures, this includes:

- Policies regarding masking, social distancing and other public health measures evolve as the situation changes. Students are responsible for understanding and complying with current University, state and city requirements.
- In some classes, masking and/or social distancing may be required as a result of an Americans with Disabilities Act (ADA) accommodation for the instructor or a student in the class even when not generally required on campus. In such cases, the instructor will notify the class.

If a student fails to comply with the [COVID-19 Expectations for Students](#) or other University expectations related to COVID-19, the instructor may ask the student to leave the class. The instructor is asked to report the incident to the Office of Community Standards for additional follow-up.

Diversity, Equity, and Inclusion

This course strives to be an inclusive learning community, respecting those of differing backgrounds and beliefs. As a community, we aim to be respectful to all students in this class, regardless of race, ethnicity, socio-economic status, religion, gender identity or sexual orientation.

Exceptions to Class Modality

Class sessions for this course will occur in person. Individual students will not be granted permission to attend remotely except as the result of an Americans with Disabilities Act (ADA) accommodation as determined by AccessibleNU.

Maintaining the health of the community remains our priority. If you are experiencing any symptoms of COVID do not attend class. Follow the steps outlined on this site for testing, isolation and reporting a positive case. Next, contact your instructor as soon as possible to arrange to complete coursework.

Students who experience other personal emergencies should contact the instructor as soon as possible to arrange to complete coursework.

Should public health recommendations prevent in-person class from being held on a given day, the instructor or the university will notify students.

Prohibition of Recording of Class Sessions by Students

Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact [AccessibleNU](#). Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University's [Copyright Policy](#), faculty own the copyright to instructional materials – including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.

Support for Wellness and Mental Health

Northwestern University is committed to supporting the wellness of our students. Student Affairs has multiple resources to support student wellness and mental health. If you are feeling distressed or overwhelmed, please reach out for help. Students can access confidential resources through the Counseling and Psychological Services (CAPS), Religious and Spiritual Life (RSL) and the Center for Awareness, Response and Education (CARE). Additional information on all of the resources mentioned above can be found here:

<https://www.northwestern.edu/counseling/>

<https://www.northwestern.edu/religious-life/>

<https://www.northwestern.edu/care/>