



National University of Engineering (UNI)

School of Civil Engineering
Syllabus 2026-II

1. COURSE

CE3S8. Architecture and Structural Models (Mandatory)

2. GENERAL INFORMATION

2.1 Course	: CE3S8. Architecture and Structural Models
2.2 Semester	: 9 th Semester.
2.3 Credits	: 3
2.4 Hours	: 2 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	: CE2S1. Structural Analysis I. (7 th Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Architecture and Structural Models bridges the architectural design studio and the structural engineering practice that supports it. The course opens with the methodology of architectural design and urban planning that civil engineers must understand to collaborate effectively with architects on building and urban projects. It then reviews the analysis of statically determinate structural systems and influence lines, the foundation on which structural models for architectural proposals are built. The course places heavy emphasis on Building Information Modeling (BIM) as the digital platform used to develop, coordinate, and deliver integrated architectural-structural models, and closes with the principles of sustainable and green building systems, and the professional practice skills – technical communication, engineering licensure and legal liability, and global engineering practice – that civil engineers need to operate in multidisciplinary, international project teams.

5. GOALS

- Describe the methodology of architectural design and the principles of urban planning as they relate to civil engineering practice.
- Analyze statically determinate structural systems and construct influence lines for moving loads.
- Develop and coordinate an integrated architectural-structural Building Information Model (BIM) for digital project delivery.
- Apply green building and sustainable urban development principles to a building design proposal.
- Communicate technical and design information effectively, and describe the professional licensure, legal liability, and international practice frameworks relevant to civil engineering.

6. COMPETENCES

- ABET-1)** An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Usage)
- ABET-2)** An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. (Usage)
- ABET-6)** An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. (Usage)

7. TOPICS

Unit 1: Foundations of Architectural Design (6 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Space, form, and order: positive and negative space, enclosure, threshold, spatial sequence, hierarchy, scale, and proportion as fundamental architectural design concepts • Architectural elements and their spatial roles: wall, floor, ceiling, and roof as enclosure; column, beam, and slab as structure • Composition and formal operations: symmetry, asymmetry, balance, rhythm, repetition, modulation, contrast, and tension as tools of architectural formal organization • Light and shadow as design media: natural light quality by orientation and time, shadow and material surface perception, light as spatial modifier - compression, expansion, focus • Program and spatial organization: functional zoning and bubble diagrams, circulation systems (horizontal, vertical, service), spatial hierarchy, and programmatic sequence • Precedent study methods: formal analysis frameworks for canonical architectural works; reading plans, sections, and photographs as design intelligence	• Identify and describe the key spatial, formal, and compositional concepts that constitute the foundations of architectural design [Familiarity] • Apply foundational design principles - space, light, program, and composition - in the development of a spatial architectural proposal [Usage] • Evaluate a design or building project for the quality of its spatial organization, formal coherence, and use of light and program, identifying strengths and areas for improvement [Assessment]
Readings : [Chi14]	

Unit 2: Design Process and Creative Methods (6 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Brief analysis and problem framing: decomposing a design brief into spatial, functional, contextual, and performative requirements; identifying constraints and opportunities • Ideation and concept development: sketching, diagramming, and collage as tools to explore spatial ideas; translating abstract concepts into spatial and formal proposals • Physical model-making as a design tool: study models for spatial exploration, massing studies, sectional models, and the role of making in discovering design solutions • Iterative design and critique: pin-up and desk critique culture, receiving and integrating feedback, revision cycles, and developing design judgment through reflection • Design narrative and argumentation: articulating design intent verbally and graphically, building a coherent design argument, and presenting spatial proposals persuasively • Collaborative and interdisciplinary design processes: co-design with engineers, landscape architects, and community stakeholders	• Describe the stages of an iterative architectural design process from brief analysis through concept development, revision, and final proposal [Familiarity] • Apply systematic ideation and iterative critique methods to develop and refine a spatial architectural proposal in response to a design brief [Usage] • Evaluate the coherence and effectiveness of a design process, including the quality of concept articulation, iteration, and responsiveness to critique [Assessment]
Readings : [Chi14]	

