
CONSTRUCTION SYSTEMS AND APPLICATIONS 4

**Grado en Estudios de Arquitectura / Bachelor in Architectural
Studies BAS SEP-2025 CS4-AS.4.M.A**

Area Architecture and Design

Number of sessions: 40

Academic year: 25-26

Degree course: FOURTH

Number of credits: 6.0

Semester: 1º

Category: COMPULSORY

Language: English

Professor: **ALEJANDRA ALBUERNE RODRÍGUEZ**

E-mail: aalbuerne@faculty.ie.edu

Dr Alejandra Albuerne is an architectural engineer with a background in construction history, urban resilience, international development and participatory design processes. She specialises in traditional and low-cost construction methods and their structural safety.

Dr Albuerne obtained her Master of Engineering degree from the University of Cambridge and her PhD from the University of Oxford. Her professional practice includes over a decade of experience in architectural and engineering firms, such as Ecosistema Urbano and Arup.

Office Hours

Office hours will be on request. Please contact at:

aalbuerne@faculty.ie.edu

Regular office hours will be held on the day of teaching, before or after class depending on the final schedule

SUBJECT DESCRIPTION

Construction Systems and Applications 4 will focus on understanding sustainability in construction and the development of a comprehensive and integrated approach to technical design in architectural projects, with a focus on façade systems.

The module will review the principles of sustainability and how they relate to the built environment, and will establish links with the materiality and performance of architectural design. The building performance and life cycle will be considered as essential design drivers. A critical approach to sustainability will be fostered through class discussions and individual research. Detailing for construction performance will be explored and practiced, designing in accordance to CTE requirements. Façade systems will be explored from these perspectives.

The course aims to:

- Develop critical thinking: what is sustainability and how does it apply to building design? What are the appropriate benchmarks and ratings to implement in a project?
- Understand construction performance and how to integrate it in architectural design, with a focus on passive strategies.
- Skill-up on the design of effective construction façade systems to deliver the desired performance and with reference to CTE requirements.
- Deepen your understanding of the practice of construction through hands-on experimentation.

The course will work at three interconnected levels: theoretical concepts, design skills and practical skills. Alongside lectures and class discussions, a construction laboratory practical and a series of design exercises will be integrated into the teaching and learning process.

The course contents correspond to three core topics:

Block 1: Understanding and evaluating sustainability, including building performance

We will cover essential concepts connected to sustainability and how they can be implemented in the built environment. We will discuss current policy, global data and current practices to highlight the paths for necessary changes and innovation in construction. Concepts of *embodied* and *operational carbon* and *circularity* will be explored. We will compare and critique industry-driven sustainability rating systems, including BREEAM, LEED and GBCe VERDE. We will understand how buildings perform, age and decay.

Block 2: Passive and bioclimatic strategies

We will present different passive and bioclimatic strategies applicable to different climatic and environmental context. First principles will be explained and case studies will be examined, moving on to exploring how to design and detail these strategies. Design and detailing will aim to optimize performance of the built systems, considering moisture behaviour, thermal performance, durability and maintenance, with reference to the CTE.

Block 3: Façade systems and detailing

We will deepen our understanding of façade systems, their materiality, environmental behaviour and appropriate detailing. This will refer to the CTE where relevant.

Construction Laboratory Project

We will design, build and monitor diverse building envelopes. In order to get a closer understanding and exposure to the construction practice, we will construct large-scale prototypes of building envelopes using different brick-based solutions. These solutions will be designed according to the CTE and will be built in our labs with the support of technicians and professional masons. The samples will then be monitored throughout the term to evaluate their environmental performance.

Design exercises

Contents seen in class will be further explored through design exercises and assignments. Alongside regular class exercises, throughout the term you will apply the main learnings from the course to your Design Studio project, leading to graded assignments.

LEARNING OBJECTIVES



??(per Ministerial Decree EDU/2075/2010, 29 of July; and the official accreditation request for the Bachelor in Architectural Studies, July 2015; see BOCYL, 14 March p. 10477-10481.)

2.1-BASIC AND GENERAL OBJECTIVES

?CB1: Students have demonstrated knowledge and an understanding of a given area of study, building upon the foundation of secondary education, supported by advanced texts, and including aspects that engage the latest advances in their area of study.

?CB2: Students know how to apply their knowledge professionally to their work or vocation and possess the competencies that are often demonstrated through elaboration and defense of arguments and the resolution of problems within their area of study.

