National University of Engineering (UNI)
Faculty of Civil Engineering
School of Civil Engineering



Book of Syllabi

– 2027-I–

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

1. COURSE

MA100. Basic Mathematics (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	MA100. Basic Mathematics
2.2 Semester	:	1st Semester.
2.3 Credits	:	5
2.4 Hours	:	3 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

The Basic Mathematics course is mandatory and provides the conceptual tools necessary for logical reasoning and problem solving. The course ranges from propositional logic and set theory to the study of real numbers, complex numbers, polynomials, and matrices. These concepts are fundamental for developing the abstraction and mathematical formalization skills required in the later stages of the Computer Science program.

5. GOALS

- Develop logical reasoning and critical thinking skills through the use of formal languages.
- Understand and apply the properties of number systems (real and complex) in problem solving.
- Manipulate polynomial and matrix structures to solve systems of equations and interpret results.
- Introduce basic concepts of statistics and probability for data analysis.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

7. TOPICS

<table>
<tr><td colspan="2">Unit 1: Logic and Sets (16 hours)</td></tr>
<tr><td colspan="2">Competences Expected: ABET-1</td></tr>
<tr><td>Topics</td><td>Learning Outcomes</td></tr>
<tr><td>Propositional logic: Connectives, truth tables, and validity.
Logical-mathematical quantifiers.
Set theory: Operations, relations, and functions.
Families of sets and Cartesian product.</td><td>Formalize natural language statements into propositional language [Familiarizarse].
Operate with sets using algebraic laws and Venn diagrams [Usar].
Prove basic properties of sets and logical relations [Evaluar].</td></tr>
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</table>

Unit 2: Number Systems (16 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• The real number system: Field and order axioms. • Mathematical induction and Newton's binomial theorem. • Complex numbers: Binomial, polar, and exponential forms. • Roots of complex numbers and De Moivre's theorem.	• Identify the algebraic structure of real and complex numbers [Familiarizarse]. • Apply the principle of mathematical induction in proofs of summations [Usar]. • Solve equations in the complex number field using various representations [Evaluar].
Readings : [**Gentile1985**], [**Pinzon1973**]	

Unit 3: Polynomials and Matrices (16 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Polynomials: Division algorithm and roots of polynomials. • Matrices: Types, operations, and determinants. • Inverse matrix and rank of a matrix. • Systems of linear equations: Gauss-Jordan method.	• Recognize the structure of polynomial rings and matrix algebra [Familiarizarse]. • Use elementary row operations to calculate the inverse of a matrix [Usar]. • Model and solve systems of linear equations applied to contextual problems [Evaluar].
Readings : [**Gentile1984**], [**Rojo1995**]	

Unit 4: Statistics and Probability (16 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Descriptive statistics: Measures of central tendency. • Dispersion measures and graphical representation. • Probability concepts: Sample space and events. • Conditional probability and independence.	• Describe data sets using basic statistical indicators [Familiarizarse]. • Calculate probabilities of simple and compound events in random experiments [Usar]. • Interpret statistical results for decision making in scientific environments [Evaluar].
Readings : [**Peterson2005**]	

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

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

1. COURSE

MA111. Calculus I (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	MA111. Calculus I
2.2 Semester	:	1st Semester.
2.3 Credits	:	5
2.4 Hours	:	3 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course introduces the fundamental concepts of differential calculus of single-variable real functions. It provides the mathematical foundations necessary for analyzing change and motion in science and engineering, developing logical reasoning through the study of limits, continuity, and derivatives.

5. GOALS

- Understand the fundamental concepts of limits and continuity.
- Master differentiation techniques for algebraic and transcendental functions.
- Apply derivatives to solve optimization problems and analyze rates of change.
- Develop a rigorous approach to the formal definition of a derivative.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

7. TOPICS

Unit 1: Limits and Continuity (20 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Limits and continuity of single-variable functions	• Interpret the concept of limit and continuity of a function and its relevance to modeling the behavior of engineering systems near a point [Familiarity]
Readings : [**Stewart2016**], [**Larson2018**], [**Thomas2014**]	

Unit 2: Differential Calculus (20 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Derivatives and rules of differentiation	• Apply differentiation rules to find rates of change and optimize engineering design parameters [Usage] • Formulate and solve optimization problems for engineering systems using differential calculus [Assessment]
Readings : [**Stewart2016**], [**Larson2018**], [**Thomas2014**]	

Unit 3: Integral Calculus (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• The Fundamental Theorem of Calculus • Integration techniques including substitution and parts • Engineering applications of integration: areas, volumes, centroids, and moments of inertia	• State and explain the Fundamental Theorem of Calculus [Familiarity] • Calculate definite integrals arising from engineering problems such as work, fluid pressure, and heat transfer [Usage]
Readings : [**Stewart2016**], [**Larson2018**], [**Thomas2014**]	

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National University of Engineering (UNI)
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Syllabus 2027-I

1. COURSE

BCH101. Chemistry I (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	BCH101. Chemistry I
2.2 Semester	:	1st Semester.
2.3 Credits	:	5
2.4 Hours	:	3 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Chemistry provides the foundation for understanding the composition, structure, and properties of matter – knowledge required across computing, and engineering programs alike as part of a rigorous grounding in the natural sciences. This course introduces the basic principles of general chemistry and extends them to chemical equilibrium and electrochemistry, together with the applied chemistry of water, polymers, and cement, topics that recur in materials science, environmental analysis, and engineering practice.

5. GOALS

- Understand the structure of matter at the atomic and molecular level.
- Apply the principles of stoichiometry to perform chemical calculations.
- Understand the different types of chemical bonds and their influence on the properties of substances.
- Apply chemical equilibrium, including acid-base and solubility equilibria, to predict the behavior of aqueous systems.
- Apply electrochemical principles to analyze corrosion of metals and reinforced concrete.
- Relate the composition and properties of water, polymers, and cement to their applications in materials science and civil engineering.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

7. TOPICS

Unit 1: Matter and Energy (8 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Classification of matter: elements, compounds, and mixtures • The scientific method and the international system of units	• Describe the properties of matter and energy and classify a given substance [Familiarity] • Perform unit conversions in engineering chemistry problems [Usage]
Readings : [**BrownLeMayBursten2017**], [**ChangGoldsby2016**]	

Unit 2: Basic Atomic Structure (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Structure of the atom, atomic number, mass number, and isotopes • Quantum model of the atom and electron configuration	• Describe the structure of the atom and its subatomic particles [Familiarity] • Determine the electron configuration of an atom and relate it to its chemical properties [Usage]
Readings : [**BrownLeMayBursten2017**], [**ChangGoldsby2016**]	

Unit 3: Chemical Bonding (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Ionic, covalent, and metallic bonding • Molecular geometry and its relationship to substance properties	• Describe the different types of chemical bonding [Familiarity] • Predict molecular geometry and relate bond type to material properties [Assessment]
Readings : [**BrownLeMayBursten2017**], [**ChangGoldsby2016**]	

Unit 4: Stoichiometry (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Molar mass, the mole concept, and balancing chemical equations • Stoichiometric calculations, limiting reagent, and percent yield	• Calculate the molar mass of a compound and balance chemical equations [Usage] • Determine the amount of reactants and products in an engineering process using stoichiometric calculations [Assessment]
Readings : [**BrownLeMayBursten2017**], [**ChangGoldsby2016**]	

Unit 5: States of Matter (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Properties of gases, liquids, and solids, and phase changes • Ideal gas laws and phase diagrams	• Describe the properties of the different states of matter and their phase changes [Familiarity] • Apply ideal gas laws to engineering problems [Usage]
Readings : [**BrownLeMayBursten2017**], [**ChangGoldsby2016**]	

Unit 6: Environmental and Water Chemistry (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Water quality parameters (pH, hardness, dissolved oxygen, BOD) for infrastructure design • Fundamentals of water treatment and major air and water pollutants	• Interpret water quality parameters for the design of treatment systems [Usage] • Identify pollutants relevant to sanitary and environmental infrastructure projects [Familiarity]
Readings : [**BrownLeMayBursten2017**], [**ChangGoldsby2016**]	

Unit 7: Polymers and Geosynthetics (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Classification of polymers: thermoplastics, thermosets, and elastomers • Geosynthetics: geotextiles, geomembranes, and geogrids, and their applications in civil works	• Classify a polymer by its structure and thermal behavior [Usage] • Select the appropriate geosynthetic for a given civil engineering application [Usage]
Readings : [**ChangGoldsby2016**], [**MamloukZaniewski2017**]	

Unit 8: Chemical Equilibrium (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• The equilibrium constant K_c and its relation to stoichiometry • Le Chatelier's principle and its effect on industrial chemical processes	• Write the equilibrium constant expression for a reaction of engineering interest [Usage] • Predict the shift of a chemical equilibrium in an engineering process [Assessment]
Readings : [**BrownLeMayBursten2017**], [**ChangGoldsby2016**]	

Unit 9: Ionic Equilibrium and Salt Hydrolysis (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Calculating the pH of strong and weak acids and bases • Salt hydrolysis and its effect on the pH of water and soils	• Calculate the pH of solutions relevant to environmental quality control [Usage] • Predict the effect of salt hydrolysis on the pH of water and soils [Assessment]
Readings : [**BrownLeMayBursten2017**], [**ChangGoldsby2016**]	

Unit 10: Salts, Solubility, and Precipitation Equilibria (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• The solubility product K_{sp} and predicting precipitation	• Predict the formation of precipitates or scale in engineering water systems [Usage]
Readings : [**BrownLeMayBursten2017**], [**ChangGoldsby2016**]	

Unit 11: Electrochemistry and Electrolysis (8 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Redox reactions, galvanic cells, and electrode potentials • Electrochemical corrosion of metals and of reinforcing steel in reinforced concrete, and protection methods	• Calculate the potential of a galvanic cell and predict the spontaneity of a redox reaction [Usage] • Analyze corrosion conditions in engineering structures and propose protection methods [Assessment]
Readings : [**BrownLeMayBursten2017**], [**ChangGoldsby2016**]	

Unit 12: Cement Chemistry (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Chemical composition of Portland cement and its main compounds • Cement hydration reactions and their relation to concrete strength development	• Describe the chemical composition of Portland cement [Familiarity] • Explain the relationship between cement hydration and concrete strength development [Usage]
Readings : [**MamloukZaniewski2017**], [**ChangGoldsby2016**]	

8. WORKPLAN

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

BME101. Learning Methodology Workshop (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	BME101. Learning Methodology Workshop
2.2 Semester	:	1st Semester.
2.3 Credits	:	2
2.4 Hours	:	2 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Success in demanding science, engineering, and computing programs depends not only on technical knowledge but also on how effectively students plan their academic and personal life, study, and learn. This workshop equips incoming students in science, engineering, and computing programs with practical learning-methodology tools: life and career planning, evidence-based study techniques, an introduction to how modern AI/ML tools can support their own learning process, the fundamentals of scientific knowledge and applied research, emotional intelligence for personal and interpersonal effectiveness, and the technical communication and teamwork/leadership skills needed to collaborate throughout their studies and professional careers.

5. GOALS

- Design a personal life project, setting academic and career goals aligned with personal values.
- Apply evidence-based study techniques and time-management strategies to improve academic performance.
- Relate machine learning fundamentals to how AI-based tools can support a student's own learning process.
- Communicate technical and academic content effectively to varied audiences.
- Distinguish basic from applied research and apply basic research- methodology and academic-integrity practices.
- Apply emotional-intelligence competencies for self-management and interpersonal effectiveness.
- Apply leadership, teamwork, and stakeholder-management skills in collaborative project settings.

6. COMPETENCES

ABET-3) An ability to communicate effectively with a range of audiences. (Familiarity)

ABET-6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. (Familiarity)

ABET-7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies. (Familiarity)

7. TOPICS

Unit 1: Life Project (8 hours)	
Competences Expected: ABET-7	
Topics	**Learning Outcomes**
• Personal-values clarification as the foundation for life planning. • Short-, medium-, and long-term goal setting using SMART criteria. • From academic path to professional career: mapping academic studies in science, engineering, or computing onto career goals. • Self-assessment tools: strengths, interests, and personality inventories. • Elaboration of a personal life-project plan with milestones and review points.	• Formulate personal values and goals to build a coherent life project [Usar]. • Design short-, medium-, and long-term academic and career goals using structured planning tools [Usar]. • Apply self-assessment techniques to identify personal strengths and areas for improvement [Familiarizarse].
Readings : [**BurnettEvans2016**]	

Unit 2: Study Techniques and Habits (12 hours)	
Competences Expected: ABET-7	
Topics	**Learning Outcomes**
• Active learning techniques: active recall, spaced repetition, and elaborative interrogation. • Note-taking systems: the Cornell method, mapping, and outlining. • Time management and time-blocking; the Pomodoro technique. • Exam-preparation strategies and self-testing. • Building sustainable study habits and routines.	• Apply active-recall and spaced-repetition techniques to improve long-term retention of course material [Usar]. • Use structured note-taking systems (e.g., the Cornell method) to organize academic content [Usar]. • Design a personal time-management plan using time-blocking and the Pomodoro technique [Usar]. • Apply self-testing and exam-preparation strategies to evaluate personal learning progress [Evaluar].
Readings : [**Dunlosky2013**], [**Newport2007**]	

Unit 3: Machine Learning Fundamentals (4 hours)	
Competences Expected: ABET-7	
Topics	**Learning Outcomes**
• Definition and examples of a broad variety of machine learning tasks: – Supervised learning: ∗ Classification ∗ Regression – Reinforcement learning – Unsupervised learning: ∗ Clustering • Fundamental ideas: – No free lunch theorem: no one learner can solve all problems; representational design decisions have consequences. – Sources of error and undecidability in machine learning • A simple statistical-based supervised learning such as linear regression or decision trees: – Focus on how they work without going into mathematical or optimization details; enough to understand and use existing implementations correctly • The overfitting problem/controlling solution complexity (regularization, pruning - intuition only): – The bias (underfitting) - variance (overfitting) tradeoff	• Describe the differences among the three main styles of learning (supervised, reinforcement, and unsupervised) and determine which is appropriate to a particular problem domain [Explain] • Differentiate the terms of AI, machine learning, and deep learning [Evaluate] • Frame an application as a classification problem, including the available input features and output to be predicted (e.g., identifying alphabetic characters from pixel grid input) [Apply] • Identify overfitting in the context of a problem and learning curves and describe solutions to overfitting [Evaluate] • Explain how machine learning works as an optimization/search process [Explain]
Readings : [**Russell2020**]	

Unit 4: Written and Technical Communication (2 hours)	
Competences Expected: ABET-3	
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 : [**GurakLannon2013**]	

Unit 5: Oral Presentation and Professional Communication (1 hours)	
Competences Expected: ABET-3	
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 : [**GurakLannon2013**]	

Unit 6: Digital and Collaborative Communication (1 hours)	
Competences Expected: ABET-3	
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 : [**GurakLannon2013**]	

Unit 7: Scientific Knowledge and Applied Research (16 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Nature and scope of scientific knowledge: definitions and limits. • Basic versus applied research; the role of applied research in engineering, computing, and scientific practice. • Research-methodology basics: problem formulation and literature review. • Formulating hypotheses and research questions. • Basics of data collection and data analysis for engineering, computing, and scientific research. • Academic integrity and citation norms: avoiding plagiarism and properly citing sources. • Introduction to research practice in engineering, computing, and science: reading and using academic papers.	• Distinguish between basic and applied research and identify their role in engineering, computing, and scientific practice [Usar]. • Formulate a research problem and a supporting literature review for a topic in engineering, computing, or science [Usar]. • Formulate testable hypotheses and research questions [Usar]. • Apply basic data-collection and data-analysis procedures to a simple research exercise [Familiarizarse]. • Apply academic-integrity principles and standard citation norms when using external sources [Usar].
Readings : [**Booth2016**], [**Leedy2019**]	

Unit 8: Emotional Intelligence (8 hours)	
Competences Expected: ABET-3	
Topics	**Learning Outcomes**
• Goleman's model of emotional intelligence: self-awareness, self-regulation, motivation, empathy, and social skills. • Self-awareness and self-regulation techniques. • Empathy and social-skills development for interpersonal effectiveness. • Stress-management and resilience-building strategies for academic life.	• Identify the five components of emotional intelligence and relate them to personal behavior [Usar]. • Apply self-regulation and stress-management techniques to cope with academic pressure [Usar]. • Apply empathy and social-skills strategies to improve interpersonal interactions [Familiarizarse].
Readings : [**Goleman1995**]	

Unit 9: Leadership, Team Dynamics, and Stakeholder Management (4 hours)	
Competences Expected: ABET-3	
Topics	**Learning Outcomes**
• Leadership styles, traits, and the difference between leadership and management • Team dynamics: forming, storming, norming, performing stages and roles • Conflict resolution strategies and negotiation • Stakeholder identification, analysis, and engagement planning • Motivation theories and their application to engineering teams • Cultural intelligence and leading diverse, global teams • Change management and leading organizational transformation • Emotional intelligence and its role in effective leadership • Ethical leadership and creating an ethical organizational culture	• Describe different leadership styles and identify situations where each might be effective [Familiarity] • Diagnose the stage of development of a project team and propose appropriate interventions [Assessment] • Resolve a simulated interpersonal conflict within a project team using a structured approach [Usage] • Develop a stakeholder engagement plan for a project with community opposition [Assessment] • Adapt communication and leadership approach when working with a team from a different cultural background [Assessment] • Explain the key steps in a change management process for implementing a new technology [Familiarity] • Evaluate one's own emotional intelligence and identify areas for development [Assessment] • Model ethical leadership behavior in a team-based project simulation [Usage]
Readings : [**Robbins2017**]	

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 ********

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

1. COURSE

BRC101. Writing and Communication (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	BRC101. Writing and Communication
2.2 Semester	:	1st Semester.
2.3 Credits	:	2
2.4 Hours	:	2 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Effective written, oral, and digital communication is a core engineering competency, independent of any particular specialty. This course develops academic and technical writing, oral presentation, and professional digital-communication skills, so that students can produce clear reports and collaborative academic work, apply standard citation norms, and communicate technical content to varied audiences throughout their engineering studies and professional careers.

5. GOALS

- Apply grammar, style, and academic writing conventions to produce clear, well-organized written texts.
- Write academic and group research texts following standard citation norms (APA).
- Deliver structured oral presentations, adapting content to different audiences.
- Communicate professionally through digital channels and with project stakeholders.

6. COMPETENCES

ABET-3) An ability to communicate effectively with a range of audiences. (Familiarity)

7. TOPICS

Unit 1: Written and Technical Communication (19 hours)	
Competences Expected: ABET-3	
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 : [**GurakLannon2013**], [**APA2020**]	

Unit 2: Oral Presentation and Professional Communication (19 hours)	
Competences Expected: ABET-3	
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 : [**GurakLannon2013**], [**APA2020**]	

Unit 3: Digital and Collaborative Communication (18 hours)	
Competences Expected: ABET-3	
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 : [**GurakLannon2013**], [**APA2020**]	

8. WORKPLAN

8.1 Methodology

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8.3 Practical Sessions

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9. EVALUATION SYSTEM

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

10. BASIC BIBLIOGRAPHY

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

1. COURSE

BIC101. Introduction to Programming (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	BIC101. Introduction to Programming
2.2 Semester	:	1st Semester.
2.3 Credits	:	5
2.4 Hours	:	3 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This is the first course in the sequence of introductory courses to Computer Science. This course introduces participants to the fundamental concepts of programming using Python. Topics include data types, control structures, functions, lists, recursion, and the mechanics of execution, testing, and debugging. Programming is one of the pillars of Computer Science; any professional in the area will need to program to materialize their models and proposals.

5. GOALS

- Introduce the fundamental concepts of programming.
- Develop the ability of abstraction using a programming language.
- Develop problem-solving skills through algorithmic thinking.
- Understand basic data structures and their applications.
- Master the Python programming language for problem solving.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

ABET-7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies. (Familiarity)

7. TOPICS

Unit 1: Introduction to Programming and History (4 hours)	
Competences Expected: ABET-1,ABET-7	
Topics	**Learning Outcomes**
• Brief history of computing and programming languages. • Overview of Python programming language. • Programming environments and tools. • Basic program structure and execution. • Writing, running, and debugging simple programs.	• Identify important trends in the history of computing. [Familiarizarse] • Discuss the historical context of programming language paradigms. [Familiarizarse] • Compare daily life before and after personal computers and the Internet. [Evaluar] • Write, compile, and run a simple Python program. [Usar]
Readings : [**Zelle2010**], [**Guttag2013**], [**Brooks2019**]	

Unit 2: Type Systems Fundamentals (6 hours)	
Competences Expected: ABET-1,ABET-7	
Topics	**Learning Outcomes**
• A type as a set of values together with a set of operations: – Primitive types (e.g., numbers, Booleans) – Compound types built from other types (e.g., records/structs, unions, arrays, lists, functions, references using set operations) • Type safety and errors caused by using values inconsistently given their intended types • Goals and limitations of static and dynamic typing: detecting and eliminating errors as early as possible. • Primitive data types in Python (int, float, str, bool). • Type conversion and casting.	• Describe, for both a primitive and a compound type, the values that have that type [Familiarizarse] • Describe examples of program errors detected by a type system [Familiarizarse] • Use types and type-error messages to write and debug programs [Usar] • Explain Python's dynamic typing system. [Familiarizarse]
Readings : [**Zelle2010**], [**Guttag2013**]	

Unit 3: Object-Oriented Programming Fundamentals (14 hours)	
Competences Expected: ABET-1,ABET-7	
Topics	**Learning Outcomes**
• Imperative programming as a subset of object-oriented programming. • Definition of classes: fields, methods, and constructors. • Dynamic vs static properties. • Variables, expressions, and assignments. • Input and output operations. • Conditional statements (if, elif, else). • Iteration structures (for loops, while loops). • Nested loops and loop control statements. • Exception handling basics.	• Compose a class through design, implementation, and testing to meet behavioral requirements [Usar] • Predict and validate control flow in a program using dynamic dispatch [Evaluar] • Use object-oriented encapsulation mechanisms such as interfaces and private members [Usar] • Implement programs using conditional and iterative structures. [Usar] • Debug programs with syntax and logical errors. [Usar] • Design and implement simple algorithms using loops. [Usar]
Readings : [**Zelle2010**], [**Guttag2013**], [**Brooks2019**]	

Unit 4: Functions and Parameter Passing (10 hours)	
Competences Expected: ABET-1,ABET-7	
Topics	**Learning Outcomes**
• Function definition and invocation. • Parameter passing mechanisms (by value, by reference). • Return values and multiple returns. • Variable scope and lifetime (local, global, nonlocal). • Recursion fundamentals. • Lambda expressions and higher-order functions. • Functions as first-class objects. • Documentation and testing of functions.	• Define and implement functions with proper parameter passing. [Usar] • Explain the difference between pass-by-value and pass-by-reference. [Familiarizarse] • Implement recursive solutions to simple problems. [Usar] • Use lambda expressions for functional programming constructs. [Usar] • Design functions with appropriate scope and documentation. [Evaluar]
Readings : [**Zelle2010**], [**Guttag2013**], [**Pragmatic2009**]	

Unit 5: Basic Data Structures (10 hours)	
Competences Expected: ABET-1,ABET-7	
Topics	**Learning Outcomes**
• Lists and list operations (indexing, slicing, mutability). • Tuples and immutability. • Dictionaries and key-value mapping. • Sets and set operations. • Strings as sequences. • List comprehensions and generator expressions. • Basic searching and sorting algorithms. • Introduction to algorithmic complexity for basic operations.	• Implement programs using lists, dictionaries, and sets. [Usar] • Choose appropriate data structures for given problems. [Evaluar] • Explain the trade-offs between different data structures. [Familiarizarse] • Implement basic search and sort operations on lists. [Usar]
Readings : [**Zelle2010**], [**Guttag2013**]	

Unit 6: Object-Oriented Programming Fundamentals (10 hours)	
Competences Expected: ABET-1,ABET-7	
Topics	**Learning Outcomes**
• Subclasses, inheritance (including multiple inheritance), and method overriding. • Dynamic dispatch: definition of method-call. • Object-oriented idioms for encapsulation: – Privacy, data hiding, and visibility of class members. – Interfaces revealing only method signatures. – Abstract base classes, traits and mixins. • Classes and objects in Python. • Attributes and methods. • Inheritance and polymorphism basics. • Encapsulation and information hiding.	• Build a simple class hierarchy utilizing subclassing that allows code to be reused for distinct subclasses [Usar] • Explain the relationship between object-oriented inheritance (code-sharing and overriding) and subtyping (the idea of a subtype being usable in a context that expects the supertype) [Familiarizarse] • Compare and contrast the benefits and costs/impact of using inheritance (subclasses) and composition (specifically, how to base composition on higher order functions) [Evaluar] • Design and implement simple classes in Python. [Usar] • Explain the benefits of OOP for code organization. [Familiarizarse]
Readings : [**Zelle2010**], [**Guttag2013**]	

Unit 7: Algorithmic Strategies (6 hours)

Competences Expected: ABET-1,ABET-7

Topics	**Learning Outcomes**
• Paradigms: – Brute-Force (e.g., linear search, selection sort, traveling salesperson, knapsack) – Decrease-and-Conquer: ∗ By a Constant (e.g., insertion sort, topological sort) ∗ By a Constant Factor (e.g., binary search) ∗ By a Variable Size (e.g., Euclid's) – Divide-and-Conquer (e.g., binary search, quicksort, mergesort, Strassen's) – Greedy (e.g., Dijkstra's, Kruskal's, Knapsack) – Transform-and-Conquer: ∗ Instance simplification (e.g., find duplicates via list presort) ∗ Representation change (e.g., heapsort) ∗ Problem reduction (e.g., least-common-multiple, linear programming) ∗ Dynamic programming (e.g., Floyd's, Marshall, Bellman-Ford) – Space vs time tradeoffs (e.g., hashing) • Iteration vs recursion (e.g., factorial, tree search) • Problem decomposition strategies. • Algorithm design techniques. • Debugging and testing strategies. • Tracing program execution.	• For each of the paradigms in this unit: – Explain its definitional characteristics – Explain an example that demonstrates the paradigm including how this example satisfies the paradigm's characteristics. [Familiarizarse] • Give examples of iterative and recursive algorithms that solve the same problem, explain the benefits and disadvantages of each approach [Usar] • Evaluate whether a greedy approach leads to an optimal solution [Evaluar] • Apply systematic debugging techniques to locate and fix errors. [Usar] • Analyze algorithm complexity for simple problems. [Familiarizarse]

Readings : [**Guttag2013**], [**Cormen2009**]

Unit 8: Modern Development Methods and Tool Usage (4 hours)

Competences Expected: ABET-1,ABET-7

Topics	**Learning Outcomes**
• Using modern programming environments (IDEs, notebooks). • Code search and reuse best practices. • Using standard libraries and APIs. • Debugging and testing techniques. • Version control basics. • Code documentation and style guidelines. • Virtual environments and package management.	• Use modern development tools effectively. [Usar] • Apply code reuse principles through libraries and APIs. [Usar] • Debug and test programs systematically. [Usar] • Follow coding standards and documentation practices. [Familiarizarse] • Manage Python packages and environments. [Familiarizarse]

Readings : [**Zelle2010**], [**Pragmatic2009**]

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

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9. EVALUATION SYSTEM

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

10. BASIC BIBLIOGRAPHY

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

1. COURSE

BEC101. General Economics (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	BEC101. General Economics
2.2 Semester	:	1st Semester.
2.3 Credits	:	3
2.4 Hours	:	2 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

General Economics introduces the fundamentals of economic theory and its historical evolution, market functioning (supply, demand, and elasticity), market structures, production, costs, and firm profits, business economic and financial management, and the basic aspects of macroeconomics, growth, and globalization, as a foundation for the economic decision-making of engineering and computing professionals.

5. GOALS

- Apply the fundamental principles of economic theory to the analysis of engineering decisions.
- Analyze market functioning through supply, demand, and elasticity.
- Analyze the production, costs, and profits of a firm under different market structures.
- Understand the basic aspects of macroeconomics, economic growth, and globalization.

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)

7. TOPICS

Unit 1: Fundamentals of Economic Theory (2 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Fundamental concepts of economic theory: scarcity, opportunity cost, and decision-making.	• Explain the fundamental concepts of economic theory [Familiarizarse].
Readings : [**Mankiw2018**]	

Unit 2: Pre-Classical and Classical Economics (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Mercantilist doctrine, Physiocracy, and the Tableau Economique of Quesnay • Adam Smith: invisible hand, division of labor, theory of value, and the critique of mercantilism • David Ricardo: comparative advantage, rent theory, Ricardian equivalence, and the corn laws debate • Marx's critique of classical economics: surplus value, exploitation, capital accumulation, and crisis theory	• Describe the central contributions of Adam Smith and David Ricardo to classical political economy [Familiarity] • Compare the Ricardian and Smithian theories of value and distribution and trace their influence on later economic schools [Usage] • Evaluate Marx's critique of classical economics and identify which elements retain analytical relevance [Assessment]
Readings : [**Mankiw2018**], [**SamuelsonNordhaus2010**]	

Unit 3: Consumer Theory (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Preference axioms (completeness, transitivity, continuity) and utility representation theorems • The utility maximization problem: Marshallian demand functions and Roy's identity • The expenditure minimization problem: Hicksian demand functions and Shephard's lemma • The Slutsky equation: decomposing price effects into substitution and income effects • Revealed preference theory: WARP, SARP, and empirical content of demand theory	• State the axioms of rational preference and the conditions for utility representation [Familiarity] • Derive Marshallian and Hicksian demand functions from utility and expenditure minimization problems [Usage] • Decompose price effects into substitution and income effects using the Slutsky equation [Assessment]
Readings : [**Mankiw2018**]	

Unit 4: Market Structures (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Competitive equilibrium: price-taking behavior, short-run and long-run supply, and zero-profit condition • Monopoly pricing: marginal revenue, deadweight loss, price discrimination (first, second, third degree) • Monopolistic competition: product differentiation, markup pricing, and free-entry equilibrium • Oligopoly models: Cournot, Bertrand, and Stackelberg competition; collusion and the prisoner's dilemma • Advanced pricing: bundling, two-part tariffs, versioning, and peak-load pricing	• Compare equilibrium outcomes across market structures in terms of price, output, and efficiency [Familiarity] • Calculate equilibrium price, quantity, and welfare under monopoly and Cournot duopoly [Usage] • Evaluate the welfare effects of market power and the rationale for antitrust policy [Assessment]
Readings : [**Mankiw2018**], [**SamuelsonNordhaus2010**]	

Unit 5: Producer Theory (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Production functions, isoquants, marginal products, and returns to scale • Cost minimization: conditional factor demands, cost functions, and Shephard's lemma • Profit maximization: output supply and factor demand under competitive and monopolistic conditions • Short-run vs. long-run costs, economies of scale and scope, and multi-product firms	• Describe production technology using production functions, isoquants, and returns to scale [Familiarity] • Derive cost functions and supply schedules from profit-maximizing behavior [Usage] • Analyze how input price changes affect output supply and factor demands using duality [Assessment]
Readings : [**Mankiw2018**]	

Unit 6: Financial Markets and Institutions (10 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Market microstructure: bid-ask spread, order flow, liquidity, and price discovery • Financial intermediation: banks as liquidity transformers, maturity mismatch, and bank runs (Diamond-Dybvig) • Systemic risk, financial contagion, macroprudential policy, and the 2008 financial crisis • Financial regulation: capital requirements, deposit insurance, lender of last resort, and Dodd-Frank	• Describe the role of financial intermediaries in the economy and the sources of systemic risk [Familiarity] • Analyze the sources of systemic risk in a financial system and identify channels of contagion using network and balance-sheet linkages [Usage] • Evaluate the design and trade-offs of macroprudential regulation in preventing financial crises [Assessment]
Readings : [**Blank2017**], [**SamuelsonNordhaus2010**]	

Unit 7: National Income Accounting (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• GDP definition and measurement: expenditure, income, and production approaches; nominal vs. real GDP • National income identities: $Y = C + I + G + NX$; saving-investment relationship and current account • Price indices: GDP deflator, CPI, PPI; measurement of inflation and real variables • Balance of payments accounts: current account, capital account, and financial account	• Define GDP and explain the three approaches to its measurement [Familiarity] • Calculate real GDP growth, the GDP deflator, and the saving-investment balance from national accounts data [Usage] • Interpret discrepancies between national accounting approaches and identify measurement limitations [Assessment]
Readings : [**SamuelsonNordhaus2010**]	

Unit 8: Economic Growth Theory (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Solow-Swan growth model: capital accumulation, steady-state, convergence, and the golden rule • Exogenous technological progress, total factor productivity, and the Solow residual • Endogenous growth models: AK model, R&D-based models (Romer, Aghion-Howitt), and knowledge spillovers • Cross-country growth regressions, conditional convergence, and the role of institutions and human capital • Institutional determinants of growth: property rights, rule of law, and political economy	• Describe the Solow model and its predictions about capital accumulation and steady-state income [Familiarity] • Analyze the impact of saving rates and technological progress on long-run growth using the Solow model [Usage] • Compare exogenous and endogenous growth theories and their implications for policy [Assessment]
Readings : [**SamuelsonNordhaus2010**]	

8. WORKPLAN

8.1 Methodology

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9. EVALUATION SYSTEM

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

10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE1G1. General Geology (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE1G1. General Geology
2.2 Semester	:	2nd Semester.
2.3 Credits	:	3
2.4 Hours	:	3 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

The General Geology course provides the future civil engineer with the descriptive and analytical foundations of Earth Sciences: the minerals and rocks that constitute geological materials, the structures that record the deformation of the Earth's crust, surface weathering and erosion processes, geological time and the reading of geological maps, and an introduction to applied geology for site characterization. This knowledge constitutes the indispensable conceptual foundation upon which subsequent courses in Soil Mechanics and Geotechnical Engineering are built.

5. GOALS

- Identify the most common minerals and rocks and relate their properties to their expected engineering behavior.
- Recognize and interpret geological structures — folds, faults, and joints — and their influence on the stability of rock masses.
- Understand the processes of weathering, erosion, and landform development relevant to site condition assessment.
- Read and interpret geological maps, stratigraphic columns, and cross-sections.
- Apply the fundamentals of general geology to the preliminary reconnaissance and descriptive characterization of civil engineering sites.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (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: Mineralogy (6 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Crystal structure and habit of minerals • Main groups of rock-forming minerals: silicates, carbonates, oxides, and sulfates • Mohs hardness scale and scratch tests • Cleavage, fracture, and other diagnostic physical properties • Luster, color, and streak as identification criteria • Basic chemical composition and reaction with dilute hydrochloric acid	• Identify the most common rock-forming minerals using physical properties [Familiarity] • Apply the Mohs scale to determine the relative hardness of mineral samples [Usage] • Distinguish similar minerals through cleavage, fracture, and luster [Assessment] • Relate the mineral composition of a rock to its expected engineering behavior [Familiarity] • Perform simple field tests (scratch, acid, luster) for mineral identification [Usage]
Readings : [**Tarbuck2014**]	

Unit 2: Petrology and the Rock Cycle (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Classification of intrusive and extrusive igneous rocks by texture and composition • Sedimentary rock formation processes: erosion, transport, deposition, and lithification • Classification of clastic, chemical, and biochemical sedimentary rocks • Metamorphic processes: contact and regional metamorphism • Classification of foliated and non-foliated metamorphic rocks • The rock cycle and transformations between lithologic types • Relevant engineering properties of rocks: strength, durability, and alterability	• Classify hand samples of igneous rocks according to their texture and mineral composition [Assessment] • Explain the formation processes of sedimentary rocks and their engineering significance [Familiarity] • Recognize foliated and non-foliated metamorphic textures in hand samples [Usage] • Trace the pathways of the rock cycle among the three lithologic groups [Familiarity] • Qualitatively evaluate the suitability of a rock type for use as a construction or foundation material [Assessment]
Readings : [**Tarbuck2014**], [**Marshak2015**]	

Unit 3: Structural Geology (6 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Stress and strain concepts in rocks • Fold types: anticlines, synclines, and their geometric elements • Fault types: normal, reverse, and strike-slip • Joint sets and their influence on rock mass strength • Measurement and interpretation of strike and dip • Unconformities and their significance in geologic history • Influence of geologic structures on slope and excavation stability	• Differentiate folds, faults, and joints based on their geometric features [Familiarity] • Measure the strike and dip of geologic planes using a geologic (Brunton-type) compass [Usage] • Interpret the orientation of structural discontinuities relative to an excavation or slope [Assessment] • Assess the influence of joint sets on the stability of a rock mass [Assessment] • Recognize unconformities and relate them to regional geologic history [Familiarity]
Readings : [**Billings1972**]	

Unit 4: Geomorphology, Weathering, and Erosion Processes (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Physical weathering: thermal fragmentation, frost wedging, and unloading • Chemical weathering: hydrolysis, oxidation, and dissolution • Biological weathering and bioerosion • Residual soil formation from in-situ weathering • Main landforms: valleys, terraces, alluvial fans, and debris cones • Water and wind erosion processes and mass wasting processes	• Distinguish physical, chemical, and biological weathering types present at an outcrop [Familiarity] • Relate the degree of weathering of a rock to the expected quality of a rock mass [Usage] • Identify landforms and their geomorphological origin [Familiarity] • Evaluate the susceptibility of a slope to erosion and mass wasting processes [Assessment] • Apply weathering grade classification criteria to estimate the durability of rock materials in slopes [Usage]
Readings : [**Tarbuck2014**]	

Unit 5: Geologic Time, Stratigraphy, and Geologic Mapping (6 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• The geologic time scale and the magnitude of deep time • Principles of relative dating: superposition, original horizontality, and cross-cutting relationships • Construction and interpretation of stratigraphic columns • Symbology and conventions of geologic maps • Construction of geologic cross-sections from maps • Stratigraphic discontinuities and their expression on geologic maps • Basic field geologic mapping techniques	• Explain the principles of relative dating to establish stratigraphic sequences [Familiarity] • Read and interpret standard geologic maps, including their symbology and legend [Usage] • Construct a geologic cross-section from a geologic map and strike/dip data [Assessment] • Correlate stratigraphic units between columns from different localities [Assessment] • Apply basic field geologic mapping techniques for a simple survey [Usage]
Readings : [**Compton1985**]	

Unit 6: Basic Surface and Groundwater Hydrology of Geologic Materials (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Porosity and permeability of soils and rocks • Water table concept and the unsaturated zone • Basic concepts of aquifer, aquitard, and aquiclude • Springs, seeps, and their relationship to the geologic context • Surface drainage patterns and their relationship to lithology and structure • Water-rock interaction and its influence on weathering	• Differentiate the concepts of porosity and permeability for different geologic materials [Familiarity] • Describe the position of the water table and its seasonal variation at a given site [Familiarity] • Relate the occurrence of springs and seeps to the local geologic and hydrogeologic context [Usage] • Identify surface drainage patterns characteristic of different geologic conditions [Assessment] • Explain conceptually the water-rock interaction and its role in chemical weathering [Familiarity]
Readings : [**Tarbuck2014**]	

Unit 7: Applied Geology (6 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Preliminary geologic site reconnaissance • Qualitative description of rock masses: degree of fracturing and weathering • Types of geologic hazards: landslides, rockfalls, seismic and volcanic activity • Use of aerial photographs and remote sensing imagery in geologic reconnaissance • Basic elements of a preliminary geologic site report • Use of field tools: geologic compass, GPS, hand lens, and rock hammer • Influence of geologic conditions on infrastructure site selection	• Conduct a preliminary geologic reconnaissance of a site of interest for civil engineering [Usage] • Qualitatively describe the degree of fracturing and weathering of a rock mass [Assessment] • Recognize the main types of geologic hazards that can affect an infrastructure project [Familiarity] • Use basic field tools to gather geologic information [Usage] • Prepare a preliminary geologic site report with basic recommendations for further studies [Assessment]
Readings : [**GonzalezDeVallejo2002**]	

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

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

1. COURSE

CS100. Introduction to Computer Science (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CS100. Introduction to Computer Science
2.2 Semester	:	2nd Semester.
2.3 Credits	:	3
2.4 Hours	:	2 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course serves as the foundation for understanding the fundamental concepts of computational thinking applicable across various professions.

The course provides, starting from ground zero, a panoramic view of: introductory computational thinking, data storage, computer architecture, operating systems, networks and the Internet, algorithms, sorting methods, software engineering, databases, data structures, software engineering, computer graphics, artificial intelligence among others.

Designed as an introductory course to Computer Science, the concepts are presented in a playful manner and using an Active Learning methodology. Throughout the course, active audience participation is encouraged, akin to a theatrical performance.

The related knowledge areas covered are directly aligned with the Computing Curricula ACM/IEEE-CS.

The course **does not require** any prior knowledge in computer handling topics and can be taken by student from any field.

5. GOALS

- Introduce the fundamental concepts of Computational Thinking and Computer Science to students from any professional background.
- Develop their ability to abstract.
- Understand how Computational Thinking is applied in each of their professions.
- Apply advanced concepts in a simplified manner in any career.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

ABET-4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. (Familiarity)

ABET-7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies. (Familiarity)

7. TOPICS

Unit 1: Computational Thinking (Part I) (4 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Explanation of the evaluation system. • General course instructions. • Definition of Computing. • Computing as a Human-Computer binomial. • Distortions in the definition of computing. • Computing as the automation of abstraction. • Computing and Engineering: similarities and differences. • Algorithmic problem-solving. • Dynamics: Understanding the execution of an algorithm at human speed.	• Apply the fundamental concepts of computing in real-life situations. [Usar] • Identify distortions of Computing in real-life situations. [Usar] • Clearly identify at least 3 contexts of using the word“Engineer” in English. [Evaluar] • Identify the limitations of humans in solving computational problems. [Usar]
Readings : [**Brookshear2019**]	

Unit 2: Computational Thinking. Part II (4 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Decomposition (Breaking a problem in smaller pieces) • Abstraction (Focus on important things) • Pattern recongnition (Identify similar sequences based on previous problems) • Designing algorithms	• Apply Computational Thinking to real-world problems. [Usar]
Readings : [**Brookshear2019**]	

Unit 3: General concepts (4 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Binary vs. decimal numbering. • Character representation: the ASCII table. • Binary search. • Computational complexity of an algorithm.	• Apply various numbering systems to real-world problems. [Usar] • Understand the internal representation of characters in the ASCII and UTF-8 tables. [Familiarizarse] • Apply Divide and Conquer algorithmic strategy. [Usar] • Determine basic analysis of algorithmic complexity. [Usar]
Readings : [**Brookshear2019**]	

Unit 4: Machine-Level Data Representation (4 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Overview and history of computer architecture • Bits, bytes, and words • Unsigned, signed and two's complement representations • Numeric data representation and number bases: – Fixed-point – Floating-point • Representation of non-numeric data • Representation of records, arrays and UTF data types	• Discuss why everything in computers are data, including instructions [Debate] • Explain how fixed-length number representations can affect accuracy and precision [Explain] • Describe how negative integers are stored in sign-magnitude and two's-complement representations [Describe] • Discuss how different formats can represent numerical data [Debate] • Explain the bit-level representation of non-numeric data, such as characters, strings, records, and arrays [Explain] • Translate numerical data from one format to another [Translate] • Describe how a single adder (without overflow detection) can handle both signed (two's complement) and unsigned (binary) input without "knowing" which format a given input is using [Describe]
Readings : [**Brookshear2019**]	

Unit 5: Program Abstraction and Representation (2 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Programs that take (other) programs as input such as interpreters, compilers, type-checkers, documentation generators • Components of a language: – Definitions of alphabets, delimiters, sentences, syntax, and semantics – Syntax vs semantics • Program as a set of non-ambiguous meaningful sentences • Basic programming abstractions: constants, variables, declarations (including nested declarations), command, expression, assignment, selection, definite and indefinite iteration, iterators, function, procedure, modules, exception handling • Types of variables: static, local, nonlocal, global; need and issues with nonlocal and global variables. • Scope rules: static vs dynamic; visibility of variables; side-effects. • Environment vs store and their properties • Data and control abstraction • Mechanisms for information exchange between program units such as procedures, functions, and modules: nonlocal variables, global variables, parameter-passing, import-export between modules • Low level instruction representation such as virtual machine instructions, assembly language, and binary representation	• Illustrate the scope of variables and visibility using simple programs [Apply] • Illustrate different types of parameter-passing using simple pseudo programming language [Apply] • Explain side-effect using global and nonlocal variables and how to fix such programs [Explain] • Explain how programs that process other programs treat the other programs as their input data [Explain] • Describe a grammar and an abstract syntax tree for a small language [Describe]
Readings : [**Brookshear2019**]	

Unit 6: Cryptography Fundamentals (2 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Basic concepts on Cryptography • Public-keys, Private-keys	• Explain the role of cryptography in supporting security and privacy [Explain] • Discuss the risks of inventing one's own cryptographic methods [Debate] • Discuss the importance of prime numbers in cryptography and explain their use in cryptographic algorithms [Debate] • Implement and cryptanalyze classical ciphers [Implement]
Readings : [**Brookshear2019**]	

Unit 7: Memory Management (4 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Review of physical memory, address translation and memory management hardware See also: Memory Hierarchy, Discrete Mathematics • Impact of memory hierarchy including cache concept, cache lookup, and per-CPU caching on operating system mechanisms and policy See also: Memory Hierarchy, Latency, Cache and Memory Hierarchy, Virtualization and Isolation • Logical and physical addressing, address space virtualization. See also: Memory Hierarchy, Discrete Mathematics • Concepts of paging, page replacement, thrashing and allocation of pages and frames • Allocation/deallocation/storage techniques (algorithms and data structure) performance and flexibility – Arenas, slab allocators, free lists, size classes, heterogeneously sized pages (huge pages) • Memory caching and cache coherence and the effect of flushing the cache to avoid speculative execution vulnerabilities. See also: Functional Organization, Memory Hierarchy, Latency, Cache and Memory Hierarchy, Virtualization and Isolation • Virtual memory: leveraging virtual memory hardware for OS services and efficiency	• Explain memory hierarchy and cost-performance tradeoffs [Explain] • Summarize the principles of virtual memory as applied to caching and paging [Summarize] • Evaluate the tradeoffs in terms of memory size (main memory, cache memory, auxiliary memory) and processor speed [Evaluate] • Describe the reason for and use of cache memory (performance and proximity, how caches complicate isolation and virtual machine abstraction) [Describe]
Readings : [**Brookshear2019**]	

Unit 8: Role and Purpose of Operating Systems (2 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Operating systems mediate between general purpose hardware and application-specific software. • Universal operating system functions (e.g., process, user and device interfaces, persistence of data) • Influences of security, networking, multimedia, parallel and distributed computing	• Understand the objectives and functions of modern operating systems [Explain] • Evaluate the design issues in different usage scenarios (e.g., real time OS, mobile, server) [Evaluate] • Understand how evolution and stability are desirable and mutually antagonistic in operating systems function [Explain]
Readings : [**Brookshear2019**]	

Unit 9: Principles of Operating System (2 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Operating system software design and approaches (e.g., monolithic, layered, modular, micro-kernel, unikernel) • Abstractions, processes, and resources • The evolution of the link between hardware architecture and the operating system functions • Leveraging interrupts from hardware level: service routines and implementations. See also: Assembly Level Machine Organization – Timer interrupts for implementing time slices – I/O interrupts for putting blocking threads to sleep without polling	• Understand how the application of software design approaches to operating systems design/implementation (e.g., layered, modular, etc.) affects the robustness and maintainability of an operating system [Explain] • Categorize system calls by purpose [Categorize] • Apply OS techniques for isolation, protection, and throughput across OS functions (e.g., starvation similarities in process scheduling, disk request scheduling, semaphores, etc.) and beyond [Apply]
Readings : [**Brookshear2019**]	

Unit 10: Fundamentals of Networks and Communications (4 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Importance of networking in contemporary computing, and associated challenges. See also: Digital Equity and Accessibility, Social Impact and AI, Civil Liberties and Expression, Data, Surveillance and Privacy Technology, Privacy Philosophical Foundations and Legislation • Organization of the internet (e.g., users, Internet Service Providers, autonomous systems, content providers, content delivery networks) • Layers and their roles (application, transport, network, datalink, and physical) • Network elements (e.g., routers, switches, hubs, access points, and hosts) • Basic queueing concepts (e.g., relationship with latency, congestion, service levels, etc.)	• Articulate the organization of the internet [Articulate] • List and define the appropriate network terminology [List] • Describe the layered structure of a typical networked architecture [Describe]
Readings : [**Brookshear2019**]	

Unit 11: Networked Applications (4 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Naming and address schemes (e.g., DNS, and Uniform Resource Identifiers) • Distributed application paradigms (e.g., client/server, peer-to-peer, cloud, edge, and fog). See also: Communication, Coordination • Diversity of networked application demands (e.g., latency, bandwidth, and loss tolerance). See also: Communication, Sustainable Design and Pervasive Computing, Environmental Footprint of Computing Systems, Systemic Effects and Social Context, Digital Equity and Accessibility, Social Impact and AI • Coverage of application-layer protocols (e.g., HTTP) • Interactions with TCP, UDP, and Socket APIs. See also: Programs: Distribution, Programs: Execution Properties, GPU Programming, Programs: Implementation Mappings, Programs: Declarative Parallelism, Programs: Starting Activities	• Define the principles of naming, addressing, resource location [Define] • Analyze the needs of specific networked application demands [Analyze]
Readings : [**Brookshear2019**]	

