



# R&D IN ARCHITECTURE AT THE UPC

2023



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## THE UPC

Get to know the Polytechnic University of Catalonia (UPC) and discover some of its indicators.

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# 01 THE UPC

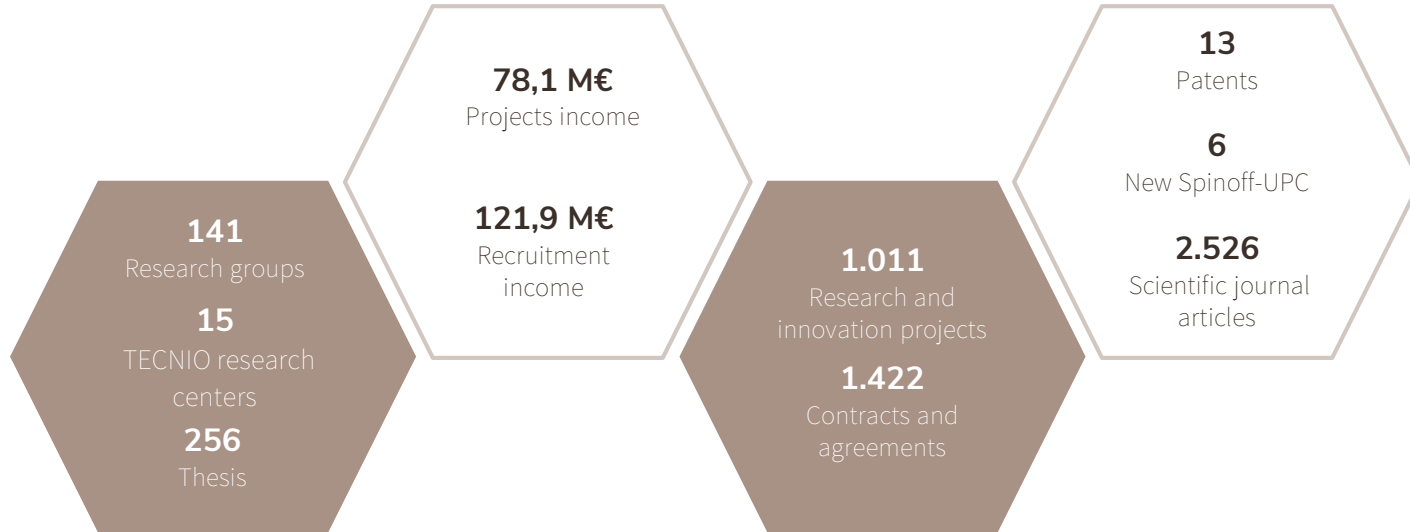
The Universitat Politècnica de Catalunya (UPC) is a public institution of research and higher education in the fields of engineering, architecture, sciences and technology, and one of the leading technical universities in Europe.

The UPC participates in the innovation system of Catalonia with projects and contracts for research, development, valorization of knowledge and commercialization of technology.



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## RESEARCH, DEVELOPMENT AND INNOVATION ACTIVITY AT THE UPC IN 2022



# 02

## ARCHITECTURE AND LANDSCAPE ARCHITECTURE

### ARCHITECTURE

Architecture is the art and technique of planning, projecting, designing and constructing buildings or monuments, modifying the human habitat and studying the aesthetics, good use and function of spaces, whether architectural or urban.

### LANDSCAPE ARCHITECTURE

Landscape architecture consists of creating large cities, streets, parks and public spaces that inspire well-being and a healthy life while protecting natural environments. But it also tries to create safe, sustainable and resilient landscapes that evolve but last over time.

## Examples of activity I

Design, validation and implementation of sustainable building systems based on natural biological materials that improve building efficiency.

Study of factors affecting **urban resilience** against extreme **climate risks**, such as soil permeability, vegetation, urban roughness, ventilation, etc.

Design of public spaces applying the formula of **tactical urbanism**, which means changing the uses of streets to adapt the city to a new mobility and concept.

Analysis of the environmental quality of **outdoor spaces** in relation to their potential to improve people's quality of life.

Development of **bio-sustainable solutions** for the **acoustic and fire improvement** of building envelopes. Analysis of the acoustic behavior of construction materials of plant origin and improvement of the fire behavior of these materials while developing flame retardants.

Development of building materials and structures that mimic biological systems with neuron-inspired smart materials and structures.