?CB3: Students can gather and interpret relevant facts (usually within their area of study) in order to make judgments that include reflection on relevant social, scientific, and ethical topics.

?CB4: Students can transmit information, ideas, problems, and solutions to both specialized and non-specialized audiences.

?CB5: Students have developed the necessary learning skills to continue their studies with a high degree of autonomy.

?CG4: An understanding of the fundamental issues in structural design, construction, and engineering as related to building projects, as well as the techniques used to address these issues.

?CG5: Knowledge of the issues related to building physics, technologies, and programmatic uses, in order to create buildings that provide internal comfort and protection from the elements.

?CG6: Knowledge of the industries, organizations, regulations, and procedures needed in order to transform projects into buildings, and to integrate drawings into the planning process.

2.2-SPECIFIC COMPETENCIES

?Module: Technical Subject: Construction

?CE18: Capacity to develop, calculate, design, and execute interior partitions, carpentry, stairs and other finished work, and to integrate them into buildings and urban complexes (Workshop Format).

?CE19: Capacity to develop, calculate, design, and execute enclosure systems, roofs/coverings, and other structural work, and to integrate them into buildings and urban complexes (Workshop Format).

?CE26: Adequate knowledge of the physical and chemical characteristics of the production process, building pathology, and use of building materials.

2.3-TRANSVERSE COMPETENCIES OF THE UNIVERSITY

?CT2: Ability to exercise professional behavior in accordance with constitutional principles and ethical values of the respective profession.

?CT4: Use disciplinary knowledge to analyze and evaluate current situations.

?CT5: Integrate oneself into interdisciplinary and multicultural teams to achieve common goals in a context of diversity.

CE13: Ability to apply technical and constructive codes and regulations.

CE15: Ability to preserve finished work.

CE25: Adequate knowledge of conventional construction systems and their pathology.

CE26: Adequate knowledge of the physical and chemical characteristics of the production process, the pathology, and use of building materials.

CE27: Adequate knowledge of industrial construction systems.

CE32: Knowledge of project safety and hygiene on site.

****New:** Per Ministerial Order EDU 2075/2010, of July 29, 2010; and the Resolution of October 14, 2016, of the General Secretariat for Universities (See BOE, 24 October 2016: p. 74365)

TEACHING METHODOLOGY

IE University teaching method is defined by its collaborative, active, and applied nature. Students actively participate in the whole process to build their knowledge and sharpen their skills. Professor's main role is to lead and guide students to achieve the learning objectives of the course. This is done by engaging in a diverse range of teaching techniques and different types of learning activities, including lectures, active discussion, laboratory-based practicals and demonstrations, case studies and design exercises. These are structured in the following way:

Learning Activity	Weighting	Estimated time a student should dedicate to prepare for and participate in
Lectures	16.0 %	24.0 hours
Discussions	3.3 %	5.0 hours
Exercises in class, Asynchronous sessions, Field Work	16.0 %	24.0 hours
Group work	10.7 %	16.0 hours
Individual studying	54.0 %	81.0 hours
TOTAL	100.0 %	150.0 hours

AI POLICY

Specific use cases of GenAI

Generative artificial intelligence (GenAI) tools may be used in this course for research, proofreading and grammar check with appropriate acknowledgement in selected coursework and class exercises, as specified in the coursework brief or exercise description. GenAI may not be used for producing graded assignments and group submissions. If a student is found to have used AI-generated content inappropriately, it will be considered academic misconduct, and the student might fail the respective assignment or the course.

If you are in doubt as to whether you are using GenAI tools appropriately in this course, I encourage you to discuss your situation with me.

Below, a suggested format to acknowledge the use of generative AI tools. Please note that acknowledging AI will not impact your grade.

I acknowledge the use of *[AI systems link]* to *[specify how you used generative AI]*. The prompts used include *[list of prompts]*. The output of these prompts was used to *[explain how you used the outputs in your work]*

If AI was permitted to use in your assignment, but you have chosen not to include any AI generated content, the following disclosure is recommended:

No content generated by AI technologies has been used in this assignment.

PROGRAM

SESSIONS 1 - 2 (LIVE IN-PERSON)

Sustainability Topics:

- Environment
- Governance
- Social Challenge
- Economic Development

Introduction, Course Overview and Learning Objectives

In this session we will present an overview of the module contents and structure, teaching methods and modes of assessment. The core learning objectives will be discussed. An outline of the course assignments will be shared.

