

# CONSTRUCTION SYSTEMS AND APPLICATIONS 1

## Bachelor in Architectural Studies BAS SEP-2023 CS1- AS.2.S.A

Area Architecture and Design

Number of sessions: 30

Academic year: 23-24

Degree course: SECOND

Number of credits: 6.0

Semester: 1<sup>o</sup>

Category: COMPULSORY

Language: English

Professor: **MATAN MAYER**

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Matan Mayer is an architect and a construction technologist. His research work focuses on life cycle innovation in the built environment, seeking to combine developments in manufacturing technology, material science, assembly techniques, and digital design platforms for the purpose of achieving leaner construction and deconstruction processes. He has taught research seminars at Harvard University and at Universidad Torcuato Di Tella. Prior to his current position at IE School of Architecture and Design, Matan completed a postdoctoral fellowship at the Harvard Center for Green Buildings and Cities, a doctorate at the GSD Design Robotics Group, a residency at the Harvard Innovation Lab Venture Incubation Program, as well as research fellowships at the Institute for Lightweight Structures and Conceptual Design at the University of Stuttgart, the Composite Construction Laboratory at the Swiss Federal Institute of Technology, and the Emerging Material Technologies Group at the University of Arizona. He holds a masters and a doctoral degree in building technology from Harvard University, and a B.Arch degree from Tel Aviv University.

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## SUBJECT DESCRIPTION

This course introduces students to construction systems with the intention of expanding design concepts beyond *form and function* to *matter and method*. A scalar overview presents principles and properties on multiple resolution levels, from materials and elements to structures and systems. Topics are explored through both lectures and by applying methods of dissection, drawing and fabrication of selected case studies. In the second half of the course, construction systems are further studied through external spheres of influence including energy transfer, environmental impact, labor, fabrication tools, policy and technical building codes.

## LEARNING OBJECTIVES

### ?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.

(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.

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- 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

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- 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	26.67 %	40.0 hours

Discussions	13.33 %	20.0 hours
Exercises in class, Asynchronous sessions, Field Work	6.67 %	10.0 hours
Group work	33.33 %	50.0 hours
Individual studying	20.0 %	30.0 hours
TOTAL	100.0 %	150.0 hours

## PROGRAM

### MODULE I: INTERNAL PARAMETERS

Objective: Understand and implement design constraints that are internal to the selected construction system.

#### SESSIONS 1 - 2 (LIVE IN-PERSON)

##### Introduction, Course Overview, Definitions and Methods

**Type:** Lecture.

**Objective:** Introduction.

**Contents:** An overview of the subject content and the basic concepts, definitions and methods of analysis and instruction.

**Credits:** 1.5 hours of meeting, 2.25 hours of work.

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##### Form and Force: Classification of Construction Systems

**Type:** Lecture.

**Objective:** Understanding construction system classification principles.

**Contents:** Construction systems are introduced through a series of classification frameworks: multi-layered, multi-material assemblies; monolithic, single material assemblies; frames with fill; and structural types. Case studies are presented and analysed.

**Credits:** 1.5 hours of meeting, 2.25 hours of work.

*Book Chapters: In The Details of Modern Architecture (Volume 2, 1928–1988. Cambridge: MIT Press, 1996. p 198–195) (See Bibliography)*

*Book Chapters: Constructing Architecture: Materials, Processes, Structures (“Solid and filigree construction”, p 13-15 and “On the metaphysics of exposed concrete”, p 56-59) (See Bibliography)*

#### SESSIONS 3 - 4 (LIVE IN-PERSON)

##### Building Materials: Units, Increments and Modularity

**Type:** Lecture.

**Objective:** Understanding dimensional units of building materials as design inputs.

**Contents:** Building materials such as wood or steel beams, clay bricks and CMUs adhere to a predefined set of universal units. These units provide a dimensional and parametric basis for construction systems. This session will focus on their significance in the context of a case study.