Unit 12: Complexity Analysis Framework (2 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Complexity Analysis Framework: – Best, average, and worst-case performance of an algorithm – Empirical and relative (Order of Growth) measurements – Input size and primitive operations – Time and space efficiency • Empirical measurements of performance • Time and space tradeoffs in algorithms	• Prepare a presentation that explains to first year students the basic concepts of algorithmic complexity including best, average, and worst-case algorithm behavior, Big-O, Omega, and Theta notations, complexity classes, time and space tradeoffs, empirical measurement, and impact on practical problems [Explain] • For each algorithm in the Foundational Data Structures, Foundational Algorithms, Advanced Algorithms unit, explain its runtime complexity class and why it belongs to this class [Explain] • Informally evaluate the foundational complexity class of simple algorithms [Evaluate] • Develop empirical studies to determine and validate hypotheses about the runtime complexity of various algorithms by running algorithms on input of various sizes and comparing actual performance to the theoretical analysis [Create] • Explain examples that illustrate time-space tradeoffs of algorithms [Explain] • Explain how tree balance affects the efficiency of binary search tree operations [Explain]
Readings : [**Brookshear2019**]	

Unit 13: Asymptotic Notation and Complexity Classes (1 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Asymptotic complexity analysis (average and worst-case bounds): – Big-O, Big-Omega, and Big-Theta formal notations – Foundational Complexity Classes and Representative Examples/Problems: ∗ $O(1)$ Constant (e.g., array access) ∗ $O(\log_2 n)$ Logarithmic (e.g., binary search) ∗ $O(n)$ Linear (e.g., linear search) ∗ $O(n \log_2 n)$ Log Linear (e.g., mergesort) ∗ $O(n^2)$ Quadratic (e.g., selection sort) ∗ $O(n^c)$ Polynomial (e.g., $O(n^3)$ Gaussian elimination) ∗ $O(2^n)$ Exponential (e.g., Knapsack, Satisfiability (SAT), Traveling Sales-Person (TSP), all subsets) ∗ $O(n!)$ Factorial (e.g., Hamiltonian circuit, all permutations)	• Using examples, explain each of the foundational complexity classes in this unit [Explain] • For each foundational complexity class in this unit, explain an algorithm that demonstrates the associated runtime complexity [Explain] • Explain to a non-technical audience the significance of tractable versus intractable algorithms using an intuitive explanation of Big-O complexity [Explain]
Readings : [**Brookshear2019**]	

Unit 14: Complexity Analysis: Recursion, Amortization, and Tight Bounds (1 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Little-o, Little-Omega, and Little Theta notations	• Given a problem to program for which there may be several algorithmic approaches, evaluate them and determine which are feasible, and select one that is optimal in implementation and run-time behavior [Evaluate]
Readings : [**Brookshear2019**]	

Unit 15: Foundational Data Structures (3 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Abstract Data Type (ADT) and operations on an ADT: – Dictionary operations (insert, delete, find) • Arrays: – Numeric vs non-numeric, character strings – Single (vector) vs multidimensional (matrix) • Records/Structs/Tuples and Objects • Linked lists (for historical reasons): – Single vs Double and Linear vs Circular • Stacks • Queues and deques: – Heap-based priority queue • Hash tables/maps: – Collision resolution and complexity (e.g., probing, chaining, rehash) • Trees: – Binary, n-ary, and search trees – Balanced (e.g., AVL, Red-Black, Heap)	• For each ADT/Data-Structure in this unit: – Explain its definition, properties, representation(s), and associated ADT operations. – Explain step-by-step how the ADT operations associated with the data structure transform it. [Explain] • Explain how collision avoidance and collision resolution is handled in hash tables [Explain] • Explain the heap property and the use of heaps as an implementation of a priority queue [Explain]
Readings : [**Brookshear2019**]	

Unit 16: Foundational Algorithms (3 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Graphs (e.g., [un]directed, [a]cyclic, [un]connected, and [un]weighted): – Graph representation: adjacency list vs matrix • Search algorithms: – $O(n)$ complexity (e.g., linear/sequential array/list search) – $O(\log_2 n)$ complexity (e.g., binary search) – $O(\log_b n)$ complexity (e.g., uninformed depth/breadth-first tree search) • Sorting algorithms (e.g., stable, unstable): – $O(n^2)$ complexity (e.g., insertion, selection) – $O(n \log n)$ complexity (e.g., quicksort, merge, timsort) • Graph algorithms: – Shortest path (e.g., Dijkstra's, Floyd's) – Minimal spanning tree (e.g., Prim's, Kruskal's) • Sorting algorithms: – $O(n \log n)$ complexity heapsort – Pseudo $O(n)$ complexity (e.g., bucket, counting, radix) • Graph algorithms: – Transitive closure (e.g., Warshall's) – Topological sort	• For each algorithm in this unit explain step-by-step how the algorithm operates [Explain] • For each algorithmic approach (e.g., sorting) in this unit apply a prototypical example of the approach (e.g., merge sort) [Apply] • Given requirements for a problem, develop multiple solutions using various data structures and algorithms. Subsequently, evaluate the suitability, strengths, and weaknesses selecting an approach that best satisfies the requirements [Create] • Explain factors beyond computational efficiency that influence the choice of algorithms, such as programming time, maintainability, and the use of application-specific patterns in the input data [Explain]
Readings : [**Brookshear2019**]	

Unit 17: Advanced Algorithms (2 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Cryptography algorithms (e.g., SHA-256) • Parallel algorithms	• An appreciation of quantum computation and its application to certain problems [Explain]
Readings : [**Brookshear2019**]	

Unit 18: Core Database System Concepts (4 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Purpose and advantages of database systems • Components of database systems • Design of core DBMS functions (e.g., query mechanisms, transaction management, buffer management, access methods) • Transaction management • Normalization • Approaches for managing large volumes of data (e.g., NoSQL database systems, use of MapReduce) • Distributed databases/cloud-based systems • Use of a declarative query language	• Identify at least four advantages that using a database system provides [Analyze] • Enumerate the components of a (relational) database system [Enumerate] • Defend the value of data independence [Defend] • Compose a simple select-project-join query in SQL [Compose] • Describe the advantages for eliminating duplicate repeated data [Describe] • Outline how MapReduce uses parallelism to process data efficiently [Outline]
Readings : [**Brookshear2019**]	

Unit 19: Object-Oriented Programming Fundamentals (4 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Imperative programming as a subset of object-oriented programming. • Object-oriented design: – Decomposition into objects carrying state and having behavior. – Class-hierarchy design for modeling. • Definition of classes: fields, methods, and constructors. • Subclasses, inheritance (including multiple inheritance), and method overriding. • Dynamic dispatch: definition of method-call. • Object-oriented idioms for encapsulation: – Privacy, data hiding, and visibility of class members. – Interfaces revealing only method signatures. – Abstract base classes, traits and mixins.	• Enumerate the differences between imperative and object-oriented programming paradigms [Enumerate] • Compose a class through design, implementation, and testing to meet behavioral requirements [Compose] • Use object-oriented encapsulation mechanisms such as interfaces and private members [Use]
Readings : [**Brookshear2019**]	

Unit 20: Version Control and CI/CD (2 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Software configuration management and version control: Software Development Practices – Configuration in version control, reproducible builds/configuration. – Version control branching strategies. Development branches vs release branches. Trunk-based development. – Merging/rebasing strategies, when relevant. • Release management. • Software process automation: – Build systems - the value of fast, hermetic, reproducible builds, compare/contrast approaches to building a project. – Continuous Integration (CI) - the use of automation and automated tests to do preliminary validation that the current head/trunk revision builds and passes (basic) tests. – Continuous Deployment (CD) - the use of automation to automatically release every change that passes the automated tests to the production environment, ensuring frequent and reliable deliveries. – Dependency management - updating external/upstream dependencies, package management, SemVer. • Tool integration concepts and mechanisms. Software Development Practices • Use of modern IDE facilities - debugging, refactoring, searching/indexing, ML-powered code assistants, etc. Software Development Practices	• Describe the difference between centralized and distributed software configuration management [Describe] • Describe how version control can be used to help manage software release management [Describe] • Identify configuration items and use a source code control tool in a small team-based project [Analyze] • Understand the use of CI/CD systems as a ground-truth for the state of the team's shared code (build and test success) [Explain] • Demonstrate the capability to use software tools in support of the development of a software product of medium size [Demonstrate]
Readings : [**Brookshear2019**]	

Unit 21: Requirements Engineering (2 hours)

Competences Expected: ABET-1,ABET-4,ABET-7

Topics	**Learning Outcomes**
• Describe functional requirements using, for example, use cases or user stories. – Using at least one method of documenting and structuring functional requirements. – Understanding how the method supports design and implementation. – Strengths and weaknesses of using a specific approach. • Requirements elicitation. – Sources of requirements, for example, users, administrators, or support personnel. – Methods of requirement gathering, for example, surveys, interviews, or behavioral analysis. • Non-functional requirements, for example, security, usability, or performance, also called as Quality Attributes. Sustainable Design and Pervasive Computing, Environmental Footprint of Computing Systems, Systemic Effects and Social Context • Risk identification and management, including ethical considerations surrounding the proposed product. Ethics Codes and Legal Accountability, Professional Responsibility and Public Policy, Professional Values, Nature and Continuing Development, Ethical Dissent and Cultural Context, Workplace Ethics • Communicating and/or formalizing requirement specifications. • Prototyping a tool for both eliciting and validating/confirming requirements. • Product evolution: when requirements change, how to understand what effect that has and what changes need to be made. • Effort estimation: – Learning techniques for better estimating the effort required to complete a task; – Practicing estimation and comparing it to how long tasks take; – Effort estimation is quite difficult, so students are likely to be way off in many cases, but seeing the process play out with their own work is valuable.	• Compare different methods of eliciting requirements along multiple axes [Compare] • Identify differences between two methods of describing functional requirements (e.g., customer interviews, user studies) and the situations where each would be preferred [Analyze] • Identify which behaviors are required, allowed, or barred from a given set of requirements and a list of candidate behaviors [Analyze] • Collect a set of requirements for a simple software system [Analyze] • Identify areas of a software system that need to be changed, given a description of the system and a set of new requirements to be implemented [Analyze] • Identify the functional and non-functional requirements in a set of requirements [Analyze] • Estimate the time to complete a set of tasks, then compare estimates to the actual time taken [Estimate] • Determine an implementation sequence for a set of tasks, adhering to dependencies between them, with a goal to retire risk as early as possible [Determine] • Write a requirement specification for a simple software system [Write]

Readings : [**Brookshear2019**]

Unit 22: Machine Learning Fundamentals (1 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Definition and examples of a broad variety of machine learning tasks: – Supervised learning: ∗ Classification ∗ Regression – Reinforcement learning – Unsupervised learning: ∗ Clustering • Fundamental ideas: – No free lunch theorem: no one learner can solve all problems; representational design decisions have consequences. – Sources of error and undecidability in machine learning • A simple statistical-based supervised learning such as linear regression or decision trees: – Focus on how they work without going into mathematical or optimization details; enough to understand and use existing implementations correctly	• Describe the differences among the three main styles of learning (supervised, reinforcement, and unsupervised) and determine which is appropriate to a particular problem domain [Explain] • Differentiate the terms of AI, machine learning, and deep learning [Evaluate] • Explain how machine learning works as an optimization/search process [Explain]
Readings : [**Brookshear2019**]	

Unit 23: Neural Networks and Ethics (1 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Basic neural networks: – Fundamentals of understanding how neural networks work and their training process, without details of the calculations – Basic introduction to generative neural networks (e.g., large language models) • Ethics for Machine Learning: – Focus on real data, real scenarios, and case studies – Dataset/algorithmic/evaluation bias and unintended consequences • Deep learning: – Deep feed-forward networks (intuition only, no mathematics) – Convolutional neural networks (intuition only, no mathematics) – Visualization of learned feature representations from deep nets – Other architectures (generative NN, recurrent NN, transformers, etc.) • Ethics for Machine Learning: – Continued focus on real data, real scenarios, and case studies – Privacy – Fairness – Intellectual property – Explainability	• Describe the neural network training process and resulting learned representations [Explain] • Visualize the training progress of a neural network through learning curves in a well-established toolkit (e.g., TensorBoard) and visualize the learned features of the network [Apply] • Given a real-world application of machine learning, describe ethical issues regarding the choices of data, preprocessing steps, algorithm selection, and visualization/presentation of results [Apply]
Readings : [**Brookshear2019**]	

Unit 24: Fundamental Concepts of Graphics and Interactive Techniques (2 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Overview of computer graphics pipeline and interactive systems • Basic rendering concepts: rasterization, ray tracing, shading models • Color theory and color spaces • Coordinate systems and transformations • Basic interaction techniques: input devices, event handling • Advanced rendering concepts: global illumination, physically based rendering • Graphics hardware and acceleration techniques • Human perception and visual cognition	• Explain the basic stages of the computer graphics pipeline [Explain] • Describe basic rendering techniques such as rasterization and ray tracing [Describe] • Apply color theory to design visually effective graphics [Apply] • Implement coordinate transformations for 2D and 3D graphics [Implement] • Design basic interactive applications using common input devices and event handling [Design] • Compare advanced rendering techniques such as global illumination and physically based rendering [Compare] • Analyze the role of graphics hardware in accelerating rendering tasks [Analyze] • Explain how human perception influences graphics and interaction design [Explain]
Readings : [**Brookshear2019**]	

Unit 25: Applied Rendering and Techniques (2 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Ray tracing: acceleration structures, sampling, shading • Texture mapping and filtering	• Implement rasterization algorithms for primitive rendering [Implement] • Implement basic ray tracing with acceleration structures [Implement]
Readings : [**Brookshear2019**]	

Unit 26: Closure Class: How Does a Search Engine Like Google Work? (2 hours)	
Competences Expected: ABET-1,ABET-4,ABET-7	
Topics	**Learning Outcomes**
• Problem analysis • The index does not grow linearly with the size of the indexed information. • Response time does not depend on the size of the "database." • Response time does not depend on the number of occurrences found. • Combining various data structures to reach a solution. • Analyzing the scalability of the solution.	• Understand the principles under which a search engine is created [Usar] • Correctly apply data structures to solve the problem [Usar] • Apply concepts related to algorithmic complexity in a search engine [Usar].
Readings : [**Brookshear2019**]	

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

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

1. COURSE

AI161. Applied AI (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	AI161. Applied AI
2.2 Semester	:	2nd Semester.
2.3 Credits	:	4
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 Prerrequisites	:	BIC101. Introduction to Programming. (1st Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course provides a practical introduction to Artificial Intelligence (AI) for students from all scientific and engineering disciplines. Focused on developing AI literacy and practical skills, it covers fundamental concepts, modern AI tools (including Western and Chinese platforms), and responsible usage. Students will learn to effectively interact with diverse AI systems, write quality prompts, and apply AI solutions to problems across various domains while understanding ethical implications and cultural contexts of AI deployment.

5. GOALS

- Develop comprehensive AI literacy by understanding fundamental concepts, capabilities, and limitations of modern AI systems across different platforms and cultures.
- Master effective prompt engineering techniques and interaction patterns with various AI tools (Western: ChatGPT, Claude, Gemini; Chinese: DeepSeek, Kimi, ERNIE).
- Apply diverse AI tools to solve practical problems in scientific, engineering, and academic contexts while maintaining critical evaluation of outputs across platforms.
- Understand ethical considerations, biases, cultural contexts, and responsible usage of AI technologies in global professional and academic settings.
- Develop workflows that integrate multiple AI tools to enhance productivity and problem-solving capabilities while understanding regional strengths and specializations.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

ABET-4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. (Familiarity)

7. TOPICS

Unit 1: AI Fundamentals and Global Landscape (16 hours)	
Competences Expected: ABET-1,ABET-4	
Topics	**Learning Outcomes**
• What is AI? Definitions, history, and current global landscape. • Types of AI systems: chatbots, image generators, research assistants across regions. • Western AI ecosystems: OpenAI, Anthropic, Google, Microsoft. • Chinese AI ecosystems: DeepSeek, Kimi, ERNIE, Zhipu AI, Baidu. • AI capabilities and limitations: comparative analysis across platforms. • Digital literacy in the AI era: critical thinking about diverse AI outputs.	• Apply fundamental AI knowledge to identify system types and their capabilities [Usar]. • Analyze global intelligent systems and their distinctive characteristics [Evaluar]. • Critically evaluate AI outputs across different cultural contexts [Evaluar].
Readings : [**Ng2024**], [**Mollick2024**], [**UNESCO2023**], [**Tencent2024**]	

Unit 2: Effective AI Interaction and Cross-Platform Prompt Engineering (20 hours)	
Competences Expected: ABET-1,ABET-4	
Topics	**Learning Outcomes**
• Principles of effective prompt writing: clarity, context, constraints across platforms. • Prompt patterns: persona, template, chain-of-thought, few-shot for different AI systems. • Western tools: specific techniques for ChatGPT, Claude, Gemini, Copilot. • Chinese tools: specific features and best practices for DeepSeek, Kimi, ERNIE. • Cross-platform strategies: leveraging different AI strengths for complex tasks. • Iterative refinement: how to improve prompts based on outputs from diverse systems. • Practical sessions: comparative prompt writing workshops across platforms.	• Design effective prompt solutions for diverse AI systems [Evaluar]. • Develop cross-platform workflows that integrate different AI tools [Usar]. • Implement iterative refinement strategies to optimize AI outputs [Usar].
Readings : [**White2023**], [**PromptEngineering2024**], [**Microsoft2024**], [**DeepSeek2024**]	

Unit 3: AI Applications Across Disciplines and Platforms (16 hours)	
Competences Expected: ABET-1,ABET-4	
Topics	**Learning Outcomes**
• AI for research: literature review, data analysis using multiple AI assistants. • AI for writing: academic papers, reports with cross-platform verification. • AI for problem-solving: scientific calculations, engineering design with specialized tools. • AI for creativity: brainstorming, concept development across cultural contexts. • Platform-specific strengths: when to use Western vs. Chinese AI tools. • Discipline-specific workshops: tailored applications using diverse AI ecosystems. • Case studies: real-world applications in scientific research across regions.	• Apply AI fundamentals to solve discipline-specific problems [Usar]. • Design solutions that integrate multiple intelligent systems for complex tasks [Evaluar]. • Develop practical applications using Western and Chinese AI tools [Usar]. • Implement workflows that leverage specific strengths of each platform [Evaluar].
Readings : [**Mollick2023**], [**Google2024**], [**Alibaba2024**], [**OpenAI2024**]	

Unit 4: Global AI Ethics and Responsible Usage (12 hours)	
Competences Expected: ABET-1,ABET-4	
Topics	**Learning Outcomes**
• Understanding AI biases: Western and Eastern cultural perspectives. • Ethical frameworks: comparing EU AI Act, Chinese regulations, and global standards. • Academic integrity: proper citation and AI usage in coursework across platforms. • Privacy and data security: regional differences in AI data handling. • Cultural sensitivity: navigating AI outputs in global contexts. • Environmental impact: sustainability considerations of different AI systems. • Developing personal guidelines for ethical AI usage in international settings. • Case studies: ethical dilemmas in AI deployment across regions.	• Demonstrate professional responsibility in using AI technologies [Evaluar]. • Apply professional ethical principles in global AI contexts [Usar]. • Develop ethical guidelines to mitigate biases in AI systems [Evaluar]. • Evaluate ethical implications of AI deployment across different cultures [Usar].
Readings : [**UNESCO2023**], [**EU2024**], [**Bender2021**], [**ChinaAI2024**], [**Tencent2023**]	

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

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CB1E1. Technical Drawing & CAD (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CB1E1. Technical Drawing & CAD
2.2 Semester	:	2nd 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Technical Drawing and CAD is a foundational course for engineering students, as it provides the graphical language needed to communicate technical projects. Mastery of descriptive geometry, drafting standards, and Computer-Aided Design (CAD) tools allows students to represent three-dimensional objects with technical precision on a two-dimensional plane, an essential skill for the design, execution, and supervision of engineering projects. The course closes with an application to civil engineering drawings, covering the symbols and conventions used in foundation and basic structural plans.

5. GOALS

- Apply national and international technical drawing standards to produce engineering drawings.
- Develop spatial visualization skills through the study of projections and descriptive geometry.
- Use modern CAD software tools to create geometric models and technical project documentation.
- Apply engineering drawing conventions to civil engineering plans, including foundations and basic structures.

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)

7. TOPICS

Unit 1: Fundamentals of Technical Drawing and Instrumentation (8 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• History and importance of technical drawing in engineering • Drawing instruments and graphical scales • Paper formats, title blocks, and line types per technical standards • Basic geometric constructions	• Correctly use technical drawing instruments in accordance with drafting standards [Familiarity] • Apply appropriate scales to represent physical elements in drawings [Usage]
Readings : [**Luzadder1993**], [**Jensen2007**]	

Unit 2: Descriptive Geometry and Projections (12 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Orthographic projection system: first-angle and third-angle projection • Projection of points, lines, and planes • Principal views and auxiliary views • Isometric and oblique (cavalier) perspectives	• Develop the ability to represent 3D objects in 2D orthographic projections [Usage] • Interpret auxiliary views to determine true lengths and slopes [Assessment]
Readings : [**Luzadder1993**]	

Unit 3: Computer-Aided Design (CAD) 2D (16 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• User interface and drawing environment configuration • Commands for creating and editing geometric entities • Layer, block, and attribute management • Technical dimensioning and generation of print files (layouts)	• Fluently handle CAD software commands to create complex geometry [Usage] • Organize graphical information through efficient use of layers and external references [Usage]
Readings : [**Omura2021**]	

Unit 4: Introduction to 3D Modeling and Engineering Drawings (12 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Basic solid and surface modeling • Automatic generation of views and sections from 3D models • Technical symbols and drawings applied to civil engineering: foundations and basic structures	• Create basic three-dimensional models using solid modeling tools [Familiarity] • Produce engineering drawings that meet professional presentation standards [Assessment] • Apply technical symbols and produce foundation and basic structural drawings for civil engineering [Usage]
Readings : [**Omura2021**], [**Jensen2007**]	

8. WORKPLAN

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

MA112. Calculus II (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	MA112. Calculus II
2.2 Semester	:	2nd Semester.
2.3 Credits	:	5
2.4 Hours	:	3 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 Prerrequisites	:	MA111. Calculus I. (1st Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course covers integral calculus for functions of a single variable and the geometric foundations needed for multivariable calculus. It emphasizes the accumulation of quantities and the inverse relationship between differentiation and integration, provides tools for calculating areas, volumes, arc length, and work, and introduces vectors and the geometry of three-dimensional space, quadric surfaces, parametric equations, polar coordinates, and vector-valued functions of a real variable.

5. GOALS

- Understand the definite integral as a limit of Riemann sums and master techniques of integration, improper integrals, and infinite series.
- Apply the definite integral to calculate areas, volumes of revolution, arc length, surface area, work, and centroids.
- Operate with vectors in three-dimensional space and use them to determine lines and planes.
- Classify quadric surfaces from their general equation.
- Analyze curves described parametrically and in polar coordinates, including their calculus and area.
- Describe space curves as vector-valued functions and compute their arc length, curvature, and torsion.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

7. TOPICS

Unit 1: Integral Calculus (14 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• The Fundamental Theorem of Calculus • Integration techniques including substitution and parts • Engineering applications of integration: areas, volumes, centroids, and moments of inertia	• State and explain the Fundamental Theorem of Calculus [Familiarity] • Calculate definite integrals arising from engineering problems such as work, fluid pressure, and heat transfer [Usage]
Readings : [**Stewart2016**], [**Larson2018**], [**Thomas2014**]	

Unit 2: Improper Integrals (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Improper integrals over unbounded intervals • Improper integrals of unbounded (discontinuous) integrands • Convergence criteria and comparison tests for improper integrals	• Determine whether an improper integral arising from an engineering model converges, using comparison and other convergence tests [Assessment] • Evaluate an improper integral by taking the appropriate limit, when it converges [Usage]
Readings : [**Stewart2016**], [**Larson2018**], [**Thomas2014**]	

Unit 3: Sequences, Series, and Power Series (14 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Sequences and series: convergence tests (ratio, root, comparison, integral) • Power series, radius of convergence, and Taylor/Maclaurin series • Engineering use of Taylor polynomials for linearization and numerical approximation	• Determine convergence of a power series and construct a Taylor series for a standard engineering function [Assessment] • Apply a Taylor polynomial to approximate or linearize an engineering function [Usage]
Readings : [**Stewart2016**], [**Larson2018**], [**Thomas2014**]	

Unit 4: Applications of the Definite Integral (16 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Area between curves by integrating with respect to x or y • Volume of solids of revolution by the disk and washer method • Volume of solids of revolution by the cylindrical shell method • Work via integration (springs, pumping fluids, cables) • Moments and centroid of a plane region or solid	• Calculate the volume of a solid of revolution using the disk, washer, or cylindrical shell method [Usage] • Calculate the work done by a variable force using integration [Usage]
Readings : [**Stewart2016**], [**Thomas2014**]	

Unit 5: Vectors and the Geometry of Space (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Dot and cross products: definition, properties, and geometric interpretation • Equations of lines and planes in space	• Compute the dot and cross products of vectors to solve engineering force and moment problems [Usage] • Determine equations of lines and planes in space from the geometric data of an engineering problem [Usage]
Readings : [**Stewart2016**], [**Larson2018**]	

Unit 6: Quadric Surfaces (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Classification of quadrics (ellipsoids, paraboloids, hyperboloids) from their general equation	• Classify a quadric surface and identify its geometry for engineering component modeling [Usage]
Readings : [**Stewart2016**], [**Larson2018**]	

Unit 7: Parametric Equations and Polar Coordinates (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Parametric curves and their calculus, applied to trajectories in kinematics • Polar coordinates and their conversion to Cartesian coordinates	• Calculate the velocity and acceleration of a trajectory described parametrically [Usage] • Convert between polar and Cartesian coordinates when modeling engineering geometries [Usage]
Readings : [**Stewart2016**], [**Thomas2014**]	

Unit 8: Vector Functions of a Real Variable (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definition, domain, and range of vector functions of a real variable • Limits, continuity, and derivatives of vector functions • Arc length and natural parametrization of a curve • Tangent, normal, and binormal vectors; moving Frenet frame • Curvature, torsion, and Frenet-Serret formulas	• Identify limits, continuity, and derivatives of vector functions of a real variable [Familiarity] • Compute tangent, normal, and binormal vectors and reparametrize a curve by arc length [Usage] • Calculate curvature and torsion using the Frenet-Serret formulas [Assessment]
Readings : [**Stewart2016**], [**Thomas2014**]	

8. WORKPLAN

8.1 Methodology

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8.2 Theory Sessions

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9. EVALUATION SYSTEM

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

10. BASIC BIBLIOGRAPHY

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

1. COURSE

BFI101. General Physics (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	BFI101. General Physics
2.2 Semester	:	2nd Semester.
2.3 Credits	:	5
2.4 Hours	:	3 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 Prerrequisites	:	MA111. Calculus I. (1st Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Physics I introduces the foundations of classical mechanics as a mathematical and experimental discipline. Through the study of kinematics, Newtonian dynamics, conservation principles, rotational motion, elasticity, fluid mechanics, vibrations and waves, and an introduction to transport phenomena, students acquire the analytical tools needed to model and solve problems of the physical world. This course provides the indispensable foundation for the study of oscillatory, wave, and electromagnetic phenomena addressed in subsequent courses.

5. GOALS

- Describe the motion of particles in different coordinate systems and formulate the equations of motion from Newton's laws.
- Apply the principles of work, potential energy, and conservation of mechanical energy to systems with conservative and non-conservative forces.
- Solve particle-system dynamics problems using conservation of linear momentum and collision analysis.
- Analyze rotational motion and angular momentum dynamics in systems of particles and extended bodies.
- Apply elastic moduli and Hooke's law to relate stress and strain in solids.
- Apply the principles of hydrostatics and hydrodynamics, including the continuity and Bernoulli equations, to fluid flow problems.
- Analyze simple harmonic motion and mechanical wave propagation, including superposition and resonance phenomena.
- Apply Fourier's and Fick's laws to describe basic heat conduction and mass diffusion processes.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

7. TOPICS

Unit 1: Kinematics and Dynamics of Particles (22 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Vector description of position, velocity, and acceleration in Cartesian, polar, and spherical coordinates • Newton's three laws of motion and inertial reference frames • Formulation and solution of equations of motion for constant and variable forces • Static and kinetic friction forces, including angle of repose • Numerical integration of equations of motion for engineering dynamics problems	• Formulate the equations of motion for a particle in one, two, and three dimensions given a force law [Usage] • Identify all forces acting on a particle and draw a correct free-body diagram [Familiarity] • Calculate the terminal velocity of an object falling through a fluid with drag resistance [Assessment] • Implement a numerical algorithm to simulate the dynamics of an engineering mechanical system [Usage] • Construct and interpret phase space diagrams for simple engineering oscillatory systems [Assessment]
Readings : [**Serway2018**], [**Young2015**]	

Unit 2: Work, Energy, and Conservative Forces (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definition of work as a line integral $W = \int \vec{F} \cdot d\vec{r}$ • Work-energy theorem: $W_{total} = \Delta K$ • Potential energy function and the force relation $\vec{F} = -\nabla U$ • Conservation of total mechanical energy $E = K + U$ • Energy diagrams, turning points, and equilibrium stability • Work done by non-conservative forces and energy dissipation in engineering systems	• Calculate the work done by a force along a specified engineering path [Usage] • Apply conservation of mechanical energy to solve for speeds and positions in engineering dynamics [Usage] • Analyze an energy diagram to identify equilibrium positions and stability [Assessment] • Estimate energy dissipated by friction and damping forces in mechanical engineering systems [Assessment]
Readings : [**Serway2018**], [**Tipler2010**]	

Unit 3: Systems of Particles and Linear Momentum (8 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definition and computation of center of mass for particle systems and distributed bodies • Linear momentum of a particle and system: $\vec{P} = M\vec{V}_{CM}$ • Conservation of linear momentum for isolated engineering systems • Two-body collisions: elastic, inelastic, and the coefficient of restitution • Variable mass systems such as rockets and conveyor belts	• Locate the center of mass for discrete particle systems and distributed engineering objects [Usage] • Apply conservation of linear momentum to analyze impact and collision problems [Usage] • Classify collisions as elastic or inelastic and determine energy loss [Familiarity] • Solve variable-mass system equations to determine velocity gain in propulsion problems [Usage]
Readings : [**Young2015**], [**Tipler2010**]	

Unit 4: Rotational Motion and Angular Momentum (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Rotational kinematics: angular displacement, velocity, and acceleration • Torque: $\vec{\tau} = \vec{r} \times \vec{F}$ and its computation • Moment of inertia $I = \sum m_i r_i^2$ and the parallel axis theorem • Rotational kinetic energy: $K_{rot} = \frac{1}{2} I \omega^2$ • Conservation of angular momentum in engineering machines and rotating structures • Rolling without slipping dynamics and applications to wheels and shafts	• Calculate torque about a given axis for an engineering power transmission system [Usage] • Determine the moment of inertia for machine components such as rods, disks, and shafts [Usage] • Apply conservation of angular momentum to analyze speed changes in rotating engineering systems [Assessment] • Analyze combined translational and rotational motion in wheeled engineering systems [Assessment]
Readings : [**Serway2018**], [**Kleppner2013**]	

Unit 5: Elasticity (2 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definition of stress (force/area) and strain ($\Delta L/L$) • Young's modulus and Hooke's law for longitudinal strain: $\sigma = E\epsilon$ • Shear modulus (rigidity) and shear strain • Bulk modulus (compressibility) and volumetric strain • Elastic limit, plastic region, and fracture point on the stress-strain diagram • Elastic energy stored in a deformed material	• Apply the scalar Hooke's law to calculate the deformation of a rod under axial load [Usage] • Calculate Young's, shear, or bulk modulus from experimental stress-strain data [Usage] • Identify the elastic region, elastic limit, and fracture point on a stress-strain curve [Familiarity] • Calculate the elastic potential energy stored in a deformed spring or rod [Usage]
Readings : [**Serway2018**], [**Young2015**]	

Unit 6: Fluids: Hydrostatics, Hydrodynamics, and Viscosity (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Density, pressure, and its variation with depth in a fluid at rest: $p = p_0 + \rho gh$ • Pascal's principle and its applications (hydraulic press) • Archimedes' principle, buoyant force, and flotation • Pressure measurement with manometers and barometers • Continuity equation for incompressible flow: $A_1 v_1 = A_2 v_2$ • Bernoulli's equation and energy conservation in ideal flow • Applications: Venturi tube, Torricelli's theorem, Pitot tube • Viscosity and Poiseuille's law for laminar flow in pipes • Reynolds number and the transition to turbulent flow • Stokes' law for the drag force on a sphere in a viscous fluid	• Calculate the pressure at a point in a fluid at rest given depth and density [Usage] • Apply Archimedes' principle to determine whether an object floats, sinks, or remains in equilibrium [Usage] • Apply the continuity and Bernoulli equations to solve flow problems in pipes of varying cross-section [Usage] • Interpret manometer and barometer readings to determine absolute and gauge pressures [Assessment] • Apply Poiseuille's law to calculate the flow rate of a viscous fluid in a cylindrical tube [Usage] • Estimate the Reynolds number of a flow and predict whether it is laminar or turbulent [Assessment]
Readings : [**Serway2018**], [**Young2015**]	

Unit 7: Vibrations and Waves (14 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Simple harmonic motion (SHM): equation of motion, position, velocity, and acceleration • Oscillating systems: spring-mass and simple/physical pendulum • Energy in simple harmonic motion • Damped and forced oscillations; introduction to resonance • Transverse and longitudinal waves; propagation speed • Wave equation and speed of a wave on a taut string: $v = \sqrt{T/\mu}$ • Superposition principle and standing waves • Sound waves, intensity, and sound intensity level (decibels) • Doppler effect for sound waves • Beats and interference of waves of nearby frequencies	• Derive the equation of motion and the period of a spring-mass system and a simple pendulum [Usage] • Calculate the kinetic, potential, and total energy of a simple harmonic oscillator at any instant [Usage] • Analyze the amplitude response of a forced oscillator near the resonance frequency [Assessment] • Calculate the propagation speed of a wave on a string from the tension and linear density [Usage] • Determine the frequencies and wavelengths of the normal modes of a standing wave on a fixed string [Usage] • Calculate the sound intensity level in decibels from the intensity of a sound wave [Usage] • Apply the Doppler effect formula for a moving source and/or observer [Usage]
Readings : [**Serway2018**], [**Young2015**]	

Unit 8: Transport Phenomena (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Heat conduction and Fourier's law: $\vec{q} = -k\nabla T$ • Thermal conductivity of materials and thermal resistance in composite walls • Molecular diffusion and Fick's first law: $\vec{J} = -D\nabla C$ • Analogy between heat, mass, and momentum transport (Prandtl and Schmidt numbers)	• Apply Fourier's law to calculate the heat flux through a plane or composite wall [Usage] • Apply Fick's first law to calculate the diffusive flux of a species in a concentration gradient [Usage] • Identify mathematical analogies between heat, mass, and momentum transport processes [Familiarity]
Readings : [**Serway2018**], [**Tipler2010**]	

8. WORKPLAN

8.1 Methodology

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

ID101. Technical and professional English I (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	ID101. Technical and professional English I
2.2 Semester	:	2nd Semester.
2.3 Credits	:	2
2.4 Hours	:	1 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

English is the primary language of science, engineering, and technology worldwide. For computing and engineering students, mastering English means gaining direct access to technical documentation, research papers, and professional collaboration without translation barriers. This course builds foundational English skills using contexts drawn from computing systems, hardware, and the everyday work of engineers and scientists.

5. GOALS

- Acquire foundational English grammar structures applied to computing and engineering contexts.
- Identify and use technical vocabulary related to hardware, software, and scientific concepts.

6. COMPETENCES

ABET-3) An ability to communicate effectively with a range of audiences. (Familiarity)

ABET-5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. (Familiarity)

7. TOPICS

Unit 1: Welcome to Computing (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Verb To Be: Affirmative, Negative, and Questions. • Personal Pronouns and Possessive Adjectives. • Number Expressions (1-100): Ports, addresses, and binary basics. • Social Expressions in academic and lab environments.	• By the end of the unit, students use the verb 'to be' to introduce themselves as computing students and describe basic properties of computing systems (e.g., "The processor is fast. It is a 64-bit CPU.").
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 2: Parts and Systems (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Possessive 's and Plural Nouns applied to components (the CPU's speed, the system's memory). • Hardware components and their relationships. • Adjective + Noun structures for technical descriptions. • Lab interactions: Asking about equipment and tools.	• Students describe computer hardware components and their relationships using possessives and noun phrases (e.g., "the motherboard's slots", "the server's processors").
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 3: How It Works (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Present Simple I (Third person: He/She/It) to describe processes. • Vocabulary: How programs, algorithms, and devices operate. • Telling the time and interpreting system clocks and schedules. • Verbs of operation: runs, compiles, executes, stores, transmits.	• Students explain how a program or device works using the present simple in the third person (e.g., "The compiler translates source code. It generates an executable file.").
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 4: What Engineers Do (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Present Simple II (I/You/We/They) for describing professional routines. • Questions and negatives with 'Do/Does' in technical contexts. • Engineering roles: developer, analyst, researcher, systems engineer. • Adverbs of frequency in describing work cycles and testing schedules.	• Students describe the daily tasks and professional roles of computing engineers and scientists using the present simple with accuracy.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 5: Inside a Computer (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Existential: There is / There are applied to architecture descriptions. • Prepositions of place: components on a motherboard, files in a directory. • Vocabulary: memory, storage, buses, slots, ports, layers. • Describing network topology and physical infrastructure.	• Students describe the spatial organization of hardware components and file systems, enabling them to interpret and produce technical architecture descriptions.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 6: Can Computers Think? (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Modal verb Can/Can't to describe computing capabilities and limitations. • Adverbs of manner applied to system performance. • Past of verb 'To Be' (Was/Were): early computing systems and pioneers. • Basic expressions for technical support and troubleshooting.	• Students describe what computing systems can and cannot do, and identify basic facts about the early history of computing using simple past structures.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 7: Computing History (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Past Simple: Regular and Irregular verbs to narrate tech history. • Time expressions for the past: invented, developed, published, launched. • Key figures: Turing, Babbage, Lovelace, von Neumann. • Vocabulary: Generations of computers, milestones, inventions.	• Students narrate key events in the history of computing and science using the simple past correctly, identifying the contributions of foundational figures.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 8: My Professional Goals in Computing (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Introduction to Technical English for Computing and Engineering. • Reading and understanding simple technical specifications. • Working in multicultural engineering teams: communication norms. • Oral presentation: "My role in the computing field".	• Students present their professional goals in computing using basic technical vocabulary and connect them to the roles and responsibilities of software and hardware engineers.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

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

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

1. COURSE

BEF201. Ethics and Political Philosophy (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	BEF201. Ethics and Political Philosophy
2.2 Semester	:	2nd Semester.
2.3 Credits	:	2
2.4 Hours	:	1 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course introduces students to the fundamentals of ethics and political philosophy as a humanistic foundation for professional practice, and extends them to engineering ethics and professional responsibility. Through the study of normative ethical theories, the major traditions of political thought, and contemporary debates in political philosophy, students develop the critical tools to analyze moral and political problems. The course closes with the application of these tools to the ethical dilemmas engineers face in professional practice.

5. GOALS

- Distinguish ethics, morality, and law, and compare the main normative ethical theories.
- Explain the foundations of the social contract tradition and the major modern ethico-political proposals.
- Analyze contemporary political philosophy debates from multiple theoretical perspectives.
- Apply ethical decision-making frameworks and professional codes of conduct to engineering practice.

6. COMPETENCES

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. (Familiarity)

ABET-4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. (Usage)

7. TOPICS

Unit 1: Basic Notions of Ethics and Political Philosophy (15 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• What is ethics? Distinguishing ethics, morality, and law as normative systems • Main normative ethical theories: consequentialism, deontology, and virtue ethics • What is political philosophy? Fundamental questions about power, legitimacy, and the state • The social contract tradition: Hobbes, Locke, and Rousseau • Conceptions of justice: distributive, procedural, and retributive	• Distinguish ethics, morality, and law as normative systems [Familiarity] • Compare the main normative ethical theories and their criteria for moral evaluation [Usage] • Explain the foundations of the social contract tradition and its main proponents [Familiarity] • Identify different conceptions of justice and apply them to concrete cases [Assessment]
Readings : [**Rachels2015**], [**Kymlicka2002**]	

Unit 2: Major Ethico-Political Proposals (6 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Political and economic liberalism: individual liberty and the limits of the state • Socialism and Marxist thought: the critique of private property and exploitation • Civic republicanism and liberty understood as non-domination • Communitarianism and its critique of liberal individualism	• Compare liberal, socialist, republican, and communitarian proposals in response to a concrete social problem [Usage] • Identify the philosophical foundations of a given ethico-political position [Assessment]
Readings : [**Kymlicka2002**]	

Unit 3: Engineering Ethics and Professional Responsibility (12 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Ethical theories applied to engineering: utilitarianism, deontological ethics, virtue ethics • Professional codes of conduct (e.g. NSPE, IEEE, ASME, and national engineering boards) and their fundamental canons • The engineer's paramount responsibility to public safety, health, and welfare • Ethical dilemmas in practice: conflicts of interest, whistleblowing, gifts • Ethical decision-making frameworks and case-study analysis • Global engineering ethics and cross-cultural challenges • Ethical obligations toward sustainable development and environmental stewardship • Ethical implications of emerging technologies (AI, automation, data privacy) • Ethical conduct in dispute resolution and litigation	• Explain the fundamental principles of an engineer's code of ethics [Familiarity] • Apply an ethical decision-making framework to a hypothetical engineering scenario [Assessment] • Identify conflicts of interest and other common ethical pitfalls in project work [Familiarity] • Analyze a historical engineering failure from an ethical perspective [Assessment] • Evaluate the ethical dimensions of a project with significant social or environmental impacts in a different cultural context [Assessment] • Articulate the ethical argument for incorporating sustainability into all engineering work [Familiarity] • Discuss the ethical responsibilities related to the collection and use of data in smart infrastructure projects [Assessment] • Describe the role of ethics in alternative dispute resolution processes [Familiarity]
Readings : [**HarrisEthics2013**], [**FleddermannEthics2020**]	

Unit 4: Currents in Contemporary Political Philosophy (9 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Rawls's theory of justice: the original position and the veil of ignorance • Contemporary libertarianism: Nozick and property rights • Feminist political philosophy and theories of care • Multiculturalism, recognition, and identity politics • Deliberative democracy and the public sphere	• Explain the concepts of the original position and the veil of ignorance in Rawls's theory [Usage] • Contrast libertarian and Rawlsian proposals on distributive justice [Assessment] • Analyze a contemporary political debate from at least two of the political philosophy currents studied [Assessment] • Describe the foundations of deliberative democracy and its role in the public sphere [Familiarity]
Readings : [**Rawls1999**], [**Kymlicka2002**]	

8. WORKPLAN

8.1 Methodology

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE1M1. Statics (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE1M1. Statics
2.2 Semester	:	3rd 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 Prerrequisites	:	BFI101. General Physics. (2nd Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Statics is the first pillar of applied mechanics in Civil Engineering. It provides the tools needed to analyze the equilibrium of particles and rigid bodies subjected to force systems. Understanding the concepts of force, moment, and equilibrium is essential for the analysis and design of structures, enabling the determination of support reactions and internal forces in structural members.

5. GOALS

- Understand and apply Newton's laws and vector algebra to solve equilibrium problems in two and three dimensions.
- Determine internal forces in trusses, frames, and machines accurately.
- Analyze the effect of friction and determine centers of gravity and moments of inertia of complex shapes.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (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: Equilibrium of Particles and Rigid Bodies (8 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Equilibrium equations and free-body diagrams for particles and rigid bodies in two and three dimensions • Flexible cables under concentrated and distributed loads	• Apply equilibrium equations to determine support reactions in two- and three-dimensional rigid-body systems [Usage] • Determine cable tension and shape under concentrated and distributed loads [Usage]
Readings : [**Hibbeler2016**], [**Meriam2014**]	

Unit 2: Internal Forces in Trusses and Frames (12 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Truss analysis using the method of joints and the method of sections • Free-body diagrams and internal-force analysis of multi-member frames and machines • Internal forces in beams: shear-force and bending-moment diagrams	• Analyze planar trusses using both the method of joints and the method of sections [Assessment] • Draw free-body diagrams for multi-member frames and machines and determine internal member forces [Usage] • Construct shear-force and bending-moment diagrams for beams under concentrated and distributed loads [Assessment]
Readings : [**Hibbeler2016**], [**Meriam2014**]	

Unit 3: Geometric Properties of Areas and Friction (12 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Centroids and centers of gravity of composite areas and lines • Moments of inertia of areas and the parallel-axis theorem • Dry friction: laws of friction, wedges, and screws • Virtual work and stability of equilibrium	• Determine the geometric properties of complex cross-sections used in structural shapes [Usage] • Analyze equilibrium problems involving static friction forces [Assessment] • Apply friction principles to the analysis of wedges and screw mechanisms [Usage] • Evaluate the stability of equilibrium using virtual work principles [Familiarity]
Readings : [**Meriam2014**]	

8. WORKPLAN

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE2C1. Materials Technology (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2C1. Materials Technology
2.2 Semester	:	3rd Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	BCH101. Chemistry I. (1st Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Materials Technology covers the science and technology of the main materials used in construction: traditional and vernacular materials (rocks, adobe, quincha, rammed earth, bamboo), concrete and advanced cementitious materials, structural metals, polymeric and sustainable composite materials, and standardized quality control and failure analysis testing. The course concludes with design in masonry, timber, and light-gauge steel.

5. GOALS

- Characterize the physical and mechanical properties of traditional and modern construction materials.
- Apply concrete and structural metals technology to the design and quality control of construction elements.
- Perform standardized quality control tests and interpret failure analysis results.
- Design elements in masonry, timber, and light-gauge steel.