Construction for Sustainability

This interactive lecture will aim to question and reflect on the concept of sustainability and how architectural construction can embrace it.

A group discussion on the meaning of sustainability will be followed by a presentation of key sustainability principles and objectives, critically reflecting on integrated approaches to sustainable building design. We will address fundamental concepts such as resource scarcity, ecosystems or equity, and will reflect on the impact of humans and the built environment in nature. In view of this, what is the role of the architect in the pursue of sustainability? These notions underpin the work to be developed during the term, in particular in understanding and applying building regulations (including CTE) and tools (e.g. sustainability rating systems), and in setting design goals and objectives.

We will introduce some tools that will be used during the term for evaluating the sustainable performance of buildings in their context, including environmental diagrams and sustainability rating systems.

Technical note: Making our buidlings fit for a greener future (2021, European Commission)

Article: Sustainable Development Goals (United Nations)

Book Chapters: McDonough, William, "A question of design", Cradle to cradle: remaking the way we make things (See Bibliography)

SESSIONS 3 - 4 (LIVE IN-PERSON)

Sustainability Topics:

- Environment
- Governance
- Social Challenge
- Economic Development

Circularity and Building Life Cycle

We will reflect on the design principles that are responsive and fair to the environment and to society, and the interaction between form, function, context and sustainability. Circularity and life-cycle analysis of architecture will be considered as useful frameworks for envisioning and delivering environmentally and socially responsible construction. How are these tools being used in the industry and how can they be applied in the core decision-making stage of a design process?

Performance of Vernacular Systems

Vernacular systems are examples of context-adapted designs that respond to the environmental demands using locally available materials and technologies. In this interactive session, students will evaluate the designs of vernacular buildings from across the globe, functioning in different climates and contexts, to understand how available resources (human, material and technological) have been used to generate construction systems that aim at providing comfortable and functioning environments concomitant with those resources.

Book Chapters: Leach, Melissa et al., Dynamic Sustainabilities: Technology, Environment, Social Justice (See Bibliography)

Book Chapters: Heywood, Huw; 101 Rules of Thumb for Low Energy Architecture. RIBA Publishing, 2019 (See Bibliography)

Book Chapters: Thomas, Randall. Environmental Design: an introduction for architects and engineers (See Bibliography)

Book Chapters: Van Lengen, Johan. The Barefoot Architect: A Handbook for Green Building (See Bibliography)

Book Chapters: Atlas of vernacular architecture of the world (See Bibliography)

SESSIONS 5 - 6 (LIVE IN-PERSON)

Sustainability Topics:

- Environment
- Governance
- Social Challenge
- Economic Development

Green and bioclimatic architecture. Passive strategies

This session will review the principles of green and bioclimatic architecture, which will set the basis for presenting and analysing passive strategies for environmental control in buildings.

We will explain passive strategies rooted on orientation; solar, wind and rain exposure; material choices; integration in the landscape; building form; or shape and position of openings. Analysis will be rooted on building physics and will be explained making reference to the CTE requirements. A practical will follow to analyse the application of these strategies in built case studies.

SESSIONS 7 - 8 (LIVE IN-PERSON)

Sustainability Topics:

- Environment

Façade Systems 1

A core topic to explore this term is façade systems, which will be studied from environmental functioning and materiality perspectives, paying close attention to detailing, performance and sustainability. This session will present an overview of the vast diversity of façades that can be found in buildings, as well as the applicable sections of the CTE code. We will also introduce the construction laboratory on brick façades that will be developed during the term.

SESSIONS 9 - 11 (LIVE IN-PERSON)

Sustainability Topics:

- Environment

CONSTRUCTION LABORATORY: Session 1

The students will work in groups to build a large-size model of a brick building envelope, with the guidance and supervision of the professor and invited masons.

The first session will include: setting out, dealing with surface water run-off, material preparation, mortar mixing and essential brick laying.

SESSIONS 12 - 13 (LIVE IN-PERSON)

Sustainability Topics:

- Environment

Façade systems 2

We will continue to investigate façade systems, reviewing materiality and environmental properties. We will end the session by working on case studies and detailing exercises.

