Summary
We are living in an urban world and the design of sustainable cities is essential in order to decrease our energy footprint. This course provides the instruments to understand the complex urban metabolism, as well as the solutions for planning future smart and sustainable cities.

Content
We live in a world that is more and more urbanised (over 50% of the world population lives in cities since 2010) and architects, urban planners and other stakeholders have to rethink their projects to integrate them to an urban context. In the architecture curriculum at the Bachelor and Master level, students have been introduced to the fundamentals and principles of building science as well as other courses that focus on the urban scale. However, none of these courses focus on the physics behind metabolism and sustainability of future districts and cities. The objective of this course is to provide the instruments to understand and to quantify the urban metabolism, focusing on the urban climate, the buildings energy design and the liveability of the “spaces between” buildings.

Keywords
• Sustainable Urban Planning
• Urban Climate
• Urban Metabolism
• Energy Systems
• Integration of Renewable Energies
• Human Thermal Perception
• Urban Greening

Learning Prerequisites
Recommended courses
Basic knowledge of physics.

Important concepts to start the course
Fundamental concept on Urbanism and Sustainability.

Learning Outcomes
By the end of the course, the student must be able to:
• Manage the physical principles and the energy fluxes within the urban environment.
• Transpose the fundamentals of urban climate on its applications and assess the impact of urban spaces on the energy demand and pedestrians thermal comfort and health.
• Analyze the impact of climate change from the global to the local scale.
• Develop an experimental campaign to measure meteorological variables.
• Synthesize and analyse the monitoring data, as well as their application for a sustainable urban design.

Transversal skills
• Take account of the social and human dimensions of the engineering profession.
• Identify the different roles that are involved in well-functioning teams and assume different roles, including leadership roles.
• Demonstrate a capacity for creativity.
• Take feedback (critique) and respond in an appropriate manner.
• Collect data.

Teaching methods
The course is subdivided into two main parts: i) in class teaching and ii) a practical exercise. The teaching part is broken down into five main topics: i) the link between the building and the city scale, ii) the urban climate and the space between buildings, iii) the energy aspects, iv) the intangible aspects behind the city and finally v) a general perspective with reflections on how cities influence the national and global systems. The practical exercise consists in one-day monitoring study of the microclimate of the EPFL campus, focusing on the impact of the campus design on the energy demand of buildings and on the pedestrian's thermal perception.

Expected student activities
Students are expected to actively participate to the course. Each student will work on one-day monitoring study on the EPFL campus, focusing on the microclimatic conditions of the site. All the measurements will be collected, stored and shared between the students in an online platform. During the semester each group will analyse the monitoring data, and provide a comprehensive study on the assigned theme, as well as practical recommendations for the sustainable design of the campus.

Assessment methods
The evaluation is based on the active participation to the measurement campaign (20%), a written report (40%) and a final presentation (40%) of the work performed during the semester, based on the monitoring study.

Supervision
Office hours  Yes
Assistants  Yes
Forum  Yes
Others  Online virtual platform to store and share the acquired data

Resources
Virtual desktop infrastructure (VDI)
No

Bibliography
A comprehensive bibliography is provided during each course.
The following readings are recommended during the semester:
Ng (2010). *Designing High-density cities. For social and Environmental Sustainability*. Earthscan

**Ressources en bibliothèque**
- Urban microclimate / Erell
- Designing high-density cities / Ng
- Computer modelling for sustainable urban design / Robinson
- Urban climate mitigations techniques / Santamouris

**Websites**
- https://leso.epfl.ch/