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: Construction Materials Science (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Physical and mechanical properties of construction materials including density, porosity, strength, and elasticity • Microstructure and phase composition of construction materials • Durability mechanisms including weathering, chemical attack, and environmental degradation • Thermal and moisture properties of construction materials • Crystalline and amorphous structures in construction materials • Material selection criteria based on performance requirements • Degradation mechanisms and service life prediction	• Describe the fundamental physical and mechanical properties of major construction materials [Familiarity] • Analyze the relationship between microstructure and macroscopic properties of materials [Assessment] • Evaluate the durability performance of materials under specific environmental conditions [Usage] • Explain the effects of thermal and moisture variations on material behavior [Familiarity] • Select appropriate construction materials based on design specifications and performance criteria [Assessment] • Predict service life and degradation patterns of materials in various environments [Usage]
Readings : [**Neville2011**]	

Unit 2: Traditional and Vernacular Construction Materials (18 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Construction stone: classification and properties • Adobe as a construction material: fabrication and properties • Quincha as a construction system: materials and technique • Tapial (rammed earth) as a construction material: fabrication and properties • Bamboo as a construction material: properties and structural applications • Quality control testing for vernacular construction materials	• Classify construction stone by its properties and applications [Familiarity] • Characterize the physical and mechanical properties of adobe, quincha, and tapial [Usage] • Evaluate the suitability of bamboo as a structural material in construction [Assessment] • Perform quality control tests on vernacular construction materials [Usage] • Recommend the use of an appropriate vernacular material based on a project's conditions [Assessment]
Readings : [**Blondet2003**]	

Unit 3: Concrete Technology and Advanced Cementitious Materials (24 hours)	
Competences Expected: ABET-1,ABET-2,ABET-6	
Topics	**Learning Outcomes**
• Portland cement chemistry and hydration process • Aggregates properties and grading requirements • Mix design methodology for normal strength concrete • Fresh concrete properties including workability, slump, and setting time • Hardened concrete properties including strength, modulus, and shrinkage • Chemical and mineral admixtures for concrete • High-performance and high-strength concrete design • Self-consolidating concrete and fiber-reinforced concrete • Durability aspects including alkali-silica reaction, sulfate attack, and freeze-thaw • Sustainable and low-carbon concrete technologies including supplementary cementitious materials such as fly ash, slag, and silica fume	• Describe the chemistry of portland cement and the hydration process [Familiarity] • Evaluate aggregate quality and suitability for concrete production [Assessment] • Design concrete mixes for specified strength and workability requirements [Usage] • Test and interpret fresh concrete properties using standard procedures [Assessment] • Predict hardened concrete properties based on mix proportions and curing conditions [Usage] • Explain the function and effects of various concrete admixtures [Familiarity] • Formulate high-performance concrete mixes for demanding applications [Usage] • Select appropriate special concretes for specific construction scenarios [Assessment] • Incorporate supplementary cementitious materials to optimize concrete performance [Usage] • Analyze durability risks and specify protective measures for concrete structures [Assessment] • Compare environmental impacts and carbon footprints of different concrete formulations [Familiarity]
Readings : [**Kosmatka2016**], [**Neville2011**]	

Unit 4: Concrete Transport and Placement (20 hours)	
Competences Expected: ABET-1,ABET-2,ABET-6	
Topics	**Learning Outcomes**
• Transit mixer transport: maximum delivery time, slump verification, and admissible conditions • Concrete pumping: pumpable mix design, operating pressure, reach, and blockage prevention • Placement methods: direct discharge, chutes, buckets, and crane placement • Concrete consolidation: internal and external vibration, frequency, amplitude, and insertion depth • Underwater concrete placement by tremie method and in restricted-access conditions • Belt conveyor and pneumatic transport systems for large-volume concrete • Concrete surface finishing: leveling, troweling, texturing, and immediate curing	• Plan concrete transport considering delivery distance, setting time, and environmental conditions [Usage] • Execute standardized concrete placement procedures for different types of structural elements [Usage] • Apply correct vibration techniques to achieve uniform concrete consolidation [Usage] • Evaluate concrete placement quality and identify deficiencies such as segregation, honeycombs, and cold joints [Assessment] • Design pumpable concrete mixes for specific pumping height and distance conditions [Usage] • Specify placement methods for restricted-access structures or underwater placement conditions [Assessment] • Develop placement plans minimizing cold joints and ensuring concrete continuity in large structural elements [Usage]
Readings : [**Neville2011**]	

Unit 5: Statistical Quality Control of Concrete (20 hours)	
Competences Expected: ABET-1,ABET-2,ABET-6	
Topics	**Learning Outcomes**
• Sampling procedures and fresh concrete specimen preparation according to ASTM standards • Compressive strength testing: procedure, minimum frequency, and testing conditions • Basic statistics applied to concrete: mean, standard deviation, and coefficient of variation • Concrete acceptance criteria according to ACI 318 and equivalent standards • Statistical control charts ($\bar{X}$, R) for continuous monitoring of concrete production • Non-conforming results analysis: investigation procedures, additional tests, and structural decisions • Process capability indices (C_p, C_{pk}) and target mean strength adjustment	• Apply standardized sampling and specimen fabrication procedures for concrete on site [Usage] • Interpret compressive strength test results and determine their validity [Assessment] • Calculate basic statistical parameters from series of concrete strength test results [Usage] • Evaluate concrete acceptance or rejection applying ACI 318 normative criteria [Assessment] • Construct statistical control charts for continuous monitoring of concrete production [Usage] • Diagnose causes of excessive variability and propose corrective actions in concrete production [Assessment] • Determine the target mean strength (f'_{cr}) considering the statistical variability of the production process [Usage]
Readings : [**Neville2011**], [**Rivva2000**]	

Unit 6: Structural Metals, Alloys, and Corrosion Engineering (5 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Steel composition, classification, and grade designations • Mechanical properties of structural steel including yield strength and ductility • Heat treatment processes and their effects on steel properties • Weldability and connection behavior of structural metals • Corrosion mechanisms in metallic structures • High-strength and weathering steel applications • Aluminum alloys and their structural applications • Fatigue behavior and fracture toughness of metals • Corrosion protection methods including coatings and cathodic protection • Material selection for corrosive and high-temperature environments	• Identify different steel grades and their appropriate structural applications [Familiarity] • Interpret stress-strain curves and determine mechanical properties of metals [Assessment] • Explain how heat treatment affects the microstructure and properties of steel [Familiarity] • Evaluate weldability of metals and specify appropriate welding procedures [Usage] • Describe the electrochemical basis of metallic corrosion [Familiarity] • Select high-strength or weathering steel for specific structural requirements [Usage] • Compare aluminum alloys with steel for lightweight structural applications [Assessment] • Analyze fatigue loading scenarios and predict service life of metal components [Assessment] • Design corrosion protection systems for metallic structures in aggressive environments [Usage] • Specify appropriate materials for structures exposed to extreme conditions [Assessment]
Readings : [**Callister2020**]	

Unit 7: Polymeric, Composite, and Sustainable Construction Materials (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Polymer chemistry and classification of construction polymers • Mechanical and thermal behavior of polymeric materials • Fiber-reinforced polymer composites and their structural applications • Adhesives, sealants, and waterproofing materials • Composite material mechanics and laminate theory • FRP strengthening and rehabilitation of concrete and masonry structures • Bio-based and recycled materials for sustainable construction • Geopolymers and alternative binder systems • Environmental degradation and long-term performance of polymers and composites	• Classify polymers used in construction and describe their basic properties [Familiarity] • Characterize the mechanical and thermal behavior of polymeric materials [Assessment] • Apply fiber-reinforced polymers in structural design and retrofitting applications [Usage] • Select appropriate adhesives and sealants for specific construction applications [Familiarity] • Analyze composite laminates using classical lamination theory [Usage] • Design FRP strengthening systems for existing concrete or masonry structures [Assessment] • Evaluate the sustainability and life-cycle performance of bio-based construction materials [Assessment] • Compare geopolymer binders with traditional portland cement systems [Familiarity] • Predict long-term degradation of polymers and composites under environmental exposure [Usage]
Readings : [**Callister2020**]	

Unit 8: Standardized Testing, Quality Control, and Failure Analysis (5 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 9: Masonry Structural Design (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Masonry materials, units, and mortar properties • Unreinforced masonry wall design for compression and flexure • Reinforced masonry design and detailing • Seismic design of masonry and timber structures	• Identify masonry unit types and specify appropriate mortar for applications [Familiarity] • Design unreinforced masonry walls for gravity and lateral loads [Assessment] • Proportion reinforced masonry elements and specify reinforcement details [Usage] • Implement seismic design provisions for masonry and timber buildings [Usage]
Readings : [**Drysdale2008**]	

Unit 10: Timber and Light-Gauge Steel Framing Design (6 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Timber properties, grading, and design values • Sawn lumber and glued-laminated timber design • Timber connections including nails, bolts, and metal connectors • Cold-formed steel members and sectional properties • Light-gauge steel framing systems and design • Engineered wood products including I-joists and structural composite lumber	• Select timber species and grades based on structural requirements [Familiarity] • Design timber beams, columns, and combined loading members [Assessment] • Specify timber connections and calculate their capacity [Usage] • Calculate effective section properties for cold-formed steel members [Assessment] • Design light-gauge steel wall studs and floor joists [Usage] • Apply engineered wood products in floor and roof systems [Assessment]
Readings : [**Drysdale2008**]	

Unit 11: Site Visits (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Technical visit to a construction materials production plant or an active construction site. • Observation of manufacturing processes, quality control, and the field use of traditional materials, concrete, metals, and composites. • Preparation of a technical visit report.	• Relate the properties and processes of construction materials studied in the course to their real application on site [Usage].
Readings :	

8. WORKPLAN

8.1 Methodology

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CB1E2. Engineering Drawing II (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CB1E2. Engineering Drawing II
2.2 Semester	:	3rd Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CB1E1. Technical Drawing & CAD. (2nd Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Engineering Drawing II is the direct continuation of Technical Drawing and CAD, deepening students' command of descriptive geometry to solve advanced positional and metric problems involving lines, planes, polyhedra, and surfaces of revolution. The course closes with an introduction to Building Information Modeling (BIM), the digital methodology that has become standard practice for the delivery and lifecycle management of civil engineering projects, connecting the graphical foundations built in the prerequisite course to modern digital project delivery workflows.

5. GOALS

- Solve positional problems (parallelism, perpendicularity, and intersections) between lines, planes, and polyhedra using descriptive geometry methods.
- Solve metric problems, including the determination of true distances between geometric elements.
- Represent surfaces of revolution and determine tangent planes to curved surfaces.
- Apply Building Information Modeling (BIM) concepts and tools to produce and manage digital representations of civil engineering projects for digital delivery and asset management.

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)

7. TOPICS

Unit 1: Positional and Metric Problems in Descriptive Geometry (28 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Auxiliary-view and change-of-plane methods for solving positional and metric problems • Parallelism and perpendicularity between lines and planes • Intersections of planes, lines, and polyhedral solids • Metric problems: true distances between points, lines, and planes	• Apply auxiliary-view and change-of-plane methods to solve positional problems in orthographic projection [Usage] • Determine parallelism and perpendicularity relationships between lines and planes, and represent intersections of polyhedral solids [Usage] • Calculate true distances between geometric elements using descriptive geometry methods [Assessment]
Readings : [**Luzadder1993**], [**Pare1997**]	

Unit 2: Surfaces of Revolution and Tangent Planes (26 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Generation and orthographic representation of surfaces of revolution: cylinders, cones, spheres, and tori • Angle problems between lines, planes, and surfaces • The rotation (change of projection) method as an auxiliary technique • Construction of tangent planes to surfaces of revolution at a point or through an external line	• Represent surfaces of revolution and their principal orthographic views [Usage] • Apply the rotation method to determine true angles between lines, planes, and surfaces [Usage] • Determine tangent planes to a surface of revolution at a given point or through an external line [Assessment]
Readings : [**Pare1997**]	

Unit 3: Building Information Modeling (BIM) for Digital Delivery and Asset Management (16 hours)	
Competences Expected: ABET-2	
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 openBIM • 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**]	

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

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

1. COURSE

MA121. Linear Algebra I (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	MA121. Linear Algebra I
2.2 Semester	:	3rd Semester.
2.3 Credits	:	5
2.4 Hours	:	3 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 Prerrequisites	:	MA100. Basic Mathematics. (1st Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course introduces the fundamental concepts of linear algebra, providing the mathematical foundations for the study of vector spaces, linear transformations, and systems of linear equations. It develops abstract thinking and problem-solving skills through matrices, determinants, and vectors. The course is fundamental for applications in science, engineering, and computing.

5. GOALS

- Understand the concepts of vector spaces and subspaces.
- Master matrix operations and determinants.
- Solve systems of linear equations using different methods.
- Apply linear transformations and compute eigenvalues and eigenvectors.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

7. TOPICS

Unit 1: Matrices and Systems of Linear Equations (28 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• LU, QR, and Cholesky factorizations for solving engineering linear systems • Singular Value Decomposition (SVD) and least squares solutions	• Solve systems of linear equations arising in structural, circuit, and fluid engineering problems [Usage] • Apply the SVD to solve over-determined systems in data fitting and signal processing [Usage]
Readings : [**Lay2016**], [**Strang2016**], [**Anton2014**]	

Unit 2: Vector Spaces and Linear Transformations (22 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Vector spaces, subspaces, bases, and dimension • Linear transformations and their matrix representations in coordinate changes	• Formulate and interpret coordinate system transformations for engineering geometry problems [Assessment]
Readings : [**Lay2016**], [**Strang2016**], [**Anton2014**]	

Unit 3: Eigenvalues and Inner Product Spaces (20 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Eigenvalues, eigenvectors, and diagonalization with applications to vibration and stability • Inner product spaces, orthogonality, and the Gram-Schmidt process	• Perform eigenvalue decomposition on symmetric matrices for modal analysis of mechanical structures [Assessment]
Readings : [**Lay2016**], [**Strang2016**], [**Anton2014**]	

8. WORKPLAN

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10. BASIC BIBLIOGRAPHY

National University of Engineering (UNI)
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Syllabus 2027-I

1. COURSE

MA210. Calculus III (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	MA210. Calculus III
2.2 Semester	:	3rd Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	MA112. Calculus II. (2nd Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course continues the study of calculus with functions of several variables, integrating concepts of vector calculus, partial derivatives, multiple integrals, and geometric and physical applications, including line and surface integrals. It develops skills for modeling and solving problems in three dimensions and introduces first-order ordinary differential equations, providing the foundations for advanced areas such as mathematical analysis, physics, and engineering.

5. GOALS

- Understand functions of several variables and their partial derivatives.
- Apply differential and integral calculus in three dimensions.
- Solve optimization problems with multiple variables.
- Master multiple, line, and surface integrals and their applications.
- Solve first-order ordinary differential equations and model simple physical systems with them.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

7. TOPICS

Unit 1: Multivariable and Vector Calculus (22 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Partial derivatives and the gradient vector • Multiple integrals in Cartesian, cylindrical, and spherical coordinate systems • Vector fields and line and surface integrals • Integral theorems: Green, Stokes, and the Divergence Theorem • Applications to flux, circulation, and conservative fields in engineering contexts	• Compute gradients and directional derivatives for scalar fields describing physical quantities [Usage] • Evaluate double and triple integrals for volumes, masses, and centroids of engineering objects [Usage] • Apply Stokes' and Gauss's Divergence Theorems to relate field integrals in electromagnetism and fluid mechanics [Assessment] • Determine whether a vector force field is conservative and compute the potential function [Assessment]
Readings : [**Stewart2016**], [**Thomas2014**]	

Unit 2: Multiple Integrals (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Double integrals over rectangles and general regions; iterated integrals (Fubini's theorem) • Double integrals in polar coordinates and change-of-variables formula • Triple integrals in Cartesian coordinates and applications to volume and mass • Triple integrals in cylindrical and spherical coordinates • Applications: area, volume, centers of mass, and moments of inertia	• Evaluate double and triple integrals over general regions using iterated integrals [Usage] • Apply coordinate changes in polar, cylindrical, and spherical systems to simplify multiple integrals [Usage] • Compute areas, volumes, and centers of mass using multiple integrals [Assessment]
Readings : [**Stewart2016**], [**Larson2018**]	

Unit 3: Line Integrals and Vector Fields (18 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Vector fields: definition, visualization, divergence, and curl • Line integrals of scalar functions: arc length and mass • Line integrals of vector fields: work and circulation • Conservative fields, potential functions, and path independence • Green's Theorem and its applications in the plane	• Compute scalar and vector line integrals over oriented curves [Usage] • Determine whether a vector field is conservative and construct its potential function [Usage] • Apply Green's Theorem to evaluate line integrals via double integrals [Assessment]
Readings : [**Marsden2003**], [**Stewart2016**]	

Unit 4: Surface Integrals and Fundamental Theorems (16 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Parametric surfaces, tangent plane, and surface area • Surface integrals of scalar functions • Flux integrals: surface integrals of vector fields • Stokes' Theorem: relation between line integrals and surface integrals • Divergence Theorem (Gauss): relation between flux and volume integral	• Parametrize surfaces and evaluate scalar and flux surface integrals [Usage] • Apply Stokes' and Divergence Theorems to reduce complex integrals [Assessment] • Relate local differential properties (curl, divergence) to global behavior via integral theorems [Assessment]
Readings : [**Marsden2003**], [**Apostol1969**]	

Unit 5: First-Order Ordinary Differential Equations (ODEs) (16 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• First-order equations: separable, linear, and exact forms	• Solve linear first-order ODEs using integrating factors [Usage]
Readings : [**Boyce2017**], [**Stewart2016**]	

8. WORKPLAN

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

BFI102. Physics II (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	BFI102. Physics II
2.2 Semester	:	3rd Semester.
2.3 Credits	:	5
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 Prerrequisites	:	BFI101. General Physics. (2nd Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Physics II consolidates the foundations of advanced classical mechanics and electromagnetism. The theory of small oscillations and coupled oscillators provides the analytical framework for the study of vibrational systems in engineering and the sciences. Continuum mechanics supplies the essential tools for the analysis of elastic solids and fluids. The study of electromagnetism, from electrostatics to electromagnetic induction, is fundamental in technology, scientific instrumentation, and geophysical exploration.

5. GOALS

- Apply the theory of small oscillations to the analysis of systems with multiple degrees of freedom to determine their normal modes of vibration.
- Understand the foundations of continuum mechanics for the analysis of elastic solids and fluids in engineering and scientific applications.
- Solve problems in electrostatics, dielectrics, and direct-current circuits using the fundamental laws of the electromagnetic field.
- Analyze magnetostatics and electromagnetic induction in the study of devices and electromagnetically based systems.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Usage)

7. TOPICS

Unit 1: Theory of Small Oscillations and Coupled Oscillators (24 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Small oscillation approximation via Taylor expansion about a stable equilibrium • Coupled oscillators and the formulation of equations of motion in matrix form • Normal modes and eigenfrequencies derived from the eigenvalue problem • Damped oscillators: underdamped, critically damped, and overdamped regimes	• Linearize equations of motion about a stable equilibrium point [Usage] • Find normal mode frequencies and eigenvectors for systems of Two coupled oscillators [Usage]
Readings : [**Marion2003**], [**French1971**]	

Unit 2: Continuum Mechanics Foundations (18 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Continuum hypothesis and the definition of density fields • Stress tensor σ_{ij} and the concept of force per unit area • Strain tensor ϵ_{ij} as a measure of local deformation • Hooke's law for isotropic materials: $\sigma_{ij} = \lambda\epsilon_{kk}\delta_{ij} + 2\mu\epsilon_{ij}$ • Navier-Stokes equation for viscous fluids: $\rho\left(\frac{\partial\vec{v}}{\partial t} + \vec{v}\cdot\nabla\vec{v}\right) = -\nabla p + \mu\nabla^2\vec{v} + \vec{f}$ • Bernoulli's principle for inviscid and incompressible fluid flow • Conservation of mass and the continuity equation: $\frac{\partial\rho}{\partial t} + \nabla\cdot(\rho\vec{v}) = 0$ • Conservation of momentum expressed in continuum mechanics form • Wave propagation in elastic media including P-waves and S-waves • Viscosity and the rheology of non-Newtonian fluids	• Interpret the physical meaning of the components of the stress tensor [Familiarity] • Calculate strain tensor components for simple deformations [Usage] • Apply Hooke's law to relate stress and strain for isotropic elastic materials [Usage] • Simplify the Navier-Stokes equation for special cases such as steady or inviscid flow [Usage] • Apply Bernoulli's principle to calculate pressure variations in fluid flow [Usage] • Derive the continuity equation from the principle of mass conservation [Usage] • Analyze different wave propagation modes in elastic solids [Assessment]
Readings : [**Marion2003**], [**Serway2018**]	

Unit 3: Electrostatics: Electric Field and Gauss's Law (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Coulomb's law for point charges and the principle of linear superposition • The electric field vector $\vec{E}$ for discrete and continuous charge distributions • Gauss's Law in integral form and its relation to enclosed charge • Differential form of Gauss's Law: $\nabla \cdot \vec{E} = \rho/\epsilon_0$ • Applications of Gauss's Law to spherical and cylindrical symmetry • The Divergence Theorem applied to electrostatic fields	• Calculate the electrostatic force on a charge distribution using superposition [Usage] • Apply Gauss's Law to find the electric field for systems with high symmetry [Usage] • Evaluate the electric flux through surfaces of engineering interest [Assessment] • Determine volume charge density from a given expression of the electric field [Usage]
Readings : [**Griffiths2017**], [**Young2015**]	

Unit 4: Electric Potential and Poisson/Laplace Equations (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definition of the scalar potential V and $\vec{E} = -\nabla V$ • Calculating potential for continuous charge distributions • Poisson's equation $\nabla^2 V = -\rho/\epsilon_0$ and Laplace's equation • Solution of Laplace's equation via separation of variables for engineering geometries • The method of images for computing fields near conducting boundaries	• Compute the electrostatic potential energy of a charge configuration [Usage] • Derive the electric field vector from a given scalar potential [Usage] • Solve Laplace's equation for a practical engineering geometry with specified boundary conditions [Assessment] • Apply the method of images to engineering problems involving grounded conductors [Usage]
Readings : [**Griffiths2017**]	

Unit 5: Electrostatic Energy and Dielectrics (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Energy density in the electric field: $u = \frac{1}{2}\epsilon_0 E^2$ • Capacitance $C = Q/V$ for standard engineering geometries • The displacement vector $\vec{D}$ and Gauss's Law in dielectric materials • Linear dielectrics, susceptibility, and relative permittivity ϵ_r • Boundary conditions for $\vec{E}$ and $\vec{D}$ at material interfaces	• Calculate the capacitance of parallel-plate and coaxial capacitors filled with dielectrics [Usage] • Evaluate bound charge distributions in polarized dielectric materials [Assessment] • Solve for electric fields on both sides of a dielectric interface using boundary conditions [Usage] • Analyze the force on a dielectric slab in a partially inserted capacitor [Assessment]
Readings : [**Griffiths2017**], [**Serway2018**]	

Unit 6: Electric Current, Circuits, and Kirchhoff's Laws (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definition of current, current density, and the continuity equation • Ohm's law, resistivity, and temperature dependence of resistance • Kirchhoff's Current Law (KCL) for circuit node analysis • Kirchhoff's Voltage Law (KVL) for circuit loop analysis • Series and parallel circuit simplification and equivalent resistance • RC and RL circuit transients and engineering time constants	• Apply KCL and KVL to solve multi-loop DC engineering circuits [Usage] • Calculate power dissipated in resistive circuit elements [Assessment] • Analyze the transient response of RC and RL circuits and determine the time constant [Usage] • Design a resistor network to meet specified voltage division or current distribution requirements [Assessment]
Readings : [**Serway2018**], [**Young2015**]	

Unit 7: Magnetostatics: Biot-Savart and Ampere's Laws (7 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Lorentz force law: $\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$ • Magnetic force on current-carrying wires and loops • Biot-Savart Law for the magnetic field of a current element • Ampere's Law in integral form for high-symmetry engineering configurations • The magnetic vector potential $\vec{A}$ and $\vec{B} = \nabla \times \vec{A}$	• Calculate the magnetic field of solenoids and toroids using Ampere's Law [Usage] • Compute the magnetic field on the axis of a current loop using the Biot-Savart Law [Usage] • Verify that a given magnetic field satisfies $\nabla \cdot \vec{B} = 0$ [Assessment] • Analyze the torque on a current loop in a non-uniform magnetic field [Assessment]
Readings : [**Griffiths2017**], [**Young2015**]	

Unit 8: Magnetic Properties of Matter (7 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• The magnetization vector $\vec{M}$ as magnetic dipole moment per unit volume • The magnetic field intensity $\vec{H}$ and Ampere's Law in matter • Physical principles of diamagnetism, paramagnetism, and ferromagnetism • Ferromagnetic domains and the hysteresis loop for engineering material selection • Linear magnetic media and magnetic permeability μ	• Find bound current distributions for magnetized engineering materials [Usage] • Classify materials as diamagnetic, paramagnetic, or ferromagnetic for engineering application suitability [Assessment] • Analyze energy loss per cycle from a ferromagnetic hysteresis loop for transformer core selection [Assessment]
Readings : [**Griffiths2017**]	

Unit 9: Electrodynamics: Faraday's Law and Induction (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Faraday's Law of induction and Lenz's Law • Self-inductance L and the back-EMF in engineering inductors • Mutual inductance M and transformer principles • Energy stored in the magnetic field of inductors • Eddy currents, magnetic braking, and core loss in electrical machines	• Calculate the induced EMF in a rotating coil and relate it to generator operation [Usage] • Apply Lenz's Law to determine the direction of induced currents in engineering scenarios [Assessment] • Compute the magnetic energy stored in a solenoid or toroidal inductor [Usage] • Evaluate mutual inductance between coupled coils for transformer design [Assessment]
Readings : [**Griffiths2017**], [**Serway2018**]	

8. WORKPLAN

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

ID102. Technical and professional English II (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	ID102. Technical and professional English II
2.2 Semester	:	3rd Semester.
2.3 Credits	:	2
2.4 Hours	:	1 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 Prerrequisites	:	ID101. Technical and professional English I. (2nd Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Building on foundational English skills, this course develops the student's ability to communicate in technical and scientific contexts with greater fluency. Grammar structures are practiced through reading and producing descriptions of technological systems, scientific phenomena, and engineering processes. Students gain vocabulary relevant to computing, data, and the physical sciences.

5. GOALS

- Develop fluency in English applied to technical and scientific communication.
- Expand vocabulary in computing, data, and engineering domains.

6. COMPETENCES

ABET-3) An ability to communicate effectively with a range of audiences. (Familiarity)

ABET-5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. (Familiarity)

7. TOPICS

Unit 1: Breakthroughs and Discoveries (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Simple Past Review: Affirmative and Negative in scientific contexts. • Time expressions with 'ago': When technologies were invented or released. • Conjunctions: and, so, but, because — structuring technical explanations. • Vocabulary: Scientific milestones, inventions, and discoveries.	• By the end of the unit, students narrate past technological breakthroughs and connect cause-and-effect relationships using simple past and conjunctions (e.g., "Scientists discovered X, so engineers developed Y").
Readings : [**Soars021S**], [**Cambridge06**], [**MacGrew99**]	

Unit 2: Data and Variables (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Countable and Uncountable nouns in computing: files, data, code, memory. • Use of some, any, a lot of in quantifying technical resources. • Expressions of quantity: a little memory, a few errors, too many processes. • Vocabulary: Data types, variables, constants, and storage units.	• Students correctly use countable and uncountable noun structures to describe data, resources, and system states in technical contexts.
Readings : [**Soars021S**], [**Cambridge06**], [**MacGrew99**]	

Unit 3: Future of Technology (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Future plans: Verb + to + infinitive in project planning. • Use of 'Will' vs 'Going to' for predictions and scheduled releases. • Auxiliary verbs in forecasting: AI trends, cloud computing, quantum computing. • Vocabulary: Emerging technologies and career pathways in computing.	• Students express technological intentions and project plans, as well as make evidence-based predictions about computing and engineering trends.
Readings : [**Soars021S**], [**Cambridge06**], [**MacGrew99**]	

Unit 4: Comparing Technologies (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Comparative and superlative adjectives applied to hardware and software. • Comparing programming languages, operating systems, and algorithms. • Synonyms and antonyms in technical vocabulary. • Reading: Short technology comparison articles and benchmark reports.	• Students make detailed technical comparisons between systems, languages, and tools, using comparative and superlative structures accurately.
Readings : [**Soars021S**], [**Cambridge06**], [**MacGrew99**]	

Unit 5: Running Processes (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Present Continuous to describe active and ongoing technical processes. • Current use: "The server is processing requests." • Future use with Present Continuous: scheduled deployments and experiments. • Writing: Status updates and progress reports in technical projects.	• Students describe active computing processes, ongoing experiments, and scheduled technical activities using the present continuous form.
Readings : [**Soars021S**], [**Cambridge06**], [**MacGrew99**]	

Unit 6: Software Milestones (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Introduction to Present Perfect to describe achievements with current relevance. • Keywords: ever, never, yet, just — applied to software releases and research. • Vocabulary: Version history, patches, upgrades, published papers. • Reading: Technology news and software changelogs.	• Students communicate technical achievements and software milestones with present relevance, without specifying an exact time, using the present perfect.
Readings : [**Soars021S**], [**Cambridge06**], [**MacGrew99**]	

Unit 7: Technical Challenges (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Adjectives ending in -ed and -ing to describe technical experiences and processes. • Modal verbs of obligation: must, have to — applied to engineering requirements. • Vocabulary: Engineering challenges, constraints, trade-offs, and standards. • Writing: Short technical problem statements.	• Students describe the emotional and technical aspects of engineering challenges and express obligations and constraints using specialized vocabulary.
Readings : [**Soars021S**], [**Cambridge06**], [**MacGrew99**]	

Unit 8: English for Technology II (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Technical terminology: Input/output devices, storage, and peripherals. • Reading and following software installation and configuration instructions. • Communication in technical support: Describing symptoms and solutions. • Presentation: Describing a computing system to a non-specialist audience.	• By the end of the course, students interpret technical instructions, describe hardware components, and communicate basic computing concepts to diverse audiences in English.
Readings : [**Soars021S**], [**Cambridge06**], [**MacGrew99**]	

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

1. COURSE

CE1M2. Dynamics (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE1M2. Dynamics
2.2 Semester	:	4^{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 Prerrequisites	:	• CE1M1. Statics. (3^{rd} Sem) • BFI102. Physics II. (3^{rd} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Dynamics studies the accelerated motion of particles and rigid bodies under the action of forces. In Civil Engineering, this knowledge is essential for the analysis of structures subjected to time-varying loads, such as earthquakes, wind, vehicular traffic, and heavy machinery. It provides the foundation for advanced courses such as Earthquake Engineering and Structural Dynamic Analysis.

5. GOALS

- Analyze the kinematics of particles and rigid bodies in various coordinate systems.
- Apply Newton's laws, the principles of work and energy, and impulse and momentum to solve kinetics problems.
- Model and solve single-degree-of-freedom mechanical vibration problems to evaluate structural response.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (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: Kinematics of Rigid Bodies in Plane Motion (10 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Translation and rotation about a fixed axis • General plane motion: relative velocity and acceleration, and the instantaneous center of rotation	• Determine the velocity and acceleration of any point in a planar mechanism using the instantaneous center of rotation [Usage] • Explain the distinction between translation, fixed-axis rotation, and general plane motion [Familiarity]
Readings : [**Hibbeler2016Dyn**]	

Unit 2: Kinetics of Rigid Bodies in Plane Motion (10 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Equations of motion for a rigid body in plane motion • Kinetic energy of a rigid body and the principle of work and energy	• Apply the equations of motion to relate external forces to the angular acceleration of rigid bodies [Assessment] • Analyze rigid-body motion problems using the principle of work and energy [Usage]
Readings : [**Hibbeler2016Dyn**]	

Unit 3: Introduction to Structural Vibrations (12 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Undamped free vibration of a single-degree-of-freedom system • Simple pendulum and mass-spring models • Natural frequency, period, and amplitude concepts • Introduction to damped free vibration	• Model simple structural systems as single-degree-of-freedom systems [Usage] • Calculate the natural frequency of a structure to avoid basic resonance phenomena [Assessment] • Describe the effect of damping on the free-vibration response of a structural system [Familiarity] • Interpret period and amplitude parameters from a structure's free-vibration response [Usage]
Readings : [**Bedford2008**]	

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

1. COURSE

CE2C3. Concrete Technology I (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2C3. Concrete Technology I
2.2 Semester	:	4^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE2C1. Materials Technology. (3^{rd} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Concrete Technology I deepens the science of construction materials and concrete technology: advanced cementitious materials, special concretes and concrete in extreme climates, transportation and placement, and statistical quality control. The course also includes polymeric and sustainable composite materials, and concludes with rehabilitation, strengthening, and structural retrofitting.

5. GOALS

- Apply materials science to the selection of construction materials and advanced cementitious materials.
- Design and control the quality of special concretes and concretes in extreme climates, including their transportation and placement.
- Apply statistical quality control to concrete production.
- Evaluate and design rehabilitation, strengthening, and structural retrofitting interventions.

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: Construction Materials Science (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Physical and mechanical properties of construction materials including density, porosity, strength, and elasticity • Microstructure and phase composition of construction materials • Durability mechanisms including weathering, chemical attack, and environmental degradation • Thermal and moisture properties of construction materials • Crystalline and amorphous structures in construction materials • Material selection criteria based on performance requirements • Degradation mechanisms and service life prediction	• Describe the fundamental physical and mechanical properties of major construction materials [Familiarity] • Analyze the relationship between microstructure and macroscopic properties of materials [Assessment] • Evaluate the durability performance of materials under specific environmental conditions [Usage] • Explain the effects of thermal and moisture variations on material behavior [Familiarity] • Select appropriate construction materials based on design specifications and performance criteria [Assessment] • Predict service life and degradation patterns of materials in various environments [Usage]
Readings : [**Neville2011**]	

Unit 2: Concrete Technology and Advanced Cementitious Materials (25 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Portland cement chemistry and hydration process • Aggregates properties and grading requirements • Mix design methodology for normal strength concrete • Fresh concrete properties including workability, slump, and setting time • Hardened concrete properties including strength, modulus, and shrinkage • Chemical and mineral admixtures for concrete • High-performance and high-strength concrete design • Self-consolidating concrete and fiber-reinforced concrete • Durability aspects including alkali-silica reaction, sulfate attack, and freeze-thaw • Sustainable and low-carbon concrete technologies including supplementary cementitious materials such as fly ash, slag, and silica fume	• Describe the chemistry of portland cement and the hydration process [Familiarity] • Evaluate aggregate quality and suitability for concrete production [Assessment] • Design concrete mixes for specified strength and workability requirements [Usage] • Test and interpret fresh concrete properties using standard procedures [Assessment] • Predict hardened concrete properties based on mix proportions and curing conditions [Usage] • Explain the function and effects of various concrete admixtures [Familiarity] • Formulate high-performance concrete mixes for demanding applications [Usage] • Select appropriate special concretes for specific construction scenarios [Assessment] • Incorporate supplementary cementitious materials to optimize concrete performance [Usage] • Analyze durability risks and specify protective measures for concrete structures [Assessment] • Compare environmental impacts and carbon footprints of different concrete formulations [Familiarity]
Readings : [**Neville2011**]	

Unit 3: Polymeric, Composite, and Sustainable Construction Materials (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Polymer chemistry and classification of construction polymers • Mechanical and thermal behavior of polymeric materials • Fiber-reinforced polymer composites and their structural applications • Adhesives, sealants, and waterproofing materials • Composite material mechanics and laminate theory • FRP strengthening and rehabilitation of concrete and masonry structures • Bio-based and recycled materials for sustainable construction • Geopolymers and alternative binder systems • Environmental degradation and long-term performance of polymers and composites	• Classify polymers used in construction and describe their basic properties [Familiarity] • Characterize the mechanical and thermal behavior of polymeric materials [Assessment] • Apply fiber-reinforced polymers in structural design and retrofitting applications [Usage] • Select appropriate adhesives and sealants for specific construction applications [Familiarity] • Analyze composite laminates using classical lamination theory [Usage] • Design FRP strengthening systems for existing concrete or masonry structures [Assessment] • Evaluate the sustainability and life-cycle performance of bio-based construction materials [Assessment] • Compare geopolymer binders with traditional portland cement systems [Familiarity] • Predict long-term degradation of polymers and composites under environmental exposure [Usage]
Readings : [**Callister2020**]	

Unit 4: Special Concretes and Concrete in Extreme Climates (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Hot-weather concrete: heat effects on hydration, retarding admixtures, and curing methods • Cold-weather concrete: freeze protection, accelerating admixtures, and enclosure protection methods • Structural lightweight concrete: materials, properties, and mix design • Mass and heavyweight concrete: heat of hydration control and applications • Shotcrete: mix design, application process, and quality control • Concrete for underwater structures: antiwashout mixes and placement methods • Pervious and architectural concrete: properties and applications	• Identify the effects of hot and cold weather on fresh and hardened concrete properties [Familiarity] • Apply preventive and corrective measures for concrete production and placement in adverse weather conditions [Usage] • Select the appropriate special concrete type according to project functional and environmental requirements [Assessment] • Design lightweight concrete mixes meeting specified strength and density requirements [Usage] • Specify shotcrete mixing, transport, and placement procedures for tunnel and slope applications [Usage] • Evaluate the suitability of special concretes for extreme exposure conditions [Assessment] • Develop specifications for concrete in extreme temperature conditions following ACI 305 and ACI 306 standards [Usage]
Readings : [**Neville2011**]	

Unit 5: Concrete Transport and Placement (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Transit mixer transport: maximum delivery time, slump verification, and admissible conditions • Concrete pumping: pumpable mix design, operating pressure, reach, and blockage prevention • Placement methods: direct discharge, chutes, buckets, and crane placement • Concrete consolidation: internal and external vibration, frequency, amplitude, and insertion depth • Underwater concrete placement by tremie method and in restricted-access conditions • Belt conveyor and pneumatic transport systems for large-volume concrete • Concrete surface finishing: leveling, troweling, texturing, and immediate curing	• Plan concrete transport considering delivery distance, setting time, and environmental conditions [Usage] • Execute standardized concrete placement procedures for different types of structural elements [Usage] • Apply correct vibration techniques to achieve uniform concrete consolidation [Usage] • Evaluate concrete placement quality and identify deficiencies such as segregation, honeycombs, and cold joints [Assessment] • Design pumpable concrete mixes for specific pumping height and distance conditions [Usage] • Specify placement methods for restricted-access structures or underwater placement conditions [Assessment] • Develop placement plans minimizing cold joints and ensuring concrete continuity in large structural elements [Usage]
Readings : [**Neville2011**]	

Unit 6: Statistical Quality Control of Concrete (3 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Sampling procedures and fresh concrete specimen preparation according to ASTM standards • Compressive strength testing: procedure, minimum frequency, and testing conditions • Basic statistics applied to concrete: mean, standard deviation, and coefficient of variation • Concrete acceptance criteria according to ACI 318 and equivalent standards • Statistical control charts ($\bar{X}$, R) for continuous monitoring of concrete production • Non-conforming results analysis: investigation procedures, additional tests, and structural decisions • Process capability indices (C_p, C_{pk}) and target mean strength adjustment	• Apply standardized sampling and specimen fabrication procedures for concrete on site [Usage] • Interpret compressive strength test results and determine their validity [Assessment] • Calculate basic statistical parameters from series of concrete strength test results [Usage] • Evaluate concrete acceptance or rejection applying ACI 318 normative criteria [Assessment] • Construct statistical control charts for continuous monitoring of concrete production [Usage] • Diagnose causes of excessive variability and propose corrective actions in concrete production [Assessment] • Determine the target mean strength (f'_{cr}) considering the statistical variability of the production process [Usage]
Readings : [**Neville2011**]	

Unit 7: Structural Rehabilitation, Strengthening, and Retrofit (3 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Condition assessment and structural evaluation procedures • Load rating and capacity evaluation of existing structures • Concrete repair materials and techniques • Strengthening techniques using external reinforcement • FRP strengthening systems for flexure and shear • Seismic retrofit strategies for buildings and bridges • Steel jacketing and external post-tensioning • Masonry rehabilitation and historic structure preservation • Performance-based assessment and retrofit design • Nondestructive evaluation and structural health monitoring	• Conduct comprehensive condition assessments of existing structures [Assessment] • Evaluate load-carrying capacity of existing structural members [Usage] • Select appropriate concrete repair materials and application methods [Familiarity] • Design strengthening interventions using conventional techniques [Assessment] • Apply FRP systems for flexural and shear strengthening of concrete members [Usage] • Develop seismic retrofit strategies for deficient structures [Assessment] • Implement steel jacketing and external post-tensioning systems [Usage] • Rehabilitate masonry structures while preserving historic character [Assessment] • Perform performance-based assessment and design retrofit interventions [Usage] • Utilize nondestructive testing and monitoring technologies for damage assessment [Familiarity]
Readings : [**ACI562**]	

Unit 8: Site Visits (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Technical visit to a ready-mix concrete plant or an active concrete placement site. • Observation of concrete transport, placement, consolidation, curing, and quality control in the field. • Preparation of a technical visit report.	• Relate the concrete technology studied in the course to its real production and placement on site [Usage].
Readings :	

8. WORKPLAN

8.1 Methodology

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8.2 Theory Sessions

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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

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

1. COURSE

CE2M1. Mechanics of Materials I (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2M1. Mechanics of Materials I
2.2 Semester	:	4^{th} Semester.
2.3 Credits	:	5
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 Prerrequisites	:	• CE1M1. Statics. (3^{rd} Sem) • MA210. Calculus III. (3^{rd} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Mechanics of Materials I studies the behavior of deformable solid bodies subjected to different types of loading. For the civil engineer, understanding concepts such as stress, strain, and elasticity is fundamental, since these allow the strength and stiffness of structural elements to be predicted. This knowledge is the basis for the safe design of beams, columns, and shafts, ensuring that materials operate within their allowable limits.

5. GOALS

- Understand the concepts of stress and strain under axial, torsional, and bending loads.
- Analyze the mechanical properties of materials from tension and compression tests.
- Determine internal stresses and deformations in statically determinate structural elements.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (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: Mechanics of Materials and Structural Behavior (24 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Stress and strain concepts including normal, shear, and principal stresses • Axial loading and deformation of members • Torsion of circular and non-circular sections • Bending stress and deflection in beams • Shear stress distribution in beams • Combined loading and stress transformation • Buckling of columns and stability analysis • Fatigue and fracture mechanics • Elastic and plastic behavior of materials • Energy methods for structural analysis	• Define stress, strain, and their relationships through constitutive laws [Familiarity] • Calculate stresses and deformations in members under axial loading [Usage] • Determine torsional stresses and angles of twist in shafts [Usage] • Analyze bending stress distribution and deflection in beams [Assessment] • Compute shear stress distribution in beam cross-sections [Usage] • Apply stress transformation equations for combined loading conditions [Assessment] • Evaluate column stability and calculate critical buckling loads [Assessment] • Explain fatigue failure mechanisms and predict fatigue life [Familiarity] • Distinguish between elastic and plastic material behavior under loading [Usage] • Use energy methods to solve deflection and indeterminate structural problems [Usage]
Readings : [**Gere2017**], [**Hibbeler2022Mat**], [**Beer2019**]	

Unit 2: Axial Stress and Strain (16 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Average normal and shear stress. • Normal and shear strain. • Hooke's law and the modulus of elasticity. • Axially loaded members: changes in length and statically indeterminate systems.	• Calculate stresses and deformations in bars subjected to axial load considering cross-sectional variations [Evaluar]. • Solve simple statically indeterminate structure problems using the deformation method [Usar].
Readings : [**Hibbeler2022Mat**]	

Unit 3: Torsion and Pure Bending (20 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Torsion in circular shafts: the torsion formula and angle of twist. • Pure bending: bending deformation and the elastic flexure formula. • Shear stresses in beams: the shear flow formula. • Design of prismatic beams for strength.	• Determine the distribution of shear stresses in circular sections subjected to torque [Usar]. • Calculate the maximum tensile and compressive stresses in beams under various bending moments [Evaluar].
Readings : [**Gere2017**]	

Unit 4: Stress Transformation and Combined Loading (20 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Plane stress transformation: general equations. • Mohr's circle for plane stress and strain. • Principal stresses and maximum shear stress. • Stress analysis under combined loading (axial, bending, and torsion).	• Use Mohr's circle to identify the planes where maximum stresses occur [Evaluar]. • Analyze the state of stress at a critical point of an element subjected to multiple types of loading [Evaluar].
Readings : [**Hibbeler2022Mat**], [**Gere2017**]	

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

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

National University of Engineering (UNI)
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Syllabus 2027-I

1. COURSE

MA202. Numerical Methods (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	MA202. Numerical Methods
2.2 Semester	:	4th Semester.
2.3 Credits	:	3
2.4 Hours	:	2 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 Prerrequisites	:	• MA121. Linear Algebra I. (3rd Sem) • BIC101. Introduction to Programming. (1st Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Numerical methods are a fundamental tool shared by computer science and engineering disciplines for approximating solutions to mathematical problems that cannot be solved analytically. This course provides an introduction to the most common numerical methods, including error analysis, solution of nonlinear equations, interpolation, numerical integration, and solution of differential equations, in scientific and engineering contexts.

5. GOALS

- Understand the importance of numerical methods in solving scientific and engineering problems.
- Apply different numerical methods to approximate solutions to mathematical problems.
- Analyze the accuracy and efficiency of the numerical methods used.

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: Error Analysis and Floating Point Arithmetic (6 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Floating point representation and round-off errors in engineering software • Conditioning of engineering problems and stability of numerical algorithms • Truncation error in series approximations and finite difference stencils • Error propagation through chains of computations in engineering simulations	• Explain the sources and consequences of round-off and truncation errors in engineering computations [Familiarity] • Calculate the condition number of a linear system and interpret its effect on solution accuracy [Assessment] • Estimate the propagation of measurement uncertainties through an engineering calculation chain [Usage] • Select numerical methods with appropriate stability properties for engineering simulation requirements [Assessment]
Readings : [**ChapraCanale2015**], [**BurdenFaires2010**]	

Unit 2: Numerical Solution of Nonlinear Equations (10 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Bracketing methods: bisection and false position • Newton-Raphson method and the secant method • Order of convergence and stopping criteria in iterative methods	• Explain the basis and convergence guarantees of the bisection and false position methods [Familiarity] • Apply the Newton-Raphson and secant methods to approximate roots of engineering equations [Usage] • Compare the convergence order of different iterative methods and select the most appropriate one for a given problem [Assessment]
Readings : [**ChapraCanale2015**], [**BurdenFaires2010**]	

Unit 3: Approximation Theory and Interpolation (10 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Polynomial interpolation: Lagrange, Newton divided differences, and Runge's phenomenon • Spline interpolation: cubic splines, B-splines, and piecewise polynomial methods • Best approximation in normed spaces: Chebyshev (minimax) and least squares • Chebyshev polynomials: properties, orthogonality, and spectral convergence • Trigonometric approximation and the fast Fourier transform (FFT)	• Explain Runge's phenomenon and justify the choice of Chebyshev nodes to mitigate it [Familiarity] • Construct cubic spline and Chebyshev interpolants for given data and estimate the interpolation error [Usage] • Apply the FFT to efficiently compute trigonometric approximations of a sampled function [Assessment]
Readings : [**ChapraCanale2015**], [**BurdenFaires2010**]	

Unit 4: Numerical Integration and Quadrature (10 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Newton-Cotes rules: trapezoidal, Simpson's, and composite rules; error analysis • Adaptive quadrature and automatic error control • Gaussian quadrature: optimal nodes and weights, orthogonal polynomial connection • Numerical treatment of improper and singular integrals • Monte Carlo integration and quasi-Monte Carlo methods for high-dimensional integrals	• Derive the error formula for composite Simpson's rule and identify its order of accuracy [Familiarity] • Select and apply an appropriate quadrature rule (Gaussian, adaptive) based on integrand regularity [Usage] • Apply Monte Carlo integration to estimate high-dimensional integrals and quantify the statistical error [Assessment]
Readings : [**ChapraCanale2015**], [**BurdenFaires2010**]	

Unit 5: Numerical Methods for ODEs and PDEs (12 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Runge-Kutta methods and adaptive time-stepping for engineering ODE problems • Stability analysis and stiffness in engineering ODE integrators • Finite difference discretization of engineering PDEs (heat equation, Laplace equation) • Finite element and shooting methods for engineering boundary value problems	• Implement a fourth-order Runge-Kutta integrator for a mechanical vibration problem [Usage] • Determine the region of absolute stability for an explicit time-stepping scheme [Assessment] • Discretize the 2D heat equation using finite differences and set up the resulting linear system [Usage] • Compare finite difference and finite element approaches for solving an engineering PDE [Assessment]
Readings : [**ChapraCanale2015**], [**BurdenFaires2010**]	

Unit 6: Numerical Linear Algebra (12 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• LU and QR decompositions for solving engineering linear systems • Iterative solvers: Jacobi, Gauss-Seidel, and Conjugate Gradient for large sparse systems • Singular Value Decomposition (SVD) for data fitting and model reduction • Sparse matrix storage formats and efficient solvers for large engineering FEM/FVM systems	• Solve engineering linear systems using LU decomposition with partial pivoting [Usage] • Analyze the convergence rate of iterative solvers applied to engineering stiffness matrices [Assessment] • Implement a Conjugate Gradient solver for a large symmetric positive-definite engineering system [Usage] • Apply SVD to compress a structural mode shape dataset and assess the approximation quality [Assessment]
Readings : [**BurdenFaires2010**], [**TrefethenBau1997**]	

Unit 7: Finite Element Method (8 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Weak (variational) formulation of boundary value problems and Sobolev spaces • Galerkin method: finite-dimensional approximation spaces and the stiffness matrix • Triangular and quadrilateral finite element spaces: Lagrange elements and conformity • A priori error estimates: Céa's lemma and interpolation error bounds • A posteriori error estimates and adaptive mesh refinement	• Derive the weak formulation of an elliptic BVP and show its equivalence to the strong form [Familiarity] • Assemble the global stiffness matrix and load vector for a linear finite element discretization [Usage] • Estimate the H^1 error of a finite element solution using Céa's lemma and interpolation theory [Assessment]
Readings : [**ReddyFEM2019**], [**BurdenFaires2010**]	

Unit 8: Optimization Algorithms (4 hours)	
Competences Expected: ABET-2,ABET-6	
Topics	**Learning Outcomes**
• Gradient descent and line search methods: Armijo-Wolfe conditions and convergence rates • Newton's method and quasi-Newton methods (BFGS, L-BFGS) • Constrained optimization: KKT conditions, penalty methods, and sequential quadratic programming • Convex optimization algorithms: interior-point methods and the alternating direction method of multipliers (ADMM) • Stochastic gradient descent (SGD), variance reduction, and Adam optimizer	• Explain the convergence guarantees of gradient descent for smooth convex functions [Familiarity] • Apply Newton and quasi-Newton methods to unconstrained optimization problems [Usage] • Formulate a constrained optimization problem as a KKT system and apply an interior-point method [Assessment]
Readings : [**NocedalWright2006**]	

Unit 9: Parallel and High-Performance Computing (4 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Parallel architectures: shared memory (OpenMP), distributed memory (MPI), and GPU (CUDA) • Performance models: Amdahl's law, roofline model, and communication complexity • Parallel algorithms for dense and sparse linear algebra (ScaLAPACK, PETSc) • Domain decomposition and parallel PDE solvers • Automatic differentiation (forward and reverse mode) and its role in scientific ML	• Explain Amdahl's law and identify the bottlenecks limiting parallel speedup in a given algorithm [Familiarity] • Implement a parallel linear algebra routine using MPI or OpenMP and measure parallel efficiency [Usage] • Apply automatic differentiation to compute gradients of complex scientific functions for optimization [Assessment]
Readings : [**PachecoMalensek2022**]	

Unit 10: Graph Theory (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Graphs: definitions, isomorphism, degree sequences, trees, and spanning trees • Connectivity, Menger's theorem, and network flows (max-flow min-cut) • Matchings (Hall's theorem), graph colorings, and the chromatic polynomial • Planar graphs, Euler's formula, Kuratowski's theorem, and the four-color theorem • Adjacency and Laplacian matrices, eigenvalues, and expander graphs	• Identify structural properties of graphs (connectivity, planarity, bipartiteness) and apply Euler's formula [Familiarity] • Apply Hall's marriage theorem and network flow algorithms to matching and routing problems [Usage] • Analyze a graph's spectrum to bound its chromatic number and connectivity properties [Assessment]
Readings : [**West2001**]	

Unit 11: Time Series Analysis (2 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Stationarity, autocovariance function, and the autocorrelation function (ACF) • ARMA models: identification, estimation (Yule-Walker, MLE), and diagnostics • Spectral density, the periodogram, and Wiener-Khinchin theorem • State-space models and the Kalman filter • ARIMA models, seasonal adjustment, and multi-step forecasting	• Identify stationarity and determine the order of an ARMA model from ACF and PACF plots [Familiarity] • Fit ARIMA models to time series data, validate residuals, and produce forecasts [Usage] • Apply the Kalman filter to estimate hidden states in a linear Gaussian state-space model [Assessment]
Readings : [**ShumwayStoffer2017**]	

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

National University of Engineering (UNI)
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Syllabus 2027-I

1. COURSE

MA211. Calculus IV (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	MA211. Calculus IV
2.2 Semester	:	4^{th} Semester.
2.3 Credits	:	5
2.4 Hours	:	3 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 Prerrequisites	:	• MA210. Calculus III. (3^{rd} Sem) • MA121. Linear Algebra I. (3^{rd} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course covers ordinary differential equations, an introduction to partial differential equations, and asymptotic and perturbation methods, extending the multivariable calculus foundations built in previous courses. It develops the analytical tools needed to model and solve differential equations arising in physics and engineering, and to approximate the solutions of problems that cannot be solved in closed form.