SESSIONS 14 - 16 (LIVE IN-PERSON)

Sustainability Topics:

- Environment
- Governance
- Social Challenge
- Economic Development

CONSTRUCTION LABORATORY: session 2

The students will work in groups to build a large-size model of a brick building envelope, with the guidance and supervision of the professor and invited masons.

The class will be split in two shifts: while half of the class is building the prototype, the other half will be doing façade detailing exercises.

Book Chapters: Vellinga, Marcel; Oliver, Paul; Bridge, Alexander. Atlas of Vernacular Architecture of the World (See Bibliography)

Book Chapters: Vellinga, Marcel; Oliver, Paul; Bridge, Alexander. Atlas of Vernacular Architecture of the World (See Bibliography)

Working Paper: European Cultural Heritage Green Paper (issuu.com)

Working Paper: European Cultural Heritage Green Paper (issuu.com)

SESSIONS 17 - 18 (LIVE IN-PERSON)

Designing and detailing for thermal comfort

Building on the knowledge from Environmental Design courses, we will dedicate this session to exploring how to design for thermal comfort. We will consider building form and exposure, envelope, insulation, ventilation, passive heating and cooling strategies. Learning through case studies and design exercises. Design will be done according to the CTE as applicable.

SESSIONS 19 - 21 (LIVE ONLINE)

Sustainability Topics:

- Environment
- Social Challenge
- Economic Development

CONSTRUCTION LABORATORY: Session 3

The students will work in groups to build a large-size model of a brick building envelope, with the guidance and supervision of the professor and invited masons.

The class will be split in two shifts: while half of the class is building the prototype, the other half will be doing façade detailing exercises.

SESSIONS 22 - 23 (LIVE IN-PERSON)

Sustainability Topics:

- Environment
- Governance
- Social Challenge
- Economic Development

Designing and detailing for water in buildings and urban contexts

The management of water in the built environment is increasingly important, as we face alterations of the rainfall patterns globally brought by climate change. There is a need to respond to three challenges:

1. Keep built fabric safe from water, as water speeds up decay of most construction materials
2. Minimise the use of water in buildings, through processes of optimisation and recycling
3. Manage heavier rainfalls and flash floods that are becoming regular occurrences, not only at building level, but also within the urban environments.

This session will look at how to respond to these three requirements, applying the CTE as applicable, and revising current available technologies, from the most simple gutters to the most extensive SUD systems.

the session will include a waterproofing workshop, with invited guests from MAPEI Academy. The workshop will cover a diversity of technologies for waterproofing building envelopes, both from a theoretical and practical perspective. After a lecture on the principles of waterproofing solutions, a hands-on session will follow in which different waterproofing solutions will be applied to roofing samples.

SESSIONS 24 - 25 (LIVE IN-PERSON)

Digital manufacturing and prefabrication

We will explore novel and systematized fabrication processes and their application to architecture and construction.

In recent years, new fabrication processes have gained weight in architecture, with many sitting at the forefront of research and experimentation. This session will present and discuss a diversity of recent technologies that are having an impact on the way we build, ranging from 3D printing and digital cutting tools, to flat-packed construction or modular prefabrication, reflecting on the advantages and potential that they bring to the sector for reducing the environmental impact of architecture.

SESSIONS 26 - 27 (LIVE IN-PERSON)

Sustainability Topics:

- Environment
- Social Challenge
- Economic Development

Construction Pathology

Understanding causes and signs of decay in common building elements is essential for ensuring both good design (design for durability) and upkeep of existing buildings. The session will include an overview of decay mechanisms and common pathologies, followed by a practical exercise on an existing building to identify pathologies.

SESSIONS 28 - 30 (LIVE IN-PERSON)

CONSTRUCTION DESIGN PROJECT: session 1

Individual tutorials to support on the development of the construction design project, associated with Design Studio 7 and the core course assignment that needs to reflect the main learnings from the course regarding construction for sustainability, delivering quality detailing.

SESSIONS 31 - 32 (LIVE IN-PERSON)

Sustainability Topics:

- Environment

Performance and durability in construction

The prototypes from the construction laboratory project will be analysed as a practical case to investigate and assess performance of building envelopes from an environmental lens, addressing some of the main topics covered in the course: material choices, passive strategies, thermal detailing and treatment of water and moisture

Furthermore, the question of durability and maintenance will be raised, reviewing the constructions under the lens of possible pathologies in order to review the likely durability.