Construction and renovation of **sustainable and energy efficient buildings**.

## Examples of activity II

Development of new construction materials through the design of low environmental impact products using recycled materials.

Analysis of perceived barriers and opportunities in relation to the implementation of **agro-green roofs** in cities.

New proposals for constructive solutions under **energy efficiency** criteria in the life cycle of buildings.

Technological interpretation of the **built heritage** and its integration in the urban territory.

**Planning, design, construction, service life, operation, maintenance, dismantling and recycling** considering economic, social, environmental, quality, health and safety aspects.

Use of Digital Twin technology for the design, operation and maintenance of buildings.

Assessment of the state and evolution of **reinforced concrete and pressed concrete** due to climate change and forms of repair and reinforcement.

## Examples of activity III

Sustainable approach to construction, closing the cycle of water and materials and reducing energy consumption in the sector.

Sustainable designs both on the **roofs** surrounding the buildings and on the roofs.

Replacement of conventional roofs with a **roof with a built-in greenhouse**.

New strategies to turn cities into a **green oasis**, reduce carbon footprint and fight global warming.

Study of forms of **growth and urban morphology**, the development of the modern city, the theory and practice of the urban project and the teaching of urban planning in the world.

Design and characterization of new materials and construction systems.

Application of **agri-food technology** from both an agronomy and sustainability perspective.



## Examples of activity IV

Valorization of agricultural waste for construction, like for example, corn stalks and sunflower stalks.

Improvement of the **hydrothermal behavior** of buildings from agricultural by-products and natural rubbers.

Integration of **greenhouses on the roofs** of buildings and taking advantage of the synergies of unidirectional waste flows, energy, water resources and CO2 emissions.

Symbiotic interaction between **buildings** and **urban agriculture**.

Development of projects in **3D, BIM and 3D printing**. Design and implementation of interactive models, virtual and augmented reality.

Socio-residential, political and urban management assessments, such as, detection of areas with **social vulnerability**, guidelines and dynamics in public spaces, immigration, etc.


Analysis of the **residential growth** according to the state of the ground and the building.

# 03

## RESEARCH & INNOVATION



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The background of the slide is a large, abstract image of a curved, textured surface, possibly a modern architectural facade or a piece of art. The surface is composed of many thin, overlapping lines that create a sense of depth and movement. The colors range from dark brown to light beige, with a soft gradient. A thin, light-colored line is visible in the upper right corner of the slide, extending from the top edge towards the center.

Through the research groups distributed by its Schools and Faculties, the UPC has facilities and resources to provide its own services, in the areas of diagnosis, advice, development, demonstration, training, promotion and support to industry, the public sector and civil society in the promotion and deployment of architectural innovation technologies.

# UPC RESEARCH GROUPS AND CENTERS – ARCHITECTURE AND LANDSCAPE ARCHITECTURE

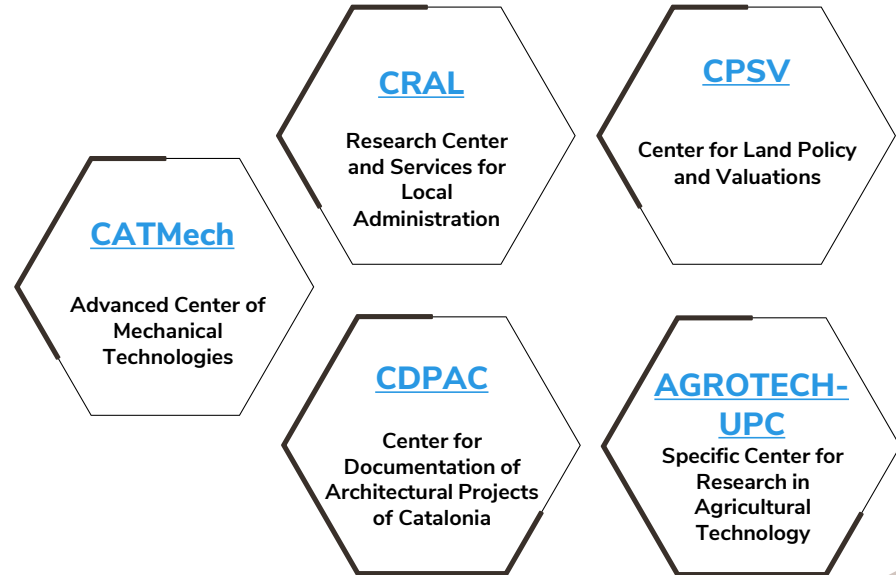
# 34

RESEARCH GROUPS (22),

RESEARCH SUBGROUPS AND  
LABORATORIES (12)