**Credits:** 3 hours of meeting, 5.5 hours of work.

*Book Chapters: Material design: informing architecture by materiality (Aggregation, 2011. p 48-61)*  
(See Bibliography)

*Book Chapters: Constructing Architecture: Materials, Processes, Structures (Masonry, p 31–45; Concrete, p 60–66; Wood, p 82–93; and Steel, p 120–31)*

## **MODULE II: EXTERNAL PARAMETERS**

Objective: Understand and learn how to utilize external constraints as design inputs for construction systems.

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

#### **Concrete Systems**

**Type:** Lecture.

**Objective:** Understanding design principles of concrete beam and envelope construction.

**Contents:** The design and production of concrete construction systems is introduced in the context of material properties, structural performance and technique.

**Credits:** 3 hours of meeting, 5.5 hours of work.

*Book Chapters: Liquid Stone: New Architecture in Concrete (Architecture and Technology. Princeton Architectural Press, 2006. p 8-19) (See Bibliography)*

*Book Chapters: Constructing Architecture: Materials, Processes, Structures (Concrete, p 56–76)*  
(See Bibliography)

### **SESSIONS 7 - 8 (LIVE IN-PERSON)**

#### **Wood Systems**

**Type:** Lecture.

**Objective:** Understanding design principles of wood beam and frame construction systems.

**Contents:** Design of wood systems is introduced and studied. The construction sequence of frame and wall systems is demonstrated and discussed.

**Credits:** 1.5 hours of meeting, 2.25 hours of work.

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#### **Masonry Systems**

**Type:** Lecture.

**Objective:** Understanding design principles of masonry construction systems.

**Contents:** This session surveys and compares various types of common masonry wall systems, including solid, cavity, reinforced, veneer and rainscreen variations.

**Credits:** 1.5 hours of meeting, 2.25 hours of work.

*Book Chapters: The Architectural Detail (Chapter 2: There are no details. New York: Princeton Architectural Press, 2011) (See Bibliography)*

*Book Chapters: Constructing Architecture: Materials, Processes, Structures (Timber, p 77–106)*  
(See Bibliography)

*Article: Building Brunelleschi's Dome: A Practical Methodology Verified by Experiment (Journal of the Society of Architectural Historians 69, no. 1 (2010): 39–61) (CED)*

*Book Chapters: Constructing Architecture: Materials, Processes, Structures (Masonry, p 22–49)*  
(See Bibliography)

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

### **Steel Systems**

**Type:** Lecture.

**Objective:** Understanding design principles of steel construction systems.

**Contents:** This session investigates and explores structural concepts and vocabulary applicable to steel systems, including frame and stressed-skin prefabricated systems. Design approaches to steel systems will be analysed and compared based on the works of Gustave Eiffel, Frederic Auguste Barthodi, Charles and Ray Eames and Frank Gehry.

**Credits:** 3 hours of meeting, 5.5 hours of work.

*Article: Inventing the I-Beam: Richard Turner, Cooper and Hewitt and others (Bulletin of the Association for Preservation Technology, 12 no. 4: 3-28) (CED)*

*Book Chapters: Constructing Architecture: Materials, Processes, Structures (Steel, p 113-138) (See Bibliography)*

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

### **Glass and Polymer Systems**

**Type:** Lecture.

**Objective:** Understanding design principles of glass and polymer construction systems.

**Contents:** Examining the various guiding principles of enclosure design using glass and polymer-based systems, this session will feature an industry guest speaker (details to follow).

**Credits:** 3 hours of meeting, 2.5 hours of work.

*Book Chapters: Tower and office: from modernist theory to contemporary practice (Evolution of Glass Curtain Wall Construction. Mit Press, 2003. pp 99-136) (See Bibliography)*

*Book Chapters: Constructing Architecture: Materials, Processes, Structures (Glass and plastic, p 151-169) (See Bibliography)*

## **SESSIONS 13 - 14 (LIVE IN-PERSON)**

### **Material Load Capacity: Experimentation and Analysis**

**Type:** Lab.

**Objective:** Observing and analyzing construction materials under tension and compression loads.

**Contents:** A visit to the material testing facilities of the Eduardo Torroja Institute for Construction Sciences (IETCC).

