# CIV_ENV 395-0-26
# Building Physics
# Spring Quarter 2020

The course aims at providing the fundamental knowledge of the physics related to buildings, with a focus on heat and mass transfer, moisture, sound/acoustics, illumination and the energy consumed in buildings to guarantee the comfort of their occupants.
At the end of the course, students will be able to:

- Describe the environmental parameters and the building components features that affect the energy consumption of a building
- Describe the heat and mass transfer through building assemblies
- Calculate the peak load of an enclosed space
- Calculate the annual energy consumption of a building
- Describe the indoor environmental parameters for occupant comfort
- Describe sustainable solutions for energy-efficient and comfortable design

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| **Instructor** | Dr. Giorgia CHINAZZO<br>Office: Tech A330<br>Office hours: Contact the instructor via email for appointment.<br>E-mail: giorgia.chinazzo@northwestern.edu |
| **Class times** | 2-3:20 Tuesday and Thursday |
| **Location** | TBD |
| **Suggested textbook** | Pinterić, M. (2017). *Building Physics: From physical principles to international standards*, 1st edition, Elsevier. (Available online through Northwestern library) |
| **Pre-requisites** | Familiarity with the fundamentals concepts of thermodynamics |
| **Course Assessment** | Homework and attendance – 15%<br>*Weekly exercises, due in class, in the first half of the course.*<br>Midterm – 25%<br>*Technical exercises on the content presented in the first half of the course.*<br>Report + final presentation – 30%<br>*Report on a sustainable technological solution, to be presented in the last week of the course.*<br>Final exam – 30%<br>*Multiple choices and open questions on the entire content of the course.* |
| **Deliverables** | Exercises, report and presentation. |

# Course Syllabus - Spring 2020 – CIV_ENV 395-0-26: Building Physics

| Week | Date | Lecture | Topic(s) | Assignment(s) | Assignment due |
|---|---|---|---|---|---|
| 1 | | Introduction: Sustainability & Climate-Responsive Architecture, Interaction building-environment | Presentation of the course, introduction into the report/exercises. Buildings and greenhouse gas emissions, climate change implications, approaches to zero energy and carbon. Climate and architecture, climate analysis, vernacular architecture, passive and active strategies | Exercise 1: climatic issues (e.g., outdoor temperature and irradiation) | |
| | | Heat transfer in the built environment - part I | Heat transport principles, heat resistance of constructions | | Presentation of sustainable technological solution to be analyzed in the report |
| 2 | | Heat transfer in the built environment - part II | Energy performances of the building envelope components, thermal bridges, thermal mass | Exercise 2: U value walls, temperature of walls, condensation | Exercise 1 |
| | | Moisture and condensation | Vapor transport, relative humidity, surface condensation, internal condensation | | |
| 3 | | Solar radiation and shading - part I | Solar geometry, solar charts, radiation on surfaces | Exercise 3: solar geometry | Exercise 2 |
| | | Solar radiation and shading - part II | Shading systems, window properties and shading requirements | | |
| 4 | | Building energy and mass balance - part I | Peak load calculation | Exercise 4: energy balance | Exercise 3 |
| | | Building energy and mass balance - part II | Peak load calculation | | |
| 5 | | **Mid-term exam** | | | |
| | | Annual energy consumption | Annual energy consumption calculation, energy codes & rating systems | | Exercise 4 |
| | | Ventilation and infiltration | Natural ventilation, mechanical ventilation, building airtightness | | |
| 6 | | Thermal comfort - part I | Psychrometrics, heat balance, PMV model, local discomfort | | |
| | | Thermal comfort - part II | Adaptive thermal comfort model | | |
| 7 | | Visual comfort- part I | Physiology of vision, physics of light, properties of light sources, daylighting, electric lighting, photometric units | | |
| | | Visual comfort - part II | Daylight metrics (daylight availability, glare, contrast on screens, view to exterior), non-image forming effects of light, color perception | | |
| 8 | | Acoustics – part I | Evaluating sound, sound absorption, acoustic of the room | | |
| | | Acoustics – part II | Sound insulation and sound proofing | | |
| 9 | | Indoor Air quality | Indoor pollutants, ventilation rate | | |
| | | Buildings and climate installations | HVAC systems, radiant systems | | |
| 10 | | Presentation of report on sustainable solution | | | |
| | | Final exam | | | |