ACC, ADR&M, AiEM, AMPC, ARIENS, ATEM,  
CERCLE, CITES, DiCEA, EC, EGEO, FORM+,  
Geo2Aqua, GICITED, GILDA, GIRAS, GIOPACT,  
GREiP, GRIC, GRU, HABITAR, LEAM, LESEC,  
LITEM, LiTA, LoG, LUB, MATCAR, MNT-Solar,  
PROTO, PTP-GlaDyM, QURBIS, REARQ,  
SMarT

## SPECIFIC RESEARCH CENTERS



## RESEARCH AND INNOVATION NETWORKS

[AdapteCCa](#) – Adaptation to Climate Change in Spain Platform.

[AESOP](#)- European Association of Planning Schools.

[Barcelona Clúster Nàutic](#)

[Comisión Permanente del Hormigón](#)

[CWP](#) - Catalan Water Partnership.

[Digital Twin Consortium](#)

[IFoU](#) - International Forum on Urbanism.

[ISOCARP](#) - International Society of Regional and Urban Planning.

[PTEC](#) – Spanish Construction Technology Platform.

[Railgrup](#)

## SPIN OFFS

Smart Engineering



Composite Structural  
Engineering Solutions



# CHAIRS IN ARCHITECTURE AT THE UPC

[Càtedra d'Accessibilitat: Arquitectura, Disseny i Tecnologia per a Tothom](#)

[Càtedra Gaudí](#)

[Càtedra Barcelona d'Estudis d'Habitatge](#)

[Càtedra Batlleiroig](#)

[Càtedra Blanca CIMSA](#)

[Càtedra de Regeneració Urbana](#)

[Càtedra Jujo!](#)

[Càtedra UNESCO de Tècnica i Cultura](#)

[Càtedra Grup Construc a: Hub d'Economia Circular Aplicada per la Construc i i la Ind stria](#)

[Càtedra Grup JG Ingenieros - UPC per a l'Estudi de la Sostenibilitat en els Edificis](#)



# 04

## UPC EXCELLENCE PROJECTS

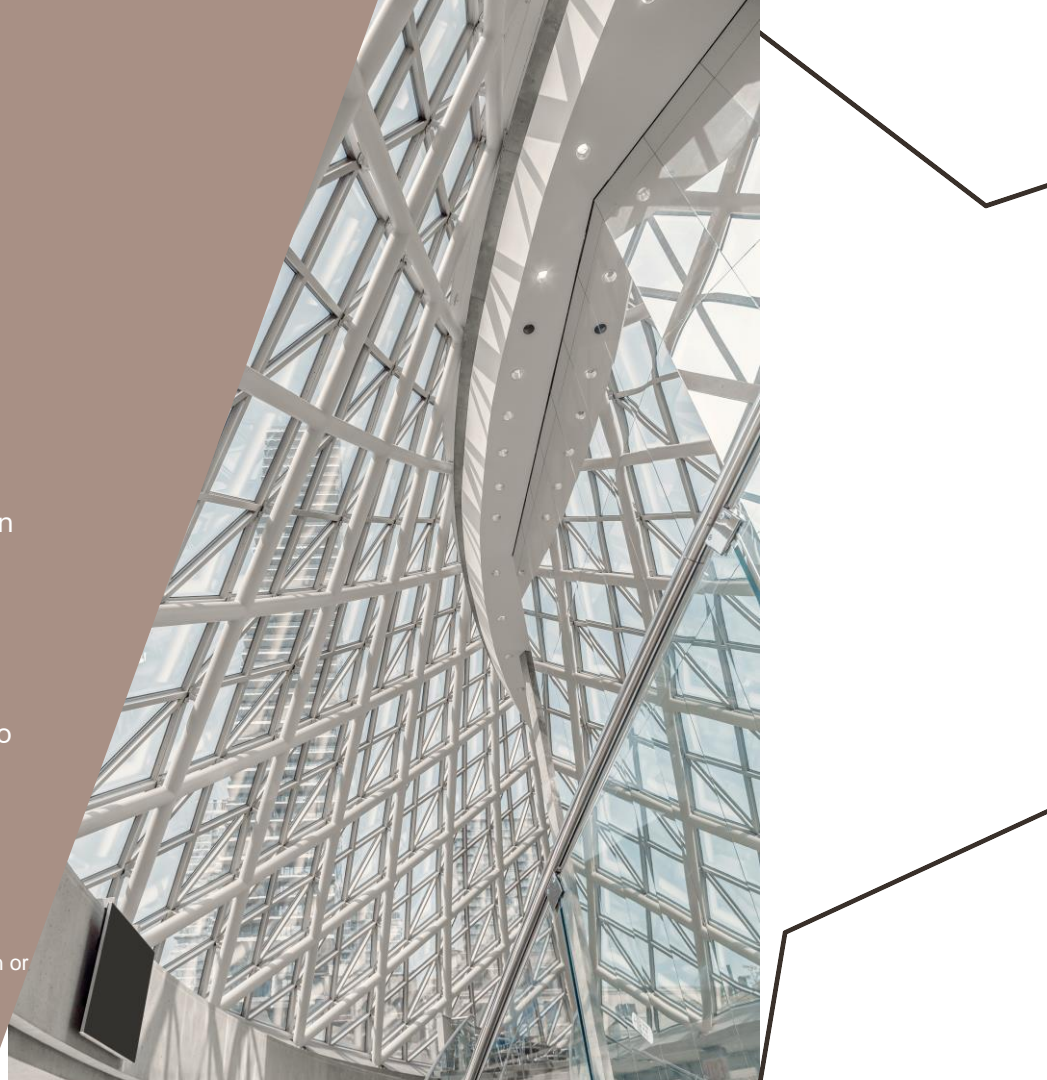
In this document are considered excellence projects those in which:

- The scientific process is rigorous and complex with high quality standards.
- They are strategic and tractors.
- They acquire a commitment to both social aspects and to great scientific and socioeconomic impact.
- They have repercussions on the territory.
- They comprise the different entities participating in the quadruple helix, so that the projects remain multidisciplinary.

The UPC excellence projects are financed by various programs, such as the State Plan or Horizon Europe.



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## Barcelona ciutat fràgil

The aim of the project is to generate a cartography of the fragile city, an alternative map of the impact of the pandemic on the city of Barcelona that can be superimposed on the map of the conventional city, allowing both images to be compared.

The project aims to discover and make visible the hidden space of the city during the period of the first state of alarm, a map that shows the practices of space and that represents the vulnerable spaces linked to the marginality and fragility of life.

With this information is intended to reconsider the spaces and recognize them as more complex things in which the experiences unfold in unpredictable ways, all marking the consciousness and memory of the space and of the private and shared imagination.

UPC research groups involved: [ACC](#), [GIOPACT](#), [AiEM](#)





# UPC EXCELLENCE PROJECTS



## CUSTOM-ART - Disruptive thin-film technologies based on customized kesterites to drive active urban furniture and architectural applications

Development of the next generation of building-integrated photovoltaic modules and BIPV and PIVP products based on sustainable thin film technologies.

The project is key to making almost zero energy buildings (nZEB) and net zero energy districts a reality through the integration of photovoltaic modules capable of completely replacing the passive elements of architecture and urban furniture.

CUSTOM-ART will take these technologies up to TRL7, demonstrating very competitive conversion efficiencies (20% at cell level and 16% at module level) and durability (over 35 years), with reduced production cost (< €75/ m<sup>2</sup>), using exclusively abundant elements and contributing to guarantee the full sustainability and competitiveness of the European BIPV and PIVP industry.

UPC research group involved: [MNT-Solar](#)



# UPC EXCELLENCE PROJECTS

## FDBR - Development of green facades using improved Bio-Receptivity Concrete

In recent years, the need of having green areas in urban areas has increased, in order to improve the quality of life.

In this sense, green facades and roofs and vertical gardens make it possible to take advantage of the existing infrastructures as support for these new areas. The main disadvantage of the currently existing solutions lies in the high cost of their maintenance and the high water consumption required for biological growth.

The UPC has patented a new concept of biological facade using a new concept of concrete: concrete with improved bioreceptivity. This material manages to optimize biological colonization by modifying three fundamental factors of the concrete composition.

