



National University of Engineering (UNI)
School of Civil Engineering
Syllabus 2027-I

1. COURSE

CE3C15. Professional Competencies Workshop (Mandatory)

2. GENERAL INFORMATION

2.1 Course	: CE3C15. Professional Competencies Workshop
2.2 Semester	: 9 th Semester.
2.3 Credits	: 3
2.4 Hours	: 4 HT; 2 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	: 190Cr

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Professional Skills Workshop is an integrative course that applies, to a real construction project, feasibility, environmental, and social studies, material selection, procurement and contract management, process standardization and quality management, safety and environmental management, planning, simulation of construction processes with BIM tools, and cost, risk, and opportunity control through an integrated management dashboard.

5. GOALS

- Develop feasibility, environmental, and social studies for a construction project.
- Apply procurement, contract, quality, safety, and environmental management to a construction project.
- Plan and simulate construction processes of a project using BIM tools.
- Control costs, risks, and opportunities of a project through an integrated management dashboard.

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: Project Context (6 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Context and scope of the construction project to be developed in the workshop.	• Describe the context and scope of a real construction project [Familiarizarse].
Readings : [PMI2021]	

Unit 2: Engineering Economics and Project Financing (PPPs) (6 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Time value of money: present worth, future worth, annual worth calculations • Comparison of project alternatives: present worth, rate of return, benefit-cost analysis • Depreciation methods and tax considerations in engineering economics • Project feasibility studies and break-even analysis • Risk and uncertainty in economic analysis: sensitivity and scenario analysis • Life-cycle costing for infrastructure assets • Project financing models: debt, equity, and public-private partnerships (PPPs) • Valuation of intangible benefits and costs in public projects • Real options analysis for flexible project planning	• Calculate present worth, future worth, and annual worth for a series of cash flows [Usage] • Compare two mutually exclusive project alternatives using present worth analysis [Assessment] • Apply straight-line and MACRS depreciation methods to a capital asset [Usage] • Conduct a basic sensitivity analysis on the key variables of a project's economic model [Assessment] • Perform a life-cycle cost analysis for a bridge, considering initial construction, maintenance, and end-of-life costs [Usage] • Compare the risk allocation in a Design-Bid-Build project versus a Public-Private Partnership (PPP) [Familiarity] • Monetize the societal benefits (e.g., reduced travel time) of a transportation project for a benefit-cost analysis [Assessment] • Explain how real options analysis can add value to the planning of a multi-phase infrastructure project [Familiarity]
Readings : [Blank2017]	

Unit 3: Environmental Impact Assessment and Sustainability Metrics (6 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• EIA process: screening, scoping, impact analysis, mitigation, and public participation • Impact prediction methods for air, water, soil, noise, and ecological systems • Mitigation hierarchy and design of environmental management plans • Legal and institutional frameworks for EIA • Sustainability concepts and the triple bottom line (environment, economy, society) • Cumulative impact assessment and strategic environmental assessment (SEA) • Social impact assessment and stakeholder engagement methods • Sustainability metrics and indicator frameworks (e.g., SDGs, Envision) • Decision-support tools and multi-criteria analysis for sustainable design	• Outline the key stages of a standardized Environmental Impact Assessment (EIA) process [Familiarity] • Predict primary environmental impacts of a proposed infrastructure project on local air and water quality [Usage] • Develop mitigation measures for identified significant environmental impacts [Assessment] • Explain the legal requirements and purpose of EIA in the project approval process [Familiarity] • Apply the triple bottom line framework to evaluate a simple engineering project [Assessment] • Conduct a scoping exercise to define the boundaries and key issues for a cumulative impact assessment [Assessment] • Design a stakeholder engagement plan for a controversial development project [Usage] • Select appropriate sustainability metrics to track the performance of a green infrastructure project [Assessment] • Use a simple multi-criteria decision analysis (MCDA) tool to compare alternative project designs [Usage]
Readings : [Glasson2019]	