Unit 3: Urban Form and Morphology (6 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Kevin Lynch's city image elements: paths, edges, districts, nodes, and landmarks; their role in legibility and wayfinding; application to urban design analysis and intervention • Street, block, and plot systems: typologies (grid, radial, organic, cul-de-sac), block dimensions and permeability, plot subdivision, • Urban building typologies: single-family detached, row house (townhouse), courtyard building, slab, point tower, and linear block • Morphological analysis methods: Conzenian (burge cycle, fringe belts), space syntax (integration, connectivity, choice), and figure-ground diagrams for reading urban form • Urban fabric layers: plot subdivision history, street network evolution, land use succession, and the persistence of plot boundaries over centuries as a design constraint	• Identify the key morphological elements of a city - streets, blocks, plots, buildings - and describe the relationships among them that define urban character [Familiarity] • Apply morphological analysis tools (figure-ground, space syntax) to an urban sector, identifying its legibility, connectivity, and typological diversity [Usage] • Evaluate the morphological coherence and permeability of a proposed urban design, comparing block sizes, street connectivity, [Assessment]
Readings : [Lyn60]	

Unit 4: Historical Urban Planning Theories (2 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Classic urban theories: Howard's Garden City, Le Corbusier's Radiant City (Towers in the Park), Wright's Broadacre City, and their influence on 20th-century planning and zoning • Post-WWII planning: the rise of the master plan, Team 10 critique of CIAM, Jane Jacobs' advocacy for mixed-use and short blocks,	• Describe the key historical urban planning theories and their influence on 20th-century city form, and explain the shift from master planning to strategic [Familiarity]
Readings : [Lyn60]	

Unit 5: Contemporary Planning Methods and Theory (4 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Planning methods: zoning (Euclidean, form-based, performance-based), master planning vs. strategic planning, public participation (charrettes, community workshops) • Smart growth and new urbanism: principles (transit-oriented development, walkability, mixed-income housing, urban growth boundaries), Andrés Duany's transect, • Contemporary urban theory: Lefebvre's production of space, Harvey's right to the city, Sennett's open city, and the role of informality, participation, • Integration of civil engineering technical constraints (structural, geotechnical, utility infrastructure, and transportation) into urban planning and architectural design frameworks; the collaborative role of civil engineers in multidisciplinary building and urban project teams	• Apply a planning method - such as form-based coding or scenario planning - to a specific urban site, producing land use or built form regulations that align with stated policy [Usage] • Evaluate a current urban plan or zoning code against contemporary planning principles (walkability, mixed-use, transit orientation, social equity), identifying strengths [Assessment]
Readings : [Lyn60]	

Unit 6: Structural Analysis I (8 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Equilibrium equations and free body diagrams for structural systems • Reactions and internal forces in determinate beams and frames • Truss analysis using method of joints and method of sections • Shear force and bending moment diagrams • Cables and arches under concentrated and distributed loads • Influence lines for beams and trusses • Moving load analysis and envelope diagrams • Three-dimensional truss and frame analysis • Compound structures and classification of structural forms	• Apply equilibrium equations to determine support reactions in determinate structures [Usage] • Calculate internal forces and moments at any section of beams and frames [Assessment] • Analyze planar trusses using both method of joints and method of sections [Usage] • Construct shear force and bending moment diagrams for various loading conditions [Assessment] • Determine internal forces in cables and arches under specified loads [Usage] • Develop influence lines for reactions and internal forces in determinate structures [Assessment] • Utilize influence lines to determine maximum effects from moving loads [Usage] • Analyze three-dimensional structural systems and determine spatial force components [Assessment] • Classify structures as determinate or indeterminate and identify stability conditions [Familiarity]
Readings : [Hib18], [Kas20]	