5. GOALS

- Solve first-order ordinary differential equations and model physical systems with them.
- Solve higher-order linear ordinary differential equations and systems of ODEs.
- Classify and solve elementary partial differential equations using separation of variables and Fourier methods.
- Construct asymptotic expansions and apply regular and singular perturbation methods to approximate solutions.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

7. TOPICS

Unit 1: First-Order Ordinary Differential Equations (ODEs) (30 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• First-order equations: separable, linear, and exact forms	• Solve linear first-order ODEs using integrating factors [Usage]
Readings : [**Boyce2017**], [**Stewart2016**]	

Unit 2: Higher-Order Differential Equations and Systems (ODEs) (20 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Linear higher-order equations with constant coefficients • Systems of first-order linear ODEs and state-space formulation • Laplace transform method for solving engineering ODEs with initial conditions • Modeling of mass-spring-damper, RLC circuits, and heat conduction with ODEs	• Apply the Laplace transform method to solve linear engineering ODEs with initial conditions [Usage] • Model a damped mechanical oscillator or RLC circuit as a second-order linear ODE [Usage] • Analyze the stability and transient response of engineering systems described by systems of ODEs [Assessment] • Formulate state-space representations for multivariable engineering dynamic systems [Usage]
Readings : [**Boyce2017**]	

Unit 3: Partial Differential Equations (PDEs) (16 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Separation of variables for heat and wave equations in engineering geometries • Laplace transform methods applied to initial-boundary value problems • Classification of PDEs: elliptic, parabolic, and hyperbolic types and their physical significance • Formulation and physical interpretation of boundary conditions in engineering problems • Green's functions and boundary value problems for advanced engineering analysis	• Apply separation of variables to solve the 1D heat conduction and wave equations [Usage] • Classify a given PDE and select the appropriate analytical or numerical solution approach [Assessment] • Formulate boundary conditions for a heat transfer or stress analysis problem [Assessment] • Derive the governing PDE for steady-state heat conduction using Fourier's law [Usage]
Readings : [**Strauss2008**], [**Stewart2016**]	

Unit 4: Asymptotic Analysis and Perturbation Methods (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Asymptotic expansions and the Landau order symbols (O, o, $\sim$) • Regular perturbation theory for algebraic equations and ODEs • Singular perturbation theory and matched asymptotic expansions (boundary layers) • Method of multiple scales and the WKB approximation	• Construct a regular perturbation expansion for an ODE with a small parameter [Familiarity] • Apply matched asymptotic expansions to solve singular perturbation problems with boundary layers [Usage]
Readings : [**BenderOrszag1999**]	

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9. EVALUATION SYSTEM

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

10. BASIC BIBLIOGRAPHY

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

1. COURSE

STA251. Statistics and Probability (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	STA251. Statistics and Probability
2.2 Semester	:	4^{th} Semester.
2.3 Credits	:	3
2.4 Hours	:	1 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 Prerrequisites	:	MA112. Calculus II. (2^{nd} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Probability and statistics provide the mathematical foundation for reasoning under uncertainty, analyzing data, and building predictive models – skills that are essential across computing, artificial intelligence, computational mathematics, and engineering alike. This course develops a rigorous understanding of probability theory and its use in describing random phenomena, together with the fundamentals of descriptive statistics, statistical inference (estimation, hypothesis testing, and Bayesian reasoning), and regression modeling, so that students can summarize and analyze data, quantify uncertainty, and draw sound quantitative conclusions in their own field of application.

5. GOALS

- Understand the fundamentals of probability theory and descriptive statistics.
- Apply probability distributions and statistical inference methods to analyze data and quantify uncertainty.
- Develop skills to model random phenomena and build predictive statistical models such as linear regression.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

7. TOPICS

Unit 1: Numerical Summaries: Location, Spread, and Shape (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Measures of location: mean, median, mode, trimmed mean, and weighted mean • Measures of spread: variance, standard deviation, IQR, MAD, and range • Measures of shape: skewness and kurtosis; quantiles and percentiles • Robust summary statistics: resistance to outliers and heavy-tailed distributions	• Calculate and interpret measures of location, spread, and shape for a univariate dataset [Usage] • Select appropriate summary statistics based on the distributional properties of the data [Usage] • Compare classical and robust summary statistics and justify the choice for a given dataset [Assessment]
Readings : [**Devore2016**]	

Unit 2: Sample Spaces and Events (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Random experiments, outcomes, and sample spaces: finite, countable, and uncountable • Set-theoretic operations on events: union, intersection, complement, and De Morgan's laws • Sigma-algebras and measurable spaces as the foundation for rigorous probability • Borel sets and the Borel sigma-algebra on the real line	• Define sample spaces, events, and sigma-algebras for a given random experiment [Familiarity] • Apply set-theoretic operations to compute probabilities of compound events [Usage] • Construct appropriate sigma-algebras for measurable spaces arising in statistical problems [Assessment]
Readings : [**Ross2014**], [**Devore2016**]	

Unit 3: Probability Axioms and Properties (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Kolmogorov's three axioms of probability and their consequences • Derived properties: complement rule, addition rule, monotonicity, and continuity of probability • Classical, frequentist, and subjective (Bayesian) interpretations of probability • Counting methods: permutations, combinations, and the multiplication principle	• State Kolmogorov's axioms and derive fundamental probability properties [Familiarity] • Calculate probabilities of events using the addition rule and complement rule [Usage] • Apply counting methods to compute probabilities in finite sample spaces [Usage]
Readings : [**Ross2014**], [**Devore2016**]	

Unit 4: Conditional Probability and Independence (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definition and interpretation of conditional probability P(A|B) and its properties • Bayes' theorem and the law of total probability: derivation and applications • Independence of events: pairwise and mutual independence • Conditional independence and its role in probabilistic graphical models	• Explain conditional probability and independence and their relationship [Familiarity] • Apply Bayes' theorem and the law of total probability to solve probability problems [Usage] • Analyze whether events are independent or conditionally independent in a given probability model [Assessment]
Readings : [**Ross2014**], [**Devore2016**]	

Unit 5: Discrete Random Variables and Distributions (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Probability mass functions (PMF) and cumulative distribution functions (CDF) for discrete random variables • Key discrete distributions: Bernoulli, Binomial, Geometric, Negative Binomial, Poisson, Hypergeometric • Properties of discrete distributions: mean, variance, skewness, and kurtosis • Poisson approximation to the Binomial and limiting distribution arguments	• Identify and describe the key discrete probability distributions and their parameters [Familiarity] • Calculate probabilities, means, and variances using PMFs of standard discrete distributions [Usage] • Select an appropriate discrete distribution to model a given random phenomenon and justify the choice [Assessment]
Readings : [**Ross2014**], [**Devore2016**]	

Unit 6: Continuous Random Variables and Distributions (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Probability density functions (PDF) and CDFs for continuous random variables • Key continuous distributions: Uniform, Normal, Exponential, Gamma, Beta, Chi-squared, t, F • The Normal distribution: properties, standard normal, and its central role in statistical inference • The exponential family of distributions: canonical form and sufficient statistics	• Describe the properties and parameters of key continuous probability distributions [Familiarity] • Calculate probabilities and quantiles for standard continuous distributions [Usage] • Identify distributions belonging to the exponential family and derive their sufficient statistics [Assessment]
Readings : [**Ross2014**], [**Devore2016**]	

Unit 7: Joint, Marginal, and Conditional Distributions (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Joint PMFs and PDFs for two or more random variables • Marginal and conditional distributions derived from joint distributions • Covariance, correlation, and their properties; independence implies zero covariance (converse not always true) • The bivariate normal distribution and its conditional distributions	• Derive marginal and conditional distributions from a given joint distribution [Usage] • Calculate covariance and correlation between two random variables [Usage] • Analyze the conditional structure of the bivariate normal distribution [Assessment]
Readings : [**Ross2014**], [**Devore2016**]	

Unit 8: Limit Theorems: LLN and CLT (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Weak law of large numbers: convergence in probability and its implications for estimation • Central limit theorem: statement, conditions, and role in justifying normal approximations • Applications of the CLT: normal approximation to the binomial and sampling distributions • Strong law of large numbers: almost sure convergence • The delta method: asymptotic distribution of smooth functions of estimators	• State the LLN and CLT and explain the conditions under which they hold [Familiarity] • Apply the CLT to derive normal approximations and sampling distributions [Usage] • Apply the delta method to derive asymptotic distributions of nonlinear estimators [Assessment]
Readings : [**Ross2014**], [**Devore2016**]	

Unit 9: Point Estimation (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Desirable properties: unbiasedness, consistency, efficiency, and sufficiency • Method of moments estimation: derivation and asymptotic properties • Maximum likelihood estimation: derivation, properties, and invariance principle • Cramer-Rao lower bound and the concept of Fisher information	• Describe the key properties of estimators and explain the trade-offs between them [Familiarity] • Derive method of moments and MLE estimators for standard distributions [Usage] • Evaluate the efficiency of an estimator using the Cramer-Rao lower bound [Assessment]
Readings : [**Devore2016**]	

Unit 10: Interval Estimation and Confidence Intervals (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Constructing confidence intervals using pivotal quantities and exact distributions • Correct interpretation of confidence intervals: coverage probability and common misconceptions • Large-sample confidence intervals based on asymptotic normality • Duality between confidence intervals and hypothesis tests	• Construct confidence intervals for means, proportions, and variances using exact and large-sample methods [Usage] • Interpret confidence intervals correctly and identify common misinterpretations [Usage] • Explain the duality between confidence intervals and hypothesis tests and use it to draw inferences [Assessment]
Readings : [**Devore2016**]	

Unit 11: Hypothesis Testing Foundations (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Neyman-Pearson framework: null/alternative hypotheses, rejection regions, Type I and II errors • p-values: definition, correct interpretation, and common misuse; power and sample size • Common parametric tests: z-test, t-test, F-test, chi-squared test • Neyman-Pearson lemma and uniformly most powerful tests	• Explain the logic of hypothesis testing, Type I and II errors, and the meaning of a p-value [Familiarity] • Apply standard parametric tests and interpret the results in context [Usage] • Derive the most powerful test for a simple hypothesis using the Neyman-Pearson lemma [Assessment]
Readings : [**Devore2016**]	

Unit 12: Bayesian Inference (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Bayesian framework: prior, likelihood, posterior, and the role of Bayes' theorem • Prior distributions: informative, non-informative, and conjugate priors • Posterior inference: point estimates, credible intervals, and posterior predictive distributions • Bayesian model comparison: Bayes factors and posterior model probabilities	• Explain the Bayesian approach to inference and contrast it with the frequentist approach [Familiarity] • Derive the posterior distribution for standard conjugate models [Usage] • Apply Bayes factors to compare statistical models and interpret the evidence [Assessment]
Readings : [**Ross2014**], [**Devore2016**]	

Unit 13: Simple Linear Regression (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Ordinary least squares estimation: derivation of coefficients and their properties • Inference for regression coefficients: t-tests, confidence intervals, and p-values • Coefficient of determination R-squared and analysis of variance decomposition • Gauss-Markov theorem: BLUE property of OLS under classical assumptions	• Fit a simple linear regression model and interpret the estimated coefficients [Usage] • Conduct hypothesis tests and construct confidence intervals for regression parameters [Usage] • Verify the Gauss-Markov assumptions and assess their consequences when violated [Assessment]
Readings : [**Devore2016**]	

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

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

ID201. Technical and professional English III (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	ID201. Technical and professional English III
2.2 Semester	:	4^{th} Semester.
2.3 Credits	:	2
2.4 Hours	:	1 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 Prerrequisites	:	ID102. Technical and professional English II. (3^{rd} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

At this level, students engage with English as the primary medium for accessing and producing technical content in computing, engineering, and the sciences. Grammar structures are applied to reading scientific articles, writing technical reports, describing engineering processes, and participating in professional discussions. The course bridges everyday English fluency with the demands of technical communication.

5. GOALS

- Train students to read, understand, and produce technical communication in English.
- Provide linguistic tools for connecting ideas in descriptive and analytical writing about computing and engineering.

6. COMPETENCES

ABET-3) An ability to communicate effectively with a range of audiences. (Familiarity)

ABET-5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. (Familiarity)

7. TOPICS

Unit 1: Technical Communication (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Review of Tenses: Present, Past, and Future in technical documentation. • Interrogative sentences with complex Wh- questions for system analysis. • Words with more than one meaning in technical contexts (Polysemy). • Expressions for describing professional activities and research interests.	• By the end of the unit, students use various tenses to exchange detailed technical information and formulate precise questions about computing systems and engineering processes.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 2: Comparing Architectures (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Use of "What's it like?": Describing system characteristics and interfaces. • Advanced comparative and superlative adjectives in benchmark analysis. • Collocations in computing: high-performance, low-level, fault-tolerant. • Reading: Architecture comparison reports (RISC vs. CISC, SQL vs. NoSQL).	• Students analyze and describe differences between computing architectures, frameworks, and systems using varied comparative structures with technical precision.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 3: Then and Now in Computing (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Present Perfect vs. Simple Past: Contrasting historic events with current state. • Time expressions: for, since, ever, never applied to technology evolution. • Adverbs of time and manner in scientific narrative. • Vocabulary: Generations of technology, legacy systems, current platforms.	• Students differentiate and correctly apply the present perfect and the simple past to narrate the evolution of computing technologies and contrast historical achievements with the current state of the field.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 4: Engineering Standards and Protocols (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Modals of obligation and permission: Have to, Must, Can in professional norms. • Giving technical recommendations: Should, Ought to — code reviews and design. • Vocabulary: IEEE/ACM standards, coding conventions, security policies. • Formal writing: Technical memos and engineering recommendations.	• Students express engineering rules, standards, and professional recommendations using appropriate modal verbs in formal technical writing and peer discussion.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 5: How Systems Are Built (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Passive Voice: Present and Simple Past to describe engineering processes. • Vocabulary: Manufacturing, deployment, integration, and testing. • Expressions for giving technical opinions and discussing design trade-offs. • Writing: Process description for a software or hardware system.	• Students use the passive voice to describe how systems are designed, built, tested, and deployed, participating in technical discussions about engineering processes.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 6: Debugging and Analysis (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Past Continuous vs. Simple Past in incident and failure reports. • Narrative and sequence connectors: while, when, suddenly, as a result. • Vocabulary: Bugs, exceptions, crashes, logs, root cause analysis. • Writing: Incident report for a software or network failure.	• Students narrate debugging sessions, system failures, and experimental incidents using narrative tenses and technical sequencing connectors fluently.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 7: Research and Innovation (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Future Forms: Will, Going to, Present Continuous for research projection. • Expressions of probability and certainty in scientific contexts. • Vocabulary: Innovation cycles, research proposals, technology forecasting. • Oral presentations: "The future of computing in my field".	• Students project research goals and discuss future directions in computing and engineering using various future structures with appropriate degrees of certainty.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 8: Technical English III (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Programming and Web Development terminology: functions, APIs, frameworks. • User Interface (UI/UX) descriptions and usability concepts. • Basic project management vocabulary: sprints, milestones, deliverables. • Writing: Simple technical specification or README document.	• By the end of the course, students use specialized software development vocabulary to describe logical and functional components and produce basic technical documentation in English.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

8. WORKPLAN

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

1. COURSE

CE2G1. Soil Mechanics I (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2G1. Soil Mechanics I
2.2 Semester	:	5^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	• CE1G1. General Geology. (2^{nd} Sem) • CE2M1. Mechanics of Materials I. (4^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Soil Mechanics I introduces the future civil engineer to soil as an engineering material, building on the descriptive foundations established in General Geology. The course develops the phase-relationship framework used to describe the state of a soil, the classification systems (USCS and AASHTO) used to communicate its expected engineering behavior, the theory and field control of compaction as the primary tool for improving earthwork properties, and the hydraulic behavior of soils — permeability, seepage, capillarity, and effective stress — that governs the interaction between water and the soil skeleton in geotechnical design. The course closes with an introduction to subsurface exploration and sampling methods, providing the field basis on which the laboratory characterization covered earlier in the course, and the subsequent Geotechnical Engineering sequence (Soil Mechanics II, Foundations, Earth Retaining Structures), are built.

5. GOALS

- Calculate phase relationships and index properties of soils from laboratory data, and relate the origin and formation of soil deposits to their expected engineering behavior.
- Classify soils according to the USCS and AASHTO systems from particle size distribution and Atterberg limit test results.
- Apply compaction theory to specify and control earthwork compaction in the laboratory and in the field.
- Determine soil permeability, construct flow nets, and calculate seepage quantities using Darcy's law.
- Explain the effective stress principle and analyze capillarity and frost action in partially saturated soils.
- Select appropriate subsurface exploration, boring, and sampling methods for a geotechnical investigation program.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (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: Phase Relationships and Seepage (66 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Phase relationships and index properties of soils • Soil classification systems including USCS and AASHTO • Particle size distribution and Atterberg limits • Compaction theory and field control methods • Permeability and Darcy's law • Seepage analysis and flow nets • Effective stress principle and pore water pressure • Capillarity and soil suction • Frost action and thermal properties of soils	• Calculate phase relationships and derive index properties from laboratory data [Usage] • Classify soils according to USCS and AASHTO classification systems [Assessment] • Interpret particle size distribution curves and plasticity charts [Assessment] • Apply compaction theory to field construction control [Usage] • Determine soil permeability using laboratory and field methods [Assessment] • Construct flow nets and calculate seepage quantities [Usage] • Explain the effective stress principle and its engineering significance [Familiarity] • Analyze capillary rise and soil suction effects in partially saturated soils [Assessment] • Evaluate frost susceptibility and design frost protection measures [Familiarity]
Readings : [**Das2019**]	

Unit 2: Site Investigation and In-Situ Testing (4 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Investigation planning and scope determination • Boring methods and subsurface exploration techniques • Sampling methods for disturbed and undisturbed samples • Standard Penetration Test and correlations • Laboratory testing program and test selection • Cone Penetration Test and piezocone testing • Vane shear test and pressuremeter testing • Geophysical methods including seismic and resistivity surveys • Groundwater monitoring and piezometer installation • Report preparation and geotechnical data presentation • In-situ permeability (Lugeon/packer) testing for foundation grouting and seepage assessment • Borrow area investigation for embankment fill material quantity and quality	• Develop appropriate site investigation programs based on project requirements [Assessment] • Select appropriate boring and exploration methods for different soil conditions [Familiarity] • Specify sampling techniques to obtain quality samples for testing [Usage] • Interpret SPT data and apply empirical correlations for design parameters [Assessment] • Design laboratory testing programs for geotechnical projects [Usage] • Analyze CPT and piezocone data for soil profiling and parameter evaluation [Assessment] • Apply vane shear and pressuremeter tests for soft clay characterization [Usage] • Utilize geophysical methods to complement traditional investigation techniques [Assessment] • Monitor groundwater conditions and interpret piezometric data [Usage] • Prepare comprehensive geotechnical investigation reports [Assessment] • Perform packer (Lugeon) testing and interpret results for foundation grouting curtain design [Usage] • Characterize borrow areas for embankment fill material quantity and quality [Assessment]
Readings : [**Das2019**]	

Unit 3: Geomorphology, Weathering, and Erosion Processes (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Physical weathering: thermal fragmentation, frost wedging, and unloading • Chemical weathering: hydrolysis, oxidation, and dissolution • Biological weathering and bioerosion • Residual soil formation from in-situ weathering • Main landforms: valleys, terraces, alluvial fans, and debris cones • Water and wind erosion processes and mass wasting processes	• Distinguish physical, chemical, and biological weathering types present at an outcrop [Familiarity] • Relate the degree of weathering of a rock to the expected quality of a rock mass [Usage] • Identify landforms and their geomorphological origin [Familiarity] • Evaluate the susceptibility of a slope to erosion and mass wasting processes [Assessment] • Apply weathering grade classification criteria to estimate the durability of rock materials in slopes [Usage]
Readings : [**Tarbuck2014**]	

8. WORKPLAN

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

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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.

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE2H1. Fluid Mechanics I (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2H1. Fluid Mechanics I
2.2 Semester	:	5^{th} Semester.
2.3 Credits	:	5
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 Prerrequisites	:	• CE1M1. Statics. (3^{rd} Sem) • CE1M2. Dynamics. (4^{th} Sem) • MA211. Calculus IV. (4^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Fluid Mechanics I is the introductory course in the Hydraulics area that lays the physical and mathematical foundations — mechanics of materials, analytical mechanics, and thermodynamics — necessary to analyze the behavior of fluids at rest and in motion. The course culminates with the formulation of the continuity and Navier-Stokes equations, the resolution of pressurized pipe flow, and the preliminary design of hydraulic structures, preparing students for subsequent courses in the Hydraulics line.

5. GOALS

- Apply the principles of mechanics of materials and analytical mechanics to the behavior of engineering hydraulic systems.
- Formulate and simplify the continuity and Navier-Stokes equations for civil engineering flow problems.
- Design and verify pressurized pipe flow systems and basic hydraulic structures.
- Recognize the role of numerical methods (finite elements) and thermodynamic tools in modern hydraulic analysis.

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: Mechanics of Materials and Structural Behavior (13 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Stress and strain concepts including normal, shear, and principal stresses • Axial loading and deformation of members • Torsion of circular and non-circular sections • Bending stress and deflection in beams • Shear stress distribution in beams • Combined loading and stress transformation • Buckling of columns and stability analysis • Fatigue and fracture mechanics • Elastic and plastic behavior of materials • Energy methods for structural analysis	• Define stress, strain, and their relationships through constitutive laws [Familiarity] • Calculate stresses and deformations in members under axial loading [Usage] • Determine torsional stresses and angles of twist in shafts [Usage] • Analyze bending stress distribution and deflection in beams [Assessment] • Compute shear stress distribution in beam cross-sections [Usage] • Apply stress transformation equations for combined loading conditions [Assessment] • Evaluate column stability and calculate critical buckling loads [Assessment] • Explain fatigue failure mechanisms and predict fatigue life [Familiarity] • Distinguish between elastic and plastic material behavior under loading [Usage] • Use energy methods to solve deflection and indeterminate structural problems [Usage]
Readings : [**Hibbeler2017**]	

Unit 2: Kinematics and Dynamics of Particles (6 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Vector description of position, velocity, and acceleration in Cartesian, polar, and spherical coordinates • Newton's three laws of motion and inertial reference frames • Formulation and solution of equations of motion for constant and variable forces • Static and kinetic friction forces, including angle of repose • Numerical integration of equations of motion for engineering dynamics problems	• Formulate the equations of motion for a particle in one, two, and three dimensions given a force law [Usage] • Identify all forces acting on a particle and draw a correct free-body diagram [Familiarity] • Calculate the terminal velocity of an object falling through a fluid with drag resistance [Assessment] • Implement a numerical algorithm to simulate the dynamics of an engineering mechanical system [Usage] • Construct and interpret phase space diagrams for simple engineering oscillatory systems [Assessment]
Readings : [**Goldstein2002**]	

Unit 3: Non-Inertial Reference Frames and Fictitious Forces (21 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Transformations between inertial and accelerating reference frames • Centrifugal force defined as $F_{cent} = -m\vec{\omega} \times (\vec{\omega} \times \vec{r}')$ • Coriolis force defined as $F_{Cor} = -2m\vec{\omega} \times \vec{v}'$ • Euler force for non-constant rotation: $F_{Euler} = -m\frac{d\vec{\omega}}{dt} \times \vec{r}'$ • Effective gravity on the rotating Earth: $g_{eff} = g - \vec{\omega} \times (\vec{\omega} \times \vec{R})$ • Foucault pendulum as a demonstration of the Earth's rotation • Coriolis effect on global weather patterns and ocean currents • Larmor precession in magnetic fields viewed as a rotating frame effect • Tidal forces as differential gravitational effects in co-rotating frames • Connection to General Relativity's equivalence principle	• Transform Newton's second law to a uniformly rotating reference frame [Usage] • Calculate centrifugal and Coriolis forces for given positions and velocities in a rotating frame [Usage] • Predict the deflection direction of projectiles due to the Earth's rotation through the Coriolis effect [Assessment] • Explain the precession of a Foucault pendulum in terms of the Earth's rotation [Familiarity] • Compute effective gravitational acceleration at different latitudes on Earth [Usage] • Analyze Larmor precession using the concept of rotating reference frames [Assessment] • Compare tidal forces to centrifugal forces in co-rotating systems [Assessment]
Readings : [**Goldstein2002**]	

Unit 4: Lagrangian and Hamiltonian Mechanics (21 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Principle of least action and Hamilton's principle of stationary action • Lagrangian definition: $L = T - V$ for conservative systems • Euler-Lagrange equations of motion: $\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\right) = \frac{\partial L}{\partial q_i}$ • Generalized coordinates and the treatment of holonomic constraints • Cyclic coordinates and the associated conservation laws • Legendre transform from the Lagrangian to the Hamiltonian: $H = \sum p_i \dot{q}_i - L$ • Hamilton's equations: $\dot{q}_i = \frac{\partial H}{\partial p_i}$ and $\dot{p}_i = -\frac{\partial H}{\partial q_i}$ • Poisson brackets: $\{f, g\} = \sum\left(\frac{\partial f}{\partial q_i}\frac{\partial g}{\partial p_i} - \frac{\partial f}{\partial p_i}\frac{\partial g}{\partial q_i}\right)$ • Canonical transformations and their generating functions • Action-angle variables for periodic Hamiltonian systems	• Construct the Lagrangian for simple mechanical systems in appropriate generalized coordinates [Usage] • Derive equations of motion from the Euler-Lagrange equations [Usage] • Identify cyclic coordinates and their associated conserved quantities in a given Lagrangian [Assessment] • Formulate the Hamiltonian from a given Lagrangian system [Usage] • Solve Hamilton's equations for simple systems such as the harmonic oscillator [Usage] • Compute Poisson brackets for pairs of dynamical variables [Usage] • Apply canonical transformations to simplify the description of Hamiltonian systems [Usage]
Readings : [**Goldstein2002**]	

Unit 5: Continuum Mechanics Foundations (8 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Continuum hypothesis and the definition of density fields • Stress tensor σ_{ij} and the concept of force per unit area • Strain tensor ϵ_{ij} as a measure of local deformation • Hooke's law for isotropic materials: $\sigma_{ij} = \lambda\epsilon_{kk}\delta_{ij} + 2\mu\epsilon_{ij}$ • Navier-Stokes equation for viscous fluids: $\rho\left(\frac{\partial\vec{v}}{\partial t} + \vec{v}\cdot\nabla\vec{v}\right) = -\nabla p + \mu\nabla^2\vec{v} + \vec{f}$ • Bernoulli's principle for inviscid and incompressible fluid flow • Conservation of mass and the continuity equation: $\frac{\partial\rho}{\partial t} + \nabla\cdot(\rho\vec{v}) = 0$ • Conservation of momentum expressed in continuum mechanics form • Wave propagation in elastic media including P-waves and S-waves • Viscosity and the rheology of non-Newtonian fluids	• Interpret the physical meaning of the components of the stress tensor [Familiarity] • Calculate strain tensor components for simple deformations [Usage] • Apply Hooke's law to relate stress and strain for isotropic elastic materials [Usage] • Simplify the Navier-Stokes equation for special cases such as steady or inviscid flow [Usage] • Apply Bernoulli's principle to calculate pressure variations in fluid flow [Usage] • Derive the continuity equation from the principle of mass conservation [Usage] • Analyze different wave propagation modes in elastic solids [Assessment]
Readings : [**Mase2010**]	

Unit 6: Laws of Thermodynamics and State Functions (4 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Zeroth Law of Thermodynamics and temperature equilibrium • First Law of Thermodynamics: $dU = dQ - dW$ for engineering systems • Enthalpy $H = U + PV$ and its role in flow processes and chemical reactions • Heat capacities C_V and C_P and their engineering measurement and application • Adiabatic processes and isentropic flow conditions in turbomachinery	• Calculate work done by a gas during isothermal and adiabatic expansions in engineering cycles [Usage] • Evaluate internal energy changes and apply the First Law to engineering thermodynamic processes [Assessment] • Apply Mayer's relation to determine heat capacity ratios for engineering working fluids [Usage] • Analyze isentropic flow conditions in engineering nozzles and turbines [Assessment]
Readings : [**Cengel2019**]	

Unit 7: Kinetic Theory of Gases (4 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Derivation of macroscopic pressure from molecular momentum transfer • Maxwell-Boltzmann speed distribution and its engineering implications • Equipartition theorem and degrees of freedom for monatomic and polyatomic gases • Mean free path and its relevance to gas flow and vacuum engineering • Transport phenomena: viscosity, thermal conductivity, and diffusion in engineering gases	• Compute the rms and average molecular velocities for engineering working gases [Usage] • Interpret the Maxwell-Boltzmann distribution and its temperature dependence for engineering applications [Assessment] • Calculate mean free path and relate it to viscosity in gas-dynamics engineering problems [Usage] • Estimate thermal conductivity and viscosity of a gas from kinetic theory for engineering design [Assessment]
Readings : [**Cengel2019**]	

Unit 8: First-Order Ordinary Differential Equations (ODEs) (4 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• First-order equations: separable, linear, and exact forms	• Solve linear first-order ODEs using integrating factors [Usage]
Readings : [**Boyce2017**]	

Unit 9: Mathematical Fluid Dynamics (6 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Continuum hypothesis, material derivative, and the Reynolds transport theorem • Euler equations for inviscid flow: conservation form, vorticity, and potential flow • Navier-Stokes equations: derivation, exact solutions, and dimensional analysis • Boundary layer theory: Prandtl equations and the Blasius solution • Turbulence: Reynolds averaging, the k-ε model, and direct numerical simulation	• Derive the Navier-Stokes equations from conservation principles and identify each term's physical meaning [Familiarity] • Analyze inviscid flows using the Euler equations and apply Bernoulli's principle [Usage] • Apply boundary layer theory to estimate drag on a flat plate and compare with the Blasius solution [Assessment]
Readings : [**ChorinMarsden1993**]	

Unit 10: Pressurized Pipe Flow and Pump Systems (8 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Pipe flow fundamentals and Darcy-Weisbach equation • Minor losses and pipe system analysis • Pipe network analysis methods • Pump characteristics and system curves • Pump selection and installation requirements • Water hammer and surge analysis • Pipeline design and material selection • Variable speed pumps and energy efficiency • Network modeling and optimization • Valve selection and hydraulic control systems	• Calculate head losses in pipe systems using friction equations [Assessment] • Determine total head loss including minor losses in complex piping [Usage] • Analyze pipe networks using Hardy Cross or equivalent methods [Assessment] • Construct pump characteristic curves and system head curves [Usage] • Select appropriate pumps based on operating point and efficiency [Assessment] • Evaluate water hammer effects and design surge protection [Usage] • Design pipelines considering hydraulic, structural, and economic factors [Assessment] • Apply variable speed drives for pump system optimization [Usage] • Optimize water distribution networks using modeling software [Assessment] • Specify valves and control systems for pipeline operations [Usage]
Readings : [**White2016**]	

Unit 11: Design of Hydraulic Structures (6 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Dam types and selection criteria • Spillway hydraulics and design • Weir and gate flow equations • Energy dissipation and stilling basin design • Culvert hydraulics and design • Dam safety analysis and risk assessment • Outlet works and control structures • Fish passage facilities and environmental hydraulics • Cavitation analysis and prevention • Physical hydraulic modeling and scale effects	• Classify dam types and select appropriate configurations for site conditions [Familiarity] • Design spillways for flood discharge capacity [Assessment] • Calculate discharge over weirs and through gates [Usage] • Proportion energy dissipation structures and stilling basins [Assessment] • Analyze culvert hydraulics for inlet and outlet control [Usage] • Perform dam safety evaluations and hazard classification [Assessment] • Design outlet works including intake structures and conduits [Usage] • Incorporate fish passage requirements in hydraulic structure design [Assessment] • Evaluate cavitation potential and design preventive measures [Usage] • Interpret physical model results and apply scale corrections [Assessment]
Readings : [**White2016**]	

Unit 12: Numerical Methods for ODEs and PDEs (8 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Runge-Kutta methods and adaptive time-stepping for engineering ODE problems • Stability analysis and stiffness in engineering ODE integrators • Finite difference discretization of engineering PDEs (heat equation, Laplace equation) • Finite element and shooting methods for engineering boundary value problems	• Implement a fourth-order Runge-Kutta integrator for a mechanical vibration problem [Usage] • Determine the region of absolute stability for an explicit time-stepping scheme [Assessment] • Discretize the 2D heat equation using finite differences and set up the resulting linear system [Usage] • Compare finite difference and finite element approaches for solving an engineering PDE [Assessment]
Readings : [**Chapra2015**]	

Unit 13: Finite Element Method (6 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Weak (variational) formulation of boundary value problems and Sobolev spaces • Galerkin method: finite-dimensional approximation spaces and the stiffness matrix • Triangular and quadrilateral finite element spaces: Lagrange elements and conformity • A priori error estimates: Céa's lemma and interpolation error bounds • A posteriori error estimates and adaptive mesh refinement	• Derive the weak formulation of an elliptic BVP and show its equivalence to the strong form [Familiarity] • Assemble the global stiffness matrix and load vector for a linear finite element discretization [Usage] • Estimate the H^1 error of a finite element solution using Céa's lemma and interpolation theory [Assessment]
Readings : [**Reddy2019**]	

8. WORKPLAN

8.1 Methodology

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9. EVALUATION SYSTEM

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

10. BASIC BIBLIOGRAPHY

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

1. COURSE

MA212. Ordinary Differential Equations (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	MA212. Ordinary Differential Equations
2.2 Semester	:	5^{th} Semester.
2.3 Credits	:	6
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 Prerrequisites	:	MA211. Calculus IV. (4^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

The Ordinary Differential Equations course provides the mathematical tools to analyze systems that evolve with respect to a single independent variable. It focuses on the modeling of dynamic systems through first-order equations, higher-order equations, and systems of equations, using both analytical and numerical methods. It is fundamental for the understanding of mechanics, electrical circuits, and population models.

5. GOALS

- Solve first-order and higher-order ordinary differential equations using analytical methods.
- Apply the Laplace transform to solve initial value problems involving discontinuous functions.
- Analyze the stability of linear and nonlinear systems of differential equations.
- Implement numerical methods for approximating solutions in complex models.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

7. TOPICS

Unit 1: First-Order Ordinary Differential Equations (ODEs) (20 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Modeling with first-order equations: growth, mixtures, and cooling	• Solve linear first-order ODEs using integrating factors [Usage]
Readings : [**Boyce2017**], [**Zill2018**]	

Unit 2: Higher-Order Differential Equations and Systems (ODEs) (40 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definition and properties of the Laplace Transform; inverse transforms and translation theorems • Derivatives of a transform and convolution integrals	• Apply the Laplace transform method to solve linear engineering ODEs with initial conditions [Usage] • Model a damped mechanical oscillator or RLC circuit as a second-order linear ODE [Usage] • Analyze the stability and transient response of engineering systems described by systems of ODEs [Assessment] • Formulate state-space representations for multivariable engineering dynamic systems [Usage]
Readings : [**Boyce2017**], [**Zill2018**]	

Unit 3: Numerical Methods for ODEs and PDEs (36 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Phase portraits and linearization of nonlinear engineering systems • Stability of critical points and nonlinear systems	• Implement a fourth-order Runge-Kutta integrator for a mechanical vibration problem [Usage] • Determine the region of absolute stability for an explicit time-stepping scheme [Assessment] • Discretize the 2D heat equation using finite differences and set up the resulting linear system [Usage] • Compare finite difference and finite element approaches for solving an engineering PDE [Assessment]
Readings : [**Boyce2017**], [**Zill2018**]	

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

ID202. Technical and professional English IV (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	ID202. Technical and professional English IV
2.2 Semester	:	5^{th} Semester.
2.3 Credits	:	2
2.4 Hours	:	1 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 Prerrequisites	:	ID201. Technical and professional English III. (4^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

At the intermediate level, students apply English to the full range of technical communication required in computing and engineering practice: reading research papers, writing structured technical documents, analyzing case studies, and engaging in professional dialogue. Grammar structures are taught through authentic computing and engineering contexts, reinforcing both linguistic competence and disciplinary knowledge.

5. GOALS

- Develop the ability to write and read structured technical documents in English.
- Bring the student to a more fluent and natural expression in technical and scientific English.
- Master vocabulary for computing, systems engineering, and applied sciences.

6. COMPETENCES

ABET-3) An ability to communicate effectively with a range of audiences. (Familiarity)

ABET-5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. (Familiarity)

7. TOPICS

Unit 1: Best Practices and Ethics (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Modals of obligation and advice: Should, Must, Have to in engineering codes. • Prohibition and absence of obligation in software licensing and data privacy. • Vocabulary: Professional ethics, intellectual property, responsible AI. • Writing: Formal technical recommendation and policy documents.	• By the end of the unit, students correctly use modal auxiliaries to express engineering standards, ethical obligations, and professional recommendations in formal technical environments.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 2: Failures and Root Causes (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Past Perfect: Structure and use in root cause analysis and post-mortems. • Contrast between Simple Past, Continuous, and Perfect in failure timelines. • Vocabulary: System outages, security breaches, cascading failures. • Expressions for reporting information: reported speech in incident briefings.	• Students reconstruct complex failure timelines and root cause analyses by establishing clear chronological sequences through the use of past tense contrasts.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 3: If-Then Logic (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Conditionals Type 0, 1, and 2 applied to computing logic and engineering decisions. • Sentences with "If" and "Unless" for system constraints and requirements. • Vocabulary: Hypothetical scenarios, risk analysis, and optimization trade-offs. • Expressions of what-if design thinking: "If we used X, the system would..."	• Students pose real and hypothetical technical scenarios and their consequences, using conditional structures to reason about design choices and engineering decisions.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 4: Ongoing Research (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Present Perfect Continuous for describing research in progress. • Contrast between Simple and Continuous Present Perfect in scientific writing. • Vocabulary: Continuous integration, agile development, iterative research. • Word formation: Prefixes and suffixes in scientific and technical terminology.	• Students describe research activities and development processes that began in the past and continue into the present, emphasizing duration and iterative progress.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 5: Manufacturing and Deployment (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Passive Voice in all basic tenses for technical process descriptions. • Verbs with two objects in passive: data is sent to the server by the client. • Vocabulary: Hardware manufacturing, cloud deployment, CI/CD pipelines. • Writing: Technical description of a deployment or production process.	• Students use the passive voice across multiple tenses to describe technical processes where the action, system, or result is the focus rather than the agent.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 6: Tech Roadmaps (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Future Continuous and Future Perfect for project timelines and milestones. • Adverbs of probability: perhaps, probably, definitely — in tech forecasting. • Vocabulary: Product roadmaps, release planning, emerging research areas. • Oral presentations: "The state of AI / quantum computing in 5 years".	• Students project technical states, completed future milestones, and research outcomes, discussing computing and engineering roadmaps with advanced vocabulary.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 7: Technical Teams (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Indirect questions and Tag questions in technical interviews and peer reviews. • Common Phrasal Verbs in engineering and research environments. • Vocabulary: Collaboration tools, code review practices, team roles. • Writing: Short technical blog posts and engineering team updates.	• Students use polite inquiry forms and confirmation strategies in technical interviews and team discussions, improving their fluency and naturalness in professional engineering contexts.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

Unit 8: Technical English IV: Networks and Security (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Networking terminology: protocols, topologies, OSI model, routing. • Cybersecurity vocabulary: vulnerabilities, threats, encryption, authentication. • Reading and writing network incident and security audit reports. • Project: Security assessment plan for a computing infrastructure.	• By the end of the course, students command networking and cybersecurity technical terminology to read specialized documentation and communicate effectively with IT and security professionals in English.
Readings : [**Soars022S**], [**Cambridge06**], [**MacGrew99**]	

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

1. COURSE

CE2M2. Mechanics of Materials II (Elective)

2. GENERAL INFORMATION

2.1 Course	:	CE2M2. Mechanics of Materials II
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	:	Elective
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	CE2M1. Mechanics of Materials I. (4^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Mechanics of Materials II is the advanced continuation of the study of deformable solids. This course addresses problems of greater technical complexity, such as beam deflection using various methods, the elastic stability of columns, and combined-stress failure analysis. These concepts enable students to carry out more refined structural designs and understand the limits of failure by instability, ensuring the integrity of buildings and civil engineering structures.

5. GOALS

- Determine deflections and slopes in beams using integration, area-moment, and energy methods.
- Analyze and design columns subjected to axial load considering elastic and inelastic buckling.
- Apply failure theories for ductile and brittle materials in the design of elements under complex stress states.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (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: Beam Deflections (24 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• The equation of the elastic curve. • Double integration method and discontinuity functions. • Moment-area method and the conjugate-beam method. • Analysis of statically indeterminate beams by superposition.	• Calculate displacements and rotations in beams under various loading and support conditions [Evaluar]. • Solve statically indeterminate structures through compatibility-of-deformation analysis [Usar].
Readings : [**Hibbeler2017Mat**], [**Gere2017**]	

Unit 2: Column Stability (16 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Concept of stability and Euler's critical load. • Columns with different support conditions: effective length. • Inelastic buckling and the secant formula. • Design of columns under concentric and eccentric loading.	• Determine the maximum load a slender column can support before failing by instability [Evaluar]. • Design column cross-sections that comply with structural safety codes [Usar].
Readings : [**Hibbeler2017Mat**]	

Unit 3: Energy Methods and Failure Theories (24 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Strain energy due to axial load, bending, and torsion. • Castigliano's theorem and its application to deflections. • Failure theories for ductile materials: Tresca and von Mises. • Failure theories for brittle materials: Mohr-Coulomb.	• Apply energy principles to solve displacement problems in structures of complex geometry [Usar]. • Predict the onset of yielding or fracture of a material under combined stress states [Evaluar].
Readings : [**Gere2017**]	

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

1. COURSE

CE2G2. Soil Mechanics II (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2G2. Soil Mechanics II
2.2 Semester	:	6^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE2G1. Soil Mechanics I. (5^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Soil Mechanics II builds directly on Soil Mechanics I, extending the phase-relationship and hydraulic-behavior framework already developed there into the stress-deformation and strength behavior that governs how soils respond to load. The course first develops shear strength theory and laboratory test interpretation, one-dimensional consolidation and settlement prediction, and stress distribution beneath loaded areas, and then applies this behavioral framework to four major geotechnical design problems: lateral earth pressure and earth-retaining structures, slope stability and landslide mitigation, shallow foundation design, and deep foundation design (piles and drilled shafts). As the second, broad-survey course of the Geotechnical Engineering track, each design topic is introduced at a level appropriate for a first exposure; students who continue into the track's specialization electives will revisit these same topics at a substantially deeper level.

5. GOALS

- Determine shear strength parameters of soils from direct shear and triaxial test data, and distinguish drained from undrained behavior.
- Predict consolidation settlement and its time-rate for saturated clays, and compute stress distribution beneath loaded areas.
- Apply lateral earth pressure theory to design retaining walls, anchored walls, and mechanically stabilized earth systems.
- Analyze the stability of natural and engineered slopes and design stabilization measures for identified failure modes.
- Design shallow foundations (isolated, combined, mat) based on bearing capacity and settlement criteria.
- Design deep foundations (piles and drilled shafts) considering axial capacity, lateral capacity, and group effects.

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)

7. TOPICS

Unit 1: Shear Strength and Consolidation (30 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Shear strength of soils and Mohr-Coulomb failure criterion • Direct shear and triaxial testing methods • Drained and undrained shear strength behavior • Consolidation theory and settlement analysis • Time-rate of consolidation and degree of consolidation • Stress distribution in soil masses using elastic theory • Critical state soil mechanics concepts • Residual shear strength and sensitivity of clays • Secondary compression and creep behavior • Anisotropy and stress path effects on soil behavior	• Apply Mohr-Coulomb criterion to determine shear strength parameters [Familiarity] • Interpret direct shear and triaxial test results [Assessment] • Distinguish between drained and undrained loading conditions [Usage] • Calculate consolidation settlement using one-dimensional theory [Assessment] • Predict time-rate of settlement for consolidating soils [Usage] • Compute stress distribution beneath loaded areas using Boussinesq theory [Assessment] • Explain critical state concepts and their application to soil behavior [Familiarity] • Evaluate residual strength and sensitivity for slope stability problems [Assessment] • Estimate secondary compression for highly plastic soils [Usage] • Analyze the effects of stress paths and anisotropy on soil response [Familiarity]
Readings : [**Das2019**]	

Unit 2: Earth Retaining Systems (10 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Earth pressure theory including active and passive pressures • Retaining wall types and selection criteria • Load testing methods including static and dynamic tests • Anchored walls and tied-back systems • Mechanically stabilized earth walls and reinforced soil systems • Basement and foundation wall design considering top-of-wall restraint conditions • Counterfort and buttressed retaining wall design	• Apply lateral earth pressure theories for retaining wall design [Assessment] • Design gravity and cantilever retaining walls [Usage] • Design anchored wall systems including ground anchor capacity [Assessment] • Proportion mechanically stabilized earth walls and select reinforcement [Usage] • Design basement and foundation walls considering top restraint, surcharge, and hydrostatic loads [Assessment] • Design counterfort retaining walls including stem, heel, toe, and counterfort elements [Usage]
Readings : [**Das2019**], [**Coduto2001**]	

Unit 3: Slope Stability Analysis and Stabilization (10 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Infinite slope analysis for simple geometries • Method of slices and limit equilibrium analysis • Circular and non-circular failure surfaces • Factor of safety determination and acceptance criteria • Stability charts and simplified methods • Landslide types and failure mechanisms • Seismic slope stability and pseudo-static analysis • Stabilization methods including drainage and reinforcement • Monitoring systems and early warning for unstable slopes • Probabilistic slope stability analysis	• Perform infinite slope stability analysis for uniform slopes [Assessment] • Apply method of slices to analyze slope stability [Usage] • Analyze slopes with circular and non-circular failure surfaces [Assessment] • Calculate factors of safety and interpret results [Usage] • Use stability charts for rapid slope evaluation [Assessment] • Identify landslide types and their characteristic features [Familiarity] • Evaluate seismic stability using pseudo-static methods [Usage] • Design slope stabilization measures for specific failure modes [Assessment] • Implement monitoring systems for potentially unstable slopes [Usage] • Conduct probabilistic stability analysis considering parameter uncertainty [Assessment]
Readings : [**DuncanWright2014**]	

Unit 4: Bearing Capacity and Design (10 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Bearing capacity theory and failure mechanisms • Ultimate bearing capacity equations for various conditions • Settlement analysis using elastic and consolidation methods • Isolated spread footing design • Combined footings and strap footings • Allowable bearing pressure and factor of safety selection • Mat foundation analysis and design • Eccentric and inclined loading effects • Soil-structure interaction effects • Differential settlement and tolerable limits • Continuous (strip) footing design for basement and foundation walls	• Explain bearing capacity failure mechanisms in shallow foundations [Familiarity] • Calculate ultimate bearing capacity using Terzaghi and Meyerhof equations [Assessment] • Predict total and differential settlements for shallow foundations [Usage] • Design isolated spread footings for gravity loads [Assessment] • Proportion combined and strap footings for column arrangements [Usage] • Determine allowable bearing pressures based on strength and settlement criteria [Assessment] • Analyze mat foundations using conventional and finite element methods [Assessment] • Evaluate bearing capacity under eccentric and inclined loading [Usage] • Consider soil-structure interaction in foundation design [Familiarity] • Assess differential settlement and apply tolerable settlement criteria [Assessment] • Design continuous strip footings for basement and foundation walls [Usage]
Readings : [**Coduto2001**], [**Das2019**]	

Unit 5: Deep Foundations (10 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Pile types and installation methods • Axial capacity of single piles in cohesive and cohesionless soils • Lateral load capacity and p-y method • Pile group behavior and group efficiency • Drilled shaft design and construction considerations • Negative skin friction and downdrag forces	• Select appropriate pile types based on soil conditions and loading [Familiarity] • Calculate axial capacity of piles using static methods [Assessment] • Analyze laterally loaded piles using p-y curves [Usage] • Evaluate pile group capacity and settlement [Assessment] • Design drilled shaft foundations including shaft diameter and reinforcement [Usage] • Interpret pile load test results and verify design assumptions [Assessment]
Readings : [**Coduto2001**], [**Das2019**]	

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

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

1. COURSE

CE2T1. Basic Geomatics (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2T1. Basic Geomatics
2.2 Semester	:	6^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Basic Geomatics introduces the civil engineering student to the fundamental ground-based measurement and positioning techniques used to characterize terrain and set out construction works. The course covers measurement theory and error propagation, horizontal measurement and traverse computation (planimetry), the operation of total stations and theodolites, vertical control through differential and trigonometric leveling and its application to profiles, cross-sections, and earthwork volume computation, modern GNSS positioning methods, and the production of topographic maps and digital terrain models, including their use in Building Information Modeling (BIM) workflows. The course closes with construction layout and stakeout surveying. This knowledge constitutes the indispensable field and computational foundation for subsequent courses in Roads and Highways, Hydraulics, and Structural and Geotechnical design, all of which depend on accurate site measurement and representation.

