

CIVIL 239: Engineering a sustainable built environment

Logistics

Lectures: Tuesdays 10:15-12:00

Exercises: 12:15-13:00

Location: GC B3 30

Instructor: Andrew Sonta, Assistant Professor of Civil Engineering, ETHOS Lab

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Office hours: Tuesdays, 14:00-15:00 (or by appointment)

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Course assistants:

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Course description

This course explicitly addresses the issue of sustainability in the built environment through an engineering lens. It covers the sustainability and energy landscape, approaches to sustainability in civil engineering, and specific tools for enacting sustainability in civil engineering.

Content

The course introduces the intersections between different areas of civil engineering and sustainability topics, the engineering knowledge needed to address sustainability topics, and engineering tools that can be used to analyze and assess sustainability.

Topics covered include:

- The sustainability landscape
- Energy supply and demand
- Mobility and sustainability
- Materials and structures
- Natural systems
- Sustainability in the civil engineering profession

Engineering knowledge and tools covered include:

- Energy
- Systems thinking
- Life cycle assessment
- Engineering economics and decision-making

Learning objectives

- Explain to an engineer, designer, policymaker, or other professional why sustainability is important in civil engineering.
- Assess / Evaluate and be critical of metrics used to measure sustainability.
- Analyze civil engineering systems in the context of sustainability.
- Quantify environmental, economic, and social impacts of the built environment.
- Construct models of systems to understand complexity of engineered civil systems.

Transversal skills

- Communicate effectively, being understood, including across different languages and cultures.
- Demonstrate the capacity for critical thinking
- Take account of the social and human dimensions of the engineering profession.
- Take responsibility for environmental impacts of her/his actions and decisions.

Coursework and assessment

Coursework will consist of graded exercises, one midterm exam, and one final exam.

- Graded exercises (20%)
 - Five graded assignments @ 4% each – 20% (see course schedule)
 - Assignments are due at the start of class on the day indicated in the schedule below
 - Assignments submitted late lose 50% of the grade for the assignment
- Midterm exam (30%)
- Final exam (50%)

Course schedule (subject to change)

| Week | Date | Course Content | Engineering knowledge and tools | Due |
|---|--------|---|--|--------------|
| Course introduction | | | | |
| 1 | 10-Sep | The climate crisis What is sustainability? Sustainability in civil engineering | The role of the built environment in sustainability | |
| 2 | 17-Sep | Sustainability indicators New economic thinking | The importance of data | |
| Buildings and energy | | | | |
| 3 | 24-Sep | Energy demand: buildings and infrastructure | How design impacts energy demand; Energy and load calcs | Assignment 1 |
| 4 | 1-Oct | Energy supply: Renewables, the grid, and grid integration | Interface between the built environment and energy systems; time-series data analysis | |
| Mobility and sustainability | | | | |
| 5 | 8-Oct | Transportation systems | Link between transportation and energy; systems thinking | Assignment 2 |
| 6 | 15-Oct | Sustainable urban design and active mobility Social systems | System dynamics | |
| 7 | 22-Oct | No Class - Fall Break | | |
| 8 | 29-Oct | Midterm exam – CE 1 1 | | Assignment 3 |
| Materials, structures, and life-cycle assessment | | | | |
| 9 | 5-Nov | Guest lecture: Embodied carbon emissions and materials | The phases of infrastructure life cycles | |
| 10 | 12-Nov | Life-cycle assessment | Environmental LCA; Safety factors | |
| Natural systems and sustainability economics | | | | |
| 11 | 19-Nov | Guest lecture: Assigning value to natural systems | Sustainability in natural systems; Engineering and sustainability economics | |
| 12 | 26-Nov | Engineering with natural systems; geotechnical engineering, water resources engineering | Multi-criteria decision-making, resilience, sensitivity analysis, nature-based solutions | Assignment 4 |
| Sustainability in the civil engineering profession | | | | |
| 13 | 3-Dec | Guest lecture: Safety and reliability in civil engineering | Load combinations, safety and reliability | |
| 14 | 10-Dec | Guest lecture: Sustainable engineering in the industry | Practical issues | |
| 15 | 17-Dec | Course wrap up Class debate | | Assignment 5 |
| 16 | 27-Jan | Final Written exam | | |