Unit 4: Standardized Testing, Quality Control, and Failure Analysis (6 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Standard test methods for material characterization and acceptance testing • Sampling procedures and representative sample selection • Quality control and quality assurance protocols in construction • Statistical analysis of test data and acceptance criteria • Non-destructive testing methods for materials and structures • Advanced material characterization techniques including microscopy and spectroscopy • Failure analysis methodology and root cause investigation • Forensic engineering and distress evaluation • Performance-based testing and specification approaches • Certification, compliance, and third-party testing requirements	• Perform standard material tests according to ASTM or equivalent specifications [Usage] • Develop appropriate sampling plans for construction material acceptance [Assessment] • Implement quality control procedures for construction materials and processes [Usage] • Analyze test data using statistical methods and establish acceptance criteria [Assessment] • Apply non-destructive testing techniques for in-situ material evaluation [Familiarity] • Utilize advanced characterization techniques to investigate material microstructure [Usage] • Conduct systematic failure analysis to determine root causes of material distress [Assessment] • Investigate structural failures using forensic engineering methodologies [Assessment] • Design performance-based test protocols for innovative materials [Usage] • Interpret certification requirements and coordinate third-party testing programs [Familiarity]
Readings : [Neville2011]	

Unit 5: Contracts, Specifications, and Construction Law (6 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Contract types: lump sum, unit price, cost-plus, and design-build • Procurement methods and bidding strategies • Project specifications: MasterFormat, performance vs. prescriptive • General conditions of contract and key clauses (e.g., AIA, FIDIC) • Change orders, extra work, and variation procedures • Claims management: delay, disruption, and acceleration • Dispute resolution: negotiation, mediation, arbitration, litigation • Professional liability, negligence, and standard of care • Ethical dilemmas and professional conduct in construction	• Compare the risk allocation between owner and contractor in different contract types [Familiarity] • Select an appropriate procurement method for a given project delivery model [Assessment] • Write a clear, unambiguous technical specification for a construction material [Usage] • Explain the purpose of key clauses in standard general conditions of contract [Familiarity] • Process a hypothetical change order, documenting cost and time impacts [Usage] • Analyze a simple delay claim and determine entitlement and damages [Assessment] • Recommend an appropriate dispute resolution method for a given conflict scenario [Assessment] • Define the engineer's standard of care and potential liabilities for design errors [Familiarity] • Resolve an ethical dilemma related to bidding practices or site safety reporting [Assessment]
Readings : [OSCE]	

Unit 6: Quality Management (6 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Total Quality Management: Deming's 14 points, continuous improvement (kaizen), and quality culture • Six Sigma methodology (DMAIC): process capability, control charts, and defects per million opportunities • Quality standards and certification: ISO 9001 framework, quality cost categories (prevention, appraisal, failure) • Quality function deployment (QFD) and voice of the customer: House of Quality matrix, customer requirement translation, and design prioritization	• Explain the TQM philosophy and the key tools used in the DMAIC improvement cycle [Familiarity] • Apply basic statistical process control methods to monitor process quality [Usage] • Evaluate the quality performance of a process and recommend improvement priorities using cost-of-quality analysis [Assessment]
Readings : [ISO9001]	

Unit 7: Staged Deliverable I (6 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Preparation and submission of the workshop's first staged deliverable report, consolidating the project context, feasibility, environmental and social studies, material selection, procurement and contract management, and quality management work completed so far. • Oral defense of the staged deliverable before a review panel.	• Prepare a staged project report consolidating the findings of the workshop's initial phases [Usar]. • Defend the staged deliverable orally before a review panel, responding to technical questions [Evaluar].
Readings : [PMI2021]	

Unit 8: Construction Safety, Health, and Risk Management (6 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Safety management systems and the role of safety culture • Common construction hazards: falls, struck-by, electrocution, caught-in/between • Occupational Safety and Health Administration (OSHA) regulations and compliance • Risk identification and assessment techniques (e.g., JSA, checklists) • Hierarchy of controls: elimination, substitution, engineering, administrative, PPE • Occupational health: silica, noise, ergonomics, and industrial hygiene • Emergency response planning and incident investigation • Insurance and bonding principles for construction risk transfer • Proactive safety leading indicators and predictive analytics	• Identify the "Fatal Four" construction hazards and basic OSHA requirements for each [Familiarity] • Conduct a Job Safety Analysis (JSA) for a common construction task [Assessment] • Develop a site-specific safety plan for a given project scenario [Usage] • Apply the hierarchy of controls to mitigate an identified safety risk [Familiarity] • Evaluate occupational health exposures (e.g., noise, dust) and recommend monitoring strategies [Assessment] • Create an emergency response plan for a construction site [Usage] • Explain the purpose and types of insurance (e.g., CGL, workers' comp) in construction risk management [Familiarity] • Propose leading safety indicators to track and predict site safety performance [Assessment]
Readings : [Hinze2005], [G050]	