5. GOALS

- Apply measurement theory and error propagation to evaluate the precision of surveying observations.
- Perform planimetric surveys, computing and adjusting traverse closures using total stations and allied field methods.
- Perform differential and trigonometric leveling, deriving elevations, longitudinal profiles, and cross-sections, and use them to compute earthwork volumes.
- Use GNSS (static and RTK) methods for horizontal and vertical positioning on civil engineering projects.
- Produce topographic maps and digital terrain models, including BIM-oriented digital models, and apply surveying techniques to the construction layout and stakeout of civil works.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (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: Surveying Fundamentals and Measurement Theory (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Surveying's role in civil engineering: geodetic vs. plane surveying, and horizontal and vertical control • Sources and types of measurement error; precision, accuracy, and significant figures • Units and coordinate systems used in surveying: UTM, local grids, and datums	• Distinguish between geodetic and plane surveying and identify which applies to a given civil engineering project [Familiarity] • Propagate and evaluate measurement error in a computed surveying quantity [Usage]
Readings : [**Ghilani2015**]	

Unit 2: Planimetry (18 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Distance measurement methods: taping and electronic distance measurement, and reduction to horizontal • Horizontal and vertical angle measurement and angular adjustment • Traverse computation: latitudes, departures, closure, and coordinate adjustment	• Compute traverse closure and adjust traverse coordinates using an accepted method (e.g. the compass rule) [Usage] • Determine the coordinates of unknown points from field angle and distance observations [Assessment]
Readings : [**Ghilani2015**]	

Unit 3: Total Stations and Theodolites (6 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Total station and theodolite setup, orientation, and field operation • Electronic distance measurement (EDM) principles and error sources	• Operate a total station to collect horizontal and vertical field measurements [Usage] • Explain the sources of instrumental error in total station measurements and how to minimize them [Familiarity]
Readings : [**Ghilani2015**], [**Kavanagh2019**]	

Unit 4: Leveling and Vertical Control (18 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Differential leveling: benchmarks, backsight/foresight readings, and level circuits • Trigonometric leveling for indirect elevation determination • Profile and cross-section leveling for linear infrastructure design	• Perform a differential leveling circuit and compute elevations with error closure within tolerance [Usage] • Generate a longitudinal profile and cross-sections from field leveling data [Usage]
Readings : [**Ghilani2015**]	

Unit 5: Earthwork Volume Computations (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Cut and fill volume computation methods: average end area and prismoidal • Mass-haul diagrams for earthwork balance and haul distance planning	• Calculate cut and fill volumes for a linear earthwork project from cross-section data [Usage] • Construct a mass-haul diagram to plan earthwork balance and haul distances [Usage]
Readings : [**Uren2010**]	

Unit 6: GNSS Surveying (6 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• GNSS positioning principles: satellite constellations, signals, and error sources • Static and Real-Time Kinematic (RTK) GNSS surveying methods • Coordinate reference systems and datum transformations for GNSS data	• Compare static and RTK GNSS surveying methods and identify which fits a given accuracy requirement [Familiarity] • Transform GNSS-derived coordinates between reference datums for use in a local project [Usage]
Readings : [**VanSickle2015**]	

Unit 7: Topographic Mapping and Digital Terrain Models (18 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Contour representation and interpretation of terrain relief • Digital Terrain Model (DTM) generation from field or GNSS survey data • Topographic map production and cartographic conventions	• Generate a contour map from field survey data [Usage] • Build a digital terrain model (DTM) from a point-based topographic survey [Assessment]
Readings : [**Ghilani2015**], [**Kavanagh2019**]	

Unit 8: Construction Layout and Stakeout Surveying (6 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Stakeout methods for horizontal and vertical alignment of civil works • As-built survey verification against design geometry	• Stake out a horizontal alignment (e.g. a road centerline or building corner) from design coordinates [Usage] • Verify as-built construction geometry against design specifications using survey data [Assessment]
Readings : [**Kavanagh2019**]	

8. WORKPLAN

8.1 Methodology

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9. EVALUATION SYSTEM

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

10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE3H1. Fluid Mechanics II (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3H1. Fluid Mechanics II
2.2 Semester	:	6^{th} Semester.
2.3 Credits	:	4
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 Prerrequisites	:	CE2H1. Fluid Mechanics I. (5^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Fluid Mechanics II deepens the hydraulic analysis and design initiated in Fluid Mechanics I, covering three major blocks: pressurized pipe flow and pumping systems (including networks, transients, and modeling with specialized software), open channel flow (uniform flow, specific energy, rapidly and gradually varied flow, and modeling with HEC-RAS), and the design of hydraulic control structures (weirs, gates, inverted siphons, and culverts). The course combines classical analytical development with the use of hydraulic modeling tools (WaterCAD, HEC-RAS) employed in professional practice.

5. GOALS

- Analyze and design pressurized piping systems, including networks, pumps, and transient phenomena such as water hammer.
- Apply hydraulic modeling tools (WaterCAD, HEC-RAS) for the analysis of pipe networks and open channel flow.
- Analyze uniform and varied flow in open channels and design efficient and stable channel sections.
- Design hydraulic control structures such as weirs, gates, inverted siphons, and culverts.

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: Pressurized Pipe Flow and Pump Systems (42 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Pipe flow fundamentals and Darcy-Weisbach equation • Minor losses and pipe system analysis • Pipe network analysis methods • Pump characteristics and system curves • Pump selection and installation requirements • Water hammer and surge analysis • Pipeline design and material selection • Variable speed pumps and energy efficiency • Network modeling and optimization • Valve selection and hydraulic control systems	• Calculate head losses in pipe systems using friction equations [Assessment] • Determine total head loss including minor losses in complex piping [Usage] • Analyze pipe networks using Hardy Cross or equivalent methods [Assessment] • Construct pump characteristic curves and system head curves [Usage] • Select appropriate pumps based on operating point and efficiency [Assessment] • Evaluate water hammer effects and design surge protection [Usage] • Design pipelines considering hydraulic, structural, and economic factors [Assessment] • Apply variable speed drives for pump system optimization [Usage] • Optimize water distribution networks using modeling software [Assessment] • Specify valves and control systems for pipeline operations [Usage]
Readings : [**White2016**], [**Sotelo2002**]	

Unit 2: Open Channel Flow and River Mechanics (30 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Channel flow classification and hydraulic elements • Energy and momentum principles in open channels • Uniform flow and Manning's equation • Critical flow and specific energy concepts • Gradually varied flow profiles • Hydraulic jump and rapidly varied flow • Channel design for stable conveyance • Sediment transport in open channels • River morphology and channel stability • Scour analysis and protection measures	• Classify open channel flow regimes and calculate hydraulic elements [Familiarity] • Apply energy and momentum equations to solve channel flow problems [Assessment] • Calculate normal depth and discharge using Manning's equation [Usage] • Determine critical depth and analyze specific energy relationships [Assessment] • Compute gradually varied flow profiles using standard methods [Usage] • Analyze hydraulic jumps and calculate energy dissipation [Assessment] • Design stable channels with appropriate cross-sections and linings [Usage] • Estimate sediment transport rates in alluvial channels [Assessment] • Evaluate river channel stability and bank erosion potential [Familiarity] • Predict scour depths at hydraulic structures and design protection [Assessment]
Readings : [**Chow1959**]	

Unit 3: Design of Hydraulic Structures (12 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Dam types and selection criteria • Spillway hydraulics and design • Weir and gate flow equations • Energy dissipation and stilling basin design • Culvert hydraulics and design • Dam safety analysis and risk assessment • Outlet works and control structures • Fish passage facilities and environmental hydraulics • Cavitation analysis and prevention • Physical hydraulic modeling and scale effects	• Classify dam types and select appropriate configurations for site conditions [Familiarity] • Design spillways for flood discharge capacity [Assessment] • Calculate discharge over weirs and through gates [Usage] • Proportion energy dissipation structures and stilling basins [Assessment] • Analyze culvert hydraulics for inlet and outlet control [Usage] • Perform dam safety evaluations and hazard classification [Assessment] • Design outlet works including intake structures and conduits [Usage] • Incorporate fish passage requirements in hydraulic structure design [Assessment] • Evaluate cavitation potential and design preventive measures [Usage] • Interpret physical model results and apply scale corrections [Assessment]
Readings : [**Novak2007**]	

8. WORKPLAN

8.1 Methodology

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

ID203. Technical and professional English V (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	ID203. Technical and professional English V
2.2 Semester	:	6^{th} Semester.
2.3 Credits	:	2
2.4 Hours	:	1 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 Prerrequisites	:	ID202. Technical and professional English IV. (5^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

A fundamental part of the integral formation of a professional is the ability to communicate in a foreign language in addition to the native language itself. In the engineering and computing career, technical English is the most critical tool for accessing the forefront of knowledge and research, writing scientific papers, participating in international conferences, and collaborating in global teams. This course brings students to the level of autonomous technical communicators capable of producing and critically evaluating academic and professional content.

5. GOALS

- Increase the ability and fluency to communicate complex technical ideas in English.
- Ensure that students interact with emphasis on scientific argumentation and advanced technical writing.
- Master vocabulary for software engineering, data science, and systems research.

6. COMPETENCES

ABET-3) An ability to communicate effectively with a range of audiences. (Familiarity)

ABET-5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. (Familiarity)

7. TOPICS

Unit 1: Scientific Argumentation (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Advanced review of auxiliary verbs and verb tenses in academic writing. • Negative questions and emphatic answers in scientific debate. • Word formation: Prefixes and suffixes common in computing and science. • Correcting misconceptions: Refuting claims in technical discussions.	• By the end of the unit, students use auxiliaries and tenses precisely to construct scientific arguments, challenge erroneous technical claims, and engage in structured academic debate.
Readings : [**Soars023S**], [**Soars023W**], [**Soars023T**], [**Cambridge06**], [**MacGrew99**]	

Unit 2: Research Methodology (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Present Simple vs. Present Continuous: Distinguishing general facts from ongoing experiments. • State verbs and action verbs in experimental descriptions. • Vocabulary: Research design, experimental variables, data collection methods. • Writing: Description of a research method or experimental procedure.	• Students differentiate between stative and progressive uses to accurately describe scientific laws, ongoing experiments, and research methodologies in computing and engineering.
Readings : [**Soars023S**], [**Soars023W**], [**Soars023T**], [**Cambridge06**], [**MacGrew99**]	

Unit 3: Case Studies (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Narrative tenses: Simple Past, Past Continuous, and Past Perfect in case study analysis. • Structure of "Used to" and "Would" for describing legacy systems and past practices. • Vocabulary: Historical computing cases, paradigm shifts, engineering lessons learned. • Writing: Structured case study report on a computing incident or innovation.	• Students analyze and narrate sequences of technical events and historical computing cases fluently, applying narrative tenses correctly in professional case study reports.
Readings : [**Soars023S**], [**Soars023W**], [**Soars023T**], [**Cambridge06**], [**MacGrew99**]	

Unit 4: Research Proposals (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Predictions and plans: Future tense review for academic proposal writing. • Future Continuous and Future Perfect in project scope and outcomes. • Vocabulary: Research objectives, expected contributions, scope and limitations. • Writing: Short research proposal or technical project abstract.	• Students project research goals and anticipated outcomes, and make evidence-based predictions about the evolution of technology using appropriate future forms in formal academic writing.
Readings : [**Soars023S**], [**Soars023W**], [**Soars023T**], [**Cambridge06**], [**MacGrew99**]	

Unit 5: Technical Documentation (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Verb patterns (Verbs followed by -ing or infinitive) in instructional writing. • Expressions with "Like" for analogies and technical comparisons. • Vocabulary: API documentation, user manuals, technical specifications. • Debates: Standards for open-source documentation and reproducibility.	• Students use complex verb patterns to write clear, precise technical documentation and use analogical reasoning to explain technical concepts to diverse audiences.
Readings : [**Soars023S**], [**Soars023W**], [**Soars023T**], [**Cambridge06**], [**MacGrew99**]	

Unit 6: Long-term Projects (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Present Perfect Continuous vs. Simple Present Perfect in research progress reports. • Modal verbs of deduction (Present and Past) for interpreting experimental results. • Vocabulary: Long-running systems, sustained research programs, startup development. • Oral presentations: "Progress report on a computing research project".	• Students discuss long-term research and development activities, make deductions about technical outcomes, and present progress reports on computing projects with appropriate academic register.
Readings : [**Soars023S**], [**Soars023W**], [**Soars023T**], [**Cambridge06**], [**MacGrew99**]	

Unit 7: Advanced Technical Writing (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Relative clauses (Defining vs. Non-defining) in technical paper writing. • Advanced passive voice in formal scientific and engineering prose. • Vocabulary: Peer review, impact factors, citation practices, open access. • Writing: Abstract and introduction section of a computing research paper.	• Students write precise, well-structured technical and scientific texts using relative clauses and advanced passive constructions to add depth and clarity to research writing.
Readings : [**Soars023S**], [**Soars023W**], [**Soars023T**], [**Cambridge06**], [**MacGrew99**]	

Unit 8: English for Software Engineering (12 hours)	
Competences Expected: ABET-3,ABET-5	
Topics	**Learning Outcomes**
• Agile Methodologies: Scrum, Kanban, and XP terminology in English. • QA (Quality Assurance) and Testing: Test plans, bug reports, acceptance criteria. • Software requirements documentation: user stories, use cases, specifications. • Simulation: Technical team meeting (Sprint planning and retrospective).	• By the end of the course, students command software engineering and project management terminology, can produce professional technical documents, and actively participate in international technical meetings and reviews in English.
Readings : [**Soars023S**], [**Soars023W**], [**Soars023T**], [**Cambridge06**], [**MacGrew99**]	

8. WORKPLAN

8.1 Methodology

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9. EVALUATION SYSTEM

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

10. BASIC BIBLIOGRAPHY

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

1. COURSE

BRN2C1. National Reality, Constitution, and Human Rights (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	BRN2C1. National Reality, Constitution, and Human Rights
2.2 Semester	:	6^{th} Semester.
2.3 Credits	:	2
2.4 Hours	:	1 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 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

National Reality, Constitution, and Human Rights introduces the historical, social, and economic reality of contemporary Peru; the relationship between law and society; the nature, history, and comparative models of constitutions and systems of government; the constitutional order of Peru under its 1993 Constitution and the constitutional guarantees that protect fundamental rights; and human rights and international humanitarian law, as a foundation for the informed and responsible civic and professional engagement of the engineer.

5. GOALS

- Describe the historical, social, and economic reality of contemporary Peru.
- Explain the relationship between law and society, and the nature, history, and comparative models of constitutions and systems of government.
- Analyze the constitutional order of Peru under its 1993 Constitution and the constitutional guarantees that protect fundamental rights.
- Apply the framework of human rights and international humanitarian law to the analysis of civic and professional questions.

6. COMPETENCES

ABET-4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. (Usage)

7. TOPICS

Unit 1: Peruvian Society in the 21st Century (6 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Peru's social structure in the 21st century: demographics, urbanization, migration, and social mobility. • Contemporary social challenges: inequality, informality, and regional disparities.	• Describe the main social characteristics and challenges of contemporary Peruvian society [Familiarizarse].
Readings : [**ContrerasCueto2013**]	

Unit 2: Peruvian Economic Landscape (6 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Structure of the Peruvian economy: productive sectors, informality, and regional disparities. • Peru's macroeconomic indicators and their social implications.	• Describe the structure and main indicators of the Peruvian economy [Familiarizarse].
Readings : [**INEI2024**]	

Unit 3: Democracy and Citizenship (6 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Citizenship and civic participation in Peru: electoral processes, civil society, and citizen oversight. • Peru's contemporary political landscape and its challenges for democratic governance.	• Explain the mechanisms of civic participation available to Peruvian citizens and the challenges facing Peru's democratic governance [Usar].
Readings : [**TuestaSoldevilla2018**]	

Unit 4: Natural Law, Positivism, and Legal Realism (6 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Classical and contemporary natural law: Aquinas, Finnis, and the relationship between law and moral obligation • Austin's command theory, Hart's concept of law (primary/secondary rules, rule of recognition), and Kelsen's pure theory of law • American legal realism (Holmes, Frank, Llewellyn): law as prediction, judicial psychology, and the indeterminacy thesis • Critical legal studies, feminist jurisprudence, and critical race theory: law as ideology and instrument of power	• Explain the central claims of natural law theory, legal positivism, and legal realism and identify the key points of disagreement between them [Familiarity] • Analyze a legal dispute using the conceptual tools of at least two competing jurisprudential schools [Usage] • Evaluate the Hart-Fuller debate on the minimum content of natural law and assess its implications for unjust legal systems [Assessment]
Readings : [**RubioCorrea2009**]	

Unit 5: Nature and History of Constitutions (12 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• The constitution as supreme law: constitutional supremacy, hierarchy of norms, and the constitution as both a legal and a political document • Historical development of constitutionalism: early charters (Magna Carta), the American and French revolutions, and the spread of written constitutions • Rigid vs. flexible constitutions: classification criteria and their implications for constitutional stability and adaptability • Constitutional amendment and reform procedures; unamendable clauses and the doctrine of unconstitutional constitutional amendments	• Explain the concept of constitutional supremacy and the historical origins of modern constitutionalism [Familiarity] • Compare the amendment procedures of rigid and flexible constitutions and their effect on constitutional stability [Usage] • Evaluate a proposed constitutional amendment against the doctrine of unconstitutional constitutional amendments [Assessment]
Readings : [**Loewenstein1970**], [**RubioCorrea1999**]	

Unit 6: Comparative Constitutional Models and Systems of Government (18 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Comparative constitutional models: civil-law vs. common-law constitutionalism, and centralized vs. diffuse (decentralized) models of judicial review • Systems of government: presidential, parliamentary, and semi-presidential (mixed) systems; their institutional design and typical crisis points • Democratic theory: representative vs. participatory and deliberative democracy; citizen participation mechanisms (referendum, recall, popular initiative) • Separation of powers and checks and balances: the executive, legislative, and judicial branches, and mechanisms of inter-branch accountability	• Compare presidential, parliamentary, and semi-presidential systems of government [Familiarity] • Analyze a country's constitutional design in terms of its model of judicial review and separation of powers [Usage] • Evaluate the adequacy of a country's citizen participation mechanisms against democratic theory's normative standards [Assessment]
Readings : [**GinsburgDixon2011**], [**Loewenstein1970**]	

Unit 7: Peru's 1993 Constitution (6 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Historical context of the 1993 Constitution: the 1992 autogolpe, the Democratic Constituent Congress, and its replacement of the 1979 Constitution • Structure and guiding principles of the 1993 Constitution: its titles and organization, and the principles of a social and democratic state of law • Peru's economic constitution: the social market economy, free private initiative, and the state's subsidiary role in economic activity • The fundamental rights catalog of Art. 2 and related provisions: equality, due process, and other constitutionally entrenched rights specific to the Peruvian order	• Describe the historical context in which the 1993 Constitution was adopted and its structural organization [Familiarity] • Explain the principles of Peru's economic constitution and their application to a specific economic policy question [Usage] • Analyze a real or hypothetical case involving a right from the Art. 2 catalog under the Peruvian constitutional framework [Assessment]
Readings : [**RubioCorrea1999**]	

Unit 8: Civil, Political, Economic, Social, and Cultural Rights (6 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Right to life (absolute prohibition of arbitrary deprivation), personal liberty and security, fair trial guarantees, privacy, freedom of expression and peaceful assembly • Right to work, just conditions of work, education, health, housing, social security, and participation in cultural life; progressive realization obligation • Indivisibility of rights: interdependence of civil/political and economic/social rights; justiciability of socioeconomic rights in domestic courts • Special protections for women, children, persons with disabilities, indigenous peoples, migrants, and LGBTQ+ persons under international law	• Identify the civil, political, economic, social, and cultural rights protected by the core international human rights instruments [Familiarity] • Analyze whether a state measure violates specific human rights standards, applying the tests of legality, legitimate aim, and proportionality [Usage] • Assess the justiciability of an economic, social, or cultural right in a domestic legal order and evaluate the remedies available [Assessment]
Readings : [**Smith2020**]	

Unit 9: Peaceful Settlement and the Use of Force (6 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• UN Charter Art. 2(4) prohibition; definition of aggression (UNGA Res. 3314); humanitarian intervention and the Responsibility to Protect (R2P) • Art. 51 self-defense: necessity, proportionality, armed attack threshold, anticipatory and preemptive self-defense; Chapter VII collective security measures • ICJ jurisdiction (contentious and advisory), arbitration (PCA, ICSID), WTO Dispute Settlement Body, and diplomatic means (negotiation, mediation, inquiry) • Applicability of jus ad bellum to cyber operations; attribution challenges; hybrid warfare and the Tallinn Manual framework • International humanitarian law (jus in bello): the four Geneva Conventions and their Additional Protocols, distinction between combatants and civilians, proportionality and precaution in attack, and the relationship between IHL and international human rights law	• Describe the UN Charter framework for the prohibition on the use of force and the permitted exceptions [Familiarity] • Apply the criteria for lawful self-defense under Art. 51 to assess the legality of a state's use of force [Usage] • Evaluate the effectiveness of the UN collective security system and the role of the ICJ in maintaining international peace and security [Assessment]
Readings : [**Dinstein2016**]	

Unit 10: Constitutional Guarantees (Procesos Constitucionales) (8 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Habeas corpus: protection of personal liberty and related rights against arbitrary detention or restriction • Amparo: protection of constitutional rights other than personal liberty and data, against acts or omissions of any authority, official, or person • Habeas data: protection of the rights of access to public information and to informational self-determination • Action of unconstitutionality: abstract judicial review of the constitutionality of laws with the force of law, before the Constitutional Tribunal	• Distinguish the scope of protection of habeas corpus, amparo, and habeas data [Familiarity] • Select the appropriate constitutional guarantee for a given rights-violation scenario, justifying the choice [Usage] • Evaluate the effectiveness of Peru's constitutional guarantees as a system for protecting fundamental rights and constitutional supremacy [Assessment]
Readings : [**LandaArroyo2018**]	

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

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

1. COURSE

CE2C6. Territorial Planning (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2C6. Territorial Planning
2.2 Semester	:	7^{th} Semester.
2.3 Credits	:	3
2.4 Hours	:	2 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 Prerrequisites	:	CE1G1. General Geology. (2^{nd} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Territorial Planning I introduces the historical process of human settlement and territorial planning, planning theories and methodologies, and the different types and modalities of urban and territorial planning through case studies.

5. GOALS

- Describe the historical process of human settlement and its relationship with territorial planning.
- Apply planning theories and methodologies to the analysis of a territory.
- Distinguish the types and modalities of urban and territorial planning based on case studies.

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)

7. TOPICS

Unit 1: Historical Urban Planning Theories (15 hours)	
Competences Expected: ABET-1	
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 : [**Hall2014**]	

Unit 2: Contemporary Planning Methods and Theory (29 hours)	
Competences Expected: ABET-1	
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 : [**Hall2014**]	

Unit 3: Urban Design at Multiple Scales (12 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Regional and city scale: transit corridors, green belts, growth boundaries, satellite towns, and the relationship between density • Neighborhood scale: walkability (5-10 minute walking radius), mixed-use zoning, social infrastructure (schools, clinics, community centers), and the 20-minute neighborhood concept • Block and street scale: block length for pedestrian permeability (80-120 m max), street section design (lane widths, sidewalks, bike lanes, street trees, furniture zone), • Public space design: squares, plazas, parks, pocket parks, and streets as public space; William Whyte's elements of successful public space (sittable space, sun, food • Urban design guidelines: building setbacks, height limits, architectural character, facade articulation, signage, lighting,	• Describe the key design considerations at each urban scale - regional, neighborhood, block, street, and public space - [Familiarity] • Develop a set of urban design guidelines for a specific neighborhood or street typology, integrating density, building height, block length, street section, [Usage] • Evaluate an urban design project for its multi-scale coherence, assessing how well it integrates regional transit, neighborhood walkability, block permeability, street safety, [Assessment]
Readings : [**Hall2014**]	

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

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

1. COURSE

CE2S1. Structural Analysis I (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2S1. Structural Analysis I
2.2 Semester	:	7^{th} Semester.
2.3 Credits	:	5
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 Prerrequisites	:	CE2M1. Mechanics of Materials I. (4^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Structural Analysis I addresses the behavior of statically indeterminate structural systems, building on the mechanics-of-materials foundation of determinate analysis. Students learn the classical energy principles (virtual work, Castigliano's theorems, and the Betti-Maxwell reciprocal theorems) that underlie the force method, apply the force method itself to beams, frames, and arches, and are introduced to displacement-based matrix formulations (slope-deflection, moment distribution, and the direct stiffness method) that make computer-based structural analysis possible. This course provides the analytical foundation required for the subsequent design of reinforced concrete, steel, and masonry structural elements.

5. GOALS

- Identify the degree of static indeterminacy of structural systems and formulate their governing compatibility conditions.
- Apply energy methods (virtual work, Castigliano's first theorem, and the Betti-Maxwell reciprocal theorems) to compute displacements in structures.
- Apply the force method and the principle of minimum work to analyze statically indeterminate beams, frames, and arches.
- Formulate the analysis of indeterminate structures using displacement-based matrix methods, including the direct stiffness method.

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)

7. TOPICS

Unit 1: Energy Methods for Structural Analysis (36 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Indeterminacy and degree of freedom concepts • Internal work of deformation and the principle of virtual work • Castigliano's first theorem for the calculation of displacements • Betti's and Maxwell's reciprocal theorems	• Identify the degree of indeterminacy for structural systems [Assessment] • Apply the principle of virtual work to calculate internal deformation energy in structural systems [Usage] • Apply Castigliano's first theorem to determine displacements in indeterminate structures [Usage] • Verify the reciprocity of displacements and forces using Betti's and Maxwell's theorems [Assessment]
Readings : [**Hibbeler2018Struct**], [**Kassimali2020**], [**McCormac2013**]	

Unit 2: Force Method for Indeterminate Structures (36 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Force method and flexibility approach for indeterminate structures • Principle of minimum work (Castigliano's second theorem) for the calculation of redundants • Analysis of statically indeterminate arches • Influence lines for indeterminate structures using Mueller-Breslau principle	• Apply the force method to analyze indeterminate beams and frames [Usage] • Apply the principle of minimum work to calculate redundant forces in the force method [Usage] • Analyze statically indeterminate arches under combined loading [Assessment] • Construct influence lines for indeterminate structures qualitatively [Usage]
Readings : [**Hibbeler2018Struct**], [**Kassimali2020**], [**McCormac2013**]	

Unit 3: Slope-Deflection Method (14 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Slope-deflection method for continuous beams and frames	• Use slope-deflection equations to solve continuous beam and frame problems [Assessment]
Readings : [**Hibbeler2018Struct**], [**Kassimali2020**], [**McCormac2013**]	

Unit 4: Moment Distribution Method (4 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Moment distribution method	• Perform moment distribution analysis for indeterminate structures [Usage]
Readings : [**Hibbeler2018Struct**], [**Kassimali2020**], [**McCormac2013**]	

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

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE2S2. Reinforced Concrete Design I (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2S2. Reinforced Concrete Design I
2.2 Semester	:	7^{th} Semester.
2.3 Credits	:	5
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 Prerrequisites	:	CE2M1. Mechanics of Materials I. (4^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Reinforced Concrete Design I introduces the principles and methodology for the design of reinforced concrete members following limit state design philosophy and the ACI 318 building code. Building on the mechanics of materials, students learn to design beams for flexure and shear, columns for combined axial load and biaxial bending, one-way slabs, and to verify deflection and serviceability requirements. The course also covers the design of supported and cantilevered concrete staircases and an introduction to shallow foundation design, providing the structural design foundation required for subsequent reinforced concrete and earthquake-resistant design courses.

5. GOALS

- Apply limit state design philosophy and load factor combinations to reinforced concrete design.
- Design reinforced concrete beams for flexure and shear.
- Design reinforced concrete columns for axial load and biaxial bending.
- Design one-way reinforced concrete slabs and verify deflection and serviceability requirements.
- Design supported and cantilevered concrete staircases.
- Design isolated spread footings for shallow foundations.

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)

7. TOPICS

Unit 1: Reinforced Concrete Design (68 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Design philosophy and limit state methodology for concrete structures • Flexural design of rectangular and T-beams • Shear and torsion design of concrete members • Compression members and column design • Slab design including one-way and two-way systems • Development length and splicing of reinforcement • Deflection control and serviceability requirements for concrete beams and slabs	• Explain limit state design philosophy and load factor combinations [Familiarity] • Design reinforced concrete beams for flexure and check serviceability [Assessment] • Calculate shear and torsional reinforcement requirements [Usage] • Proportion columns for axial load and biaxial bending [Assessment] • Design one-way and two-way slab systems with appropriate reinforcement [Usage] • Determine development lengths and design lap splices for reinforcing bars [Assessment] • Control deflections and verify serviceability requirements through adequate member sizing and reinforcement [Usage]
Readings : [**Wight2016**], [**ACI31819**], [**McCormac2021**]	

Unit 2: Design of Reinforced Concrete Stairs (6 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Geometry of stair flights, landings, and waist slabs • Load distribution and effective span for simply supported staircases • Load distribution and effective span for cantilevered staircases • Reinforcement detailing for stair flights, landings, and supports	• Design a supported reinforced concrete staircase for gravity loads [Assessment] • Design a cantilevered reinforced concrete staircase for gravity loads [Assessment] • Detail reinforcement for stair flights, landings, and supports [Usage]
Readings : [**McCormac2021**]	

Unit 3: Bearing Capacity and Design (10 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Bearing capacity theory and failure mechanisms • Ultimate bearing capacity equations for various conditions • Settlement analysis using elastic and consolidation methods • Isolated spread footing design • Combined footings and strap footings • Allowable bearing pressure and factor of safety selection • Mat foundation analysis and design • Eccentric and inclined loading effects • Soil-structure interaction effects • Differential settlement and tolerable limits • Continuous (strip) footing design for basement and foundation walls	• Explain bearing capacity failure mechanisms in shallow foundations [Familiarity] • Calculate ultimate bearing capacity using Terzaghi and Meyerhof equations [Assessment] • Predict total and differential settlements for shallow foundations [Usage] • Design isolated spread footings for gravity loads [Assessment] • Proportion combined and strap footings for column arrangements [Usage] • Determine allowable bearing pressures based on strength and settlement criteria [Assessment] • Analyze mat foundations using conventional and finite element methods [Assessment] • Evaluate bearing capacity under eccentric and inclined loading [Usage] • Consider soil-structure interaction in foundation design [Familiarity] • Assess differential settlement and apply tolerable settlement criteria [Assessment] • Design continuous strip footings for basement and foundation walls [Usage]
Readings : [**Coduto2001**]	

8. WORKPLAN

8.1 Methodology

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8.2 Theory Sessions

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE2S3. Steel Design (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2S3. Steel Design
2.2 Semester	:	7^{th} Semester.
2.3 Credits	:	5
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 Prerrequisites	:	CE2M1. Mechanics of Materials I. (4^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Steel Design covers the fundamentals and application of the limit states design method (LRFD/ASD) to structural steel members and connections. The course addresses structural steel grades, design criteria and load combinations, the design of tension and compression members, compact and non-compact beams and plate girders, beam-columns under combined flexure-compression/tension, bolted and welded connections, and composite members in compression and in flexure. It provides the design competencies required for steel-framed buildings and industrial structures.

5. GOALS

- Apply LRFD/ASD design criteria and load combinations to structural steel members.
- Design tension members, compression members, beams, and plate girders using the limit states method.
- Design beam-columns under combined axial force and bending, and their bolted and welded connections.
- Design composite members in compression (encased and concrete-filled columns) and in flexure (composite beams).

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)

7. TOPICS

Unit 1: Design of Steel Members in Tension and Compression (19 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Tension member design and effective area considerations • Compression member design and column buckling	• Design tension members considering net area and block shear [Assessment] • Select appropriate column sections and check buckling capacity [Usage]
Readings : [**McCormac2019**], [**AISC2017**]	

Unit 2: Design of Steel Members in Flexure (29 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Flexural design of beams and lateral-torsional buckling • Combined axial force and bending interaction • Plate girders and web design	• Proportion steel beams considering both local and lateral-torsional buckling [Assessment] • Evaluate beam-columns using interaction equations [Usage] • Design plate girders with consideration of web buckling and stiffeners [Assessment]
Readings : [**McCormac2019**], [**AISC2017**]	

Unit 3: Steel Connections and Composite Systems (36 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Bolted connections design and failure modes • Welded connections and design considerations • Composite beams and shear connectors • Moment-resisting frames and seismic provisions for steel structures • Braced frames and concentrically braced frame design • Connection design for special moment frames and prequalified connections	• Design bolted connections for shear, tension, and combined loading [Assessment] • Specify welded connections and determine weld sizes [Usage] • Analyze composite beams and design shear stud connectors [Usage] • Design moment-resisting frames for seismic and wind loads [Assessment] • Proportion bracing members and connections in braced frame systems [Usage] • Detail prequalified moment connections according to seismic provisions [Assessment]
Readings : [**Segui2018**], [**AISC2017**]	

8. WORKPLAN

8.1 Methodology

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE2T2. Applied Geomatics (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2T2. Applied Geomatics
2.2 Semester	:	7^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE2T1. Basic Geomatics. (6^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Applied Geomatics extends the ground-survey fundamentals established in Basic Geomatics (Surveying I) – measurement theory, planimetry, leveling, and total-station operation – into the advanced field applications a civil engineer uses throughout a project's life cycle. The course opens with the general considerations and feasibility-stage surface information a civil works project requires, then develops how topographic mapping techniques (contour-based gradient-line analysis, route alignment, and preliminary route evaluation) support planning decisions and feed digital terrain models into Building Information Modeling (BIM) workflows. It then returns to the control-network techniques that make all subsequent surveying consistent and reliable: trigonometric leveling, least-squares network adjustment, classical triangulation/trilateration, and modern GNSS static and Real-Time Kinematic (RTK) positioning. The course next covers the construction-stage application of total-station surveying to stake out horizontal alignments, points of inflection, curves, and grade lines, together with the planning and budgeting of a topographic field campaign. It closes with specialized surveying applications for bridges, tunnels, and water-resources works – bathymetric surveys and reservoir/impoundment volume computations – building on the earthwork volume methods covered earlier. Because photogrammetry, Geographic Information Systems (GIS), and satellite-derived geospatial information are each the subject of their own dedicated course later in the curriculum (Geodesy in CE2T3, Photogrammetry in CE3T1, GIS in CE3T3), this course introduces them only briefly, as a preview of the broader geospatial-information toolchain a civil engineer will use.

5. GOALS

- Apply error theory and least-squares adjustment to establish reliable horizontal and vertical control networks, combining classical methods (triangulation/trilateration, trigonometric leveling) with modern GNSS positioning.
- Produce the topographic mapping and digital terrain models a civil works project needs at the feasibility and planning stages, including gradient-line analysis and route evaluation, and integrate them into BIM workflows.
- Collect field data using GNSS static/RTK and total-station instruments appropriate to a given project's accuracy requirement.
- Stake out horizontal alignments, points of inflection, curves, and grade lines using total-station methods, and verify as-built geometry against the design.
- Plan and budget a topographic field survey campaign for a civil works project.
- Compute earthwork and reservoir/impoundment volumes from specialized surveys (bridges, tunnels, bathymetry), and recognize how photogrammetry, GIS, and satellite-derived geospatial data extend these techniques.

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: Topographic Mapping and Digital Terrain Models (30 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Contour representation and interpretation of terrain relief • Digital Terrain Model (DTM) generation from field or GNSS survey data • Topographic map production and cartographic conventions	• Generate a contour map from field survey data [Usage] • Build a digital terrain model (DTM) from a point-based topographic survey [Assessment]
Readings : [**GhilaniWolf2015**], [**SchofieldBreach2007**]	

Unit 2: GNSS Surveying (15 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• GNSS positioning principles: satellite constellations, signals, and error sources • Static and Real-Time Kinematic (RTK) GNSS surveying methods • Coordinate reference systems and datum transformations for GNSS data	• Compare static and RTK GNSS surveying methods and identify which fits a given accuracy requirement [Familiarity] • Transform GNSS-derived coordinates between reference datums for use in a local project [Usage]
Readings : [**LeickRapoportTatarnikov2015**], [**GhilaniWolf2015**]	

Unit 3: Construction Layout and Stakeout Surveying (15 hours)	
Competences Expected: ABET-2,ABET-6	
Topics	**Learning Outcomes**
• Stakeout methods for horizontal and vertical alignment of civil works • As-built survey verification against design geometry	• Stake out a horizontal alignment (e.g. a road centerline or building corner) from design coordinates [Usage] • Verify as-built construction geometry against design specifications using survey data [Assessment]
Readings : [**SchofieldBreach2007**], [**Kavanagh2014**]	

Unit 4: Earthwork Volume Computations (10 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Cut and fill volume computation methods: average end area and prismoidal • Mass-haul diagrams for earthwork balance and haul distance planning	• Calculate cut and fill volumes for a linear earthwork project from cross-section data [Usage] • Construct a mass-haul diagram to plan earthwork balance and haul distances [Usage]
Readings : [**GhilaniWolf2015**], [**UrenPrice2010**]	

8. WORKPLAN

8.1 Methodology

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9. EVALUATION SYSTEM

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

10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE2T3. Geodesy (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2T3. Geodesy
2.2 Semester	:	7^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE2T1. Basic Geomatics. (6^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Geodesy extends the ground-survey fundamentals established in Basic Geomatics (Surveying I) into the science of determining the Earth's exact size, shape, orientation, and gravity field, and of establishing the precise reference systems that every other survey, map, and GNSS position ultimately depends on. The course opens with classical geodesy – the reference ellipsoid and geoid, horizontal and vertical geodetic datums, global reference frames (ITRF, WGS84), and the relationship between geodetic/geocentric coordinates and the projected (UTM) coordinates used in ordinary topographic work. It then develops the design, least-squares adjustment, and accuracy classification of geodetic control networks, including Peru's national geodetic network maintained by the IGN and its densification for project-level surveys. The course turns next to satellite geodesy: satellite orbit fundamentals, static GNSS baseline processing and Precise Point Positioning (PPP), and the planning and execution of a geodetic-grade GNSS observation campaign. It closes with physical geodesy and applied geodesy – the Earth's gravity field, gravimetric surveying, geoid models, and the conversion between orthometric and ellipsoidal height systems that a civil engineer needs to apply geodetic results correctly in practice. This foundation underlies every subsequent geospatial and construction-layout course in the Vialidad, Geomática y Transporte track that depends on a consistent, accurate geodetic reference.

5. GOALS

- Distinguish Earth shape models (the reference ellipsoid and the geoid) and select horizontal and vertical geodetic datums and global reference frames, converting coordinates between geodetic, geocentric, and projected (UTM) systems.
- Design a geodetic control network and adjust it by least squares, and classify its control points against national (IGN) geodetic accuracy standards.
- Plan and process a geodetic-grade GNSS observation campaign using static baseline processing and Precise Point Positioning (PPP), and mitigate its error sources.
- Apply gravity field and geoid models to convert between orthometric and ellipsoidal heights, and conduct a gravimetric survey.

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: Geodetic Fundamentals and Reference Systems (22 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Earth shape models: the reference ellipsoid and the geoid • Horizontal geodetic datums and their realization • Vertical geodetic datums and height reference surfaces • Global reference frames (ITRF, WGS84) and their realization and maintenance • Geodetic, geocentric, and projected coordinate systems and conversions between them	• Distinguish the reference ellipsoid from the geoid and explain their respective roles [Familiarity] • Select an appropriate horizontal and vertical datum for a given project [Usage] • Transform coordinates between global reference frames (e.g. ITRF realizations) [Assessment] • Convert coordinates between geodetic, geocentric, and projected coordinate systems [Usage] • Explain how a geodetic datum is realized and maintained over time [Familiarity]
Readings : [**VanicekKrakiwsky1986**], [**TorgeMueller2012**]	

Unit 2: Geodetic Control Networks (13 hours)	
Competences Expected: ABET-2,ABET-6	
Topics	**Learning Outcomes**
• Geodetic control network design: configuration, redundancy, and point selection • Least-squares network adjustment and error ellipse interpretation • National geodetic control networks and their institutional maintenance (e.g. Peru's IGN network) • Control network densification for local and project-level surveys • Geodetic accuracy standards and classification of control points	• Design a geodetic control network with appropriate configuration and redundancy [Usage] • Adjust a geodetic network by least squares and interpret the resulting error ellipses [Assessment] • Describe the structure and maintenance of a national geodetic control network [Familiarity] • Densify a national control network for a local or project-level survey [Usage] • Classify a control point against its applicable geodetic accuracy standard [Assessment]
Readings : [**VanicekKrakiwsky1986**], [**GhilaniWolf2015**]	

Unit 3: Satellite Geodesy and Precise Positioning (25 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• GNSS geodetic positioning: static baseline processing for control-quality accuracy • Satellite orbit fundamentals and broadcast versus precise ephemerides • Precise Point Positioning (PPP) principles and applications • Planning and execution of a geodetic-grade GNSS observation campaign • GNSS error sources affecting geodetic-grade positioning and their mitigation	• Process static GNSS baselines to achieve control-quality positioning accuracy [Usage] • Explain satellite orbit fundamentals and the difference between broadcast and precise ephemerides [Familiarity] • Apply Precise Point Positioning to a geodetic observation [Assessment] • Plan a geodetic-grade GNSS observation campaign [Usage] • Mitigate GNSS error sources affecting geodetic-grade positioning [Assessment]
Readings : [**HofmannWellenhofLichteneggerWasle2008**], [**LeickRapoportTatarnikov2015**]	

Unit 4: Physical Geodesy and the Gravity Field (10 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Gravity field fundamentals and normal gravity formulas • Geoid models and geoid undulation determination • Gravimetric surveying methods and instrumentation • Orthometric versus ellipsoidal height systems and the role of the geoid in converting between them • Application of geoid undulation to obtain orthometric heights from GNSS data	• Explain the Earth's gravity field and the normal gravity formula [Familiarity] • Apply a geoid model to determine geoid undulation at a point [Usage] • Conduct a gravimetric survey and process the resulting data [Assessment] • Distinguish orthometric from ellipsoidal heights and explain when each is used [Familiarity] • Convert ellipsoidal heights from GNSS to orthometric heights using a geoid model [Usage]
Readings : [**HeiskanenMoritz1967**], [**TorgeMueller2012**]	

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

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

1. COURSE

CE3G3. Applied Geology (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3G3. Applied Geology
2.2 Semester	:	7^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE2G2. Soil Mechanics II. (6^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Applied Geology extends the descriptive foundations of General Geology, and draws on the field investigation skills introduced in the Geotechnical Engineering sequence, into the practicing engineering geologist's toolkit for civil infrastructure. The course develops rock mass characterization and standard classification systems, engineering geological and geotechnical mapping, and the geological evaluation of soils and rocks as natural resources for construction materials, then applies this framework to the siting and design of two major groups of infrastructure works — roads and canals, and bridges, tunnels, and dams — and closes with the classification, field recognition, and hazard mapping of mass movements and other geological hazards relevant to civil works. As part of the Geotechnical specialization track, it complements the design-oriented Soil Mechanics sequence (Soil Mechanics I-II) with the geological judgment required to characterize sites, select construction materials, choose infrastructure alignments, and anticipate geological hazards.

5. GOALS

- Plan and interpret geotechnical field investigations to characterize subsurface conditions for engineering projects.
- Characterize rock masses in the field and estimate their strength and deformability using standard classification systems (RMR, Q, GSI, and the Hoek-Brown criterion).
- Prepare and interpret engineering geological and geotechnical maps for infrastructure planning and hazard zonation.
- Evaluate soils and rocks as natural resources for construction materials.
- Apply engineering geological criteria to the siting and design of roads and canals.
- Apply engineering geological criteria to the siting and design of bridges, tunnels, and dams.
- Classify, recognize in the field, and map geological hazards and mass movements, and propose appropriate mitigation measures.