Unit 7: Building Information Modeling (BIM) for Digital Delivery and Asset Management (36 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• BIM concepts: dimensions (3D, 4D, 5D, 6D, 7D), LOD, and LOIN • BIM authoring tools and parametric modeling techniques • Model coordination, clash detection, and interference checking • Collaboration platforms, Common Data Environments (CDE), and BIM execution plans • BIM-based analysis: quantity takeoff, energy simulation, and structural analysis • Digital twins and the connection between BIM and operational data • Interoperability standards: IFC, COBie, and open-BIM • Asset information models (AIM) and BIM for facilities management (FM) • Regulatory submission and automated code compliance checking	• Define the different dimensions of BIM (3D-7D) and their associated information [Familiarity] • Create a basic 3D parametric model of a structural framing system using BIM software [Usage] • Perform a clash detection analysis between architectural and structural models [Assessment] • Outline the key components of a BIM Execution Plan (BEP) [Familiarity] • Extract a material quantity takeoff schedule from a BIM model [Usage] • Explain the relationship between a BIM model and a digital twin for an asset [Familiarity] • Export a BIM model using the IFC format to ensure interoperability [Usage] • Develop an Asset Information Model (AIM) deliverable for handover to a facility manager [Assessment] • Evaluate the potential of automated rule-checking for building code compliance [Assessment]
Readings : [Eas+18]	

Unit 8: Green Building Systems and Sustainable Urban Development (4 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• High-performance building envelopes and passive design strategies • Energy modeling, efficient HVAC systems, and on-site renewable generation • Water efficiency: low-flow fixtures, rainwater harvesting, and greywater reuse • Indoor environmental quality (IEQ): thermal comfort, daylighting, and air quality • Sustainable site design: stormwater management, heat island reduction, habitat preservation • Net-zero energy and water building design • Smart building technologies and IoT for operational optimization • Urban sustainability: transit-oriented development, density, and mixed-use planning • Green building certification systems: LEED, BREEAM, Living Building Challenge	• Design a building section illustrating key passive heating and cooling strategies [Assessment] • Size a rainwater harvesting system for a given roof area and demand [Usage] • Explain the key parameters affecting indoor air quality and thermal comfort [Familiarity] • Develop a site plan that minimizes impervious surfaces and incorporates green infrastructure [Usage] • Model a building's energy use to demonstrate a path to net-zero energy [Assessment] • Describe how a building automation system can optimize energy and water use [Familiarity] • Plan a transit-oriented development (TOD) node for reduced vehicle dependence [Assessment] • Prepare documentation for a project targeting a specific level of LEED certification [Usage]
Readings : [Kib16]	

Unit 9: Written and Technical Communication (2 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Audience analysis and adaptation of technical content • Written communication: technical reports, memos, emails, and specifications • Visual communication: graphs, charts, diagrams, and effective slide design	• Write a clear, concise, and well-organized technical report on a laboratory experiment or design project [Usage] • Create effective graphs and diagrams to present engineering data [Assessment]
Readings : [BM18]	

Unit 10: Oral Presentation and Professional Communication (1 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Oral presentations: structure, delivery techniques, and handling Q&A • Proposal writing: technical approach, management plan, and cost estimating • Executive summaries and communicating with non-technical stakeholders	• Deliver a structured oral presentation on a technical topic using appropriate visual aids [Usage] • Outline the key sections of a competitive engineering proposal [Familiarity] • Develop an executive summary that conveys key project findings to a senior management audience [Usage]
Readings : [BM18]	

Unit 11: Digital and Collaborative Communication (1 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Collaborative writing and document management in team settings • Digital communication: web content, social media guidelines for engineers • Persuasive communication and negotiation techniques	• Manage a collaborative document (e.g., on Google Docs or SharePoint) for a team project [Assessment] • Explain the professional risks and opportunities associated with engineers using social media [Familiarity] • Employ basic negotiation tactics to resolve a simulated conflict over project scope [Usage]
Readings : [BM18]	