**Credits:** 3 hours of meeting, 5.5 hours of work.

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

### **Climate and Construction Systems: Building Envelopes**

**Type:** Lecture.

**Objective:** Understanding design principles of building envelope systems.

**Contents:** This session kicks off the second part of the course, where we will discuss external considerations influencing construction systems. The part begins with an overview of design constraints in the context of climatic considerations, including energy transfer, glare, and vapour regulation.

**Credits:** 3 hours of meeting, 5.5 hours of work.

*Article: Moisture Control in the Modern Building Envelope: History of the Vapor Barrier in the U.S.,*

1923–52 (*APT Bulletin 28, no. 4 (1997): 13–19*) (CED)

*Book Chapters: Constructing Architecture: Materials, Processes, Structures (Insulation, p 139-146)*  
(See Bibliography)

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

### **Geology, Hydrology and Construction Systems: Foundations**

**Type:** Lecture.

**Objective:** Understanding design principles of foundation systems.

**Contents:** This session will focus on design considerations pertaining to water management and soil conditions in both the building and foundation levels. Subject covered will include roof forms, drainage planes, building foundation system types and their interface with site soils and rocks.

**Credits:** 1.5 hours of meeting, 2.25 hours of work.

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### **Time, Logistics, Maintenance and Construction Systems**

**Type:** Lecture.

**Objective:** Understanding design implications of logistics and maintenance considerations.

**Contents:** This session will discuss two parallel viewpoints of the role of time in construction system design. The first relates to time and logistics as constraints that guide the construction process while the other looks at time from an ecological point of view, defining construction and maintenance as lifecycle components.

**Credits:** 1.5 hours of meeting, 2.25 hours of work.

*Article: Built Mostly of Itself: The Chicago Brick Industry and the Masonry Skyscraper in the Late 19th Century (Construction History 25, 2010: 69–84)* (CED)

*Book Chapters: Constructing Architecture: Materials, Processes, Structures (Building Underground, p 169-176)* (See Bibliography)

*Article: Maintenance Architecture (Praxis 6, 2004)* (CED)

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

### **Construction site visit**

**Type:** Field trip

**Objective:** Observing and analyzing applied construction systems.

**Contents:** Exact location to be announced.

**Credits:** 3 hours of meeting, 5.5 hours of work.

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

### **Environment and Construction I: Industrial Ecology**

**Type:** Lecture.

**Objective:** Understanding design implications of industrial ecology principles.

**Contents:** In this session, we will discuss the theory of practice of industrial ecology as it pertains to construction systems. Subject covered include material flow analysis, life cycle assessment, metabolism and symbiosis in the built environment, and material sourcing and processing considerations.

**Credits:** 3 hours of meeting, 5.5 hours of work.

*Book Chapters: How Buildings Learn: What Happens After They're Built (Built for Change. Penguin,*

1995) (See Bibliography)

*Book Chapters: Constructing Architecture: Materials, Processes, Structures (Sustainability, p 335-338) (See Bibliography)*

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

### **Environment and Construction II: Material Recovery**

**Type:** Lecture.

**Objective:** Learning how to use material recovery as a design driver for construction systems.

**Contents:** This session will explore the concept of material recovery in construction through case studies in metal, glass, concrete, steel and plastics. Levels of recovery will be identified and characterized and the impact of their understanding on design of new construction systems will be discussed.

**Credits:** 3 hours of meeting, 5.5 hours of work.

*Book Chapters: Re-Inventing Construction (Architecture isn't here to Stay. Towards a Reversibility of Construction. Berlin: Ruby Press, 2010. S. 34 – 45) (See Bibliography)*

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

### **The Technical Code and Construction Systems**

**Type:** Lecture.

**Objective:** Understanding the role of regulation in construction system design.

**Contents:** Compliance with building codes plays a major role in shaping design decisions and directly impacts construction systems. This session will explore how components of the Código Técnico de la Edificación (CTE) and the International Building Code (IBC) could be used as a constructive design drivers.

