

1. COURSE

AR2D2. Design Studio V (Mandatory)

2. GENERAL INFORMATION

2.1 Course	: AR2D2. Design Studio V
2.2 Semester	: 5 th Semester.
2.3 Credits	: 4
2.4 Hours	: 4 HT; 4 HP;
2.5 Duration of the period	: 16 weeks
2.6 Type of course	: Mandatory
2.7 Learning modality	: Face to face
2.8 Prerequisites	: AR2D1. Design Studio IV. (4 th Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Design Studio V: Educational/Cultural Building develops a medium-scale building with a markedly more complex program than Design Studio IV (AR2D1, prerequisite) – a school, library, or small cultural center – in which an explicit long-span structural system and a deliberately performance-driven design process generate, rather than merely accommodate, the architectural proposal. The studio asks students to resolve daylight, acoustic, and mechanical comfort criteria for spaces with specific performance requirements (classrooms, auditoria, galleries), and to detail a high-performance building envelope that supports those criteria. This course is the foundation for Design Studio VI (AR2D3).

5. GOALS

- Design a long-span structural system (trusses, arches, shells, or space frames) appropriate to the spatial requirements of a mid-sized educational or cultural building.
- Integrate environmental and structural performance criteria as generative drivers of the design proposal from the earliest design stages.
- Design apertures and shading for adequate daylight performance in classrooms, galleries, and other program-specific spaces.
- Resolve acoustic performance requirements (reverberation, isolation) appropriate to the program's specific spaces.
- Select and coordinate mechanical (HVAC) systems with the architectural design.
- Detail a high-performance building envelope that supports the building's daylight, thermal, and acoustic performance goals.

6. COMPETENCES

- AG-A08)** Understands the structural and environmental design problems associated with construction and the engineering of building design. (Usage)
- AG-A11)** Demonstrates knowledge of the physical problems and technologies that allow buildings to provide internal comfort and protection within environmental parameters. (Usage)
- AG-A14)** Possesses creative capacity in construction techniques, grounded in a comprehensive understanding of the disciplines and construction methods related to architecture. (Usage)

7. TOPICS

Unit 1: Long-Span and Special Structures (10 hours)	
Competences Expected: AG-A08	
Topics	Learning Outcomes
• Arches and vaults: funicular compression geometry, buttressing requirements, ribbed vs. continuous vaults, and historic and contemporary applications (Guastavino, Candela) • Domes and shells: membrane theory, edge ring forces, buckling in thin shells, geodesic domes (Fuller), and reinforced concrete shells (Nervi, Isler) • Space frames and long-span trusses: three-dimensional truss action, node design, modular systems (Mero, Unistrut), and application in arenas, airports, and exhibition halls • Tensile and cable structures: cable nets (Frei Otto), fabric membranes (PTFE-coated fiberglass, ETFE), masts and anchorage design, and form-finding via physical • Folded plate structures: corrugated geometry for stiffness, folded plate concrete roofs, and timber folded plate systems (CLT folded plates) • Deployable and transformable structures: scissor linkages, pantographic systems, and their application in retractable roofs, emergency shelters, and kinetic architecture	• Describe the principal long-span structural systems - arches, domes, space frames, tensile membranes - and identify the appropriate span range [Familiarity] • Select and conceptualize a long-span structural system for a given program (e.g., stadium, airport terminal, convention center), justifying the choice by span, load, [Usage] • Evaluate the structural efficiency and architectural expression of a built long-span structure, analyzing its load path, stability, and integration of form with structural logic [Assessment]
Readings : [Schierle2012]	

Unit 2: Performance-Driven Design (10 hours)	
Competences Expected: AG-A08	
Topics	Learning Outcomes
• Integration of performance criteria into early design: using daylighting, solar access, thermal comfort, and structural efficiency as spatial • Simulation-based design feedback: using tools such as Ladybug, Honeybee, and Grasshopper to evaluate energy, daylight, • Passive design strategies: solar shading, natural ventilation, thermal mass, and orientation as architectural design elements that reduce mechanical energy loads • Structural form-finding as design: integrating structural logic (arches, shells, trusses, tensile systems) into spatial and formal decisions from schematic design onward • Building performance metrics and certification frameworks: EUI (energy use intensity), daylight autonomy, thermal comfort indices (PMV, SET), • AI-assisted performance optimization: generative adversarial networks and reinforcement learning for multi-objective design optimization	• Identify the key environmental and structural performance criteria relevant to a design project and describe how they can inform early-stage spatial and formal decisions [Familiarity] • Apply passive design strategies and simulation feedback to develop a performance-informed architectural proposal that meets defined energy and comfort targets [Usage] • Evaluate a building design for environmental and structural performance using simulation outputs and standard metrics, and propose targeted design improvements [Assessment]
Readings : [Lechner2014]	

