

CIVIL-450

Thermodynamics of comfort in buildings

Cursus	Sem.	Type
Civil Engineering	MA2, MA4	Opt.
Mechanical engineering	MA2, MA4	Opt.
Minor in Integrated Design, Architecture and Sustainability	E	Opt.

Language of teaching	English
Credits	3
Session	Summer
Semester	Spring
Exam	During the semester
Workload	90h
Weeks	14
Hours	3 weekly
Lecture	1 weekly
Exercises	2 weekly
Number of positions	

Remark

Pas donné en 2023-24

Summary

This course provides an integrated approach to analyzing human indoor thermal comfort by examining the correlation between the thermodynamic processes in buildings, human thermoregulation, local thermal sensation of occupants, and outdoor environment.

Content

- Basics of human drivers in terms of heating and cooling in buildings
- Ergonomics of the thermal environment, subjective and objective assessment of the indoor thermal environment
- Instrumentation for measuring physical quantities of the indoor thermal environment
- Heat transfer through opaque and transparent building elements and their effect on spatial and temporal indoor thermal conditions
- Relation of human comfort needs with energy systems in buildings, matching the quality of energy demand and supply, the cost of comfort
- Practical evaluation of the intricate thermodynamic relationship between human body, indoor and outdoor environment, building envelope, and mechanical conditioning systems.

Keywords

Human thermal comfort, ergonomics of indoor environment, indoor climatization, heat transfer, energy

Learning Prerequisites**Required courses**

- Building energetics (ENG-445)

Recommended courses

- General physics: thermodynamics (PHYS-106)
- Building physics (PHYS-118)
- Thermodynamics and energetics (ME-251)

- Comfort and architecture: sustainable strategies (AR-442)

Important concepts to start the course

Heat transfer, human comfort, indoor thermal environment, thermal demand in buildings

Learning Outcomes

By the end of the course, the student must be able to:

- Characterize local thermal environment and comfort
- Assess / Evaluate energy expenditure to provide indoor comfort
- Carry out measurements of indoor comfort and energy performance using diagnostic instrumentation
- Take into consideration the effect of various modes of heat transfer on human body
- Perform data analysis and presentation

Transversal skills

- Write a scientific or technical report.
- Make an oral presentation.
- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Demonstrate the capacity for critical thinking

Teaching methods

- Lectures and exercises on theoretical introduction to the search of the equilibrium between human body, indoor thermal environment, performance of the building, and mechanical thermal conditioning systems
- Practical activities in Fribourg to enrich understanding of students on dynamic indoor environment and the associated energy expense to maintain comfortable conditions.

Expected student activities

Participate in lectures and exercise sessions, work in groups on practical activity, analyze results, prepare a presentation, and write a technical report

Assessment methods

- Written tests on the course material (60%)
- Practical group work and presentation (40%)

Supervision

Office hours	No
Assistants	Yes
Forum	Yes

Resources

Virtual desktop infrastructure (VDI)

Yes

Bibliography

- Lecture notes (primary source)
- P. O. Fanger, Thermal Comfort, Danish Technical Press, 1970
- Y. A. Çengel; A. J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, McGraw Hill Education, 5th edition.
- M. Moran, H. N. Shapiro, D. D. Boettner, M.B. Bailey, Fundamentals of Engineering Thermodynamics, John Wiley & Sons, 7th edition.
- 2017 ASHRAE Handbook: Fundamentals

Ressources en bibliothèque

- P. O. Fanger, Thermal Comfort, Danish Technical Press, 1970
- ASHRAE Handbook
- Y. A. Çengel; A. J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, McGraw Hill Education, 5th edition.
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Moodle Link

- <https://go.epfl.ch/CIVIL-450>

Prerequisite for