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: Site Investigation and In-Situ Testing (5 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Investigation planning and scope determination • Boring methods and subsurface exploration techniques • Sampling methods for disturbed and undisturbed samples • Standard Penetration Test and correlations • Laboratory testing program and test selection • Cone Penetration Test and piezocone testing • Vane shear test and pressuremeter testing • Geophysical methods including seismic and resistivity surveys • Groundwater monitoring and piezometer installation • Report preparation and geotechnical data presentation • In-situ permeability (Lugeon/packer) testing for foundation grouting and seepage assessment • Borrow area investigation for embankment fill material quantity and quality	• Develop appropriate site investigation programs based on project requirements [Assessment] • Select appropriate boring and exploration methods for different soil conditions [Familiarity] • Specify sampling techniques to obtain quality samples for testing [Usage] • Interpret SPT data and apply empirical correlations for design parameters [Assessment] • Design laboratory testing programs for geotechnical projects [Usage] • Analyze CPT and piezocone data for soil profiling and parameter evaluation [Assessment] • Apply vane shear and pressuremeter tests for soft clay characterization [Usage] • Utilize geophysical methods to complement traditional investigation techniques [Assessment] • Monitor groundwater conditions and interpret piezometric data [Usage] • Prepare comprehensive geotechnical investigation reports [Assessment] • Perform packer (Lugeon) testing and interpret results for foundation grouting curtain design [Usage] • Characterize borrow areas for embankment fill material quantity and quality [Assessment]
Readings : [**Das2019**]	

Unit 2: Engineering Geological and Geotechnical Mapping (5 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Types and purposes of engineering geological and geotechnical maps • Geotechnical zonation and microzonation mapping for urban and infrastructure planning • Specialized symbology and legends for engineering geological maps • Use of GIS and remote sensing tools in geotechnical mapping	• Distinguish the types and purposes of engineering geological and geotechnical maps [Familiarity] • Prepare a basic geotechnical zonation map for a project area [Usage] • Apply GIS tools to compile and present geotechnical mapping information [Usage]
Readings : [**GonzalezDeVallejo2002**]	

Unit 3: Rock Mass Characterization and Applied Rock and Soil Mechanics (10 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Characterization of rock mass discontinuities: orientation, spacing, persistence, roughness, aperture, and infill • Rock Quality Designation (RQD) and geotechnical core logging • Rock mass classification systems: RMR, Q-system, and GSI • Estimation of rock mass strength and deformability using the Hoek-Brown criterion • Influence of weathering grade on rock mass mechanical behavior • Influence of geological origin -residual versus transported- on soil engineering properties	• Characterize rock mass discontinuities from field or core data [Usage] • Determine RQD and classify rock mass quality using RMR, Q, and GSI systems [Assessment] • Estimate rock mass strength and deformability parameters using the Hoek-Brown criterion [Assessment] • Relate weathering grade to expected rock mass mechanical behavior [Familiarity] • Relate the geological origin of a soil to its expected engineering properties [Usage]
Readings : [**Bieniawski1989**], [**HoekBray1981**], [**GonzalezDeVallejo2002**]	

Unit 4: Soils and Rocks as Natural Resources for Construction Materials (5 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Geological sources and quality evaluation of aggregates for concrete and construction • Site selection and geological evaluation of quarries and borrow pits • Dimension stone and other rock and soil resources used in construction • Basic quality control criteria and tests for construction material sources	• Evaluate geological sources of aggregates and construction materials for quality and suitability [Usage] • Select and assess quarry and borrow-pit sites based on geological criteria [Assessment] • Apply basic quality control criteria to construction material sources [Familiarity]
Readings : [**Smith2001**], [**GonzalezDeVallejo2002**]	

Unit 5: Engineering Geology Applied to Roads and Canals (15 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Geological considerations for highway and road alignment selection • Geological and hydrogeological conditions for canal siting and seepage control • Structural geological controls on cut-slope stability along transportation corridors • Geological and geotechnical conditions for road and canal embankment foundations • Engineering geological mapping and hazard identification along linear infrastructure corridors	• Evaluate geological conditions to support road and canal alignment selection [Assessment] • Assess seepage and foundation conditions for canal design based on geological survey [Usage] • Analyze structural geological controls on cut-slope stability along a transportation corridor [Assessment] • Prepare an engineering geological map identifying hazards along a linear infrastructure corridor [Usage]
Readings : [**FHWAFieldManual2001**], [**GonzalezDeVallejo2002**]	

Unit 6: Engineering Geology Applied to Bridges, Tunnels, and Dams (20 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Engineering geological studies required at each phase of an infrastructure project: reconnaissance, feasibility, design, and construction • Geological and rock mass considerations for tunnel alignment, excavation method, and support selection • Geological siting and foundation and abutment characterization for dams • Reservoir geology: seepage, landslide-induced impoundment hazards, and sedimentation sources • Geological considerations for bridge site selection and pier and abutment foundation conditions • Comparative geological criteria for selecting sites and alignments among infrastructure alternatives	• Identify the engineering geological studies required at each phase of an infrastructure project [Familiarity] • Evaluate rock mass conditions relevant to tunnel excavation method and support selection [Assessment] • Characterize the geological suitability of a site for dam foundations and abutments [Assessment] • Assess reservoir-related geological hazards including landslide-induced impoundment risk [Usage] • Evaluate geological conditions relevant to bridge foundation siting [Usage]
Readings : [**FHWAFieldManual2001**], [**HoekKaiserBawden1995**], [**GonzalezDeVallejo2002**]	

Unit 7: Geological Hazards and Mass Movements (10 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Classification of mass movements: falls, topples, slides, flows, and lateral spreads • Triggering and controlling factors of mass movements: geological, hydrological, and seismic • Field recognition of landslide morphology and indicators of active or past instability • Geological hazards from seismic and volcanic activity relevant to civil infrastructure • Geological hazard susceptibility mapping and risk zonation • Overview of structural and non-structural mitigation measures for geological hazards	• Classify mass movements according to their mechanism and material type [Assessment] • Identify triggering and controlling factors of mass movements at a given site [Familiarity] • Recognize field indicators of landslide morphology and slope instability [Usage] • Prepare a geological hazard susceptibility map for a project area [Assessment] • Propose mitigation measures appropriate to a specific type of geological hazard [Usage]
Readings : [**Cruden1996**], [**HoekBray1981**], [**GonzalezDeVallejo2002**]	

8. WORKPLAN

8.1 Methodology

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8.2 Theory Sessions

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE3H2. General Hydrology (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3H2. General Hydrology
2.2 Semester	:	7th Semester.
2.3 Credits	:	3
2.4 Hours	:	2 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 Prerrequisites	:	• CE3H1. Fluid Mechanics II. (6th Sem) • STA251. Statistics and Probability. (4th Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

General Hydrology covers the hydrologic cycle processes relevant to water resources engineering: climatology and basic meteorology, measurement and analysis of basin-scale precipitation, hydrometric station networks, and statistical analysis of extreme hydrological events (maximum floods) using probability distributions. The course provides the hydrological analysis tools that support the design of hydraulic and water resources structures in subsequent courses of the Hydraulics line.

5. GOALS

- Understand the processes of the hydrologic cycle and estimate its components (precipitation, evaporation, runoff) at the basin scale.
- Analyze precipitation records using areal estimation methods (arithmetic, Thiessen, isohyetal, hypsometric).
- Perform frequency analysis of maximum floods applying goodness-of-fit tests and probability distributions (Normal, Log Normal, Pearson III, Log Pearson III, Gumbel).

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (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: Hydrologic Cycle and Water Balance (22 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Hydrologic cycle and water balance concepts • Precipitation measurement and analysis • Evaporation and evapotranspiration estimation • Infiltration theory and rainfall-runoff processes	• Explain the hydrologic cycle and quantify water balance components [Familiarity] • Analyze precipitation data and develop depth-area-duration relationships [Assessment] • Estimate evaporation and evapotranspiration using empirical methods [Usage] • Apply infiltration models to estimate runoff from rainfall events [Assessment]
Readings : [**ChowMaidmentMays1988**]	

Unit 2: Surface Hydrology and Watershed Modeling (17 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Hydrograph analysis and unit hydrograph method • Watershed modeling and hydrologic simulation • Streamflow measurement and gauging techniques	• Derive unit hydrographs and synthesize runoff hydrographs [Usage] • Develop watershed models using software tools for hydrologic simulation [Usage] • Conduct streamflow measurements and interpret flow duration curves [Assessment]
Readings : [**ChowMaidmentMays1988**]	

Unit 3: Flood Frequency Analysis and Climate Change (17 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Flood frequency analysis and design storms • Hydrologic routing methods for channels and reservoirs • Climate change impacts on hydrologic systems	• Perform flood frequency analysis using statistical methods [Assessment] • Route flood hydrographs through channels and reservoirs [Usage] • Evaluate climate change impacts on watershed hydrology and design implications [Assessment]
Readings : [**ChowMaidmentMays1988**]	

8. WORKPLAN

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE2C2. Construction Technology I (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2C2. Construction Technology I
2.2 Semester	:	8th Semester.
2.3 Credits	:	3
2.4 Hours	:	2 HT; 1 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Mandatory
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	CE2C1. Materials Technology. (3rd Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Construction Technology I covers construction methods, equipment, and productivity, including earthmoving and construction processes for concrete and steel structures. The course also includes safety and risk management on construction sites, and an introduction to digital construction technologies (BIM) for project management.

5. GOALS

- Select appropriate methods, equipment, and construction processes for earthmoving operations and structural construction.
- Measure and analyze the productivity of construction operations.
- Apply safety and risk management principles on construction sites.
- Use BIM tools for digital management of construction projects.

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: Construction Methods, Equipment, and Productivity (38 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 2: Construction Safety, Health, and Risk Management (4 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**]	

Unit 3: Building Information Modeling (BIM) for Digital Delivery and Asset Management (2 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 openBIM • 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 4: Site Visits (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Technical visit to an active construction site. • Observation of the construction methods, equipment, productivity, and safety practices used in the field. • Preparation of a technical visit report.	• Relate the construction methods, equipment, and safety practices studied in the course to their real application on site [Usage].
Readings :	

8. WORKPLAN

8.1 Methodology

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE2C8. Business Management in Construction I (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2C8. Business Management in Construction I
2.2 Semester	:	8th 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 Prerrequisites	:	BEC101. General Economics. (1st Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Business Management in Construction I applies the fundamentals of business administration – contract law, project finance, cost accounting, entrepreneurship, marketing, labor regulation, and managerial decision-making – to the specific problem of running a construction company. Building on the introductory organizational and operational concepts covered in Organization and Business Management, this course equips the future civil engineer to negotiate and manage construction contracts, evaluate the financial viability of projects and control their costs, structure and market a construction business, comply with labor regulation, and make sound managerial decisions under the risk and uncertainty typical of the construction sector.

5. GOALS

- Analyze the formation, terms, breach, and remedies of construction contracts.
- Apply capital budgeting techniques to evaluate the financial viability of construction investment projects.
- Apply cost-volume-profit analysis, budgeting, and variance analysis to control the costs of a construction company.
- Design and validate the business model of a construction company using the Business Model Canvas and customer discovery techniques.
- Design a digital marketing strategy for construction services.
- Explain the employment-law and regulatory-compliance obligations of a construction employer.
- Apply managerial decision-making models under risk and uncertainty to construction management problems.

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: Contract Law and Business Transactions (14 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Elements of a valid contract: offer, acceptance, consideration, capacity, and legality • Express and implied terms, exclusion clauses, misrepresentation, and frustration of contracts • Breach of contract: types, consequences, and remedies (damages, specific performance, rescission) • E-contracts and digital signatures: legal validity, electronic signature laws (eIDAS, ESIGN), and click-wrap and browse-wrap agreements	• Identify the essential elements of a legally binding contract and the circumstances that render contracts void or voidable [Familiarity] • Apply contract law principles to analyze the legal enforceability of a business agreement [Usage] • Evaluate contractual remedies available in a given breach scenario and recommend appropriate legal action [Assessment]
Readings : [**Clarkson2021**]	

Unit 2: Capital Budgeting and Investment Decisions (12 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Net present value (NPV), internal rate of return (IRR), modified IRR, and their decision rules • Payback period, discounted payback, and profitability index as capital budgeting criteria • Sensitivity analysis, scenario analysis, Monte Carlo simulation, and break-even analysis in capital projects • Real options in capital investment: option to expand, abandon, or defer; recognizing strategic flexibility in project valuation	• Explain the NPV rule and its superiority over alternative capital budgeting criteria [Familiarity] • Calculate NPV and IRR for a capital project and apply decision rules [Usage] • Evaluate a capital investment proposal under uncertainty using sensitivity and scenario analysis [Assessment]
Readings : [**Brealey2020**]	

Unit 3: Managerial Accounting and Cost Analysis (12 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Cost classification: fixed vs. variable, direct vs. indirect, product vs. period, and relevant costs for decisions • CVP analysis: break-even point, contribution margin, margin of safety, and operating leverage • Master budgets, flexible budgets, standard costing, and variance analysis (price and efficiency variances) • Activity-based costing (ABC): cost drivers, activity pools, overhead allocation accuracy, and ABC versus traditional costing	• Identify different types of costs and explain their relevance for managerial decision-making [Familiarity] • Calculate break-even point, contribution margin, and budget variances for a business unit [Usage] • Evaluate a business unit's performance using variance analysis and flexible budgets [Assessment]
Readings : [**Garrison2021**]	

Unit 4: Business Model Design and Validation (12 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Business Model Canvas: nine building blocks (customer segments, value propositions, channels, revenue streams, key resources, key activities, key partnerships, cost structure) • Customer discovery and validation: problem interviews, solution interviews, and pivot vs. persevere decisions • Minimum viable product (MVP): design principles, lean experimentation, and build-measure-learn feedback loop • Platform business models and network effects: multi-sided platforms, winner-take-all dynamics, and monetization strategies for digital platforms	• Describe the components of the Business Model Canvas and explain how they interact to create and deliver value [Familiarity] • Design a business model canvas for a new venture idea and identify key assumptions to test [Usage] • Evaluate a startup's business model for internal consistency and market viability [Assessment]
Readings : [**Osterwalder2010**]	

Unit 5: Digital Marketing (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• SEO, SEM, and social media marketing: platforms, algorithms, organic vs. paid reach, and community management • Content marketing strategy: content types, editorial calendars, storytelling, and inbound marketing • Digital analytics: web metrics, conversion funnels, A/B testing, and data-driven campaign optimization • Email marketing and marketing automation: segmentation, drip campaigns, lead nurturing, CRM integration, and deliverability metrics	• Describe the key digital marketing channels and the metrics used to measure their effectiveness [Familiarity] • Develop a digital marketing plan including channel selection, content strategy, and KPI definition [Usage] • Evaluate the ROI of a digital marketing campaign using analytics data [Assessment]
Readings : [**Chaffey2019**]	

Unit 6: Regulatory Compliance and Employment Law (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Antitrust and competition law: prohibited agreements, abuse of dominance, merger control, and enforcement • Data protection regulation: GDPR principles, data subject rights, controller/processor responsibilities, and breach notification • Employment law: contract of employment, wrongful dismissal, discrimination, health and safety, and collective bargaining • Consumer protection law: unfair commercial practices, product liability, warranty obligations, and redress mechanisms for consumers	• Identify the major regulatory frameworks affecting business operations in key domains (competition, data, employment) [Familiarity] • Apply data privacy and employment law principles to analyze a business compliance scenario [Usage] • Design a compliance management framework for a specific regulatory area faced by a business [Assessment]
Readings : [**Clarkson2021**]	

Unit 7: Managerial Decision-Making (12 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Rational decision-making model vs. bounded rationality; satisficing and heuristics in managerial decisions • Decision-making under risk and uncertainty: expected value, decision trees, and sensitivity analysis • Common cognitive biases (anchoring, overconfidence, availability heuristic) and debiasing strategies • Group decision-making techniques: Delphi method, nominal group technique, brainstorming, and consensus building processes	• Describe the rational model of decision-making and its limitations under bounded rationality [Familiarity] • Construct a decision tree and calculate expected values to support a managerial decision under risk [Usage] • Evaluate how cognitive biases distort managerial decisions and recommend debiasing interventions [Assessment]
Readings : [**Robbins2017**]	

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

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

1. COURSE

CE2T4. Transportation Engineering (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2T4. Transportation Engineering
2.2 Semester	:	8^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	• CE2G1. Soil Mechanics I. (5^{th} Sem) • CE2H1. Fluid Mechanics I. (5^{th} Sem) • CE2T3. Geodesy. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Transportation Engineering is the introductory survey course of the Highway, Geomatics, and Transportation (DAVG) specialization area. It gives students a panoramic view of every major transportation mode – highways, railways, ports, and airports – introducing the planning and economic framework common to all of them, the traffic control devices and intelligent transportation systems (ITS) used to operate road networks, and the fundamental alignment, operations, planning, hydraulic, and geometric design concepts specific to railway, port, and airport facilities. The course does not go in depth into any single mode; each is developed further in a dedicated course later in the specialization (e.g., Transportation Planning, Ports), for which this course lays the conceptual foundation.

5. GOALS

- Describe the fundamentals of multimodal transportation planning and economic evaluation, recognizing how road, rail, port, and air transportation systems integrate within a transportation network.
- Recognize the function, design principles, and technologies of traffic control devices and intelligent transportation systems (ITS) used to manage road traffic.
- Identify the fundamental alignment, operations, and capacity concepts of railway transportation systems.
- Identify the fundamental planning, maritime hydraulics, and structural design concepts applied to port terminals.
- Identify the fundamental planning and geometric design concepts applied to airports.

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: Transportation Planning and Economics (2 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Transportation planning process and institutional framework • Travel demand modeling and forecasting methods • Four-step travel demand model • Data collection methods for transportation planning • Economic evaluation and benefit-cost analysis • Activity-based modeling and advanced forecasting techniques • Multimodal transportation planning and integration • Sustainable transportation and environmental considerations • Public participation and stakeholder engagement • Performance measures and system monitoring	• Explain the transportation planning process and institutional relationships [Familiarity] • Apply travel demand forecasting methods to predict future travel patterns [Assessment] • Implement the four-step travel demand model for regional analysis [Usage] • Design data collection programs for transportation studies [Assessment] • Conduct benefit-cost analysis for transportation projects [Usage] • Utilize activity-based models for advanced travel demand analysis [Assessment] • Develop integrated multimodal transportation plans [Usage] • Incorporate sustainability principles into transportation planning [Assessment] • Facilitate public participation processes in transportation planning [Familiarity] • Establish performance measures and monitoring systems for transportation networks [Assessment]
Readings : [**Mannering2013**]	

Unit 2: Traffic Control Devices (2 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Classification and design of regulatory, warning, and guide signs • Sign placement, sizing, and retroreflectivity standards • Pavement marking types, materials, and placement standards • Traffic signal warrant analysis and justification studies • Signal phasing, sequencing, and vehicle/pedestrian detection design • Signal equipment, controllers, and maintenance considerations	• Classify traffic signs according to national/MUTCD-equivalent standards and select the appropriate sign for a given condition [Familiarity] • Specify sign placement, size, and retroreflectivity per design standards [Usage] • Design a pavement marking plan for a given roadway section [Assessment] • Conduct a signal warrant analysis to justify installing a traffic signal [Assessment] • Design signal phasing and detection layouts for an intersection [Usage] • Evaluate signal equipment and controller requirements for an installation [Familiarity]
Readings : [**Mannering2013**]	

Unit 3: Intelligent Transportation Systems and Connected Vehicles (3 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• ITS architecture and system components • Traffic detection and surveillance technologies • Advanced traffic management systems • Traveler information systems and real-time data • Connected vehicle technologies and V2X communication • Autonomous vehicle systems and infrastructure requirements • Adaptive signal control and traffic-responsive systems • Electronic toll collection and congestion pricing • Transit signal priority and bus rapid transit systems • Data analytics and artificial intelligence in transportation	• Explain ITS architecture and identify system components [Familiarity] • Select appropriate traffic detection technologies for specific applications [Assessment] • Design advanced traffic management system deployments [Usage] • Implement traveler information systems and dissemination strategies [Assessment] • Describe connected vehicle technologies and communication protocols [Familiarity] • Evaluate infrastructure requirements for autonomous vehicle deployment [Assessment] • Apply adaptive signal control algorithms for traffic optimization [Usage] • Analyze electronic toll collection systems and pricing strategies [Assessment] • Integrate transit signal priority in multimodal networks [Usage] • Utilize data analytics and AI for transportation system optimization [Assessment]
Readings : [**Sussman2005**]	

Unit 4: Railway Alignment Design (3 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Horizontal alignment and curve design for railway track • Vertical alignment and grade design for railway track • Superelevation (cant) and transition curve design • Track gauge and kinematic envelope (clearance) standards • Alignment design criteria by service type (freight, passenger, high-speed)	• Design horizontal alignment and curves for a railway track [Usage] • Determine vertical alignment and grades for a railway track [Usage] • Compute superelevation and transition curve lengths for a design speed [Assessment] • Describe track gauge standards and kinematic envelope requirements [Familiarity] • Select alignment design criteria appropriate to the service type [Usage]
Readings : [**Profillidis2014**]	

Unit 5: Railway Capacity and Operations (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Railway line and network capacity analysis • Timetabling methods and conflict resolution • Operations planning for freight and passenger service • Train dispatching and control center operations	• Analyze railway line and network capacity [Assessment] • Develop a conflict-free railway timetable [Usage] • Plan freight and passenger railway operations [Usage] • Describe train dispatching and control center functions [Familiarity]
Readings : [**Profillidis2014**]	

Unit 6: Port Planning (2 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Port master planning process • Site selection criteria for port development • Port system planning within national and regional logistics networks • Cargo and vessel traffic demand forecasting	• Develop a port master plan [Usage] • Evaluate candidate sites for port development [Assessment] • Describe how a port fits within a national or regional logistics network [Familiarity] • Forecast cargo and vessel traffic demand [Usage]
Readings : [**Thoresen2014**]	

Unit 7: Maritime Hydraulics for Ports (2 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Wave generation, propagation, and transformation analysis • Tide and current characterization for port design • Harbor agitation and resonance (seiche) analysis • Design metocean conditions and return-period selection	• Analyze wave generation, propagation, and transformation at a port site [Usage] • Characterize tides and currents relevant to port design [Familiarity] • Assess harbor agitation and resonance risk for a proposed layout [Assessment] • Select design metocean conditions for a given return period [Usage]
Readings : [**USACE2002**]	

Unit 8: Berth and Quay Design (3 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Quay wall design (gravity, sheet pile, and piled structures) • Berth dimensioning for design vessel classes • Mooring systems and bollard layout • Fender system selection and energy absorption design	• Design a quay wall for specified soil and loading conditions [Assessment] • Dimension a berth for a design vessel class [Usage] • Lay out a mooring system and bollard arrangement [Usage] • Specify a fender system based on berthing energy absorption requirements [Assessment]
Readings : [**Tsinker2004**]	

Unit 9: Airport Planning and Demand Forecasting (3 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Airport master planning process and site selection • Airport system planning within the regional and national context • Aviation demand forecasting methods • Airport capacity analysis and level of service	• Describe the airport master planning process and site selection criteria [Familiarity] • Integrate an airport within a regional airport system plan [Usage] • Forecast aviation demand using established methods [Usage] • Conduct airport capacity analysis and evaluate level of service [Assessment]
Readings : [**Horonjeff2010**]	

Unit 10: Airside Geometric Design (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Aerodrome reference code and airport reference code (ARC) classification • Runway orientation analysis and wind rose evaluation • Runway and taxiway geometric design standards • Safety area separations, runway/taxiway strips, and obstacle-free zones • Apron and aircraft holding bay geometric design	• Classify an aerodrome according to its reference code [Familiarity] • Determine runway orientation from wind rose analysis [Usage] • Design runway and taxiway geometry following FAA/ICAO standards [Assessment] • Verify required safety area separations and obstacle-free zones [Assessment] • Lay out aprons and aircraft holding bays [Usage]
Readings : [**Horonjeff2010**]	

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

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

1. COURSE

CE3G1. Soil Dynamics (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3G1. Soil Dynamics
2.2 Semester	:	8^{th} Semester.
2.3 Credits	:	3
2.4 Hours	:	3 HT;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Mandatory
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	CE3G3. Applied Geology. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Soil Dynamics is an advanced elective of the Geotechnical Engineering track that extends the static shear-strength and deformation framework developed in Soil Mechanics II into the time-varying loading regime relevant to earthquakes and vibrating machinery. The course begins with the theoretical foundations of single-degree-of-freedom dynamic systems and one-dimensional wave propagation through soil deposits, then develops the tools needed to characterize seismicity, process strong-motion signals, and determine the dynamic properties of soils from laboratory and field testing. This foundation supports the analysis of seismic site response and the seismic stability of slopes, retaining structures, and foundations, and is applied to two design problems of markedly different scale: the design of foundations for vibrating machinery under steady-state dynamic loads, and the assessment, mitigation, and post-earthquake analysis of soil liquefaction, including the residual strength of liquefied soils. As a specialization elective following Soil Mechanics I and II, the course prepares students to perform the seismic geotechnical analyses required in professional practice in a seismically active country.

5. GOALS

- Formulate single-degree-of-freedom dynamic models and one-dimensional wave-propagation equations to characterize how seismic waves travel through soil deposits.
- Characterize regional seismicity, classify earthquakes by their expected consequences, and process strong-motion signals for use in geotechnical seismic analysis.
- Determine the dynamic properties of soils from laboratory and field testing for use in seismic response and liquefaction analyses.
- Perform seismic site response analysis to estimate ground motion amplification and design ground motions.
- Analyze the seismic stability of slopes, retaining structures, and foundations using pseudo-static and performance-based methods.
- Design foundations for vibrating machinery considering dynamic soil-foundation stiffness, resonance avoidance, and permissible vibration amplitudes.
- Evaluate liquefaction susceptibility and triggering, assess its effects on structures and infrastructure, and select mitigation measures including ground improvement.
- Evaluate the residual strength of liquefied soils and perform post-earthquake stability analysis.

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: Geotechnical Earthquake Engineering (42 hours)	
Competences Expected: ABET-1,ABET-2,ABET-6	
Topics	**Learning Outcomes**
• Single-degree-of-freedom dynamic systems and one-dimensional wave propagation through soil deposits • Site response and ground motion amplification • Seismic hazard analysis and design ground motions • Liquefaction susceptibility and triggering mechanisms • Cyclic stress ratio and liquefaction evaluation procedures • Effects of liquefaction on structures and infrastructure • Dynamic soil properties and laboratory testing • Design of foundations for vibrating machinery under dynamic loading • Ground improvement methods for liquefaction mitigation • Lateral spreading and flow failures • Seismically induced settlement and bearing capacity • Performance-based design for geotechnical earthquake engineering	• Formulate single-degree-of-freedom models and one-dimensional wave-propagation equations to characterize seismic wave transmission through soil deposits [Usage] • Explain site response effects and ground motion characteristics [Familiarity] • Determine design ground motions for geotechnical seismic analysis [Assessment] • Evaluate liquefaction susceptibility using field investigation data [Usage] • Calculate cyclic stress ratios and assess liquefaction potential [Assessment] • Assess the consequences of liquefaction on foundations and structures [Familiarity] • Characterize dynamic soil properties from laboratory and field tests [Usage] • Proportion machine foundations considering dynamic soil-foundation stiffness, resonance avoidance, and permissible vibration amplitudes [Assessment] • Select and design ground improvement methods to mitigate liquefaction [Assessment] • Predict lateral spreading displacements and flow failure potential [Usage] • Analyze seismically induced settlement and reduced bearing capacity [Assessment] • Implement performance-based approaches for seismic geotechnical design [Assessment]
Readings : [**Kramer1996**], [**Das1983SoilDynamics**], [**Prakash1981**]	

Unit 2: Slope Stability Analysis and Stabilization (6 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Infinite slope analysis for simple geometries • Method of slices and limit equilibrium analysis • Circular and non-circular failure surfaces • Factor of safety determination and acceptance criteria • Stability charts and simplified methods • Landslide types and failure mechanisms • Seismic slope stability and pseudo-static analysis • Stabilization methods including drainage and reinforcement • Monitoring systems and early warning for unstable slopes • Probabilistic slope stability analysis	• Perform infinite slope stability analysis for uniform slopes [Assessment] • Apply method of slices to analyze slope stability [Usage] • Analyze slopes with circular and non-circular failure surfaces [Assessment] • Calculate factors of safety and interpret results [Usage] • Use stability charts for rapid slope evaluation [Assessment] • Identify landslide types and their characteristic features [Familiarity] • Evaluate seismic stability using pseudo-static methods [Usage] • Design slope stabilization measures for specific failure modes [Assessment] • Implement monitoring systems for potentially unstable slopes [Usage] • Conduct probabilistic stability analysis considering parameter uncertainty [Assessment]
Readings : [**DuncanWright2014**]	

Unit 3: Ground Improvement Techniques (6 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Compaction methods including dynamic and vibratory techniques • Stone columns and vibro-replacement methods • Preloading and vertical drains for soft ground treatment • Deep mixing and jet grouting techniques • Chemical stabilization and grouting methods	• Select appropriate ground improvement methods for specific soil conditions [Familiarity] • Design stone column systems for settlement reduction [Assessment] • Calculate consolidation time reduction using vertical drains [Usage] • Identify geosynthetic types and their engineering applications [Familiarity] • Proportion reinforcement for mechanically stabilized earth structures [Assessment]
Readings : [**Koerner2012**], [**Das2019**]	

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

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

1. COURSE

CE3G2. Soil Mechanics Applied to Foundations (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3G2. Soil Mechanics Applied to Foundations
2.2 Semester	:	8^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE3G3. Applied Geology. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Soil Mechanics Applied to Foundations is a specialization elective of the Geotechnical Engineering track, taken after Soil Mechanics II, in which the foundation-design and slope-stability topics introduced there at a survey level are revisited in substantially greater depth. The course opens with the identification and classification of foundation soils – including problematic soils such as expansive, collapsible, and dispersive soils, and engineered fills – and the site-investigation criteria required under Peru's RNE Norma E.050. It then develops ground improvement techniques for weak or hazard-prone soils, extends bearing capacity theory to stratified profiles, sloping ground, and seismic loading, and deepens the design of both shallow and deep foundations, including pile load testing and integrity testing. The course closes with the static and pseudo-static (seismic) stability analysis of slopes. Together, these topics prepare students to characterize difficult foundation conditions and design the full range of foundation solutions encountered in professional geotechnical practice.

5. GOALS

- Classify foundation soils from geologic maps and subsurface data, and identify expansive, collapsible, dispersive, and engineered-fill soils and their implications for foundation design.
- Apply Peru's RNE Norma E.050 criteria to define foundation-soil classification and geotechnical investigation requirements.
- Select and design ground improvement measures for soils with inadequate bearing or settlement characteristics.
- Evaluate liquefaction susceptibility of foundation soils using field investigation data.
- Design shallow foundations considering bearing capacity in stratified soils, sloping ground, and seismic loading conditions.
- Design deep foundations (piles) and interpret static and dynamic load test and integrity test results.
- Analyze the static and pseudo-static (seismic) stability of slopes and design stabilization measures.

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: Problematic Soils and Foundation-Soil Classification (17 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Types of foundation soils and site characterization from geologic maps and subsurface data • Foundation-soil classification and investigation requirements under Peru's RNE Norma E.050 • Identification and mineralogy of expansive (swelling) soils • Swell potential testing and foundation design measures for expansive soils • Identification and behavior of collapsible (metastable) soils • Identification and treatment of dispersive soils • Specification and quality control of engineered fill for foundation support	• Classify foundation soils using geologic maps and subsurface investigation data [Familiarity] • Apply Peru's RNE Norma E.050 criteria to classify foundation soils and define investigation requirements [Assessment] • Identify expansive soils from mineralogy and index test data [Usage] • Design foundations for expansive soils based on swell potential test results [Assessment] • Recognize collapsible and dispersive soil behavior from field and laboratory indicators [Familiarity] • Specify engineered fill requirements for foundation support [Usage]
Readings : [**Coduto2001**], [**NelsonMiller1992**], [**E050**]	

Unit 2: Geotechnical Earthquake Engineering (3 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Single-degree-of-freedom dynamic systems and one-dimensional wave propagation through soil deposits • Site response and ground motion amplification • Seismic hazard analysis and design ground motions • Liquefaction susceptibility and triggering mechanisms • Cyclic stress ratio and liquefaction evaluation procedures • Effects of liquefaction on structures and infrastructure • Dynamic soil properties and laboratory testing • Design of foundations for vibrating machinery under dynamic loading • Ground improvement methods for liquefaction mitigation • Lateral spreading and flow failures • Seismically induced settlement and bearing capacity • Performance-based design for geotechnical earthquake engineering	• Formulate single-degree-of-freedom models and one-dimensional wave-propagation equations to characterize seismic wave transmission through soil deposits [Usage] • Explain site response effects and ground motion characteristics [Familiarity] • Determine design ground motions for geotechnical seismic analysis [Assessment] • Evaluate liquefaction susceptibility using field investigation data [Usage] • Calculate cyclic stress ratios and assess liquefaction potential [Assessment] • Assess the consequences of liquefaction on foundations and structures [Familiarity] • Characterize dynamic soil properties from laboratory and field tests [Usage] • Proportion machine foundations considering dynamic soil-foundation stiffness, resonance avoidance, and permissible vibration amplitudes [Assessment] • Select and design ground improvement methods to mitigate liquefaction [Assessment] • Predict lateral spreading displacements and flow failure potential [Usage] • Analyze seismically induced settlement and reduced bearing capacity [Assessment] • Implement performance-based approaches for seismic geotechnical design [Assessment]
Readings : [**Kramer1996**], [**Das2019**]	

Unit 3: Ground Improvement Techniques (10 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Compaction methods including dynamic and vibratory techniques • Stone columns and vibro-replacement methods • Preloading and vertical drains for soft ground treatment • Deep mixing and jet grouting techniques • Chemical stabilization and grouting methods	• Select appropriate ground improvement methods for specific soil conditions [Familiarity] • Design stone column systems for settlement reduction [Assessment] • Calculate consolidation time reduction using vertical drains [Usage] • Identify geosynthetic types and their engineering applications [Familiarity] • Proportion reinforcement for mechanically stabilized earth structures [Assessment]
Readings : [**Koerner2012**], [**Das2019**]	

Unit 4: Bearing Capacity and Design (26 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Bearing capacity theory and failure mechanisms • Ultimate bearing capacity equations for various conditions • Settlement analysis using elastic and consolidation methods • Isolated spread footing design • Combined footings and strap footings • Allowable bearing pressure and factor of safety selection • Mat foundation analysis and design • Eccentric and inclined loading effects • Soil-structure interaction effects • Differential settlement and tolerable limits • Continuous (strip) footing design for basement and foundation walls	• Explain bearing capacity failure mechanisms in shallow foundations [Familiarity] • Calculate ultimate bearing capacity using Terzaghi and Meyerhof equations [Assessment] • Predict total and differential settlements for shallow foundations [Usage] • Design isolated spread footings for gravity loads [Assessment] • Proportion combined and strap footings for column arrangements [Usage] • Determine allowable bearing pressures based on strength and settlement criteria [Assessment] • Analyze mat foundations using conventional and finite element methods [Assessment] • Evaluate bearing capacity under eccentric and inclined loading [Usage] • Consider soil-structure interaction in foundation design [Familiarity] • Assess differential settlement and apply tolerable settlement criteria [Assessment] • Design continuous strip footings for basement and foundation walls [Usage]
Readings : [**Coduto2001**], [**Das2019**]	

Unit 5: Deep Foundations (8 hours)	
Competences Expected: ABET-2,ABET-6	
Topics	**Learning Outcomes**
• Pile types and installation methods • Axial capacity of single piles in cohesive and cohesionless soils • Lateral load capacity and p-y method • Pile group behavior and group efficiency • Drilled shaft design and construction considerations • Negative skin friction and downdrag forces	• Select appropriate pile types based on soil conditions and loading [Familiarity] • Calculate axial capacity of piles using static methods [Assessment] • Analyze laterally loaded piles using p-y curves [Usage] • Evaluate pile group capacity and settlement [Assessment] • Design drilled shaft foundations including shaft diameter and reinforcement [Usage] • Interpret pile load test results and verify design assumptions [Assessment]
Readings : [**Coduto2001**], [**Das2019**]	

Unit 6: Slope Stability Analysis and Stabilization (6 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Infinite slope analysis for simple geometries • Method of slices and limit equilibrium analysis • Circular and non-circular failure surfaces • Factor of safety determination and acceptance criteria • Stability charts and simplified methods • Landslide types and failure mechanisms • Seismic slope stability and pseudo-static analysis • Stabilization methods including drainage and reinforcement • Monitoring systems and early warning for unstable slopes • Probabilistic slope stability analysis	• Perform infinite slope stability analysis for uniform slopes [Assessment] • Apply method of slices to analyze slope stability [Usage] • Analyze slopes with circular and non-circular failure surfaces [Assessment] • Calculate factors of safety and interpret results [Usage] • Use stability charts for rapid slope evaluation [Assessment] • Identify landslide types and their characteristic features [Familiarity] • Evaluate seismic stability using pseudo-static methods [Usage] • Design slope stabilization measures for specific failure modes [Assessment] • Implement monitoring systems for potentially unstable slopes [Usage] • Conduct probabilistic stability analysis considering parameter uncertainty [Assessment]
Readings : [**DuncanWright2014**]	

8. WORKPLAN

8.1 Methodology

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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.

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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

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

1. COURSE

CE3H4. Water Resources (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3H4. Water Resources
2.2 Semester	:	8^{th} Semester.
2.3 Credits	:	4
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 Prerrequisites	:	CE3H2. General Hydrology. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Water Resources addresses the comprehensive planning of water utilization projects: from the analysis of availability and demand (irrigation, municipal use, energy, navigation, ecological flow) and groundwater hydrology, to the formulation and evaluation of projects through economic, financial, environmental, social, and multi-criteria criteria. The course concludes with the application of linear programming and system optimization criteria, as well as the operating criteria and the national regulatory framework that govern water resources projects in Peru.

5. GOALS

- Analyze the availability and demand of water resources for different uses, including the groundwater component.
- Formulate water resources projects by defining the problem, alternatives, schedule, and budget.
- Evaluate project alternatives using economic, financial, environmental, social, and multi-criteria criteria.
- Apply linear programming and system optimization criteria to water resources planning.

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: Introduction and Methodology of Water Resources Analysis (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definitions and methodology for water resources project analysis. History of water resources development. • Current status of water resources in Peru and the National Water Resources Plan. • Management of basic information and water resources simulation tools.	• Describe the general methodological framework for the analysis of water resources projects [Familiarizarse]. • Collect and organize the basic information required for a water resources study [Usar].
Readings : [**Loucks2017**]	

Unit 2: Hydrologic Cycle and Water Balance (11 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Hydrologic cycle and water balance concepts • Precipitation measurement and analysis • Evaporation and evapotranspiration estimation • Infiltration theory and rainfall-runoff processes	• Explain the hydrologic cycle and quantify water balance components [Familiarity] • Analyze precipitation data and develop depth-area-duration relationships [Assessment] • Estimate evaporation and evapotranspiration using empirical methods [Usage] • Apply infiltration models to estimate runoff from rainfall events [Assessment]
Readings : [**ChowMaidmentMays1988**], [**Loucks2017**]	

Unit 3: Surface Hydrology and Watershed Modeling (9 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Hydrograph analysis and unit hydrograph method • Watershed modeling and hydrologic simulation • Streamflow measurement and gauging techniques	• Derive unit hydrographs and synthesize runoff hydrographs [Usage] • Develop watershed models using software tools for hydrologic simulation [Usage] • Conduct streamflow measurements and interpret flow duration curves [Assessment]
Readings : [**ChowMaidmentMays1988**], [**Loucks2017**]	

Unit 4: Flood Frequency Analysis and Climate Change (8 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Flood frequency analysis and design storms • Hydrologic routing methods for channels and reservoirs • Climate change impacts on hydrologic systems	• Perform flood frequency analysis using statistical methods [Assessment] • Route flood hydrographs through channels and reservoirs [Usage] • Evaluate climate change impacts on watershed hydrology and design implications [Assessment]
Readings : [**ChowMaidmentMays1988**], [**Loucks2017**]	

Unit 5: Groundwater Hydrology (8 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Aquifer types: confined, unconfined, and semi-confined • Darcy's law applied to groundwater flow and hydraulic conductivity • Well hydraulics: Theis and Thiem equations for transient and steady-state flow • Pumping tests and estimation of hydrogeologic parameters (transmissivity, storativity) • Numerical modeling of groundwater flow and aquifer water balance • Groundwater-surface water interaction and conjunctive use of resources • Groundwater quality and basic contaminant transport • Design and construction of water supply wells • Sustainable aquifer management and prevention of overexploitation	• Classify aquifer types and describe their hydraulic boundary conditions [Familiarity] • Apply Darcy's law to calculate groundwater flow rates and velocities [Usage] • Solve the Theis and Thiem equations to determine drawdown in pumping wells [Assessment] • Estimate hydrogeologic parameters from pumping test data [Usage] • Model the water balance of an aquifer and evaluate exploitation scenarios [Assessment] • Design a water supply well accounting for aquifer characteristics [Usage] • Evaluate the sustainability of aquifer exploitation and propose management measures [Assessment]
Readings : [**Fetter2001**]	

Unit 6: Scope and Requirements Planning (12 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Requirements elicitation techniques across predictive and adaptive approaches • Scope definition: project scope statement vs. product backlog depending on approach • Requirements traceability: linking requirements to outcomes across all approaches • Scope decomposition: WBS for predictive, backlog structuring for adaptive	• Define project and product scope using techniques appropriate to the selected development approach [Usage] • Compare scope planning approaches in predictive and adaptive development contexts [Assessment] • Design a requirements traceability approach ensuring all deliverables are linked to stated stakeholder needs [Assessment]
Readings : [**PMI2021**]	

Unit 7: Schedule Planning (2 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Activity estimation techniques: analogous, parametric, three-point, and story points • Schedule development: critical path for predictive, sprint and release planning for adaptive • Building schedule flexibility: buffers, contingency, and iteration capacity • Schedule baseline in predictive vs. release roadmap in adaptive: comparison and use	• Develop a project schedule appropriate to the selected development approach [Usage] • Compare scheduling practices in predictive and adaptive project environments [Assessment] • Evaluate a project schedule for realism, buffer adequacy, and alignment with scope and resource constraints [Assessment]
Readings : [**PMI2021**]	

Unit 8: Cost and Budget Planning (1 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Cost estimation techniques: analogous, parametric, bottom-up, and three-point • Budget structure: cost baseline, contingency reserves, and management reserves • Cost planning in adaptive environments: fixed-capacity budgeting and cost per iteration • Establishing and maintaining the cost performance baseline and managing reserve drawdown	• Estimate project costs and develop a budget using appropriate techniques [Usage] • Adapt cost planning practices for adaptive and hybrid project environments [Assessment] • Evaluate the adequacy of a project budget including contingency and management reserves [Assessment]
Readings : [**PMI2021**], [**Blank2017**]	

Unit 9: Economic, Financial and Social Evaluation of Water Resources Projects (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Economic evaluation indicators: Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit-Cost ratio • Selecting among project alternatives by comparing economic indicators • Sensitivity analysis to variations in costs, benefits, and discount rate • Funding sources and financial structuring of water projects • User payment capacity and tariff schemes • Cost allocation among beneficiaries in multipurpose projects • Social evaluation of projects: exchange theory and shadow prices • Distributional impacts and equity in project social evaluation	• Calculate NPV, IRR, and Benefit-Cost ratio for a water resources project [Usage] • Select among project alternatives based on compared economic indicators [Assessment] • Perform a sensitivity analysis of project profitability to changes in key variables [Usage] • Evaluate funding sources and tariff schemes based on user payment capacity [Assessment] • Allocate costs among beneficiaries in a multipurpose project [Usage] • Apply social evaluation principles to estimate a project's net benefit to society [Assessment]
Readings : [**Blank2017**]	

Unit 10: Environmental Impact Assessment and Sustainability Metrics (3 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 11: Weighted Sum and Scoring Methods (3 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Weighted sum model (SAW): normalization of criteria, weight assignment, and aggregation • Weight elicitation methods: direct assignment, rank order centroid, and swing weights • Weighted product model and its advantage for ratio-scale criteria • VIKOR method: compromise ranking based on closeness to the ideal and maximum group utility	• Apply the weighted sum model to rank alternatives and conduct sensitivity analysis on weights [Usage] • Elicit criteria weights using swing weights or rank order centroid and justify the chosen method [Usage] • Compare weighted sum and VIKOR rankings and explain differences due to aggregation approach [Assessment]
Readings : [**TrianRamanathan2000**]	

Unit 12: LP Formulation and Modeling (6 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Decision variables, objective function (minimization and maximization), and constraint types • Standard and canonical forms of an LP: converting inequalities to equalities, non-negativity restrictions • Common LP modeling patterns: resource allocation, blending, production planning, and diet problems • Modeling with soft constraints: penalty methods and goal relaxation in LP formulations	• Formulate a linear programming model from a verbal problem description, identifying variables, objective, and constraints [Usage] • Convert an LP between its inequality, equality (standard), and canonical forms [Usage] • Evaluate the adequacy of an LP model and identify modeling errors or inappropriate linearization assumptions [Assessment]
Readings : [**HillierLieberman2021**]	

Unit 13: Operation Criteria and Regulatory Framework (3 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Operation criteria for water utilization systems. • National regulatory framework for water resources (Water Resources Law and its regulations).	• Apply operation criteria to a water utilization system [Usar]. • Identify the national regulatory framework applicable to a water resources project [Familiarizarse].
Readings : [**ANA2016**]	

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

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

1. COURSE

CE3S4. Earthquake-Resistant Engineering and Disaster Prevention (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3S4. Earthquake-Resistant Engineering and Disaster Prevention
2.2 Semester	:	8^{th} Semester.
2.3 Credits	:	4
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 Prerrequisites	:	• CE2S1. Structural Analysis I. (7^{th} Sem) • CE2S2. Reinforced Concrete Design I. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Earthquake-Resistant Engineering and Disaster Prevention introduces the seismological and regulatory foundations required to design earthquake- resistant civil structures in Peru's highly seismic environment. Students begin with the fundamentals of seismology and plate tectonics, the typology of natural disasters, and disaster risk management, before studying the Peruvian seismic design code (E.030) and the structural configuration criteria – regularity, redundancy, and torsional control – that govern the layout of earthquake-resistant buildings. The course closes with structural dynamics: from single- and multi-degree-of-freedom vibration theory to response-spectrum and modal analysis, providing the analytical foundation for the seismic design of building structures.

5. GOALS

- Explain the seismological origin of earthquakes and the typology and management of natural disaster risk relevant to civil engineering practice in Peru.
- Apply the Peruvian seismic design code (E.030) to determine seismic hazard parameters and select an appropriate structural system.
- Apply structural configuration criteria to identify and avoid plan and vertical irregularities in the earthquake-resistant design of a building.
- Analyze the dynamic response of single- and multi-degree-of-freedom structural systems subjected to earthquake ground motion.
- Apply the modal response-spectrum method to determine the seismic design forces and displacements of building structural systems.

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)

7. TOPICS

Unit 1: Seismology and Natural Hazards (17 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Plate tectonics and earthquake generation mechanisms through fault rupture • Seismic waves: types (P, S, surface) and their propagation • Magnitude (seismic moment) and intensity (Modified Mercalli) scales • Historical seismicity and subduction tectonic context of Peru • Typology of natural disasters: seismic, volcanic, tsunami, and mass movement • Disaster risk management: prevention, mitigation, preparedness, and response (SINAGERD framework) • Seismological instrumentation: seismographs, accelerographs, and national monitoring networks	• Explain plate tectonics and earthquake generation mechanisms through fault rupture [Familiarity] • Differentiate types of seismic waves and their effects on buildings [Usage] • Interpret and distinguish between earthquake magnitude and intensity scales [Usage] • Describe the historical seismicity and subduction context of Peru [Familiarity] • Classify the main types of natural disasters affecting Peruvian territory [Familiarity] • Analyze the disaster risk management framework for earthquake prevention and response [Assessment]
Readings : [**Bolt2005**], [**Kramer1996**]	

Unit 2: Seismic Design Code and Structural Configuration Criteria (11 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Scope and structure of the Peruvian seismic design code E.030 • Seismic hazard parameters: seismic zonation (Z), usage factor (U), and soil profile (S) • Structural systems and seismic force reduction coefficient (R) • Plan structural irregularities: torsional irregularity, re-entrant corners, and diaphragm discontinuity • Vertical structural irregularities: soft story, weak story, and mass irregularity • Structuring principles: symmetry, redundancy, hyperstaticity, and continuity • Minimum base shear and inter-story drift limits	• Explain the scope and structure of the Peruvian seismic design code E.030 [Familiarity] • Determine the seismic hazard parameters (Z, U, S) applicable to a given site [Usage] • Select the structural system and corresponding reduction coefficient R [Usage] • Classify the plan and vertical structural irregularities of a building [Assessment] • Apply structuring principles to propose a regular structural configuration [Usage] • Verify the minimum base shear and inter-story drift limits [Assessment]
Readings : [**E030-2018**], [**BazanMeli2002**]	

Unit 3: Structural Dynamics and Earthquake Engineering (56 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Single-degree-of-freedom systems and free vibration • Forced vibration and harmonic excitation • Damping models and energy dissipation mechanisms • Response spectrum analysis • Earthquake ground motion characteristics and seismicity • Multi-degree-of-freedom systems and modal analysis • Time-history analysis and numerical integration methods • Seismic design philosophy and capacity design principles • Base isolation and energy dissipation devices • Performance-based seismic design methodology	• Analyze free vibration of single-degree-of-freedom systems and determine natural frequencies [Assessment] • Calculate structural response to harmonic and periodic loads [Usage] • Explain the role of damping in reducing dynamic response [Familiarity] • Apply response spectrum method for seismic analysis [Usage] • Interpret earthquake ground motion parameters and seismic hazard maps [Familiarity] • Perform modal analysis for multi-degree-of-freedom systems [Assessment] • Conduct time-history analysis using numerical integration techniques [Usage] • Design structures following capacity design and ductile detailing principles [Assessment] • Evaluate the effectiveness of base isolation and damping systems [Familiarity] • Implement performance-based seismic design procedures [Assessment]
Readings : [**Chopra2017**]	

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

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE3S5. Bridges and Structures (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3S5. Bridges and Structures
2.2 Semester	:	8^{th} Semester.
2.3 Credits	:	3
2.4 Hours	:	2 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 Prerrequisites	:	• CE2S1. Structural Analysis I. (7^{th} Sem) • CE2S2. Reinforced Concrete Design I. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Bridges and Structures introduces the fundamentals of bridge engineering, from conceptual planning and typology selection to the structural analysis and design of highway bridge superstructures and substructures according to the AASHTO LRFD Bridge Design Specifications. Building on structural analysis and reinforced concrete design, students learn the basic site and design studies required for a bridge project, the loads and load combinations that govern bridge design, approximate and refined methods for analyzing slab-and-girder superstructures, and the flexural and shear design of reinforced concrete, prestressed concrete, steel composite, and truss superstructure members. The course also covers the design of bridge bearings, abutments, and foundations, and closes with an introduction to road and bridge asset management, providing the design foundation required for professional practice in bridge engineering.

5. GOALS

- Identify the basic studies, design specifications, aesthetic considerations, and typology-selection factors involved in a bridge project.
- Determine the loads, load models, and load combinations that govern the design of highway bridges according to AASHTO LRFD.
- Model and analyze bridge superstructures using refined and approximate methods for slab-and-girder systems.
- Design reinforced concrete, prestressed concrete, and steel composite bridge superstructure members for flexure and shear according to AASHTO LRFD.
- Design truss bridge members subject to combined flexure and axial force, and design bridge bearings, abutments, and foundations.
- Recognize the fundamentals of road and bridge asset management for the operation and preservation of highway infrastructure.