Unit 9: Project Planning, Scheduling, and Control (CPM, 4D/5D) (6 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Work breakdown structure (WBS) development and activity definition • Network diagramming: activity-on-node (AON) and precedence diagramming method (PDM) • Critical Path Method (CPM) for schedule calculation: forward/backward pass, floats • Resource allocation, loading, and leveling techniques • Schedule updating, monitoring, and control using earned value management (EVM) • Program Evaluation and Review Technique (PERT) for schedule risk analysis • Line of balance (LOB) scheduling for repetitive projects • 4D scheduling (time + 3D model) for visualization and clash detection • 5D scheduling (time + cost + 3D model) for integrated cost control	• Develop a Work Breakdown Structure (WBS) for a medium-scale construction project [Usage] • Construct a CPM network diagram and calculate the critical path and activity floats [Assessment] • Perform resource leveling on a simple project schedule to minimize resource fluctuations [Usage] • Monitor project progress using schedule variance (SV) and cost variance (CV) from earned value data [Assessment] • Apply PERT to estimate project duration probabilities and identify schedule risks [Assessment] • Create a Line of Balance (LOB) schedule for a repetitive housing project [Usage] • Generate a 4D simulation to visualize the construction sequence and identify spatial conflicts [Usage] • Integrate cost data with a 3D model to perform a 5D analysis for budget tracking [Assessment]
Readings : [Callahan1992]	

Unit 10: Building Information Modeling (BIM) for Digital Delivery and Asset Management (6 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 : [Eastman2018]	

Unit 11: Construction Methods, Equipment, and Productivity (6 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Earthwork operations: excavation, hauling, compaction, and mass diagrams • Concrete construction: formwork, placing, finishing, and curing • Steel erection, connection, and safety procedures • Construction equipment types, capabilities, and selection criteria • Productivity measurement, cycle time analysis, and crew balancing • Heavy civil construction methods for tunnels, dams, and bridges • Equipment economics: ownership vs. rental, depreciation, and operating cost • Trenchless technologies and deep excavation support systems • Automation and robotics in construction operations	• Select appropriate construction equipment for common earthwork and material handling tasks [Usage] • Design basic formwork and shoring for a concrete slab or wall [Assessment] • Explain the sequence and safety considerations for steel erection [Familiarity] • Calculate productivity rates and cycle times for equipment operations [Usage] • Balance a construction crew to optimize productivity for a given task [Assessment] • Compare construction methods for a heavy civil project like a cut-and-cover tunnel [Assessment] • Analyze the economic life and hourly cost of a piece of construction equipment [Usage] • Describe the applications and limitations of trenchless construction technologies [Familiarity] • Evaluate the potential for automation to improve safety and productivity on a construction site [Assessment]
Readings : [Peurifoy2018]	

Unit 12: Construction Budgeting, Bidding, and Financial Control (6 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Bid preparation, submission, and analysis processes • Cash flow forecasting and management for construction projects • Value engineering and constructability analysis • Financial statements and performance metrics for construction firms	• Explain the components and typical markup structure of a competitive bid [Familiarity] • Develop a monthly cash flow forecast for a construction project [Usage] • Perform a value engineering workshop to identify cost-saving alternatives without sacrificing function [Assessment] • Interpret key financial ratios for assessing a construction company's health [Familiarity]
Readings : [CAPECO]	

Unit 13: Dashboards and Information Radiators (6 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Designing effective project dashboards: key metrics, visual clarity, and stakeholder relevance • Information radiators: physical and digital tools for continuous team transparency • Real-time dashboards: automated data feeds and live project status visualization • Maintaining and evolving dashboards as the project progresses and information needs change	• Design a project performance dashboard with relevant KPIs for team and stakeholder use [Usage] • Implement information radiators that provide real-time project transparency to the team [Assessment] • Evaluate the effectiveness of a dashboard in communicating project health and recommend improvements [Assessment]
Readings : [PMI2021]	

Unit 14: Staged Deliverable II (6 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Preparation and submission of the workshop's final staged deliverable report, consolidating the safety and environmental management, planning, BIM modeling, construction process simulation, and cost/risk/opportunity control work completed in the second half of the workshop. • Oral defense of the final deliverable before a review panel.	• Prepare a final staged project report consolidating the findings of the workshop's later phases [Usar]. • Defend the final deliverable orally before a review panel, responding to technical questions [Evaluar].
Readings : [PMI2021]	

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