

CIVIL-450

Thermodynamics of comfort in buildings

Khovalyg Dolaana

Cursus	Sem.	Type
Civil 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
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Summary

This course provides an integrated approach to analyze thermal performance of buildings by examining thermodynamics of heat flows in buildings and correlation between human thermoregulation, thermal sensation of occupants, dynamic indoor and outdoor environment, performance of the building envelope

Content

- Ergonomics of the thermal environment, subjective and objective assessment of the indoor thermal environment
- Dynamic thermal performance of the building envelope and its effect on energy required for conditioning indoors
- Space heating and cooling generation and emission systems, personalized comfort systems (PCSs)
- Thermodynamic analysis of the intricate relationship between human body, indoor and outdoor environment, building envelope, and mechanical conditioning systems.
- Practical evaluation of the thermal sensation and comfort of occupants in an office building prototype, analysis of the dynamic behavior of the building and energy expense to maintain indoor comfort.

Keywords

Indoor thermal environment, dynamic building performance, heating/cooling, energy use

Learning Prerequisites**Required courses**

- Building energetics (ENG-445)

Recommended courses

- Thermodynamics and energetics (ME-251)
- Comfort and architecture: sustainable strategies (AR-442)
- Building physics (PHYS-118)

Important concepts to start the course

- Indoor environmental quality (IEQ), thermal comfort

- Thermal conditioning needs in buildings
- Thermal transmittance of the building envelope

Learning Outcomes

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

- Characterize performance of the building envelope, know the basic principles of integrated HVAC equipment and efficiency metrics, critically evaluate the dynamic performance of the heating/cooling system envelope
- Assess / Evaluate energy expenditure to provide indoor comfort
- Carry out measurements of indoor comfort and energy performance using diagnostic instrumentation
- Take into consideration energy performance of indoor comfort and energy performance using diagnostic instrumentation
- 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 personal sensation, indoor thermal environment, performance of the building envelope and mechanical thermal conditioning systems
- Laboratory activities to enrich understanding of students on dynamic indoor environment and the associated energy expense to maintain comfortable conditions. Students will perform measurements in an office room and analyze heat flow and energy consumption of the integrated HVAC system. The test facility is a small building prototype located on the Smart Living Lab (www.smartlivinglab.ch) site in Fribourg

Expected student activities

Participate in lectures, work on exercises, work in groups on measurements in the building prototype, analyze results, prepare a presentation, and write a technical report

Assessment methods

Three mini-tests: 45% (3 x 15%)

Laboratory report and presentation: 55%

Resources

Bibliography

- 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
- C.-E. Hagentoft, Introduction to Building Physics, Studenlitteratur, 2001
- P. O. Fanger, Thermal Comfort, Danish Technical Press, 1970

- M. Humphreys, F. Nicol, S. Roaf, Adaptive Thermal Comfort – Foundations and Analysis, Taylor and Francis Group, 2016

Ressources en bibliothèque

- Y. A. Çengel; A. J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, McGraw Hill Education, 5th edition.
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- P. O. Fanger, Thermal Comfort, Danish Technical Press, 1970
- M. Moran, H. N. Shapiro, D. D. Boettner, M.B. Bailey, Fundamentals of Engineering Thermodynamics, John Wiley & Sons, 8th edition.
- 2017 ASHRAE Handbook - Fundamentals

Prerequisite for

"Le contenu de cette fiche de cours est susceptible d'être modifié en raison du covid-19"