

REGENERATIVE AND SMART BUILDING TECHNOLOGIES

Scientific Disciplinary Sector (SSD): CEAR 80-A / Architectural Technology

Credits: 6 ECTS

Lectures: 24 hours (3 ECTS)

Design studio / practical activities: 24 hours (3 ECTS)

Lecturers: Ilaria Garofolo, Carlo Stival

Course Contents

With the expansion of urban contexts and the increasing intensity of environmental pressures, regenerative design and digital technologies converge into an approach capable not only of reducing environmental impacts but also of actively improving the built environment from the perspective of direct and indirect users.

The regenerative design approach integrates and extends sustainable design within a systemic framework: unlike conventional sustainability, which primarily focuses on reducing negative environmental impacts, regenerative design incorporates proactive strategies aimed at recovering and enhancing ecosystems and community well-being.

Smart building technologies represent a natural complement to these concepts. By integrating sensors, automation, and real-time data monitoring, they enable the development of adaptive, efficient, and responsive buildings capable of reacting to both environmental changes and occupants' needs.

Educational Objectives

The course aims to provide both theoretical foundations and operational tools to:

- understand the transition from sustainability to regenerative design;
- interpret the building project as a complex and integrated system;
- apply principles of circular economy and lifecycle-oriented design;
- integrate smart technologies for performance monitoring and control;
- develop design capabilities oriented towards environmental and social sustainability.

Learning Outcomes (Dublin Descriptors)

Knowledge and Understanding

- knowledge of principles of sustainable and regenerative design
- understanding of buildings as complex and interconnected systems
- knowledge of smart building technologies and monitoring and control systems

Applying Knowledge and Understanding

- ability to apply design strategies for sustainability and regeneration
- ability to integrate technological solutions for automation and monitoring (BMS, sensor systems) into sustainable building design
- ability to apply lifecycle-based approaches and performance evaluation methods

Making Judgements

- ability to critically evaluate design solutions in environmental, energy, and social terms

- ability to select materials and technologies based on lifecycle impacts
- ability to interpret performance data and indicators to support design decisions

Communication Skills

- ability to effectively communicate design strategies and solutions
- ability to represent data and performance through analytical and graphical tools
- ability to argue design choices within interdisciplinary contexts

Learning Skills

- ability to address the interdisciplinary complexity of contemporary building design
- ability to integrate knowledge from technological, environmental, and social domains

Prerequisites

Basic knowledge of architectural technology, building physics, and building design.

Teaching Methods

Lectures embedding case study analysis, thematic seminars, and design studio activities.

Assessment Methods

Assessment is based on a design project. The project will be discussed during an oral examination, supported by technical reports and graphical representations.

Course Programme

Fundamentals of Sustainability and Regenerative Design

sustainability and limitations of the traditional model

regenerative design and systems thinking

circular economy and lifecycle approach

The Building as a Complex System

environment–building–user relationships

Minimum Environmental Criteria

S-layers model

adaptability and durability

Regenerative Design Strategies

sustainable and locally sourced materials

energy, water, and waste management

biodiversity and green infrastructures

indoor environmental quality and well-being

Smart Technologies for Adaptive Buildings

Building Management Systems (BMS)

environmental and performance monitoring (sensor systems)

smart grids and energy flexibility

Essential Bibliography

du Plessis, C. (2022), *Designing for Hope*, Routledge

Girardet, H. (2020), *Regenerative Cities*, Routledge

De Wolf, C., Çetin, S., Bocken, N. (2024), *A Circular Built Environment in the Digital Age*, Springer

Further readings will be suggested during the course.

MOOC Resources (TU Delft)

Circular Economy for a Sustainable Built Environment

Managing Building Adaptation: a Sustainable Approach

Nature-Based Metropolitan Solutions