

## CONSTRUCTION SYSTEMS AND APPLICATIONS 4

### Bachelor in Architectural Studies BAS SEP-2023 CS4- AS.4.M.A

Area Architecture and Design

Number of sessions: 30

Academic year: 23-24

Degree course: FOURTH

Number of credits: 6.0

Semester: 1º

Category: COMPULSORY

Language: English

Professor: **ALEJANDRA ALBUERNE RODRÍGUEZ**

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

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The regular office hours will be held on Wednesdays after the class.

### SUBJECT DESCRIPTION

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

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 deeply considered as essential design drivers. A critical approach to sustainability will be fostered through group and individual research. Alongside theoretical and practice frameworks, the course will consider:

- A diversity of ways of building, broadening the core knowledge of construction materials and typologies, with a particular focus on low-energy materials and digital technologies.
- Industry-driven sustainability rating systems, including BREEAM, LEED and GBCe VERDE
- Context-based design will be explored through the study of construction solutions across the globe and in a diversity of socio-economic and environmental contexts.
- Construction detail implementation: consideration of moisture behaviour, thermal performance,

relative movements, durability and maintenance.

The core learning objectives are:

1. 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?
2. Explore diverse ways of building, through traditional and natural materials to modern and digital systems.
3. Skill up on the design of effective details to deliver the desired performance the material and environmental sustainability of construction.

## **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.

## **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 such as the following:

Learning Activity	Weighting	Estimated time a student should dedicate to prepare for and participate in
Lectures	16.0 %	24.0 hours
Discussions	4.67 %	7.0 hours
Exercises in class, Asynchronous sessions, Field Work	8.0 %	12.0 hours
Group work	14.67 %	22.0 hours
Individual studying	56.67 %	85.0 hours
TOTAL	100.0 %	150.0 hours

## 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, reflecting on integrated approaches to sustainable building design. We will address fundamental concepts such as biodiversity, ecosystems or ecosystem services, and will reflect on the impact of humans and our built environment. In view of this, what is the role of the architect in the pursue of sustainability?

*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

## **Context-adapted design and life-cycle analysis**

How does construction adapt to different contexts in pursuit of a sustainable built environment? Explore the concept of context-adapted design and its links to construction. We will inquire what is the environment and what is its value. Understanding the environment as a dynamic system, the session will consider fundamental concepts such as sustainable development and how it deploys in different contexts.

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. Life-cycle analysis of architecture will be considered as a useful framework for environmentally and socially responsible construction. Sustainability rating systems will be introduced and critiqued.

*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)*

## **SESSIONS 5 - 6 (LIVE IN-PERSON)**

### **Sustainability Topics:**

- Environment
- Governance
- Social Challenge
- Economic Development

### **INDIVIDUAL DESIGN PROJECT - Design workshop I: Sustainability Indicators**

You will carry out an INDIVIDUAL DESIGN PROJECT aimed at proposing a sustainable and integrated construction system for a building, in coordination with design studio. To support the development of the INDIVIDUAL DESIGN PROJECT, three workshops are planned throughout the course.

In the first workshop, *Sustainability Indicators*, you will work towards proposing a set of context-driven sustainability indicators that you will have to meet with your construction system design. During the workshop you will:

1. Investigate how to measure sustainability in a construction project. Review and critique BREEAM, LEED and GBCe VERDE (among other) sustainability certifications.
2. Evaluate the project program and context, to gain sufficient understanding to identify technical, social and cultural performance and life-cycle objectives for the project.

## **SESSIONS 7 - 8 (LIVE ONLINE)**

### **Integrating fire design**

Objective: Understanding the principles of building fire safety and their integration in the design of buildings, from concept to detail.

Contents: Fire safety is one of the leading design criteria for any building, with dedicated building codes implemented in most countries. It is therefore essential in the design of a building form to understand the principles behind fire safety in order to integrate them successfully from conceptual design, rather than as an ad-hoc addition at detail design. This session will present a comprehensive overview of fire safety in buildings, including a range of design case studies to exemplify successful practice from leading architectural designers.

*Article: The Building Envelope: Failing to Understand Complexity in Tall Building Design (PDF copy to be provided)*

*Book Chapters: Stollard, Paul; Abrahams, John. Fire from First Principles: A Design Guide to International Building Fire Safety (See Bibliography)*

## **SESSIONS 9 - 10 (LIVE IN-PERSON)**

### **Sustainability Topics:**

- Environment

### **Ways of Building: Green Architecture**

This session will review the theory of green architecture and will discuss the main strategies for obtaining environmentally high-performing architecture.

### **GROUP RESEARCH PROJECT: Workshop 1 - Introduction to group project & construction material life cycle**

Students will work in groups to gain in-depth understanding of a construction material, exploring its application and sustainability credentials and potential. You will be asked to address a series of topics that will require academic and practical research, as well as the study and evaluation of relevant case studies. In this first workshop, students will explore the life cycle of their materials.

## **SESSIONS 11 - 12 (LIVE IN-PERSON)**

### **Ways of Building: Natural materials I**

These sessions will explore the main natural construction materials and their most common uses in the production of buildings throughout the globe. Attention will be placed in material sourcing and lifecycle, performance, technology and potential.

This session will focus on stone and earth.

*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)*

## **SESSIONS 13 - 14 (LIVE ONLINE)**

### **Ways of Building: natural materials II**

These sessions will explore the main natural construction materials and their most common uses in the production of buildings throughout the globe. Attention will be placed in material sourcing and lifecycle, performance, technology and potential.

This session will focus on timber and bamboo.