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)

7. TOPICS

Unit 1: Bridge Superstructure Design (36 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Bridge types, components, and structural systems • Load models and load combinations for bridge design • Concrete slab bridges and T-beam bridge design • Steel girder bridges and composite bridge deck design • Prestressed concrete girder bridges • Box girder and curved bridge analysis • Truss bridge design considerations for members under combined flexure and axial force	• Classify bridge types and select appropriate systems for given site conditions [Familiarity] • Apply AASHTO load models and determine critical load combinations [Usage] • Design reinforced concrete slab bridges and T-beam superstructures [Assessment] • Proportion steel girders and design composite deck systems [Assessment] • Analyze and design prestressed concrete girder bridges [Assessment] • Model box girder bridges and analyze curved alignment effects [Usage] • Design truss bridge members subject to combined flexo-tension and flexo-compression [Usage]
Readings : [**Barker2013**], [**AASHTOLRFD2020**], [**ChenDuan2014**]	

Unit 2: Bridge Substructure, Evaluation, and Special Systems (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Substructure design including abutments and piers • Cable-stayed and suspension bridge concepts • Bearings, expansion joints, and bridge deck details • Bridge load rating and evaluation procedures • Seismic design of bridges and isolation systems	• Design bridge abutments and piers for vertical and lateral loads [Usage] • Explain the structural behavior of cable-supported bridge systems [Familiarity] • Select and design bridge bearings and expansion joint systems [Assessment] • Perform load rating analysis for existing bridges [Usage] • Implement seismic design criteria for bridge structures [Assessment]
Readings : [**Barker2013**], [**AASHTOLRFD2020**]	

Unit 3: Road and Bridge Asset Management (2 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Inventory, inspection, and condition assessment of roads and bridges • Condition indices, deterioration models, and prioritization criteria for maintenance and rehabilitation programs • Life-cycle cost analysis and budgeting for road and bridge network preservation	• Describe the fundamentals of an infrastructure asset management system for roads and bridges [Familiarity] • Apply condition indices and prioritization criteria to plan maintenance and rehabilitation actions for a road or bridge network [Usage] • Analyze life-cycle cost to budget preservation programs for road and bridge infrastructure [Assessment]
Readings : [**Hudson1997**]	

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

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE3T1. Aerial Photogrammetry (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3T1. Aerial Photogrammetry
2.2 Semester	:	8^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE2T3. Geodesy. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Aerial Photogrammetry is the geomatics course of the Vialidad, Geomatica y Transporte (DAVG) track, building on the satellite geodesy foundations established in Geodesy (Satellite Geodesy) to address the extraction of geometric measurements from aerial and UAV imagery for civil engineering projects. The course first develops the photogrammetric fundamentals of camera geometry, stereoscopic vision, and flight and acquisition planning; then covers the interior/exterior orientation, bundle adjustment, and ground-control-based georeferencing procedures that tie photogrammetric imagery together geometrically through aerial triangulation; then addresses the processing and generation of digital photogrammetric products (digital elevation/surface models, orthophotos, and dense point clouds), together with the accuracy assessment and quality-control procedures used to validate them; and closes with UAV and close-range photogrammetric acquisition and its interpretation and application to civil engineering projects.

5. GOALS

- Explain camera geometry, the central projection image-formation model, and stereoscopic vision, and plan an aerial or UAV photogrammetric flight with appropriate overlap, flying height, and image scale.
- Select and distribute ground control points, and perform interior and exterior orientation and aerial triangulation to geo-reference a block of photogrammetric imagery.
- Generate digital elevation/surface models, orthophotos, and dense point clouds from oriented photogrammetric imagery, including Structure-from-Motion workflows.
- Evaluate the accuracy of digital photogrammetric products against ground truth and apply quality-control criteria to a photogrammetric project.
- Plan and execute a UAV photogrammetric mission, selecting appropriate sensors and payloads and complying with applicable flight regulations.
- Apply close-range and UAV photogrammetric techniques to document structures, and interpret photogrammetric products in civil engineering applications.

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: Photogrammetric Fundamentals (20 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Camera geometry: focal length, principal point, and lens distortion • The central projection image-formation model • Stereoscopic vision and parallax measurement • Flight planning: overlap, flying height, and strip layout • Image scale determination and its relationship to flying height and focal length	• Explain camera geometry and the central projection image-formation model [Familiarity] • Measure parallax on a stereo pair to determine relative elevation [Usage] • Plan an aerial photography flight with appropriate overlap and flying height [Assessment] • Compute image scale from flying height and camera focal length [Usage] • Identify lens distortion effects and their correction [Familiarity]
Readings : [**Wolf2014**]	

Unit 2: Aerial Triangulation and Georeferencing (8 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Ground control point selection, measurement, and distribution • Interior orientation and camera calibration parameters • Exterior orientation and camera position/attitude determination • Bundle adjustment for simultaneous multi-image orientation • Aerial triangulation workflow for large image blocks	• Select and distribute ground control points for a photogrammetric project [Usage] • Explain interior orientation and the role of camera calibration parameters [Familiarity] • Determine exterior orientation parameters for an acquired image [Assessment] • Perform a bundle adjustment over a block of overlapping images [Assessment] • Execute an aerial triangulation workflow for a large image block [Usage]
Readings : [**Wolf2014**], [**ASPRS2013**]	

Unit 3: Digital Photogrammetric Products (18 hours)	
Competences Expected: ABET-2,ABET-6	
Topics	**Learning Outcomes**
• Digital Elevation/Surface Model (DEM/DSM) generation from stereo imagery • Orthophoto production and mosaicking • Dense point cloud generation from photogrammetric image matching • Structure-from-Motion (SfM) workflows for unordered image sets • Accuracy assessment of digital photogrammetric products against ground truth	• Generate a digital elevation/surface model from stereo imagery [Usage] • Produce and mosaic an orthophoto from oriented imagery [Assessment] • Generate a dense point cloud from photogrammetric image matching [Usage] • Apply a Structure-from-Motion workflow to an unordered image set [Assessment] • Evaluate the accuracy of a digital photogrammetric product against ground truth [Assessment]
Readings : [**Linder2016**], [**ASPRS2013**]	

Unit 4: UAV and Close-Range Photogrammetry (10 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• UAV mission planning: flight paths, overlap, and ground sample distance • UAV sensors and payloads for photogrammetric acquisition • Close-range photogrammetry applications (e.g. facade/structure documentation) • Regulatory considerations for UAV survey operations • End-to-end UAV photogrammetric processing workflows	• Plan a UAV photogrammetric mission with appropriate overlap and ground sample distance [Usage] • Select UAV sensors and payloads appropriate to a photogrammetric task [Familiarity] • Apply close-range photogrammetric techniques to document a structure [Assessment] • Comply with applicable UAV survey operation regulations [Familiarity] • Execute an end-to-end UAV photogrammetric processing workflow [Usage]
Readings : [**Colomina2014**], [**ASPRS2013**]	

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.

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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

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

1. COURSE

CE3T2. General Cartography and Cartographic Design (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3T2. General Cartography and Cartographic Design
2.2 Semester	:	8^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE2T3. Geodesy. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

General Cartography and Cartographic Design is the cartography course of the Vialidad, Geomática y Transporte (DAVG) track, building on the geodetic reference frameworks established in Geodesy — and specifically in satellite geodesy — to address how the curved surface of the Earth is projected, modeled, and communicated as a map. The course first develops map projection theory, the UTM system and local grid conventions, and the distortion properties and selection criteria that govern which projection is appropriate for a given mapping purpose and extent. It then covers the vector and raster data models, national mapping standards and spatial data infrastructure, and the web mapping and tile services that underlie modern digital cartographic products, together with the data interoperability and quality control practices that support them. The course continues with the principles of cartographic design — map composition, symbolization, generalization across scales, and the use of color and visual hierarchy — used to communicate spatial information effectively. It closes with the production of topographic map series and thematic maps applied to civil engineering practice, and the evaluation of the quality and fitness for use of a finished cartographic product through positional accuracy testing and metadata documentation.

5. GOALS

- Explain map projection theory and apply the UTM system and local grid conventions, selecting a projection appropriate to a given mapping purpose and geographic extent.
- Apply national mapping standards and spatial data infrastructure specifications, distinguish vector from raster data models, and publish cartographic data as a web map or tile service while verifying data interoperability.
- Compose a map layout and design symbolization, color, and visual hierarchy for point, line, and area features, generalizing map content appropriately for a target scale.
- Produce topographic map series and thematic maps applied to civil engineering practice, following a defined digital cartographic production workflow.
- Test a cartographic product against an applicable positional accuracy standard and document its metadata to evaluate its quality and fitness for use.

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: Map Projections and Coordinate Reference Systems (30 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Map projection theory: developable surfaces and projection families • The Universal Transverse Mercator (UTM) system and zone conventions • Projection distortion: conformality, equal-area, and equidistant properties • Local and national grid systems derived from a base projection • Criteria for selecting a map projection for a given mapping purpose and extent	• Explain map projection theory and the trade-offs among projection families [Familiarity] • Apply the UTM system's zone conventions to a mapping project [Usage] • Evaluate the distortion characteristics of a given projection for a mapping task [Assessment] • Derive a local grid system from a national base projection [Usage] • Select a map projection appropriate to a given purpose and geographic extent [Assessment]
Readings : [**Snyder1987**], [**Iliffe2008**]	

Unit 2: Cartographic Data Models and Standards (12 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Vector and raster data models for cartographic products • National mapping standards and spatial data infrastructure (e.g. Peru's IDEP) • Web mapping services and tile-based map delivery standards • Data interoperability standards for exchanging cartographic data • Quality control procedures for cartographic data production	• Distinguish vector from raster data models and identify when each is appropriate for a cartographic product [Familiarity] • Apply a national mapping standard or spatial data infrastructure specification to a mapping project [Usage] • Publish a cartographic product as a web map or tile service [Usage] • Verify data interoperability when exchanging cartographic data between systems [Assessment] • Perform quality control on a cartographic data production workflow [Assessment]
Readings : [**Longley2015**]	

Unit 3: Cartographic Design and Generalization (12 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Map composition elements: title, legend, scale, north arrow, and layout • Symbolization of point, line, and area features • Cartographic generalization: simplification, selection, and exaggeration across scales • Map scale selection and its relationship to feature detail and generalization • Color theory and visual hierarchy in map design	• Compose a map layout with appropriate title, legend, scale, and north arrow elements [Usage] • Design symbolization for point, line, and area features on a map [Assessment] • Generalize map content appropriately for a target scale [Assessment] • Select an appropriate map scale for a given purpose and level of detail [Familiarity] • Apply color theory and visual hierarchy principles to improve map readability [Usage]
Readings : [**Robinson1995**]	

Unit 4: Topographic and Thematic Cartography (30 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Topographic map series conventions and national mapping grids (e.g. Peru's Carta Nacional) • Thematic map types: choropleth, isoline, dot-density, and proportional symbol maps • Digital cartographic production workflows • Map accuracy standards and positional accuracy testing • Cartographic metadata documentation	• Explain topographic map series conventions and national mapping grid systems [Familiarity] • Select an appropriate thematic map type for a given dataset and message [Usage] • Produce a digital cartographic product following a defined production workflow [Usage] • Test a map product against an applicable positional accuracy standard [Assessment] • Document the metadata of a cartographic product [Familiarity]
Readings : [**Slocum2022**]	

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

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

1. COURSE

CE3T3. Geographic Information Systems (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3T3. Geographic Information Systems
2.2 Semester	:	8^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE2T3. Geodesy. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Geographic Information Systems is the geospatial-data-analysis course of the Vialidad, Geomática y Transporte (Roads, Geomatics, and Transportation) track, building on the measurement and positioning fundamentals established in Basic Geomatics and the planning concepts introduced in Transportation Engineering to address the capture, management, analysis, and engineering application of spatial data. The course first develops the data models, spatial database structure, and coordinate reference system handling that underlie a GIS, then covers the spatial analysis and geoprocessing operations (overlay, proximity, network, and terrain analysis, and spatial interpolation) used to derive engineering information from spatial datasets, the methods for acquiring and integrating field, GNSS, and remote-sensing data into a GIS together with the data quality and metadata practices that make that data reliable, and closes with the application of GIS to civil engineering decision-making: infrastructure asset mapping, land use and environmental analysis, web GIS and spatial data infrastructure, and GIS-based decision support, illustrated through tsunami hazard analysis, geotechnical-seismic microzonation mapping, and seismic risk calculation.

5. GOALS

- Distinguish vector from raster spatial data models and build a topologically correct, well-structured GIS database, including coordinate reference system management.
- Design a spatial database schema and manage attribute data joins for a GIS project.
- Perform overlay, proximity, network, and terrain analysis geoprocessing operations, and interpolate continuous surfaces from sample data.
- Capture and integrate field, GNSS, and remote-sensing data into a GIS, and evaluate and document spatial datasets against recognized data quality and metadata standards.
- Build infrastructure asset inventories and analyze land use and environmental conditions using GIS, and publish datasets through a web GIS or spatial data infrastructure.
- Support GIS-based decision-making for civil engineering hazard and risk problems – such as tsunami hazard analysis, geotechnical-seismic microzonation mapping, and seismic risk calculation – by designing an end-to-end GIS project workflow.

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: GIS Fundamentals and Data Models (16 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Vector data model: points, lines, and polygons, and topology • Raster data model: cell size, resolution, and raster-vector tradeoffs • Spatial database structure and spatial indexing • Coordinate reference system handling and on-the-fly reprojection in a GIS • Attribute data management and relational joins	• Distinguish vector from raster data models and select the appropriate one for a given dataset [Familiarity] • Build a topologically correct vector dataset in a GIS [Usage] • Design a spatial database schema for a GIS project [Assessment] • Manage coordinate reference systems and reprojection within a GIS project [Usage] • Join attribute data to spatial features using relational joins [Usage]
Readings : [**Longley2015**]	

Unit 2: Spatial Analysis and Geoprocessing (17 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Overlay analysis: intersection, union, and spatial join operations • Buffer and proximity analysis • Network analysis: shortest path, service areas, and allocation • Terrain analysis from a raster DEM: slope, aspect, and watershed delineation • Spatial interpolation methods for generating continuous surfaces from sample data	• Perform overlay analysis to combine multiple spatial datasets [Usage] • Conduct a buffer/proximity analysis for a siting or impact study [Assessment] • Solve a network analysis problem (shortest path, service area, or allocation) [Usage] • Derive slope, aspect, and watershed boundaries from a raster DEM [Assessment] • Interpolate a continuous surface from point sample data [Usage]
Readings : [**Longley2015**], [**Burrough2015**]	

Unit 3: GIS Data Acquisition and Integration (17 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Field data capture methods: digitizing, heads-up capture, and mobile GIS • Integration of GNSS-collected data into a GIS • Integration of remote sensing imagery and derived products into a GIS • Data quality standards: positional accuracy, completeness, and lineage • Spatial data metadata documentation standards	• Capture field data into a GIS using digitizing or mobile GIS tools [Usage] • Integrate GNSS-collected data into a GIS dataset [Assessment] • Integrate remote sensing-derived products into a GIS analysis [Usage] • Evaluate a spatial dataset against applicable data quality standards [Assessment] • Document a spatial dataset's metadata following a recognized standard [Familiarity]
Readings : [**Longley2015**], [**Lillesand2015**]	

Unit 4: GIS Applications in Civil Engineering (20 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Infrastructure asset mapping and inventory in a GIS • Land use and environmental analysis using GIS • Web GIS and spatial data infrastructure (SDI) for data sharing • GIS-based decision support and multi-criteria site selection • Design of a GIS project workflow from data acquisition to final product	• Build an infrastructure asset inventory in a GIS [Usage] • Analyze land use or environmental conditions using GIS layers [Assessment] • Publish a dataset through a web GIS or spatial data infrastructure [Usage] • Support a site-selection decision using GIS-based multi-criteria analysis [Assessment] • Design an end-to-end GIS project workflow for a civil engineering application [Assessment]
Readings : [**Longley2015**], [**Chang2019**]	

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

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

1. COURSE

CE3T8. Professional Competencies Workshop - Transportation (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3T8. Professional Competencies Workshop - Transportation
2.2 Semester	:	8^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	190Cr

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Professional Competencies Workshop - Transportation is the capstone/synthesis course of the Vialidad, Geomática y Transporte (DAVG) specialization track. It integrates, around a real road or transportation project, the transportation planning and system-dynamics framework developed in Transportation Engineering with the applied field-surveying techniques developed in Basic and Applied Geomatics, and with the four principal practice domains of highway and traffic engineering developed in Highway Geometric Design and Traffic Engineering and Urban Road Design: vehicular traffic analysis, road safety auditing and inspection, road network inventory, highway geometric design, and microscopic traffic simulation and operational analysis. Rather than introducing new content, the workshop revisits and applies, at a professional level of integration, the knowledge units developed throughout the specialization's preceding courses.

5. GOALS

- Set the scope and baseline studies of a real transportation project to be developed throughout the workshop.
- Apply transportation planning principles and travel-demand/system- dynamics analysis to the project's study corridor.
- Apply field-surveying (topographic) techniques to characterize the project's terrain and support its design.
- Analyze vehicular traffic flow and capacity for the project's road network.
- Conduct a road safety audit and inspection and propose countermeasures for the project.
- Compile a road inventory of the project's existing infrastructure.
- Apply highway geometric design criteria to the project's horizontal alignment.
- Use microscopic simulation to evaluate the project's operational performance.

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: Transportation Planning and Economics (15 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Transportation planning process and institutional framework • Travel demand modeling and forecasting methods • Four-step travel demand model • Data collection methods for transportation planning • Economic evaluation and benefit-cost analysis • Activity-based modeling and advanced forecasting techniques • Multimodal transportation planning and integration • Sustainable transportation and environmental considerations • Public participation and stakeholder engagement • Performance measures and system monitoring	• Explain the transportation planning process and institutional relationships [Familiarity] • Apply travel demand forecasting methods to predict future travel patterns [Assessment] • Implement the four-step travel demand model for regional analysis [Usage] • Design data collection programs for transportation studies [Assessment] • Conduct benefit-cost analysis for transportation projects [Usage] • Utilize activity-based models for advanced travel demand analysis [Assessment] • Develop integrated multimodal transportation plans [Usage] • Incorporate sustainability principles into transportation planning [Assessment] • Facilitate public participation processes in transportation planning [Familiarity] • Establish performance measures and monitoring systems for transportation networks [Assessment]
Readings : [**Ortuzar2011**]	

Unit 2: Workshop Project Scope and Baseline Studies (5 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Scope and location of the real road/transportation project to be developed in the workshop, and the general baseline studies (topographic, traffic, and socioeconomic context) that establish its starting conditions.	• Describe the scope, location, and baseline conditions of a real transportation project [Familiarizarse].
Readings : [**Mannering2013**]	

Unit 3: Topographic Mapping and Digital Terrain Models (5 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Contour representation and interpretation of terrain relief • Digital Terrain Model (DTM) generation from field or GNSS survey data • Topographic map production and cartographic conventions	• Generate a contour map from field survey data [Usage] • Build a digital terrain model (DTM) from a point-based topographic survey [Assessment]
Readings : [**Ghilani2015**], [**Kavanagh2019**]	

Unit 4: Traffic Flow Theory and Capacity Analysis (5 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Traffic flow characteristics and fundamental relationships • Highway capacity analysis using HCM methodology • Level of service concepts and analysis procedures • Traffic control devices and MUTCD standards • Signal timing and phasing design • Intersection capacity and delay analysis	• Explain traffic flow theory and fundamental traffic stream parameters [Familiarity] • Perform highway capacity analysis for various facility types [Assessment] • Determine level of service for transportation facilities [Usage] • Apply MUTCD standards for traffic control device design and placement [Assessment] • Design signal timing plans for isolated intersections [Usage] • Analyze intersection capacity and calculate control delay [Assessment]
Readings : [**Roess2019**], [**HCM2022**]	

Unit 5: Road Safety Engineering (10 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Crash data analysis and identification of high-risk locations • Road safety audits and systematic safety reviews • Vision Zero and the safe systems approach to street design • Pedestrian and bicycle safety countermeasures	• Analyze crash data to identify high-risk locations and contributing factors [Assessment] • Conduct a road safety audit for a roadway or intersection [Usage] • Explain the Vision Zero safe systems approach to street design [Familiarity] • Recommend pedestrian and bicycle safety countermeasures for a given location [Usage]
Readings : [**HSM2010**]	

Unit 6: Traffic Control Devices (10 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Classification and design of regulatory, warning, and guide signs • Sign placement, sizing, and retroreflectivity standards • Pavement marking types, materials, and placement standards • Traffic signal warrant analysis and justification studies • Signal phasing, sequencing, and vehicle/pedestrian detection design • Signal equipment, controllers, and maintenance considerations	• Classify traffic signs according to national/MUTCD-equivalent standards and select the appropriate sign for a given condition [Familiarity] • Specify sign placement, size, and retroreflectivity per design standards [Usage] • Design a pavement marking plan for a given roadway section [Assessment] • Conduct a signal warrant analysis to justify installing a traffic signal [Assessment] • Design signal phasing and detection layouts for an intersection [Usage] • Evaluate signal equipment and controller requirements for an installation [Familiarity]
Readings : [**MUTCD2023**], [**Roess2019**]	

Unit 7: Horizontal Alignment Design (10 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Simple circular curve geometry and layout • Spiral transition curves and their application • Superelevation design, rates, and runoff/transition lengths • Side friction factors and minimum radius determination • Horizontal sight distance and sight obstructions on curves • Compound and reverse curve design considerations	• Design simple circular horizontal curves for a given design speed [Usage] • Apply spiral transition curves where required by design speed and curvature [Assessment] • Design superelevation rates and transition/runoff lengths for a horizontal curve [Assessment] • Determine minimum curve radius from side friction and superelevation limits [Usage] • Verify horizontal sight distance and identify sight obstructions along a curve [Assessment] • Evaluate compound and reverse curve layouts against design guidance [Familiarity]
Readings : [**AASHTO2018GreenBook**], [**GarberHoel2019**]	

Unit 8: Traffic Operations and Management (10 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Arterial analysis and signal coordination • Freeway operations and bottleneck analysis • Traffic simulation and microsimulation modeling • Incident management and traffic management centers • Roundabout design and capacity analysis	• Develop coordinated signal systems for arterial corridors [Usage] • Evaluate freeway performance and identify operational bottlenecks [Assessment] • Utilize traffic simulation models for complex operational analysis [Usage] • Implement incident management strategies and traffic management operations [Assessment] • Design roundabouts and analyze their operational performance [Usage]
Readings : [**Roess2019**], [**Barcelo2010**]	

8. WORKPLAN

8.1 Methodology

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8.2 Theory Sessions

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9. EVALUATION SYSTEM

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

10. BASIC BIBLIOGRAPHY

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

1. COURSE

BMI201. Methodology of Engineering Research (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	BMI201. Methodology of Engineering Research
2.2 Semester	:	8^{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 Prerrequisites	:	150Cr

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Research Methodology in Engineering introduces students to the systematic process of formulating, conducting, and communicating engineering research. The course covers the foundations of the scientific and engineering research process – problem formulation, literature review, research design, data collection and analysis, and academic writing and citation norms – and then applies them directly: each student develops an original research or applied-engineering proposal under individualized faculty advising, presenting and defending it through continuous and final evaluation.

5. GOALS

- Formulate a well-defined engineering research problem and conduct a supporting literature review.
- Design a research approach appropriate to an engineering problem, selecting suitable data-collection and data-analysis methods.
- Apply academic-integrity principles and standard citation norms when producing engineering research writing.
- Develop, under individualized advising, an original research or applied-engineering proposal from problem formulation through preliminary results.
- Present and defend engineering research work, responding to continuous and final evaluation.

6. COMPETENCES

ABET-6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. (Familiarity)

7. TOPICS

Unit 1: Problem Formulation and Literature Review (10 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• The engineering research process: from problem identification to dissemination of results • Formulating a research problem and specific, investigable research questions for engineering practice • Literature review methodology: search strategies, source evaluation, and synthesis	• Formulate a specific, investigable engineering research problem [Usage] • Conduct a supporting literature review, evaluating and synthesizing sources [Usage]
Readings : [**Booth2016**], [**Leedy2019**], [**ASCE2019**]	

Unit 2: Research Design and Data Methods (10 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Research design: quantitative, qualitative, and mixed-methods approaches applied to engineering problems • Data collection instruments and methods for engineering research (surveys, experiments, field measurements, simulation) • Data analysis methods and interpretation of engineering research results	• Design a research approach, appropriate for an engineering research question, including data collection and analysis methods [Usage] • Select data collection instruments and analysis methods appropriate to a given engineering research question [Usage]
Readings : [**Booth2016**], [**Leedy2019**], [**ASCE2019**]	

Unit 3: Research Communication and Academic Integrity (10 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Academic integrity, plagiarism, and citation standards (reference norms) in engineering writing • Structure of a research proposal, thesis, and technical paper • Oral presentation and defense of engineering research work	• Apply academic integrity principles and standard citation norms in an engineering research write-up [Usage] • Structure a research proposal or technical paper following standard engineering academic conventions [Assessment] • Present and defend engineering research work in response to an evaluation committee's questions [Assessment]
Readings : [**Booth2016**], [**Leedy2019**], [**ASCE2019**]	

8. WORKPLAN

8.1 Methodology

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9. EVALUATION SYSTEM

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

10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE2C5. Construction planning and scheduling (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2C5. Construction planning and scheduling
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 Prerrequisites	:	CE2C2. Construction Technology I. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Construction Project Management I covers the planning, scheduling, and management of construction works, including the use of Critical Path Method (CPM) and 4D/5D modeling tools for project control, construction cost estimating and financial management, and the day-to-day management of construction site execution.

5. GOALS

- Plan a construction project by defining its scope and work breakdown structure.
- Schedule a construction project using the Critical Path Method (CPM) and 4D/5D modeling tools.
- Estimate construction costs and manage the financial control of a construction project.
- Manage and control the execution of a construction project at the site level.

6. COMPETENCES

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-5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. (Usage)

7. TOPICS

Unit 1: Project Planning, Scheduling, and Control (CPM, 4D/5D) (42 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**], [**PMI2021**]	

Unit 2: Construction Cost Estimating and Quantification (10 hours)	
Competences Expected: ABET-5	
Topics	**Learning Outcomes**
• Estimating types: conceptual, preliminary, and detailed • Quantity takeoff methods from drawings and digital models • Pricing components: labor, material, equipment, and overhead • Parametric and probabilistic estimating techniques • Life-cycle cost analysis for building systems	• Perform a detailed quantity takeoff for concrete, formwork, and reinforcement from construction drawings [Usage] • Prepare a unit price estimate for a defined work package [Assessment] • Apply parametric models to develop a conceptual cost estimate for a building [Assessment] • Conduct a life-cycle cost analysis to compare two alternative building envelope systems [Usage]
Readings : [**RSMeans2024**], [**PMI2021**]	

Unit 3: Construction Budgeting, Bidding, and Financial Control (8 hours)	
Competences Expected: ABET-5	
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 : [**RSMeans2024**], [**PMI2021**]	

Unit 4: Construction Site and Field Management (24 hours)	
Competences Expected: ABET-5	
Topics	**Learning Outcomes**
• Site mobilization: temporary facilities, access, utilities, and site organization • Field supervision and daily site operations management • Subcontractor and trade coordination and sequencing • Progress reporting, documentation, and site coordination meetings • Materials management: procurement tracking, delivery, and storage • Quality control and inspection during construction execution • Stakeholder communication and conflict resolution on site • Project closeout: punch lists, commissioning, and turnover	• Develop a site mobilization plan including temporary facilities and access logistics [Usage] • Supervise daily site operations and resolve field-level execution issues [Assessment] • Coordinate subcontractor and trade sequencing to avoid schedule conflicts [Usage] • Prepare a progress report and lead a site coordination meeting [Usage] • Track material procurement, delivery, and on-site storage for a work package [Assessment] • Conduct a quality control inspection during a construction execution phase [Assessment] • Resolve a stakeholder conflict arising during site execution [Familiarity] • Manage project closeout activities, including punch lists and turnover [Usage]
Readings : [**Gould2018**], [**Fisk2013**]	

8. WORKPLAN

8.1 Methodology

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8.2 Theory Sessions

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9. EVALUATION SYSTEM

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

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

1. COURSE

CE2T5. Highway Geometric Design (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE2T5. Highway Geometric Design
2.2 Semester	:	9^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	• CE2T1. Basic Geomatics. (6^{th} Sem) • CE2T4. Transportation Engineering. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Highway Geometric Design is the roadway design course of the Vialidad, Geomática y Transporte (DAVG) track, building on the field measurement and mapping skills established in Basic Geomatics and on the route-planning and traffic-demand concepts introduced in Transportation Engineering to address the geometric design of two-lane and multilane highways and urban roadways. The course first develops the design controls and criteria –design vehicle, functional classification, design speed, and design domain– that govern every subsequent decision, under Peru's DG-2018 geometric design manual and the AASHTO Green Book, and the methods used to select a route (homogeneous sections, grade-line, decision matrix, and the Bruce method). It then covers horizontal alignment (simple and spiral curves, superelevation, sight distance, and widening) and vertical alignment (grade control and crest/sag vertical curves), coordinated three-dimensionally, followed by the geometric design of the cross section and roadside (lanes, shoulders, clear zone, barriers, earthwork volume computation, and mass-haul diagrams) and of at-grade intersections and grade-separated interchanges. The course closes with context-sensitive, multimodal design practice and the application of BIM and 3D modeling methodologies for the digital delivery and asset management of a highway geometric design project.

5. GOALS

- Apply Peru's DG-2018 normative framework and the AASHTO Green Book criteria, together with route-location methods (grade-line, decision matrix, Bruce method), to select design controls for a highway project.
- Design horizontal alignment elements –simple and spiral curves, superelevation, and widening– for a given design speed, and verify horizontal sight distance.
- Design vertical alignment elements –grade control, crest and sag vertical curves– coordinated three-dimensionally with the horizontal alignment.
- Design cross-section and roadside elements –lane and shoulder widths, clear zone, barriers– and compute earthwork volumes and mass-haul diagrams.
- Design at-grade intersection channelization and select grade-separated interchange types appropriate to traffic, right-of-way, and terrain constraints.
- Apply context-sensitive and complete-streets design principles to balance multimodal users in an urban or rural context.
- Use BIM and 3D modeling tools for the digital delivery and asset management of a highway geometric design project.

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: Design Controls and Criteria (14 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Design vehicle types and turning template characteristics • Driver performance characteristics: perception-reaction time and eye/object height • Functional classification of highways and streets and its relation to design criteria • Design speed selection and its relationship to operating speed • Design domain concept and flexible design criteria ranges • Design exception process for substandard criteria	• Select an appropriate design vehicle and apply its turning template to a layout [Familiarity] • Apply driver performance parameters (perception-reaction time, eye/object height) in design computations [Usage] • Determine the functional classification of a facility and the design criteria it implies [Assessment] • Select a design speed consistent with context, function, and operating speed expectations [Assessment] • Explain the design domain concept and its use in flexible design [Familiarity] • Document a design exception for a criterion that cannot be met [Usage]
Readings : [**MTCDG2018**], [**AASHTO2018GreenBook**]	

Unit 2: Horizontal Alignment Design (20 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Simple circular curve geometry and layout • Spiral transition curves and their application • Superelevation design, rates, and runoff/transition lengths • Side friction factors and minimum radius determination • Horizontal sight distance and sight obstructions on curves • Compound and reverse curve design considerations	• Design simple circular horizontal curves for a given design speed [Usage] • Apply spiral transition curves where required by design speed and curvature [Assessment] • Design superelevation rates and transition/runoff lengths for a horizontal curve [Assessment] • Determine minimum curve radius from side friction and superelevation limits [Usage] • Verify horizontal sight distance and identify sight obstructions along a curve [Assessment] • Evaluate compound and reverse curve layouts against design guidance [Familiarity]
Readings : [**AASHTO2018GreenBook**], [**GarberHoel2019**]	

Unit 3: Vertical Alignment Design (12 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Maximum and minimum grade control and critical length of grade • Crest vertical curve design for stopping sight distance • Sag vertical curve design for headlight and comfort criteria • Stopping sight distance computation and application • Passing sight distance on two-lane highways • Vertical clearance requirements at structures and underpasses	• Apply grade control criteria including critical length of grade for trucks [Assessment] • Design crest vertical curves satisfying stopping sight distance [Assessment] • Design sag vertical curves satisfying headlight and comfort criteria [Assessment] • Compute stopping sight distance for a given design speed and grade [Usage] • Determine passing sight distance requirements on two-lane highways [Usage] • Verify vertical clearance at structures against design standards [Familiarity]
Readings : [**AASHTO2018GreenBook**], [**GarberHoel2019**]	

Unit 4: Cross-Section Elements and Roadside Design (14 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Lane and shoulder width selection by functional class and context • Median types, widths, and median barrier warrants • Cross slope, superelevation transition, and drainage considerations • Clear zone width determination and roadside hazard rating • Roadside barrier selection, placement, and end treatments • Sidewalk, bike lane, and buffer cross-section design	• Select lane and shoulder widths appropriate to functional class and context [Usage] • Determine median type, width, and barrier warrant for a given facility [Assessment] • Explain cross slope and drainage requirements in cross-section design [Familiarity] • Determine clear zone width from roadside hazard rating and design speed [Assessment] • Select and place roadside barriers and end treatments [Usage] • Design sidewalk, bike lane, and buffer cross-sections for a complete street [Assessment]
Readings : [**AASHTO2018GreenBook**], [**GarberHoel2019**]	

Unit 5: At-Grade Intersections and Interchanges (10 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• At-grade intersection types and alignment/skew considerations • Channelization and turning lane design (left/right turn lanes) • Intersection sight distance and approach sight triangles • Interchange types and selection criteria (diamond, cloverleaf, directional) • Ramp geometric design and gore area treatment • Weaving section geometry and auxiliary lane design	• Select an at-grade intersection type and alignment appropriate to approach conditions [Assessment] • Design channelization and turning lanes for an at-grade intersection [Usage] • Verify intersection sight distance against approach sight triangle criteria [Usage] • Select an interchange type appropriate to traffic, right-of-way, and terrain constraints [Assessment] • Design ramp geometry and gore area treatments [Usage] • Analyze weaving section geometry and auxiliary lane requirements [Assessment]
Readings : [**AASHTO2018GreenBook**], [**GarberHoel2019**]	

Unit 6: Context-Sensitive and Multimodal Design (8 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Context-sensitive design process and stakeholder-based criteria flexibility • Complete streets principles and multimodal accommodation • Traffic calming elements for urban and residential streets • Three-dimensional coordination of horizontal and vertical alignment • Aesthetic and environmental considerations in geometric design • Access management and driveway spacing criteria	• Explain the context-sensitive design process and when design flexibility is appropriate [Familiarity] • Apply complete streets principles to accommodate multiple travel modes [Usage] • Select traffic calming elements appropriate to an urban or residential context [Assessment] • Coordinate horizontal and vertical alignment for a three-dimensionally consistent design [Assessment] • Consider aesthetic and environmental factors in geometric design decisions [Familiarity] • Apply access management criteria to driveway and intersection spacing [Usage]
Readings : [**NACTO2013**], [**AASHTO2018GreenBook**]	

Unit 7: 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 openBIM • 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**]	

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

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 Prerrequisites	:	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 openBIM • 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

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

1. COURSE

CE3C2. Construction Technology II (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3C2. Construction Technology II
2.2 Semester	:	9^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE2C2. Construction Technology I. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Construction Technology II deepens the construction processes of structural elements: layout and staking of works, formwork and shoring systems, soil mechanics applied to foundations, shallow and deep foundations, structural and non-structural masonry, and rebar detailing and placement of reinforcing steel.

5. GOALS

- Perform the layout and staking of a construction project and design the necessary formwork and shoring systems.
- Apply soil mechanics to the design of shallow and deep foundations.
- Execute and supervise construction processes for structural and non-structural masonry.
- Design and detail the reinforcing steel placement for reinforced concrete elements.

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)

7. TOPICS

Unit 1: Construction Methods, Equipment, and Productivity (20 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 2: Shear Strength and Consolidation (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Shear strength of soils and Mohr-Coulomb failure criterion • Direct shear and triaxial testing methods • Drained and undrained shear strength behavior • Consolidation theory and settlement analysis • Time-rate of consolidation and degree of consolidation • Stress distribution in soil masses using elastic theory • Critical state soil mechanics concepts • Residual shear strength and sensitivity of clays • Secondary compression and creep behavior • Anisotropy and stress path effects on soil behavior	• Apply Mohr-Coulomb criterion to determine shear strength parameters [Familiarity] • Interpret direct shear and triaxial test results [Assessment] • Distinguish between drained and undrained loading conditions [Usage] • Calculate consolidation settlement using one-dimensional theory [Assessment] • Predict time-rate of settlement for consolidating soils [Usage] • Compute stress distribution beneath loaded areas using Boussinesq theory [Assessment] • Explain critical state concepts and their application to soil behavior [Familiarity] • Evaluate residual strength and sensitivity for slope stability problems [Assessment] • Estimate secondary compression for highly plastic soils [Usage] • Analyze the effects of stress paths and anisotropy on soil response [Familiarity]
Readings : [**Das2019**]	

Unit 3: Bearing Capacity and Design (3 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Bearing capacity theory and failure mechanisms • Ultimate bearing capacity equations for various conditions • Settlement analysis using elastic and consolidation methods • Isolated spread footing design • Combined footings and strap footings • Allowable bearing pressure and factor of safety selection • Mat foundation analysis and design • Eccentric and inclined loading effects • Soil-structure interaction effects • Differential settlement and tolerable limits • Continuous (strip) footing design for basement and foundation walls	• Explain bearing capacity failure mechanisms in shallow foundations [Familiarity] • Calculate ultimate bearing capacity using Terzaghi and Meyerhof equations [Assessment] • Predict total and differential settlements for shallow foundations [Usage] • Design isolated spread footings for gravity loads [Assessment] • Proportion combined and strap footings for column arrangements [Usage] • Determine allowable bearing pressures based on strength and settlement criteria [Assessment] • Analyze mat foundations using conventional and finite element methods [Assessment] • Evaluate bearing capacity under eccentric and inclined loading [Usage] • Consider soil-structure interaction in foundation design [Familiarity] • Assess differential settlement and apply tolerable settlement criteria [Assessment] • Design continuous strip footings for basement and foundation walls [Usage]
Readings : [**Das2019**]	

Unit 4: Deep Foundations (3 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Pile types and installation methods • Axial capacity of single piles in cohesive and cohesionless soils • Lateral load capacity and p-y method • Pile group behavior and group efficiency • Drilled shaft design and construction considerations • Negative skin friction and downdrag forces	• Select appropriate pile types based on soil conditions and loading [Familiarity] • Calculate axial capacity of piles using static methods [Assessment] • Analyze laterally loaded piles using p-y curves [Usage] • Evaluate pile group capacity and settlement [Assessment] • Design drilled shaft foundations including shaft diameter and reinforcement [Usage] • Interpret pile load test results and verify design assumptions [Assessment]
Readings : [**Das2019**]	

Unit 5: Masonry Structural Design (6 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Masonry materials, units, and mortar properties • Unreinforced masonry wall design for compression and flexure • Reinforced masonry design and detailing • Seismic design of masonry and timber structures	• Identify masonry unit types and specify appropriate mortar for applications [Familiarity] • Design unreinforced masonry walls for gravity and lateral loads [Assessment] • Proportion reinforced masonry elements and specify reinforcement details [Usage] • Implement seismic design provisions for masonry and timber buildings [Usage]
Readings : [**Drysdale2008**]	

Unit 6: Reinforced Concrete Design (6 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Design philosophy and limit state methodology for concrete structures • Flexural design of rectangular and T-beams • Shear and torsion design of concrete members • Compression members and column design • Slab design including one-way and two-way systems • Development length and splicing of reinforcement • Deflection control and serviceability requirements for concrete beams and slabs	• Explain limit state design philosophy and load factor combinations [Familiarity] • Design reinforced concrete beams for flexure and check serviceability [Assessment] • Calculate shear and torsional reinforcement requirements [Usage] • Proportion columns for axial load and biaxial bending [Assessment] • Design one-way and two-way slab systems with appropriate reinforcement [Usage] • Determine development lengths and design lap splices for reinforcing bars [Assessment] • Control deflections and verify serviceability requirements through adequate member sizing and reinforcement [Usage]
Readings : [**ACI318**]	

Unit 7: Construction Layout and Staking of Works (6 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Establishment and preservation of horizontal and vertical control points • Staking of building axes, column lines, and reference offsets • Transfer of design elevations and benchmarks to excavation and formwork • Layout instruments: total station, automatic/digital level, and GNSS/GPS receivers	• Establish horizontal and vertical control points for a building site using a total station [Usage] • Stake out building axes and column locations from a foundation layout plan [Usage] • Explain the appropriate use of GNSS/GPS receivers for construction layout tasks [Familiarity]
Readings : [**Ghilani2020**]	

Unit 8: Formwork Design and Shoring Systems (14 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Lateral pressure of fresh concrete on formwork and design loads • Formwork systems for walls and columns: panel, ganged, and slip forms • Formwork systems for slabs and beams: conventional, flying, and table forms • Formwork materials: wood, plywood, engineered forms, and modular metal systems • Shoring and falsework design: post shores, scaffold shoring, and heavy-duty shoring towers • Reshoring and backshoring procedures for multistory construction • Formwork removal and stripping time criteria based on concrete strength gain • Safety considerations in formwork and shoring erection and dismantling	• Calculate the lateral pressure of fresh concrete on wall formwork for a given pour rate [Assessment] • Design wall or column formwork, including sheathing, studs, and ties, for a specified pressure [Assessment] • Select an appropriate slab formwork system for a given floor plan and cycle time [Usage] • Design a shoring system, including post shore spacing and load path, for an elevated slab [Assessment] • Plan a reshoring sequence for a multistory concrete building [Usage] • Determine the minimum stripping time for formwork based on concrete strength development [Assessment]
Readings : [**Hurd2005**], [**Peurifoy2018**]	

Unit 9: Rebar Detailing, Fabrication, and Placement (10 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Interpretation of structural drawings and bar bending schedules (BBS) • Bar bending and cutting to standard hooks, bends, and fabrication tolerances • Splicing methods: lap splices, mechanical couplers, and welded splices • Placement, support (chairs/spacers), and tying of reinforcing bars • Concrete cover and bar spacing tolerances for durability and structural performance • Site quality control and inspection of reinforcement prior to concrete pour	• Interpret a bar bending schedule and structural drawing to fabricate reinforcing bars [Usage] • Select an appropriate splicing method for a given bar size and location [Assessment] • Place and tie reinforcing steel to meet specified cover and spacing tolerances [Usage] • Inspect a completed reinforcement placement for compliance before authorizing concrete pour [Assessment]
Readings : [**CRSI2020**], [**ACI318**]	

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

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

1. COURSE

CE3C5. Costs and Budgeting in Civil Engineering (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3C5. Costs and Budgeting in Civil Engineering
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 Prerrequisites	:	CE2C2. Construction Technology I. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Costs and Budgeting deepens the economic management and control of construction works: analysis of bid documents, quantity takeoffs by specialty, unit cost analysis, direct and indirect costs, budgeting, bidding, and cost control, together with the mechanisms used to adjust contract prices for cost escalation and to certify and pay work actually performed: polynomial price-adjustment formulas and monthly progress valuations.

5. GOALS

- Analyze bid documents and prepare quantity takeoffs by specialty.
- Prepare project budgets distinguishing direct and indirect costs, and analyze a competitive bid.
- Exercise economic control of a construction project through cost tracking and cash-flow management.
- Apply the polynomial price-adjustment formula and prepare monthly progress valuations for a construction contract.

6. COMPETENCES

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: Construction Cost Estimating and Quantification (54 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Estimating types: conceptual, preliminary, and detailed • Quantity takeoff methods from drawings and digital models • Pricing components: labor, material, equipment, and overhead • Parametric and probabilistic estimating techniques • Life-cycle cost analysis for building systems	• Perform a detailed quantity takeoff for concrete, formwork, and reinforcement from construction drawings [Usage] • Prepare a unit price estimate for a defined work package [Assessment] • Apply parametric models to develop a conceptual cost estimate for a building [Assessment] • Conduct a life-cycle cost analysis to compare two alternative building envelope systems [Usage]
Readings : [**Peurifoy2018**], [**CAPECO**]	

Unit 2: Construction Budgeting, Bidding, and Financial Control (44 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 : [**Peurifoy2018**], [**CAPECO**]	

Unit 3: Price Adjustment and Progress Valuations (32 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Polynomial price-adjustment formula: structure, incidence coefficients (coeficientes de incidencia), and representative unit-cost components • Official unified construction cost indices: publication cycle, sourcing, and application to the adjustment formula • Monthly progress valuations: measurement of completed quantities and certification for payment • Advance payments and retentions: calculation and amortization schedule within progress valuations • Disputed price-adjustment and valuation calculations: common sources of disagreement and resolution mechanisms	• Calculate the adjusted contract price for a work item using a polynomial price-adjustment formula and official cost indices [Usage] • Prepare a monthly progress valuation certifying completed quantities for payment [Usage] • Explain the role of advance payments and retentions in a progress-payment schedule [Familiarity] • Resolve a disputed price-adjustment calculation by correctly applying index-based escalation rules [Assessment]
Readings : [**CAPECO**]	

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

1. COURSE

CE3C6. Risk and Environmental Impact Assessment (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3C6. Risk and Environmental Impact Assessment
2.2 Semester	:	9^{th} Semester.
2.3 Credits	:	4
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 Prerrequisites	:	CE3H4. Water Resources. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Environmental Risk and Impact Assessment introduces the systematic process for identifying, predicting, evaluating, and mitigating the environmental effects of civil engineering projects before major decisions are taken, together with the identification of environmental hazards and risk sources and the use of probability-consequence risk matrices to prioritize them and formulate environmental risk management and contingency plans. The course also develops the specialized assessment of impacts on rivers, coastal and maritime zones, and lakes or reservoirs that are characteristic of water resources infrastructure. It covers the EIA process (screening, scoping, impact prediction, mitigation, and public participation), environmental risk assessment, sustainability metrics and multi-criteria decision analysis, and the Peruvian regulatory and permitting framework (ANA, SENACE, DICAPI) that governs water-body-adjacent works.

5. GOALS

- Apply the stages of a standardized Environmental Impact Assessment process to a civil engineering project.
- Predict and evaluate the environmental impacts of a project on air, water, soil, and ecological systems.
- Design mitigation measures and environmental management plans for identified impacts.
- Identify environmental hazards and risk sources, and apply a risk matrix to prioritize the environmental risks of a project.
- Assess the specific hydromorphological and ecological impacts of works sited in fluvial, maritime, and lacustrine environments.
- Determine ecological flow requirements and apply the Peruvian permitting framework for water-body-adjacent projects.

6. COMPETENCES

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)

7. TOPICS

Unit 1: Environmental Impact Assessment and Sustainability Metrics (40 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 • Identification of environmental hazards and risk sources associated with a civil engineering project • Environmental risk assessment methodology: probability x consequence matrices and risk prioritization • Development of environmental risk management and contingency plans integrated into the EIA process	• 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] • Identify the environmental hazards and risk sources of a civil engineering project [Familiarity] • Apply a risk matrix (probability x consequence) to prioritize the environmental risks of a project [Usage] • Formulate an environmental risk management and contingency plan integrated into a project's EIA [Assessment]
Readings : [**Glasson2019**]	

Unit 2: Environmental Impact Assessment in Fluvial, Maritime, and Lacustrine Environments (32 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Impacts of river-adjacent works (bridges, bank protection, dredging) on fluvial morphology, sediment regime, and aquatic habitat • Impacts of port, coastal, and marine works on currents, sediment transport, water quality, and marine ecosystems • Impacts of works on lakes and reservoirs: eutrophication, thermal stratification, sedimentation, and littoral habitat alteration • Environmental (ecological) flow requirements for rivers affected by water infrastructure • Peruvian permitting framework for water-body-adjacent works (ANA water-use and discharge authorizations, SENACE certification, DICAPI maritime/river-navigation clearance)	• Explain the hydromorphological and ecological impacts specific to fluvial, maritime, and lacustrine environments [Familiarity] • Assess the environmental impact of a river-, coastal-, or lake-adjacent civil work on its aquatic environment [Usage] • Determine the ecological flow requirements for a river reach affected by a water infrastructure project [Assessment] • Identify the Peruvian permitting requirements applicable to a water-body-adjacent project [Usage]
Readings : [**Glasson2019**]	

Unit 3: Climate Adaptation Engineering for Water Systems (16 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Climate science fundamentals and downscaling of global climate model projections • Hydrologic impacts of climate change: precipitation intensity, drought, and snowmelt • Vulnerability and risk assessment frameworks for water infrastructure • Water supply system adaptation: source diversification and demand management • Stormwater system adaptation for increased intensity rainfall • Coastal adaptation strategies: managed retreat, protective structures, and nature-based solutions • Decision-making under uncertainty and adaptive management pathways • Infrastructure design standards and codes under non-stationary climate conditions • Economic appraisal of adaptation options and financing mechanisms	• Interpret downscaled climate projections for key hydrologic variables [Familiarity] • Assess the vulnerability of a water supply system to projected changes in drought frequency [Assessment] • Redesign a stormwater culvert for increased design rainfall intensity based on climate projections [Usage] • Describe adaptation strategies for managing urban water demand under water scarcity [Familiarity] • Compare hard and soft (nature-based) engineering options for coastal flood protection [Assessment] • Develop an adaptive management plan for a reservoir facing uncertain future inflow regimes [Usage] • Propose revisions to infrastructure design standards to incorporate climate resilience [Assessment] • Conduct a cost-benefit analysis for a portfolio of water infrastructure adaptation measures [Usage]
Readings : [**Glasson2019**]	

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE3H3. Water Supply and Sewerage (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3H3. Water Supply and Sewerage
2.2 Semester	:	9^{th} Semester.
2.3 Credits	:	4
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 Prerrequisites	:	CE3H2. General Hydrology. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Water Supply and Sewerage is an integrative course that brings together knowledge from hydrology, hydraulics, geotechnics, materials science, environmental chemistry, statistics, optimization, and project management for the design of urban water supply and sanitation systems. The student applies this multidisciplinary foundation to demand projection, the design of distribution and sewer networks, water and wastewater treatment, and the evaluation of sustainability and environmental impact of these systems.

