EPFL

CIVIL-309	**Urban Thermodynamics**

Cursus	Sem.	Type
Civil Engineering	BA5	Obl.

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

Remark

Pas donné en 2023-24

Summary

This course introduces the analysis of urban areas from a thermodynamics perspective, considering the heat exchange between different urban elements (buildings, vegetation, water surfaces, ground, and environment). Urban heat island effect and outdoor comfort topics are also discussed.

Content

- Urban physical processes at different scales, and their analysis
- Characteristics of the urban environment and urban micro-meteorology
- Environment-buildings-vegetation-ground-water surfaces thermal interaction
- Spatial distribution and dynamics of airflow, temperature, and humidity in cities
- Role of materials and urban design in thermal heat exchange
- Effect of urban elements on urban climate, outdoor comfort

Keywords

Urban heat exchange, urban atmosphere/boundary layer, urban elements interaction, environmental impact, built environment, urban green areas and water bodies, urban heat island (UHI) effect, outdoor thermal comfort

Learning Prerequisites

Required courses

- General physics: thermodynamics PHYS-106

Recommended courses

- Fluid mechanics (for GC) CIVIL-210
- Fundamentals of indoor climate CIVIL-221

Important concepts to start the course

Heat transfer modes (convection, conduction, radiation)

Learning Outcomes

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

- Assess / Evaluate heat distribution in urban zones
- Critique the choice of urban materials and design and propose alternative solutions
- Analyze various modes of heat transfer in urban environment
- Carry out thermodynamic analysis at urban scale
- Examine the effect of the outdoor built environment on human comfort
- Assess / Evaluate surface energy balance at various urban surfaces

Transversal skills

- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Demonstrate the capacity for critical thinking
- Access and evaluate appropriate sources of information.

Teaching methods

Ex cathedra and exercises in class

Expected student activities

Participate in lectures and exercise sessions

Assessment methods

Three written tests: 30%+45%+25%

Supervision

Office hours	No
Assistants	Yes
Forum	No

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

- T.R. Oke, G.Mills, A. Christensen, J.A. Vooght, **Urban Climates**, Cambridge University Press
- S. Medved, **Building Physics: Heat, Ventilation, Moisture, Light, Sound, Fire, and Urban Microclimate**, Springer
- A. Rodrigues, R.A. Sardinha, G. Pita, **Fundamental Principles of Environmental Physics,** Springer
- N. Mason, P. Hughes, **Introduction to Environmental Physics: Planet Earth, Life and Climate,** Taylor & Francis

Ressources en bibliothèque

- T.R. Oke, G.Mills, A. Christensen, J.A. Vooght, Urban Climates, Cambridge University

- S. Medved, Building Physics: Heat, Ventilation, Moisture, Light, Sound, Fire, and Urban Microclimate, Springer
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Moodle Link

- https://go.epfl.ch/CIVIL-309

Prerequisite for

- Building energetics ENG-445
- Thermodynamics of comfort in buildings CIVIL-450

NB: ce cours ne sera pas dispensé en 2023-2024