Unit 3: Daylighting and Visual Comfort (8 hours)	
Competences Expected: AG-A11	
Topics	Learning Outcomes
• Daylight performance metrics: daylight factor (DF), spatial daylight autonomy (sDA), annual sunlight exposure (ASE), useful daylight illuminance (UDI), and glare indices (DGP, DGI) • Aperture design for daylight: window-to-wall ratio (WWR), head height, sill height, clerestories, saw-tooth roofs, light shelves, • Shading integration for glare and cooling: fixed (overhangs, fins, louvers), operable (roller shades, venetian blinds, screens), • Daylight simulation tools: climate-based modeling (Radiance, DIVA, ClimateStudio, Ladybug Tools); annual simulation for LEED and other certification credits • Electric lighting integration: daylight harvesting controls (dimming, stepped switching), task-ambient lighting strategies,	• Describe the principal daylight performance metrics (sDA, ASE, UDI) and explain how they inform aperture and shading design decisions [Familiarity] • Design and simulate a daylighting strategy for a building facade or roof aperture, iterating on WWR, orientation, and shading to meet defined sDA and ASE targets [Usage] • Evaluate a building's daylighting design from simulation outputs, identifying areas of glare or insufficient illuminance [Assessment]
Readings : [Lechner2014]	

Unit 4: Acoustics and Noise Control (8 hours)	
Competences Expected: AG-A11	
Topics	Learning Outcomes
• Sound measurement metrics: sound pressure level (SPL, dB), A-weighting (dBA), reverberation time (RT_{60}), sound transmission class (STC), impact insulation class (IIC), • Absorption and diffusion: porous absorbers (fiber-glass, foam), resonant absorbers (perforated panels, membrane), and diffusers (quadratic residue, binary amplitude) • Sound isolation and flanking paths: mass-law, double-wall and decoupled assemblies, sealed penetrations, gasketed doors, floating floors, • Room acoustic design: calculating RT_{60} from volume and absorption, early decay time (EDT), clarity (C50, C80), and speech intelligibility (STI) for auditoria, classrooms, • Noise control from external sources: site planning for noise barriers, facade STC selection based on exterior noise levels (road, rail, air),	• Describe the key acoustic metrics (STC, IIC, RT_{60}, NC) and explain how each influences the design of building assemblies and room finishes [Familiarity] • Design a wall and floor-ceiling assembly to meet a specified STC and IIC rating, detailing flanking path controls and penetrations to achieve target isolation [Usage] • Evaluate a room's acoustic design by calculating its reverberation time and comparing it to recommended values for its intended use (lecture, music, conferencing) [Assessment]
Readings : [MehtaAcoustics1999]	

Unit 5: Mechanical Systems (HVAC) (8 hours)	
Competences Expected: AG-A11	
Topics	Learning Outcomes
• HVAC system classification: all-air (VAV, CAV, dual-duct), all-water (fan-coil, radiant), air-water (induction), and decentralized (heat pumps, PTAC, split systems) • Thermal zoning and load calculation: zone definition by orientation, occupancy, and use; heating and cooling load components (sensible, latent); peak load vs. part-load performance • Distribution system integration: ceiling plenum depth for ducts, raised floors for underfloor air distribution (UFAD), vertical riser coordination, • Dedicated outdoor air systems (DOAS) and energy recovery: enthalpy wheels, run-around loops, and heat pipes • High-efficiency HVAC technologies: variable refrigerant flow (VRF), chilled beams (active and passive), displacement ventilation, radiant heating and cooling slabs,	• Identify the principal HVAC system types and describe the architectural implications of each in terms of floor-to-floor height, ceiling plenum, mechanical room space, [Familiarity] • Select an appropriate HVAC system type for a building program and climate zone, integrating thermal zoning and distribution layout into the architectural floor plan and section [Usage] • Evaluate the HVAC system layout of a building for efficiency, constructability, and architectural integration [Assessment]
Readings : [Lechner2014]	

Unit 6: Facade and Building Envelope Technology (12 hours)	
Competences Expected: AG-A14	
Topics	Learning Outcomes
- Envelope performance criteria: thermal transmittance (U-value), solar heat gain coefficient (SHGC), air infiltration, acoustic transmission loss, - Glazing systems: double and triple glazing, low-e coatings, electrochromic and thermochromic glass, structural silicone glazing, and point-fixed glazing - Curtain wall and rainscreen systems: pressure-equalized rainscreen principle, back-ventilated facades, unitized curtain wall panels, and the detailing of movement joints - Insulation and airtightness: continuous insulation strategies for thermal bridge elimination, air barrier systems, blower-door testing, and Passivhaus envelope standards - Opaque wall systems: masonry veneer, EIFS, pre-cast concrete panels, metal panels, and fiber cement; fire rating, moisture management, and structural attachment for each system - Responsive and dynamic facade systems: kinetic facades (louvered, origami, pneumatic), electrochromic and BIPV panels, and media facades	- Describe the main types of building envelope systems and their performance characteristics, including thermal, moisture, acoustic, and solar control properties [Familiarity] - Select and detail an appropriate building envelope system for a specific climate and building program, justifying the choice in terms of performance, cost, and constructability [Usage] - Evaluate a facade design for thermal, moisture, and solar performance, identifying deficiencies in detailing and proposing improvements to meet defined performance targets [Assessment]
Readings : [AllenIano2019]	

8. WORKPLAN

8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

9. EVALUATION SYSTEM

***** EVALUATION MISSING *****

10. BASIC BIBLIOGRAPHY