

Course “Thermodynamics of Comfort in Buildings”

Responsible Instructor: Assist. Prof. Dolaana KHOVALYG

Instruction Language: English

Semester: MA2, MA4

Credits: 3

Schedule: Fridays, 9h15 – 12h00

Location: Lausanne/Fribourg campuses, see the detailed schedule

SUMMARY:

The comfort and well-being of occupants of buildings have become the central values of the modern built environment. Therefore, engineering the human-centered indoor environment and understanding the key parameters influencing it are crucial skills to learn to face the current challenges of society and the building industry. This course provides an integrated approach to analyzing human thermal comfort by examining the correlation between the indoor and outdoor environment, human thermoregulation, and thermal sensation of occupants. Particularly, detailing of heat flows that an occupant is exposed to, along with thermodynamic processes happening across the building envelope and the mechanical climatization system, will be analyzed during the course.

CONTENT:

- Overview of the heat exchange between humans and the environment, thermoregulation
- Definition of thermal comfort, its fundamentals, and objective characterization
- Building-environment interaction, exergy analysis
- Integrated analysis of the thermal environment and thermal sensation via lab measurements

TEACHING METHODS:

- Lectures on theoretical background regarding the human energy balance, thermal comfort, performance of the built environment, and thermal systems.
- Laboratory activities at the *EPFL-Fribourg campus* at the facilities of the *Laboratory of Integrated Comfort Engineering* and *Smart Living Lab* to enrich understanding of the heating & cooling of the human body and the associated energy expense to maintain comfortable conditions. Students will perform measurements of the thermal environment and evaluate subjective comfort in an environment with and without solar exposure.

STUDENT ACTIVITIES:

- Attend lectures and laboratory activities
- Work in groups, data analysis and interpretation, reporting, and presentation
- Groups of 4 students should be formed by Week 3

MOODLE PAGE:

- <https://moodle.epfl.ch/course/view.php?id=15866>
- Lecture materials will be available ~3 days before each class

LABORATORY FACILITIES:

- A virtual tour of EPFL-Fribourg and the research facilities: <https://building2050-rdi.epfl.ch/virtualtour/slldemo/>
- Experimental facilities overview: <https://www.epfl.ch/labs/ice/research-facilities-2/>

ASSESSMENT METHOD:

The grading is based on the following activities:

- Presentation and report on the lab work #1: **50% (15+35)**
- Presentation and report on the lab work #2: **50% (15+35)**

DETAILED SCHEDULE:

Classroom GC D0 386 is on the Lausanne campus

WEEK	Date	Content	Location
1	21.02.2025	Intro to thermal comfort and human thermoregulation	GC D0 386
2	28.02.2025	Human body energy balance	GC D0 386
3	07.03.2025	Exergy analysis in the built environment (<i>guest lecture</i>)	GC D0 386
4	14.03.2025	Lab #1 in Fribourg (climatic chamber). Measurements and instrumentation.	EPFL-Fribourg
5	21.03.2025	Group work on Lab #1	GC D0 386
6	28.03.2025	Group work on Lab #1	GC D0 386
7	04.04.2025	Invisible radiant heat: transparent & translucent building elements and their effect on comfort (<i>guest lecture</i>)	GC D0 386
8	11.04.2025	Lab #1 presentations, reports submission	GC D0 386
9	18.04.2025	Good Friday (holiday)	No class
10	25.04.2025	Easter break	No class
11	02.05.2025	Lab #2 in Fribourg (building prototype)	EPFL-Fribourg
12	09.05.2025	Building-environment interaction and energy balance	GC D0 386
		Group work on Lab #2	
13	16.05.2025	Group work on Lab #2	GC D0 386
14	23.05.2025	Group work on Lab #2	GC D0 386
15	30.05.2025	Lab #2 presentations, reports submission. Course summary and course evaluation.	GC D0 386

Guest lecturer:

Associate Prof. Forrest Meggers, Andlinger Center for Energy and the Environment, Princeton University (USA), <https://soa.princeton.edu/content/forrest-meggers>

Practical details of laboratory activities at EPFL-Fribourg:

- Expected arrival to the lab by 8:45 and a wrap-up by 11:30
- Travel expenses will be reimbursed
- Morning coffee and croissants will be provided to kick-start the day
- For the trips, we recommend the following trains:
 - *Lausanne-Fribourg*: train IR15 at 07:40 from Lausanne Gare (arrival to Fribourg at 8:32)
 - *Fribourg-Lausanne*: train IC1 at 11:57 from Fribourg Gare (arrival to Lausanne at 12:43)