Thermodynamics of comfort in buildings

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**Summary**

This course provides an integrated approach to analyze indoor thermal comfort by examining thermodynamics of heat flows in buildings and correlation between indoor thermal environment, performance of the building envelope and thermal conditioning systems (HVAC).

**Content**

Energy, entropy and exergy concepts; their application to analyze technical services of buildings.

Indoor thermal comfort and ventilation requirements, indoor environmental standards

Thermal conditioning, heat/cold generation and distribution systems, loads calculation

Exergy analysis of various systems used for thermal management and ventilation of buildings

Practical evaluation of indoor comfort, energy, and exergy of air conditioning in building prototype

**Keywords**

Thermal comfort, thermal conditioning, HVAC, thermodynamics, energy efficiency, energy analysis.

**Learning Prerequisites**

Required courses

N/A

Recommended courses

Thermodynamics and energetics (ME-251)

Building energetics (ENG-445)

Comfort and architecture: sustainable strategies (AR-442)

Important concepts to start the course

Energy, entropy and exergy

Indoor environmental quality (IEQ), thermal comfort requirements

Thermal conditioning needs in buildings

**Learning Outcomes**

By the end of the course, the student must be able to:
• Characterize performance performance of the building envelope, know the basic principles of HVAC equipment and efficiency parameters, critically evaluate the dynamic performance of the ventilation and heating/cooling
• Use the concept of exergy as a measure to evaluate sustainability of heating/cooling services and ventilation in buildings
• Assess / Evaluate energy and exergy expenditure to provide indoor comfort
• Carry out measurements of indoor comfort and energy performance using diagnostic instrumentation
• Take into consideration energy performance and requirements of IEQ standards
• Perform data analysis and presentation
• Specify indoor comfort requirements

Transversal skills

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

Teaching methods

- Lectures and exercises for theoretical introduction to the search of the equilibrium between thermal comfort, performance of the building envelope and mechanical systems; comparative analysis of energy and exergy performance of thermal conditioning systems in buildings
- Laboratory activity to enrich understanding of students on indoor comfort and the associated energy expense. Students will perform measurements of the indoor thermal comfort in an office room and analyze exergy flow and energy consumption of the integrated HVAC system. The test facility is a small building prototype located on the smart living lab site in Fribourg

Expected student activities

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

Assessment methods

Mid-term exam: 20%
Laboratory report: 50%
Final exam: 30%

Supervision

Office hours Yes
Assistants Yes
Forum No

Resources

Bibliography

• 2017 ASHRAE Hanbook – Fundamentals
• C.-E. Hagentoft, Introduction to Building Physics, Studenlitteratur, 2001

Ressources en bibliothèque

• 2017 ASHRAE Handbook - Fundamentals

Websites

• http://www.lowex.net
• http://www.annex69.org

Prerequisite for

Master Project