# Urban Thermodynamics

## Cursus
Civil Engineering

## Sem.
BA5

## Type
Obl.

## Contact Language
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
- 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
• S. Medved, Building Physics: Heat, Ventilation, Moisture, Light, Sound, Fire, and Urban Microclimate, Springer
• N. Mason, P. Hughes, Introduction to Environmental Physics: Planet Earth, Life and Climate, Taylor & Francis
• A. Rodrigues, R.A. Sardinha, G. Pita, Fundamental Principles of Environmental Physics, Springer

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