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

*Book Chapters: Van Der Lugt, Pablo. Booming Bamboo: The (re)discovery of a Sustainable Material with Endless Possibilities (See Bibliography)*

*Article: Earth Architecture online resource (eartharchitecture.org)*

*Book Chapters: Damluji, Salma´ Samar, Hassan. Fathy, and Viola Bertini. Hassan Fathy: Earth &*

*Utopia (See Bibliography)*

*Book Chapters: Refined Earth: Construction & Design of Rammed Earth (issuu.com)*

## **SESSIONS 15 - 16 (LIVE IN-PERSON)**

### **Sustainability Topics:**

- Environment
- Social Challenge

### **GROUP RESEARCH PROJECT: Research workshop 2 - Material characteristics and applications**

Students will work in their groups to explore their construction material, investigating its main properties and applications in architecture. This will be done applying a critical sustainability lense: What are the strengths and weaknesses of these materials when it comes to delivering sustainable architecture?

## **SESSIONS 17 - 18 (LIVE IN-PERSON)**

### **Sustainability Topics:**

- Environment
- Social Challenge
- Economic Development

### **Construction performance: adapting to climatic and socio-economic context**

What does it mean for a construction to be high performing? How does that vary between different contexts? These essential questions will be explored through theory (first session) and review of built examples (interactive second session)

*Book Chapters: Olgay Victor et al.; Design with Climate (See Bibliography)*

*Book Chapters: Banham, Reyner; The Architecture of the Well-tempered Environment (See Bibliography)*

## **SESSIONS 19 - 20 (LIVE IN-PERSON)**

### **INDIVIDUAL DESIGN PROJECT: Design Workshop II - Selection of a sustainable construction solution**

This workshop will guide students in the technology decisions with the ultimate pursue of an effective and sustainable construction solution. Students will explore ways of implementing their sustainability targets identified in the first workshop.

## **SESSIONS 21 - 22 (LIVE IN-PERSON)**

### **GROUP RESEARCH PROJECTS: Presentations**

Presentation and review of group projects exploring the sustainability of diverse construction materials.

Groups will present their research to a panel of academics and professionals.

## **SESSIONS 23 - 24 (LIVE IN-PERSON)**

### **Ways of Building: Advances in fabrication and construction processes**

We will explore novel 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.

*Book Chapters: Burry, Mark; Burry, Jane; Prototyping for Architects (See Bibliography)*

*Book Chapters: Bianconi, Fabio; Filippucci, Marco; Digital Wood Design: Innovative Techniques of Representation in Architectural Design (See Bibliography)*

*Book Chapters: Sheil, Bob; Manufacturing the Bespoke: Making and Prototyping Architecture (See Bibliography)*

## **SESSIONS 25 - 26 (LIVE IN-PERSON)**

### **Developing construction details**

Effective construction details are an essential element of a well-performing building. This session will cover core concepts and designs for moisture-related and thermal-related details. What does effective waterproofing look like? How to avoid thermal bridges? these are some of the questions that will be addressed in this session through theory and hands-on exercises.

## **SESSIONS 27 - 28 (LIVE IN-PERSON)**

### **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.

### **INDIVIDUAL DESIGN PROJECT: Design workshop III: Detailing for performance and durability**

Through guided individual research and design, students will explore construction detailing that is high-performing and durable for the required context and climatic conditions.

*Book Chapters: Manufacturing Architecture. An Architect's Guide to Custom Processes, Materials and Applications. Laurence King Publishing, 2018 (See Bibliography)*

## **SESSIONS 29 - 30 (LIVE IN-PERSON)**

### **Site Visit**

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

## **EVALUATION CRITERIA**

The final grade for this module will be comprised of separate grades for the group project developed throughout the module (a total of 30%) and a piece of individual design work (70%).

Group projects will involve a piece of research, evaluation and critique. Each group will generate written and graphic documentation (20% of the overall grade) and will present their outputs orally to the class (10% of the overall grade).

An individual assignment involving the design of a sustainable construction system, coordinated with Design Studio, will comprise 70% of the course overall grade.

<b>criteria</b>	<b>percentage</b>	<b>Learning Objectives</b>	<b>Comments</b>
Group Presentation	10 %		Synthesis and communication



Individual Work	70 %		Integrating sustainability in architecture. Exploring diverse construction systems. Striving for performance.
Workgroups	20 %		Principles of sustainability, life cycle analysis, research capacity

### RE-SIT / RE-TAKE POLICY

Students must pass the individual work component in order to pass the course. Students who do not reach 50% on the individual work component will need to re-take the assignment.

### BIBLIOGRAPHY

#### Recommended

- Francis D.K. Ching, Ian M. Shapiro. (2020). *Green Building Illustrated*. Wiley. ISBN 1119653967 (Digital)
- Pablo Van Der Lugt. (2017). *Booming Bamboo. The (re)discovery of a sustainable material with endless possibilities*. Materia. ISBN 9082755203 (Digital)
- Otto Kapfinger, Marko Sauer. (2022). *Martin Rauch Refined Earth: Construction & Design of Rammed Earth*. DETAIL. ISBN 9783955535742 (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. (2018). *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 Olgay and Aladar Olgay. (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`jī 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)

### **ADDITIONAL MATERIALS**

London Energy Transformation Initiative. (2020). LETI Climate Emergency Design Guide: <https://www.leti.uk/cedg>  
 Green Building Council España. (2022). VERDE Edificios. Guía de Evaluación: <https://gbce.es/recursos/verde-edificios-2022-guia-de-evaluacion/>

### **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.