UPC research group involved: [EC](#)



# UPC EXCELLENCE PROJECTS



## VEUVE - Urban shelters for vulnerable neighborhoods: Environmental behavior of public space for the resilient city

This project focuses on the definition of environmental comfort parameters that can favor the presence of urban shelters where the population of vulnerable neighborhoods can find a space to satisfy the need for contact with nature, while contributing to reducing the impact of the heat island in the city.

The project aims to characterize these possible urban shelters and, based on existing vulnerability indicators with some additions such as energy, to identify urban areas that do not have comfortable spaces. Thanks to this, guidelines can be given to help make decisions that increase the resilience of the city.

UPC research group involved: [AiEM](#)

# UPC EXCELLENCE PROJECTS



## IMIP- Innovative Eco-Construction System Based on Interlocking Modular Insulation Wood & Cork-Based Panels

The project contributes to the mitigation of climate change by increasing the use of wood and cork products in the construction and rehabilitation of public buildings thanks to their high energy and carbon storage capacity.

The IMIP promotes the circular bioeconomy by designing a new construction system based on prefabricated modular parts characterized by easy, quick and economical assembly and disassembly for reuse.

UPC research groups involved: [ADR&M](#), [GILDA](#), [QURBIS](#),  
[CPSV \(CER\)](#)

# UPC EXCELLENCE PROJECTS

## ASHVIN - DIGITAL TWIN technology applied to the construction sector

Establishment of a digital twin platform based on an open code that integrates IoT technology, simulation methods and 4D visualization of construction processes.

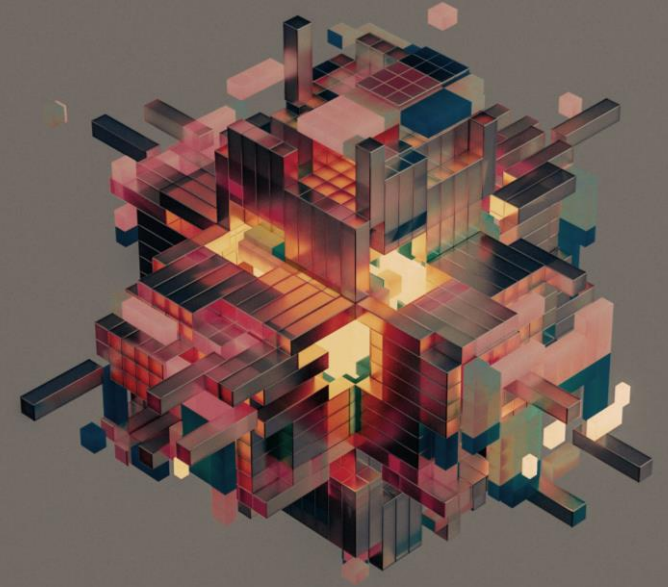
The platform provides a digital representation of the construction product and enables real-time data collection before, during and after production to enable continuous monitoring of changes in the environment.

It is about integrating the monitoring of the health structure, the simulation, the risk analysis and the decision-making in a joint application in the form of a virtual environment.

UPC research groups involved: [ATEM](#), [EC](#), [EGEO](#), [Geo2Aqua](#)



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# UPC EXCELLENCE PROJECTS



## NEUROCRETE – Neuromorphic cementitious materials for civil engineering applications

The aim of the NEUROCRETE project is to introduce neuromorphic design principles for the development of intelligent cementitious materials for civil engineering applications. It is about developing materials and structures that reproduce the functioning of biological systems: networks of materials and structures that imitate neurons and the brain.

The project explores the use of cement composites incorporating carbonaceous materials such as memristors to mimic neural systems. Likewise, it incorporates the use of additive manufacturing technologies to obtain multilayer materials. Therefore, it enables the tailor-made design of smart materials that will reveal new properties and behaviors. And finally, it explores the use of new deep learning algorithms with smart cement materials.

UPC research groups involved: [ATEM](#), [EC](#)

# UPC EXCELLENCE PROJECTS



## **BINAFET**- Integrated agriculture in buildings for an effective ecological transition: Modeling and implementation

BINAFET builds a strategy for the integration of flows between buildings and Urban Agriculture (UA) as a key and necessary step for an ecological transition in cities.