SESSIONS 33 - 35 (LIVE IN-PERSON)

CONSTRUCTION DESIGN PROJECT: session 2

Construction detailing as design driver

A practice-based session exploring the integration of construction details in the design process, where design is sometimes driven by the desire of delivering a particular detail with a particular performance.

A presentation from industry guests reviewing relevant projects will be followed by individual tutorials to address detailing requirements of the individual construction design project (course assignment).

SESSIONS 36 - 37 (LIVE IN-PERSON)

Site Visit

An active building site will be visited to gain understanding of construction processes and management.

SESSIONS 38 - 40 (LIVE IN-PERSON)

CONSTRUCTION DESIGN PROJECT: session 3

Individual tutorials on the development of the construction design project (course assignment).

Course wrap-up: summary of main learnings.

EVALUATION CRITERIA

criteria	percentage	Learning Objectives	Comments
Construction Lab Report	35 %		
Individual Design	50 %		
Class and Lab Participation	15 %		

RE-SIT / RE-TAKE POLICY

BIBLIOGRAPHY

Compulsory

- Thomas Herzog, Roland Krippner, Werner Lang.. (2017). *Façade Construciton Manual*. DETAIL. ISBN 9783955533700 (Digital)

Recommended

- Francis D.K. Ching, Ian M. Shapiro. (2020). *Green Building Illustrated*. Wiley. ISBN 1119653967 (Digital)

- William McDonough and Michael Braungart. (2002). *Cradle to cradle : remaking the way we make things*. North Point Press. ISBN 9780865475878 (Digital)

- Dana K Gulling. (2918). *Manufacturing architecture : an architect's guide to custom processes, materials, and applications*. Laurence King Publishing Ltd. ISBN 9781786271334 (Printed)

- Mark Burry and Jane Burry. (2017). *Prototyping for architects*. Thames & Hudson. ISBN 9780500292495 (Printed)

- Fabio Bianconi and Marco Filippucci. (2019). *Digital Wood Design: Innovative Techniques of Representation in Architectural Design*. Springer. ISBN 9783030036768 (Digital)

- Bob Sheil. (2013). *Manufacturing the bespoke : making and prototyping architecture*. Hoboken, N.J. : Wiley. ISBN 9781119969129 (Printed)

- Victor Olgyay and Aladar Olgyay. (1963). *Design with climate: bioclimatic approach to architectural regionalism Some chapters based on cooper*. Princeton University Press. ISBN B0006AX05Q (Digital)

- Reyner Banham. (1969). *The architecture of the well-tempered environment*. The University of Chicago Press. ISBN 9780226036984 (Digital)

- Melissa Leach, Andrew Charles Charles Stirling and Ian Scoones. (2012). *Dynamic Sustainabilities: "Technology, Environment, Social Justice"*. Earthscan. ISBN 9781849775069 (Digital)

- Huw Heywood. (2021). *101 rules of thumb for low energy architecture*. RIBA Publishing. ISBN 9781859469910 (Digital)

- Johan van Lengen. (2018). *The barefoot architect : a handbook for green building*. Shelter Publications. ISBN 9780936070421 (Digital)

- P Stollard (Paul) and Brian J Meacham. (2014). *Fire from first principles : a*

design guide to international building fire safety. Routledge, Taylor & Francis Group. ISBN 9780415832618 (Digital)

- Randall Thomas. (2006). *Environmental design an introduction for architects and engineers*. Taylor & Francis. ISBN 9786610463251 (Digital)

- Salma´ Samar Damlu`ji` et al. (2018). *Hassan Fathy : earth & utopia*. Laurence King. ISBN 9781786272614 (Digital)

- Marcel Vellinga, Paul Oliver and Alexander Bridge. (2007). *Atlas of vernacular architecture of the world*. New York Routledge. ISBN 9780415411516 (Printed)

- Knaack, Ulrich, Marcel Bilow, Thomas Auer, and Tillmann Klei. (2014). *Façades: Principles of Construction*. Birkhäuser. ISBN 9783038211457 (Digital)

BEHAVIOR RULES

Please, check the University's Code of Conduct [here](#). The Program Director may provide further indications.

ATTENDANCE POLICY

Please, check the University's Attendance Policy [here](#). The Program Director may provide further indications.

ETHICAL POLICY

Please, check the University's Ethics Code [here](#). The Program Director may provide further indications.