**Credits:** 3 hours of meeting, 5.5 hours of work.

*Article: The Politics Of The Envelope (Log, (13/14), pp.193-207. 2008) (CED)*

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

### **Tools, Emergent Technologies and Construction Systems**

**Type:** Lecture

**Objective:** Understanding future trajectories of construction and material technology.

**Contents:** This session concludes the course by offering a future outlook for construction systems. Additive manufacturing and automation is discussed, as well as new developments in material science and computation.

**Credits:** 3 hours of meeting, 5.5 hours of work.

*Article: Fibrous structures: an integrative approach to design computation, simulation and fabrication for lightweight, glass and carbon fibre composite structures in architecture based on biomimetic design principles (Computer-Aided Design 52 (2014): 27-39) (CED)*

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

**Final review**

## **EVALUATION CRITERIA**



Assignments for this course will include weekly exercises. Student cohorts for this purpose will be assigned at the first session and should collaborate on all assignments throughout the course. Coursework will focus on built case studies and will include both analytical and applied exercises corresponding with content taught in class. Additionally, weekly readings will be discussed at the beginning of each session. Student groups will be assigned with presenting each reading and leading a discussion in which all attending students are expected to participate. All assignment deliverables should be uploaded to the appropriate folder on the discussion board 1 hour prior to the beginning of class on the day they are due. Failure to upload an assignment in a timely manner will result in a score of 0 for that assignment. Late submissions via email are not accepted. The course will culminate in several individual and group deliverables including drawings, physical models and prototypes, as well a final review.

criteria	percentage	Learning Objectives	Comments
Participation	10 %		
Weekely Reading Presentation	10 %		
Group Assignments	50 %		
Individual Assignment	30 %		

#### RE-SIT / RE-TAKE POLICY

1. Students have access to a total of four enrollments, in two consecutive academic years.
2. Students must attend at least 70% of all class sessions. Students who do not meet this minimum percentage automatically fail both first and second enrollments, and pass directly to the third enrollment.
3. Grading of students in the extraordinary enrollments will follow the following guidelines:
  - Students that have failed the subject in first enrollment pass to the second enrollment, except those who do not meet the minimum attendance percentage, and that therefore pass directly to the third enrollment.
4. The maximum grade that a student may achieve in second enrollment is an 8.

#### BIBLIOGRAPHY

##### Compulsory

- Andrea Deplazes. (2022). *Constructing Architecture: Materials, Processes, Structures*. 5th edition. Birkhäuser Architecture. ISBN 9783035626650 (Printed)

##### Recommended

- Ford, Edward R.. (1996). *The Details of Modern Architecture*. ISBN 0262061856 (Printed)

- Ching, Francis D.K.. (2014). *Building Construction Illustrated*. ISBN 1118458341 (Printed)

- Allen, Edward and Joseph Iano. (2013). *Fundamentals of Building Construction, Materials and Methods*. ISBN 1118138915 (Printed)

- Larrambebere, Gonzalo. (2004). *Eladio Dieste: Innovation in Structural Art*. ISBN 1568983714 (Printed)

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ISBN 3034600354 (Printed)

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- Peterson, Charles E.. (1980). *Inventing the I-Beam: Richard Turner, Cooper and Hewitt and others*. ISBN 0262511902 (Printed)

- Herreros, Juan, and Joan Ockman. (2003). *Tower and office: from modernist theory to contemporary practice*. ISBN 0262511902 (Printed)

- Hilary Sample. (2004). *Maintenance Architecture*. Praxis 6. ISBN 0140139969 (Printed)

- Ruby, I. and Ruby, A. eds.. (2010). *Reinventing Construction*. Ruby Press. ISBN 3981343625 (Printed)

- Zaera-Polo, A.. (2008). *The Politics of the Envelope*. Log. ISBN 3981343625 (Printed)

- Bechthold, Martin. (2013). *Design Robotics: New Strategies For Material System Research*. ISBN 0140139969 (Printed)

- Brand, Stewart. (1995). *How Buildings Learn: What Happens After They're Built*. ISBN 0140139969 (Printed)

- Jean-Louis Cohen, Gerard Martin Moeller. (2006). *Liquid stone : new architecture in concrete*. Princeton Architectural Press. ISBN 9783764374839 (Printed)

## **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.