The BINAFET project proposes a symbiotic interaction between buildings and urban agriculture, to improve their circularity by generating flows of residual heat, yellow water and CO<sub>2</sub> to reduce energy consumption, nutrient production, urban water pollution and increase local food production.

UPC research group involved: [GRIC](#)

# 05

## EDUCATION



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# EDUCATION – BACHELOR'S DEGREES



## Architecture, urbanism and Building construction

- [Bachelor's degree in Architectural Technology and Building Construction](#)
- [Bachelor's degree in Landscape Architecture](#)
- [Degree in Architecture Studies \(ETSAV\)](#)
- [Degree in Architecture Studies \(ETSAB\)](#)



## Civil Engineering

- [Bachelor's degree in Civil Engineering](#)
- [Bachelor's degree in Environmental Engineering](#)
- [Bachelor's degree in Geoinformation and Geomatics Engineering](#)



## Industrial Engineering

- [Bachelor's degree in Energy Engineering](#)
- [Bachelor's degree in Materials Engineering](#)





# EDUCATION – MASTER’S DEGREES



## Architecture, Urbanism and Building Construction

- [Master's degree in Architecture \(ETSAB\)](#)
- [Master's degree in Architecture \(ETSAV\)](#)
- [Master's degree in Advanced Building Construction](#)
- [Master's degree in Diagnosis and Intervention Techniques in Building Construction](#)
- [Master's degree in Advanced Studies in Architecture-Barcelona \(MBArch\)](#)
- [Master's degree in Advanced Studies in Design-Barcelona \(MBDesign\)](#)
- [Master's degree in Building Construction Management](#)
- [Master's degree in Sustainable Intervention in the Built Environment \(MISMec\)](#)
- [Master's degree in Landscape Architecture \(MBLandArch\)](#)



# EDUCATION – MASTER’S DEGREES



## Civil Engineering

- [Master's degree in Structural and Construction Engineering](#)
- [Erasmus Mundus master's degree in Coastal and Marine Engineering and Management \(CoMEM\)](#)
- [Master's degree in Structural Analysis of Monuments and Historical Constructions \(SAHC\)](#)



## Industrial Engineering

- [Master's degree in Energy Engineering \(linked to the InnoEnergy programme\)](#)
- [Master's degree in Advanced Studies in Design-Barcelona \(MBDesign\)](#)



## Environment, Sustainability and Natural Resources

- [Master's degree in Environmental Engineering](#)
- [Master's degree in Sustainability Science and Technology](#)
- [Master's degree in Sustainable Intervention in the Built Environment \(MISMeC\)](#)

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# DOCTORAL PROGRAMMES



[Architecture, Energy and Environment](#)



[Urban and Architectural Management and Valuation](#)



[Architectural, Building Construction and Urbanism Technology](#)



[Architectural Design](#)



[Theory and History of Architecture](#)



[Architectural, Civil and Urban Heritage and Refurbishment of Existing Buildings](#)



# CONTINUING EDUCATION AT UPC SCHOOL - MASTERS

- [Master's degree in Restoration of Architectural Monuments](#)
- [Master's degree in Architectural Structures Engineering](#)
- [Master's Degree in Design and Production of Spaces](#)
- [Master's Degree in Geographical Information Systems](#)
- [Master's degree Parametric Design in Architecture \(MPDA\)](#)
- [Master's degree in Urban Planning and Sustainability](#)
- [Master's degree in Architecture and the Environment: Urban Space, Light and Integration of Energy in Architecture](#)
- [Master's degree in Lighting Design](#)
- [Master's degree in Urban and Territorial Development: Management and Transformation of Cities](#)



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- [SUSTAINABLE URBAN SPACE](#)
- [EPHEMERAL SPACES AND RADICAL MUSEOLOGY](#)
- [INTERIOR DESIGN](#)
- [STEEL AND CONCRETE STRUCTURES AND SOIL MECHANICS](#)
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- [RESTORATION AND REHABILITATION OF THE ARCHITECTURAL HERITAGE](#)
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- [BIM IN MODELLING, CALCULATION AND SIMULATION](#) (ONLINE & FACE-TO-FACE)
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- [ARCHITECTURAL DESIGN FOR HOSPITAL PROJECTS](#)
- [ENVIRONMENTAL APPLICATIONS OF GIS](#)
- [TERRITORIAL APPLICATIONS OF GIS](#)
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- [CONCRETE STRUCTURES](#)
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