Unit 12: Engineering Licensure, Legal Liability, and Regulatory Frameworks (4 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Professional licensure process: EIT/FE exam, experience requirements, PE exam • Legal fundamentals: torts (negligence), contracts, and intellectual property • Professional liability, errors and omissions, and standard of care • Regulatory framework for design and construction (building codes, environmental regulations) • Risk management strategies: insurance, indemnification, limitation of liability • International licensure and mutual recognition agreements • Forensic engineering and expert witness testimony • Government contracting and the Federal Acquisition Regulation (FAR) • Compliance programs and ethics training for engineering firms	• Outline the typical steps and requirements to become a licensed Professional Engineer (PE) [Familiarity] • Define the legal concepts of negligence, standard of care, and breach of contract in an engineering context [Familiarity] • Analyze a case to determine if an engineer's actions met the professional standard of care [Assessment] • Identify the key regulatory permits required for a typical land development project [Familiarity] • Explain the purpose of professional liability insurance and common policy exclusions [Familiarity] • Compare the licensure requirements in two different countries [Familiarity] • Prepare an outline for an expert witness report on a technical failure [Assessment] • Describe the unique challenges and rules of government contracting for engineering services [Familiarity] • Design a simple ethics and compliance training module for an engineering consultancy [Assessment]
Readings : [EN19], [Uff17]	

Unit 13: Global Engineering Practice and International Standards (4 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Globalization of engineering: drivers, opportunities, and challenges • Cultural dimensions and their impact on communication, negotiation, and project management • International standards organizations (ISO) and their role in harmonization • FIDIC contract conditions and international project delivery • Global challenges: UN Sustainable Development Goals (SDGs) and the engineer's role • Global supply chain management and logistics for construction • Expatriate assignments and working in multinational teams • Risk management for international projects: political, currency, force majeure • Technology transfer and capacity building in developing regions	• Describe how cultural differences can affect team dynamics and project outcomes on international projects [Familiarity] • Use a cultural dimensions framework to analyze a cross-cultural misunderstanding in a project case study [Assessment] • Identify key ISO standards relevant to quality management (ISO 9001) and environmental management (ISO 14001) in engineering [Familiarity] • Explain the structure and key principles of FIDIC Red and Yellow Books [Familiarity] • Map the objectives of a civil engineering project to relevant UN Sustainable Development Goals (SDGs) [Assessment] • Develop a risk register for an international joint venture project, identifying political and currency risks [Assessment] • Outline the key considerations for an engineer accepting a long-term assignment in a foreign country [Familiarity] • Design a technology transfer plan for implementing a new water treatment process in a developing community [Assessment]
Readings : [Con17], [HHM10]	

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

- [Lyn60] Kevin Lynch. *The Image of the City*. MIT Press, 1960.
- [HHM10] Geert Hofstede, Gert Jan Hofstede, and Michael Minkov. *Cultures and Organizations: Software of the Mind*. 3rd. McGraw-Hill, 2010.
- [Chi14] Francis D. K. Ching. *Architecture: Form, Space, and Order*. 4th. John Wiley & Sons, 2014.
- [Kib16] Charles J. Kibert. *Sustainable Construction: Green Building Design and Delivery*. 5th. John Wiley & Sons, 2016.

- [Con17] International Federation of Consulting Engineers (FIDIC). *FIDIC Rainbow Suite of Contracts*. Tech. rep. FIDIC, 2017.
- [Uff17] John Uff. *Construction Law*. 12th. Sweet & Maxwell, 2017.
- [BM18] David F. Beer and David McMurrey. *A Guide to Writing as an Engineer*. 5th. John Wiley & Sons, 2018.
- [Eas+18] Chuck Eastman et al. *BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers*. 3rd. John Wiley & Sons, 2018.
- [Hib18] Russell C. Hibbeler. *Structural Analysis*. 10th. Pearson, 2018.
- [EN19] National Council of Examiners for Engineering and Surveying (NCEES). *Guidelines for Responsible Charge of Engineering Work*. Tech. rep. NCEES, 2019.
- [Kas20] Aslam Kassimali. *Structural Analysis*. 6th. Cengage Learning, 2020.