5. GOALS

- Apply principles of hydrology, fluid mechanics, and geotechnics to the design of water supply and sewerage systems.
- Design potable water distribution networks and sewerage systems, including the selection of materials and associated hydraulic structures.
- Apply statistical, optimization, and graph theory tools to network sizing and layout.
- Evaluate the sustainability, environmental impact, and economic feasibility of water and sanitation projects.

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: Hydrologic Cycle and Water Balance (2 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Hydrologic cycle and water balance concepts • Precipitation measurement and analysis • Evaporation and evapotranspiration estimation • Infiltration theory and rainfall-runoff processes	• Explain the hydrologic cycle and quantify water balance components [Familiarity] • Analyze precipitation data and develop depth-area-duration relationships [Assessment] • Estimate evaporation and evapotranspiration using empirical methods [Usage] • Apply infiltration models to estimate runoff from rainfall events [Assessment]
Readings : [**ChowMaidmentMays1988**]	

Unit 2: Surface Hydrology and Watershed Modeling (2 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Hydrograph analysis and unit hydrograph method • Watershed modeling and hydrologic simulation • Streamflow measurement and gauging techniques	• Derive unit hydrographs and synthesize runoff hydrographs [Usage] • Develop watershed models using software tools for hydrologic simulation [Usage] • Conduct streamflow measurements and interpret flow duration curves [Assessment]
Readings : [**ChowMaidmentMays1988**]	

Unit 3: Flood Frequency Analysis and Climate Change (2 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Flood frequency analysis and design storms • Hydrologic routing methods for channels and reservoirs • Climate change impacts on hydrologic systems	• Perform flood frequency analysis using statistical methods [Assessment] • Route flood hydrographs through channels and reservoirs [Usage] • Evaluate climate change impacts on watershed hydrology and design implications [Assessment]
Readings : [**ChowMaidmentMays1988**]	

Unit 4: Environmental Chemistry and Microbiology for Engineers (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Aquatic chemistry principles: acidity, alkalinity, hardness, and buffer capacity • Chemical equilibria and kinetics relevant to environmental processes • Microbial metabolism, growth, and classification in environmental contexts • Biogeochemical cycles of carbon, nitrogen, phosphorus, and sulfur • Water quality indicators and standard analytical methods • Colloid and surface chemistry for contaminant fate and transport • Toxicology and risk assessment of environmental contaminants • Molecular biology tools for environmental engineering applications • Fate and transport modeling of pollutants in engineered and natural systems	• Calculate pH, buffer intensity, and chemical speciation in aquatic systems [Usage] • Explain the role of key microbial groups in wastewater treatment and biogeochemical cycling [Familiarity] • Apply mass balance and reaction kinetics to environmental systems [Assessment] • Describe the major steps and environmental significance of the nitrogen and phosphorus cycles [Familiarity] • Interpret water quality data from standard analytical reports [Usage] • Analyze the role of colloidal and interfacial processes in contaminant removal [Assessment] • Define key toxicological parameters and concepts used in environmental risk assessment [Familiarity] • Evaluate the application of molecular techniques for monitoring engineered biological systems [Assessment] • Model the fate and transport of a conservative pollutant in a simple environmental compartment [Usage]
Readings : [**Davis2010**]	

Unit 5: Population Dynamics (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Exponential and logistic growth models; carrying capacity and the Allee effect • Lotka-Volterra predator-prey and competition models; equilibria and stability analysis • Age-structured models: Leslie matrices and the Euler-Lotka equation • Reaction-diffusion models and traveling waves in spatial ecology (Fisher-KPP equation) • Evolutionary dynamics: replicator equations, game theory, and the Price equation	• Analyze the stability of equilibria in Lotka-Volterra systems using linearization and phase portraits [Familiarity] • Construct age-structured population models using Leslie matrices and compute long-term growth rates [Usage] • Apply reaction-diffusion theory to model the spatial spread of an invasive species using the Fisher-KPP equation [Assessment]
Readings : [**Metcalf2013**]	

Unit 6: Mathematical Statistics and Estimation Theory (4 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Point estimation: Method of Moments and Maximum Likelihood Estimation • Construction and interpretation of confidence intervals in engineering tests • Hypothesis testing for engineering quality control and process validation • Linear and nonlinear regression for engineering data fitting • Introduction to Design of Experiments (DoE) for engineering optimization	• Derive Maximum Likelihood Estimators for parameters of engineering failure models [Usage] • Verify the statistical significance of engineering test results using hypothesis testing [Assessment] • Construct confidence intervals for key process parameters from experimental data [Usage] • Apply linear regression to model and predict engineering performance from measured data [Assessment]
Readings : [**AngTang2007**]	

Unit 7: Interest Theory and Time Value of Money (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Compound interest: accumulation functions, effective and nominal rates, and force of interest • Annuities-immediate and annuities-due: present and accumulated values, perpetuities • Bond pricing: price-yield relationship, duration, convexity, and amortization schedules • Yield curves: spot rates, forward rates, and bootstrap methods for term structure • Portfolio immunization: Redington's conditions and cash-flow matching	• Compute the present value and accumulated value of annuities under various interest rate assumptions [Familiarity] • Price bonds using the price-yield relationship and calculate duration and convexity for interest rate sensitivity [Usage] • Construct a portfolio satisfying Redington's immunization conditions against parallel yield curve shifts [Assessment]
Readings : [**Blank2017**]	

Unit 8: Urban Water Systems (8 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Water demand estimation and distribution system design • Distribution network analysis and modeling • Water quality considerations in distribution systems • Stormwater runoff estimation using rational method • Storm sewer design and hydraulic analysis • Urban drainage best management practices • Advanced water distribution system modeling • Detention and retention facility design • Green infrastructure and low impact development • Combined sewer systems and overflow control	• Estimate water demands and design distribution system capacity [Assessment] • Analyze distribution networks for pressure and flow adequacy [Usage] • Address water quality issues including disinfection and corrosion [Familiarity] • Calculate stormwater runoff using the rational method [Assessment] • Design storm sewer systems following hydraulic grade line principles [Usage] • Implement stormwater best management practices for runoff control [Assessment] • Develop advanced water distribution models for system optimization [Usage] • Proportion detention and retention basins for peak flow reduction [Assessment] • Apply green infrastructure techniques for sustainable stormwater management [Usage] • Evaluate combined sewer overflow issues and design control measures [Assessment]
Readings : [**Metcalf2013**], [**White2016**]	

Unit 9: Design of Hydraulic Structures (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Dam types and selection criteria • Spillway hydraulics and design • Weir and gate flow equations • Energy dissipation and stilling basin design • Culvert hydraulics and design • Dam safety analysis and risk assessment • Outlet works and control structures • Fish passage facilities and environmental hydraulics • Cavitation analysis and prevention • Physical hydraulic modeling and scale effects	• Classify dam types and select appropriate configurations for site conditions [Familiarity] • Design spillways for flood discharge capacity [Assessment] • Calculate discharge over weirs and through gates [Usage] • Proportion energy dissipation structures and stilling basins [Assessment] • Analyze culvert hydraulics for inlet and outlet control [Usage] • Perform dam safety evaluations and hazard classification [Assessment] • Design outlet works including intake structures and conduits [Usage] • Incorporate fish passage requirements in hydraulic structure design [Assessment] • Evaluate cavitation potential and design preventive measures [Usage] • Interpret physical model results and apply scale corrections [Assessment]
Readings : [**Novak2007**]	

Unit 10: Site Investigation and In-Situ Testing (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Investigation planning and scope determination • Boring methods and subsurface exploration techniques • Sampling methods for disturbed and undisturbed samples • Standard Penetration Test and correlations • Laboratory testing program and test selection • Cone Penetration Test and piezocone testing • Vane shear test and pressuremeter testing • Geophysical methods including seismic and resistivity surveys • Groundwater monitoring and piezometer installation • Report preparation and geotechnical data presentation • In-situ permeability (Lugeon/packer) testing for foundation grouting and seepage assessment • Borrow area investigation for embankment fill material quantity and quality	• Develop appropriate site investigation programs based on project requirements [Assessment] • Select appropriate boring and exploration methods for different soil conditions [Familiarity] • Specify sampling techniques to obtain quality samples for testing [Usage] • Interpret SPT data and apply empirical correlations for design parameters [Assessment] • Design laboratory testing programs for geotechnical projects [Usage] • Analyze CPT and piezocone data for soil profiling and parameter evaluation [Assessment] • Apply vane shear and pressuremeter tests for soft clay characterization [Usage] • Utilize geophysical methods to complement traditional investigation techniques [Assessment] • Monitor groundwater conditions and interpret piezometric data [Usage] • Prepare comprehensive geotechnical investigation reports [Assessment] • Perform packer (Lugeon) testing and interpret results for foundation grouting curtain design [Usage] • Characterize borrow areas for embankment fill material quantity and quality [Assessment]
Readings : [**Das2019**]	

Unit 11: Pressurized Pipe Flow and Pump Systems (6 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Pipe flow fundamentals and Darcy-Weisbach equation • Minor losses and pipe system analysis • Pipe network analysis methods • Pump characteristics and system curves • Pump selection and installation requirements • Water hammer and surge analysis • Pipeline design and material selection • Variable speed pumps and energy efficiency • Network modeling and optimization • Valve selection and hydraulic control systems	• Calculate head losses in pipe systems using friction equations [Assessment] • Determine total head loss including minor losses in complex piping [Usage] • Analyze pipe networks using Hardy Cross or equivalent methods [Assessment] • Construct pump characteristic curves and system head curves [Usage] • Select appropriate pumps based on operating point and efficiency [Assessment] • Evaluate water hammer effects and design surge protection [Usage] • Design pipelines considering hydraulic, structural, and economic factors [Assessment] • Apply variable speed drives for pump system optimization [Usage] • Optimize water distribution networks using modeling software [Assessment] • Specify valves and control systems for pipeline operations [Usage]
Readings : [**White2016**], [**Sotelo2002**]	

Unit 12: Mechanics of Materials and Structural Behavior (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Stress and strain concepts including normal, shear, and principal stresses • Axial loading and deformation of members • Torsion of circular and non-circular sections • Bending stress and deflection in beams • Shear stress distribution in beams • Combined loading and stress transformation • Buckling of columns and stability analysis • Fatigue and fracture mechanics • Elastic and plastic behavior of materials • Energy methods for structural analysis	• Define stress, strain, and their relationships through constitutive laws [Familiarity] • Calculate stresses and deformations in members under axial loading [Usage] • Determine torsional stresses and angles of twist in shafts [Usage] • Analyze bending stress distribution and deflection in beams [Assessment] • Compute shear stress distribution in beam cross-sections [Usage] • Apply stress transformation equations for combined loading conditions [Assessment] • Evaluate column stability and calculate critical buckling loads [Assessment] • Explain fatigue failure mechanisms and predict fatigue life [Familiarity] • Distinguish between elastic and plastic material behavior under loading [Usage] • Use energy methods to solve deflection and indeterminate structural problems [Usage]
Readings : [**Hibbeler2017**]	

Unit 13: Standardized Testing, Quality Control, and Failure Analysis (4 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 14: Construction Materials Science (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Physical and mechanical properties of construction materials including density, porosity, strength, and elasticity • Microstructure and phase composition of construction materials • Durability mechanisms including weathering, chemical attack, and environmental degradation • Thermal and moisture properties of construction materials • Crystalline and amorphous structures in construction materials • Material selection criteria based on performance requirements • Degradation mechanisms and service life prediction	• Describe the fundamental physical and mechanical properties of major construction materials [Familiarity] • Analyze the relationship between microstructure and macroscopic properties of materials [Assessment] • Evaluate the durability performance of materials under specific environmental conditions [Usage] • Explain the effects of thermal and moisture variations on material behavior [Familiarity] • Select appropriate construction materials based on design specifications and performance criteria [Assessment] • Predict service life and degradation patterns of materials in various environments [Usage]
Readings : [**Neville2011**]	

Unit 15: Solid State and Material Chemistry (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Crystal systems, Bravais lattices, and Miller indices for engineering materials • X-ray diffraction for crystal structure determination and phase identification • Ionic compounds: crystal structures and lattice energies • Metallic and covalent network solids: bonding and engineering properties • Point defects, vacancies, interstitials, and non-stoichiometry in engineering solids • Band theory and the electronic properties of engineering conductors, semiconductors, and insulators • Synthesis methods for engineering inorganic materials: solid-state reactions, sol-gel, and CVD	• Identify crystal systems and describe symmetry operations in engineering solid materials [Familiarity] • Interpret X-ray diffraction patterns to identify crystal phases and determine unit cell parameters [Usage] • Calculate lattice energies using Born-Haber cycles for engineering ionic compounds [Usage] • Explain how point defects control diffusion, conductivity, and corrosion in engineering materials [Assessment] • Apply band theory to predict and engineer the electrical properties of solid materials [Assessment] • Select synthesis methods appropriate for producing specific engineering inorganic materials [Usage]
Readings : [**Callister2020**]	

Unit 16: Optimization Algorithms (4 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Gradient descent and line search methods: Armijo-Wolfe conditions and convergence rates • Newton's method and quasi-Newton methods (BFGS, L-BFGS) • Constrained optimization: KKT conditions, penalty methods, and sequential quadratic programming • Convex optimization algorithms: interior-point methods and the alternating direction method of multipliers (ADMM) • Stochastic gradient descent (SGD), variance reduction, and Adam optimizer	• Explain the convergence guarantees of gradient descent for smooth convex functions [Familiarity] • Apply Newton and quasi-Newton methods to unconstrained optimization problems [Usage] • Formulate a constrained optimization problem as a KKT system and apply an interior-point method [Assessment]
Readings : [**NocedalWright2006**]	

Unit 17: Graph Theory (4 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Graphs: definitions, isomorphism, degree sequences, trees, and spanning trees • Connectivity, Menger's theorem, and network flows (max-flow min-cut) • Matchings (Hall's theorem), graph colorings, and the chromatic polynomial • Planar graphs, Euler's formula, Kuratowski's theorem, and the four-color theorem • Adjacency and Laplacian matrices, eigenvalues, and expander graphs	• Identify structural properties of graphs (connectivity, planarity, bipartiteness) and apply Euler's formula [Familiarity] • Apply Hall's marriage theorem and network flow algorithms to matching and routing problems [Usage] • Analyze a graph's spectrum to bound its chromatic number and connectivity properties [Assessment]
Readings : [**West2001**]	

Unit 18: Climate Adaptation Engineering for Water Systems (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Climate science fundamentals and downscaling of global climate model projections • Hydrologic impacts of climate change: precipitation intensity, drought, and snowmelt • Vulnerability and risk assessment frameworks for water infrastructure • Water supply system adaptation: source diversification and demand management • Stormwater system adaptation for increased intensity rainfall • Coastal adaptation strategies: managed retreat, protective structures, and nature-based solutions • Decision-making under uncertainty and adaptive management pathways • Infrastructure design standards and codes under non-stationary climate conditions • Economic appraisal of adaptation options and financing mechanisms	• Interpret downscaled climate projections for key hydrologic variables [Familiarity] • Assess the vulnerability of a water supply system to projected changes in drought frequency [Assessment] • Redesign a stormwater culvert for increased design rainfall intensity based on climate projections [Usage] • Describe adaptation strategies for managing urban water demand under water scarcity [Familiarity] • Compare hard and soft (nature-based) engineering options for coastal flood protection [Assessment] • Develop an adaptive management plan for a reservoir facing uncertain future inflow regimes [Usage] • Propose revisions to infrastructure design standards to incorporate climate resilience [Assessment] • Conduct a cost-benefit analysis for a portfolio of water infrastructure adaptation measures [Usage]
Readings : [**Davis2010**]	

Unit 19: Open Channel Flow and River Mechanics (8 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Channel flow classification and hydraulic elements • Energy and momentum principles in open channels • Uniform flow and Manning's equation • Critical flow and specific energy concepts • Gradually varied flow profiles • Hydraulic jump and rapidly varied flow • Channel design for stable conveyance • Sediment transport in open channels • River morphology and channel stability • Scour analysis and protection measures	• Classify open channel flow regimes and calculate hydraulic elements [Familiarity] • Apply energy and momentum equations to solve channel flow problems [Assessment] • Calculate normal depth and discharge using Manning's equation [Usage] • Determine critical depth and analyze specific energy relationships [Assessment] • Compute gradually varied flow profiles using standard methods [Usage] • Analyze hydraulic jumps and calculate energy dissipation [Assessment] • Design stable channels with appropriate cross-sections and linings [Usage] • Estimate sediment transport rates in alluvial channels [Assessment] • Evaluate river channel stability and bank erosion potential [Familiarity] • Predict scour depths at hydraulic structures and design protection [Assessment]
Readings : [**Chow1959**]	

Unit 20: Environmental Impact Assessment and Sustainability Metrics (4 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 21: 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 : [**Kibert2016**]	

Unit 22: Water and Wastewater Treatment Process Design (8 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Water quality parameters and regulatory standards for drinking water and wastewater effluent • Physical treatment processes: screening, sedimentation, flotation, and filtration • Chemical treatment processes: coagulation, flocculation, disinfection, and pH adjustment • Biological treatment principles: suspended growth (activated sludge) and attached growth (trickling filters) systems • Process selection and design criteria based on source water or wastewater characteristics • Advanced treatment processes: membrane filtration, advanced oxidation, and nutrient removal (N&P) • Sludge and biosolids handling, treatment, and disposal methods • Plant layout, hydraulic profile, and pumping system design • Industrial wastewater pretreatment and specific contaminant removal strategies • Process control, monitoring, and troubleshooting in treatment plants	• Identify key water quality parameters and their significance for human health and the environment [Familiarity] • Select appropriate physical and chemical unit processes for a given water or wastewater treatment objective [Assessment] • Design fundamental components of water treatment plants, such as rapid mix basins, flocculators, and sedimentation tanks [Usage] • Explain the biological mechanisms and operational parameters of activated sludge systems [Familiarity] • Size primary and secondary treatment units based on flow rates and pollutant loading [Assessment] • Design advanced treatment trains for water reuse or stringent nutrient discharge limits [Usage] • Evaluate sludge management alternatives and select appropriate thickening/dewatering methods [Assessment] • Develop hydraulic profiles and pump specifications for treatment plant layouts [Usage] • Propose pretreatment strategies for specific industrial wastewater streams [Assessment] • Implement basic process control strategies to optimize treatment plant performance [Usage]
Readings : [**Metcalf2013**]	

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

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

1. COURSE

CE3S1. Structural Analysis II (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3S1. Structural Analysis II
2.2 Semester	:	9^{th} Semester.
2.3 Credits	:	4
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 Prerrequisites	:	CE2S1. Structural Analysis I. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Structural Analysis II extends the matrix methods introduced in Structural Analysis I to the practical, computer-based analysis of building structural systems. Students deepen their command of the direct stiffness method through its application to plane trusses and frames, incorporate seismic loading through dynamic and response-spectrum analysis, and apply these tools in team seminars to the analysis of real building case studies. The course concludes with an introduction to the finite element method and to material and geometric nonlinear analysis, providing the computational foundation required for advanced structural design and specialized graduate study.

5. GOALS

- Apply the direct stiffness method to formulate and solve the analysis of plane trusses and frames using matrix-based computer methods.
- Apply dynamic and response-spectrum analysis to determine the seismic response of building structural systems.
- Analyze real building structural systems in team-based seminars, integrating stiffness-method and seismic-analysis techniques into practical models.
- Formulate finite element models of structural systems, including an introduction to material and geometric nonlinear analysis.

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: Matrix Structural Analysis (38 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Displacement method and stiffness approach • Direct stiffness method and matrix formulation • Coordinate transformations and assembly of global stiffness matrices	• Implement the displacement method for structural analysis [Assessment] • Formulate structural problems using the direct stiffness method in matrix form [Usage] • Assemble global stiffness matrices and solve for nodal displacements [Assessment]
Readings : [**McGuire2000**], [**KassimaliMatrix2012**]	

Unit 2: Structural Dynamics and Earthquake Engineering (14 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Single-degree-of-freedom systems and free vibration • Forced vibration and harmonic excitation • Damping models and energy dissipation mechanisms • Response spectrum analysis • Earthquake ground motion characteristics and seismicity • Multi-degree-of-freedom systems and modal analysis • Time-history analysis and numerical integration methods • Seismic design philosophy and capacity design principles • Base isolation and energy dissipation devices • Performance-based seismic design methodology	• Analyze free vibration of single-degree-of-freedom systems and determine natural frequencies [Assessment] • Calculate structural response to harmonic and periodic loads [Usage] • Explain the role of damping in reducing dynamic response [Familiarity] • Apply response spectrum method for seismic analysis [Usage] • Interpret earthquake ground motion parameters and seismic hazard maps [Familiarity] • Perform modal analysis for multi-degree-of-freedom systems [Assessment] • Conduct time-history analysis using numerical integration techniques [Usage] • Design structures following capacity design and ductile detailing principles [Assessment] • Evaluate the effectiveness of base isolation and damping systems [Familiarity] • Implement performance-based seismic design procedures [Assessment]
Readings : [**Chopra2017**]	

Unit 3: Building Structural Analysis and Modeling Practicum (12 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Overview of case-study buildings: geometry, structural systems, and load paths • Development of plane frame and truss models of real buildings using stiffness-method-based structural analysis software • Application of static and seismic response-spectrum analysis to representative building case studies • Presentation and peer discussion of structural analysis results and their design implications • Definition of geometry, materials, sections, and boundary conditions for a three-dimensional building model in commercial structural analysis software (ETABS, Midas Gen) • Assignment of gravity, seismic, and wind loads and their combinations to a three-dimensional building model • Static and dynamic (modal) analysis of building models and interpretation of results, including story drifts, member forces, and vibration periods • Verification of software-generated results against simplified hand calculations and code checks	• Model real building structural systems for stiffness-method-based static and seismic analysis using structural analysis software [Usage] • Interpret and validate computer-generated analysis results against expected structural behavior [Assessment] • Present and defend structural analysis results and their design implications to peers [Usage] • Assign gravity, seismic, and wind loads and load combinations to a three-dimensional building model in commercial structural analysis software [Usage] • Interpret dynamic analysis results, including story drifts, member forces, and vibration periods [Assessment] • Verify software-generated results against simplified hand calculations [Assessment]
Readings : [**McGuire2000**], [**Chopra2017**]	

Unit 4: Finite Element Methods in Structural Engineering (20 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Fundamentals of finite element theory and discretization • Element types including truss, beam, and frame elements • Stiffness matrix formulation and assembly • Plane stress and plane strain elements • Modeling techniques, boundary conditions, and mesh refinement • Shell and plate elements • Solid elements and three-dimensional analysis • Nonlinear analysis including material and geometric nonlinearity • Dynamic analysis using finite element methods • Verification, validation, and error estimation in FEA	• Explain the fundamental principles and assumptions of finite element analysis [Familiarity] • Formulate element stiffness matrices for basic element types [Usage] • Assemble global stiffness matrices and apply boundary conditions [Assessment] • Apply plane stress and plane strain elements to two-dimensional problems [Usage] • Develop appropriate finite element models with proper mesh density [Assessment] • Utilize shell and plate elements for thin-walled structure analysis [Usage] • Model complex three-dimensional structures using solid elements [Assessment] • Perform nonlinear finite element analysis for material and geometric effects [Usage] • Conduct dynamic finite element analysis including modal and time-history analysis [Assessment] • Validate finite element results and estimate discretization errors [Assessment]
Readings : [**Bathe2014**]	

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

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

1. COURSE

CE3S11. Professional Competency Workshop - Structures (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3S11. Professional Competency Workshop - Structures
2.2 Semester	:	9^{th} Semester.
2.3 Credits	:	3
2.4 Hours	:	1 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 Prerrequisites	:	CE3S4. Earthquake-Resistant Engineering and Disaster Prevention. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Professional Competency Workshop - Structures is an integrative review course that consolidates and applies the structural engineering competencies developed throughout the Structures specialization track. It revisits mechanics of materials and structural behavior, standardized testing and quality control, structural dynamics and seismic-resistant engineering, reinforced concrete and prestressed concrete design, structural health monitoring technologies, resilient design for natural hazards and climate change, and engineering ethics and professional responsibility, preparing students to face the professional practice of structural engineering as a whole.

5. GOALS

- Review and apply mechanics of materials and structural behavior principles to real structural elements.
- Apply standardized testing, quality control, and failure analysis methods to structural materials and systems.
- Analyze the seismic response of structures and apply seismic-resistant design criteria.
- Design reinforced concrete and prestressed concrete structural elements.
- Apply structural health monitoring (SHM) and sensor technologies to assess the condition of civil infrastructure.
- Formulate resilient design solutions for natural hazards and climate change.
- Apply engineering ethics and professional responsibility principles to structural engineering practice.

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: Mechanics of Materials and Structural Behavior (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Stress and strain concepts including normal, shear, and principal stresses • Axial loading and deformation of members • Torsion of circular and non-circular sections • Bending stress and deflection in beams • Shear stress distribution in beams • Combined loading and stress transformation • Buckling of columns and stability analysis • Fatigue and fracture mechanics • Elastic and plastic behavior of materials • Energy methods for structural analysis	• Define stress, strain, and their relationships through constitutive laws [Familiarity] • Calculate stresses and deformations in members under axial loading [Usage] • Determine torsional stresses and angles of twist in shafts [Usage] • Analyze bending stress distribution and deflection in beams [Assessment] • Compute shear stress distribution in beam cross-sections [Usage] • Apply stress transformation equations for combined loading conditions [Assessment] • Evaluate column stability and calculate critical buckling loads [Assessment] • Explain fatigue failure mechanisms and predict fatigue life [Familiarity] • Distinguish between elastic and plastic material behavior under loading [Usage] • Use energy methods to solve deflection and indeterminate structural problems [Usage]
Readings : [**Gere2017**], [**Hibbeler2017Mat**]	

Unit 2: 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 3: Structural Dynamics and Earthquake Engineering (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Single-degree-of-freedom systems and free vibration • Forced vibration and harmonic excitation • Damping models and energy dissipation mechanisms • Response spectrum analysis • Earthquake ground motion characteristics and seismicity • Multi-degree-of-freedom systems and modal analysis • Time-history analysis and numerical integration methods • Seismic design philosophy and capacity design principles • Base isolation and energy dissipation devices • Performance-based seismic design methodology	• Analyze free vibration of single-degree-of-freedom systems and determine natural frequencies [Assessment] • Calculate structural response to harmonic and periodic loads [Usage] • Explain the role of damping in reducing dynamic response [Familiarity] • Apply response spectrum method for seismic analysis [Usage] • Interpret earthquake ground motion parameters and seismic hazard maps [Familiarity] • Perform modal analysis for multi-degree-of-freedom systems [Assessment] • Conduct time-history analysis using numerical integration techniques [Usage] • Design structures following capacity design and ductile detailing principles [Assessment] • Evaluate the effectiveness of base isolation and damping systems [Familiarity] • Implement performance-based seismic design procedures [Assessment]
Readings : [**Chopra2017**]	

Unit 4: Seismic Design Code and Structural Configuration Criteria (10 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Scope and structure of the Peruvian seismic design code E.030 • Seismic hazard parameters: seismic zonation (Z), usage factor (U), and soil profile (S) • Structural systems and seismic force reduction coefficient (R) • Plan structural irregularities: torsional irregularity, re-entrant corners, and diaphragm discontinuity • Vertical structural irregularities: soft story, weak story, and mass irregularity • Structuring principles: symmetry, redundancy, hyperstaticity, and continuity • Minimum base shear and inter-story drift limits	• Explain the scope and structure of the Peruvian seismic design code E.030 [Familiarity] • Determine the seismic hazard parameters (Z, U, S) applicable to a given site [Usage] • Select the structural system and corresponding reduction coefficient R [Usage] • Classify the plan and vertical structural irregularities of a building [Assessment] • Apply structuring principles to propose a regular structural configuration [Usage] • Verify the minimum base shear and inter-story drift limits [Assessment]
Readings : [**E030-2018**], [**BazanMeli2002**]	

Unit 5: Reinforced Concrete Design (10 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Design philosophy and limit state methodology for concrete structures • Flexural design of rectangular and T-beams • Shear and torsion design of concrete members • Compression members and column design • Slab design including one-way and two-way systems • Development length and splicing of reinforcement • Deflection control and serviceability requirements for concrete beams and slabs	• Explain limit state design philosophy and load factor combinations [Familiarity] • Design reinforced concrete beams for flexure and check serviceability [Assessment] • Calculate shear and torsional reinforcement requirements [Usage] • Proportion columns for axial load and biaxial bending [Assessment] • Design one-way and two-way slab systems with appropriate reinforcement [Usage] • Determine development lengths and design lap splices for reinforcing bars [Assessment] • Control deflections and verify serviceability requirements through adequate member sizing and reinforcement [Usage]
Readings : [**Wight2016**], [**ACI31819**], [**McCormac2021**]	

Unit 6: Seismic Detailing of Reinforced Concrete (3 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Beam-column joints and moment-resisting frame connections • Seismic detailing and ductile design of concrete structures • Design of special reinforced concrete structural walls (shear walls) for seismic lateral force resistance • Special seismic detailing provisions for reinforced concrete moment-resisting frames	• Detail beam-column joints for moment transfer and shear resistance [Assessment] • Implement seismic detailing requirements for ductile concrete frames [Assessment] • Design special reinforced concrete structural walls for combined axial, flexural, and shear demands under seismic loading [Assessment] • Apply special seismic detailing provisions to reinforced concrete moment frame members and beam-column joints [Usage]
Readings : [**Wight2016**], [**ACI31819**], [**Moehle2015**]	

Unit 7: Prestressed Concrete Analysis (3 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Prestressed concrete principles and pre-tensioning methods • Elastic analysis of stresses in prestressed concrete sections under service loads • Composite prestressed concrete sections: precast members with cast-in-place topping • Immediate and time-dependent losses of prestress	• Apply prestressing principles to design pre-tensioned members [Usage] • Analyze stresses in prestressed concrete sections under service loads using elastic theory [Usage] • Design composite prestressed concrete sections combining precast members and cast-in-place concrete [Assessment] • Calculate immediate and time-dependent losses of prestress [Usage]
Readings : [**Wight2016**], [**ACI31819**], [**Moehle2015**]	

Unit 8: Prestressed Concrete Design (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Post-tensioned concrete systems and tendon design • Deflection control and serviceability requirements • Flexural strength of prestressed concrete members at ultimate limit state • Shear and torsion design of prestressed concrete members • Statically indeterminate prestressed concrete structures, including secondary moments	• Design post-tensioned slabs and beams including tendon layout [Assessment] • Control deflections through appropriate member sizing and reinforcement [Usage] • Design prestressed concrete members for flexural strength at the ultimate limit state [Assessment] • Design prestressed concrete members for shear and torsion strength [Assessment] • Analyze statically indeterminate prestressed concrete structures, including secondary moments [Assessment]
Readings : [**Wight2016**], [**ACI31819**], [**Moehle2015**]	

Unit 9: Structural Health Monitoring (SHM) and Sensor Technologies (2 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• SHM objectives, paradigms, and lifecycle cost-benefit analysis • Sensor types: strain gauges, accelerometers, tiltmeters, fiber optics, piezoelectrics • Data acquisition systems, signal conditioning, and sampling theory • Wireless sensor networks (WSN) and IoT communication protocols • Vibration-based damage detection and modal analysis • Advanced sensing: distributed fiber optics, computer vision, and radar interferometry • Data management, cloud storage, and cybersecurity for SHM systems • Statistical pattern recognition and anomaly detection algorithms • Decision-support systems for maintenance planning based on SHM data	• List the primary objectives and potential benefits of a Structural Health Monitoring (SHM) system [Familiarity] • Select appropriate sensor types for monitoring specific structural responses (strain, vibration, deflection) [Assessment] • Design the layout of a basic sensor network for a simply supported beam or a bridge pier [Usage] • Explain the advantages and challenges of wireless sensor networks over wired systems [Familiarity] • Perform a basic modal analysis on a set of acceleration data to identify natural frequencies [Usage] • Compare advanced sensing technologies for detecting crack propagation or settlement [Assessment] • Develop a data management plan for a long-term SHM project, considering cloud storage [Usage] • Apply a simple statistical control chart to identify anomalies in time-series sensor data [Assessment] • Propose a maintenance action based on the output of a SHM-based decision-support system [Usage]
Readings : [**Farrar2013**]	

Unit 10: Resilient Design for Natural Hazards and Climate Change (8 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Resilience concepts: robustness, redundancy, resourcefulness, rapid recovery • Hazard identification and probabilistic risk assessment • Multi-hazard design approaches and trade-offs • Climate change projections and their translation into design parameters • Structural resilience: performance-based design and damage-control technologies • System-of-systems resilience for interconnected infrastructure networks • Adaptive capacity and flexible design for uncertain futures • Community resilience and social dimensions of infrastructure recovery • Financing resilience: benefit-cost analysis and innovative funding mechanisms	• Describe the four key properties (4Rs) of a resilient system [Familiarity] • Perform a qualitative risk assessment for a site exposed to multiple natural hazards [Assessment] • Incorporate projected sea-level rise or increased precipitation into the design basis for a coastal or drainage structure [Usage] • Explain how base isolation or damping devices enhance structural resilience [Familiarity] • Analyze the cascading failures in interconnected water and power networks after an earthquake [Assessment] • Design a flexible foundation system that can be adapted for future increased loads [Usage] • Evaluate the role of social capital and community preparedness in post-disaster recovery [Assessment] • Conduct a benefit-cost analysis for a proposed infrastructure resilience upgrade [Usage]
Readings : [**ASCE2018**]	

Unit 11: Engineering Ethics and Professional Responsibility (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Ethical theories: utilitarianism, duty ethics, virtue ethics • Professional codes of conduct (e.g., ASCE, NSPE) and their fundamental canons • Engineer's paramount responsibility to public safety, health, and welfare • Ethical dilemmas in practice: conflicts of interest, whistleblowing, gift-giving • Ethical decision-making frameworks and case study analysis • Global engineering ethics and cross-cultural challenges • Ethical obligations for sustainable development and environmental stewardship • Ethical implications of emerging technologies (AI, automation, data privacy) • Ethical conduct in dispute resolution and litigation	• Explain the primary tenets of the engineer's code of ethics [Familiarity] • Apply an ethical decision-making framework to a hypothetical engineering scenario [Assessment] • Identify conflicts of interest and other common ethical pitfalls in project work [Familiarity] • Analyze a historical engineering failure case from an ethical perspective [Assessment] • Evaluate the ethical dimensions of a project with significant social or environmental impacts in a different cultural context [Assessment] • Articulate the ethical argument for incorporating sustainability into all engineering work [Familiarity] • Discuss the ethical responsibilities related to data collection and use in smart infrastructure projects [Assessment] • Describe the role of ethics in alternative dispute resolution processes [Familiarity]
Readings : [**Harris2019**]	

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

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

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 Prerrequisites	:	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 • Embodied perception of space: scale as bodily experienced rather than drawn, movement and kinesthetic sequence through space, and the visual, acoustic, and tactile engagement that shapes how a space is actually inhabited and felt • Materiality as an experiential design medium: texture, weight, surface finish, and color, and the atmosphere and character that material choice and craft give to a space, as distinct from a material's structural or technical properties • 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, perceptual, material, and compositional concepts that constitute the foundations of architectural design [Familiarity] • Apply foundational design principles - space, perception, materiality, 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, perceptual experience, material expression, and use of light and program, identifying strengths and areas for improvement [Assessment]
Readings : [**Ching2014**]	

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 • Architectural site analysis: solar orientation and sun path, prevailing wind and microclimate, topography and drainage, views and visual axes, vehicular and pedestrian access, surrounding urban fabric and context, and existing site constraints (easements, setbacks, utilities) as inputs to a design concept • Design-criteria formulation: translating client and user requirements, site-analysis findings, and regulatory constraints into a prioritized, measurable set of functional, spatial, environmental, and budgetary criteria used to generate and evaluate design alternatives • Ideation and concept development: sketching, diagramming, and collage as tools to explore spatial ideas; arriving at the parti (partido arquitectónico) – the single organizing idea that drives a design – and translating it 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 and site analysis through design-criteria formulation, concept development (parti), revision, and final proposal [Familiarity] • Apply site analysis, design-criteria formulation, and 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 : [**Ching2014**]	

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 (burgage 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 : [**Lynch1960**]	

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 : [**Lynch1960**]	

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 : [**Lynch1960**]	

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 : [**Hibbeler2018Struct**], [**Kassimali2020**]	

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 openBIM • 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 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 onsite 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 : [**Kibert2016**]	

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 : [**Beer2018**]	

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 : [**Beer2018**]	

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 : [**Beer2018**]	

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 : [**NCEES2019**], [**Uff2017**]	

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 : [**FIDIC2017**], [**Hofstede2010**]	

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

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

1. COURSE

CE3T4. Traffic Engineering and Urban Road Design (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3T4. Traffic Engineering and Urban Road Design
2.2 Semester	:	9^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE2T4. Transportation Engineering. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Traffic Engineering and Urban Road Design is the traffic-operations course of the Vialidad, Geomática y Transporte (DAVG) track, building on the transportation-systems foundation established in Transportation Engineering (CE2T4) to address how vehicular flow is measured, modeled, controlled, and made safe on urban streets and highways. The course opens with the planning context in which traffic facilities are sized and sequenced, and the geometric design practices used to translate planning decisions into context-sensitive urban roadway cross-sections. It then develops the analytical core of traffic engineering: traffic flow theory, highway capacity and level-of-service analysis, and the design of control strategies for both unsignalized and signalized intersections using national and MUTCD-equivalent standards. The course continues with macro/microsimulation modeling and arterial/freeway operations, intelligent transportation systems and connected-vehicle technologies, the estimation of a proposed development's traffic impact and the mitigation measures it requires, and closes with road safety engineering: crash data analysis, safety audits, and the Vision Zero safe-systems approach.

5. GOALS

- Explain the transportation planning process and apply travel demand and economic analysis methods that establish the context for traffic engineering decisions.
- Apply context-sensitive, multimodal geometric design principles to urban streets and complete-street cross-sections.
- Analyze traffic flow characteristics, highway capacity, and level of service for a range of transportation facilities.
- Design traffic control strategies – including signal warrant analysis, phasing, signage, and pavement markings – for unsignalized and signalized intersections.
- Utilize macro/microsimulation models and apply ITS/connected-vehicle technologies to evaluate and improve traffic operations.
- Estimate the traffic impact of proposed developments and design the mitigation measures required to maintain acceptable operating conditions.
- Analyze crash data and conduct road safety audits to recommend countermeasures under a Vision Zero safe-systems approach.

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: Transportation Planning and Economics (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Transportation planning process and institutional framework • Travel demand modeling and forecasting methods • Four-step travel demand model • Data collection methods for transportation planning • Economic evaluation and benefit-cost analysis • Activity-based modeling and advanced forecasting techniques • Multimodal transportation planning and integration • Sustainable transportation and environmental considerations • Public participation and stakeholder engagement • Performance measures and system monitoring	• Explain the transportation planning process and institutional relationships [Familiarity] • Apply travel demand forecasting methods to predict future travel patterns [Assessment] • Implement the four-step travel demand model for regional analysis [Usage] • Design data collection programs for transportation studies [Assessment] • Conduct benefit-cost analysis for transportation projects [Usage] • Utilize activity-based models for advanced travel demand analysis [Assessment] • Develop integrated multimodal transportation plans [Usage] • Incorporate sustainability principles into transportation planning [Assessment] • Facilitate public participation processes in transportation planning [Familiarity] • Establish performance measures and monitoring systems for transportation networks [Assessment]
Readings : [**Ortuzar2011**]	

Unit 2: Context-Sensitive and Multimodal Design (8 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Context-sensitive design process and stakeholder-based criteria flexibility • Complete streets principles and multimodal accommodation • Traffic calming elements for urban and residential streets • Three-dimensional coordination of horizontal and vertical alignment • Aesthetic and environmental considerations in geometric design • Access management and driveway spacing criteria	• Explain the context-sensitive design process and when design flexibility is appropriate [Familiarity] • Apply complete streets principles to accommodate multiple travel modes [Usage] • Select traffic calming elements appropriate to an urban or residential context [Assessment] • Coordinate horizontal and vertical alignment for a three-dimensionally consistent design [Assessment] • Consider aesthetic and environmental factors in geometric design decisions [Familiarity] • Apply access management criteria to driveway and intersection spacing [Usage]
Readings : [**AASHTO2018**], [**NACTO2013**]	

Unit 3: Traffic Flow Theory and Capacity Analysis (16 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Traffic flow characteristics and fundamental relationships • Highway capacity analysis using HCM methodology • Level of service concepts and analysis procedures • Traffic control devices and MUTCD standards • Signal timing and phasing design • Intersection capacity and delay analysis	• Explain traffic flow theory and fundamental traffic stream parameters [Familiarity] • Perform highway capacity analysis for various facility types [Assessment] • Determine level of service for transportation facilities [Usage] • Apply MUTCD standards for traffic control device design and placement [Assessment] • Design signal timing plans for isolated intersections [Usage] • Analyze intersection capacity and calculate control delay [Assessment]
Readings : [**Roess2019**], [**HCM2022**]	

Unit 4: Traffic Control Devices (14 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Classification and design of regulatory, warning, and guide signs • Sign placement, sizing, and retroreflectivity standards • Pavement marking types, materials, and placement standards • Traffic signal warrant analysis and justification studies • Signal phasing, sequencing, and vehicle/pedestrian detection design • Signal equipment, controllers, and maintenance considerations	• Classify traffic signs according to national/MUTCD-equivalent standards and select the appropriate sign for a given condition [Familiarity] • Specify sign placement, size, and retroreflectivity per design standards [Usage] • Design a pavement marking plan for a given roadway section [Assessment] • Conduct a signal warrant analysis to justify installing a traffic signal [Assessment] • Design signal phasing and detection layouts for an intersection [Usage] • Evaluate signal equipment and controller requirements for an installation [Familiarity]
Readings : [**MUTCD2023**], [**Roess2019**]	

Unit 5: Traffic Operations and Management (8 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Arterial analysis and signal coordination • Freeway operations and bottleneck analysis • Traffic simulation and microsimulation modeling • Incident management and traffic management centers • Roundabout design and capacity analysis	• Develop coordinated signal systems for arterial corridors [Usage] • Evaluate freeway performance and identify operational bottlenecks [Assessment] • Utilize traffic simulation models for complex operational analysis [Usage] • Implement incident management strategies and traffic management operations [Assessment] • Design roundabouts and analyze their operational performance [Usage]
Readings : [**Roess2019**], [**Barcelo2010**]	

Unit 6: Intelligent Transportation Systems and Connected Vehicles (4 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• ITS architecture and system components • Traffic detection and surveillance technologies • Advanced traffic management systems • Traveler information systems and real-time data • Connected vehicle technologies and V2X communication • Autonomous vehicle systems and infrastructure requirements • Adaptive signal control and traffic-responsive systems • Electronic toll collection and congestion pricing • Transit signal priority and bus rapid transit systems • Data analytics and artificial intelligence in transportation	• Explain ITS architecture and identify system components [Familiarity] • Select appropriate traffic detection technologies for specific applications [Assessment] • Design advanced traffic management system deployments [Usage] • Implement traveler information systems and dissemination strategies [Assessment] • Describe connected vehicle technologies and communication protocols [Familiarity] • Evaluate infrastructure requirements for autonomous vehicle deployment [Assessment] • Apply adaptive signal control algorithms for traffic optimization [Usage] • Analyze electronic toll collection systems and pricing strategies [Assessment] • Integrate transit signal priority in multimodal networks [Usage] • Utilize data analytics and AI for transportation system optimization [Assessment]
Readings : [**Sussman2005**]	

Unit 7: Traffic Impact Studies (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Trip generation and distribution estimation for proposed land developments • Site access and driveway operational impact analysis • Mitigation measure design and improvement requirements	• Estimate trip generation and distribution for a proposed development using standard trip generation rates [Usage] • Analyze the operational impact of a proposed site's access and driveways on the adjacent street network [Assessment] • Design mitigation measures required to maintain acceptable levels of service around a proposed development [Assessment]
Readings : [**ITE2021**], [**ITE2020**]	

Unit 8: Road Safety Engineering (4 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Crash data analysis and identification of high-risk locations • Road safety audits and systematic safety reviews • Vision Zero and the safe systems approach to street design • Pedestrian and bicycle safety countermeasures	• Analyze crash data to identify high-risk locations and contributing factors [Assessment] • Conduct a road safety audit for a roadway or intersection [Usage] • Explain the Vision Zero safe systems approach to street design [Familiarity] • Recommend pedestrian and bicycle safety countermeasures for a given location [Usage]
Readings : [**HSM2010**]	

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

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

1. COURSE

CE402. Capstone project I (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE402. Capstone project I
2.2 Semester	:	9^{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 Prerrequisites	:	BMI201. Methodology of Engineering Research. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Este curso tiene por objetivo que el alumno pueda realizar un estudio del estado del arte de un tema escogido para investigar dentro del ámbito de la ingeniería civil. Se busca que el estudiante consolide su base teórica y demuestre capacidad crítica para evaluar soluciones técnicas existentes.

5. GOALS

- Que el alumno realice una investigación inicial en un tema específico realizando el estudio del estado del arte del tema elegido.
- Que el alumno muestre dominio en el tema de la línea de investigación elegida (p.e. comportamiento inelástico de materiales, modelación hidrológica, etc.).
- Que el alumno elija un docente que domine el área de investigación elegida como asesor.
- Los entregables de este curso son:

  Avance parcial: Bibliografía sólida y avance de un Reporte Técnico.

  Final: Reporte Técnico con experimentos o simulaciones preliminares comparativas que demuestren que el alumno ya conoce las técnicas existentes en el área de su proyecto.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Assessment)

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. (Assessment)

ABET-3) An ability to communicate effectively with a range of audiences. (Assessment)

ABET-4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. (Assessment)

ABET-5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. (Assessment)

7. TOPICS

Unit 1: Levantamiento del estado del arte (60 hours)	
Competences Expected: ABET-1,ABET-2,ABET-3,ABET-4,ABET-5	
Topics	**Learning Outcomes**
• Realizar un estudio profundo del estado del arte en un determinado tópico del área de Ingeniería Civil. • Redacción de reportes técnicos y artículos científicos.	• Hacer un levantamiento bibliográfico del estado del arte del tema escogido (capítulos de marco teórico y revisión crítica) [Usar]. • Redactar un documento en LaTeX en formato artículo (*paper*) con alta calidad técnica (tablas, figuras, ecuaciones, citaciones) [Usar]. • Realizar presentaciones de avance utilizando herramientas profesionales como Beamer o similares [Usar]. • Mostrar resultados de experimentos básicos o simulaciones computacionales preliminares [Usar]. • Elegir un asesor que domine el área de investigación realizada [Usar].
Readings : [**ASCE_StateOfTheArt**]	

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

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

BLW201. Law and Legislation (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	BLW201. Law and Legislation
2.2 Semester	:	9^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	1 HT; 1 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Mandatory
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Engineers routinely operate within a dense web of legal obligations: they sign and administer contracts, employ and supervise construction personnel, own or encumber the land and equipment their projects require, pay taxes on their professional and business activity, and compete for and execute public infrastructure works regulated by the state procurement system. This course gives future engineers the legal literacy needed to recognize, anticipate, and responsibly manage these obligations. Starting from the foundations of legal theory and the civil law of persons, the course proceeds through obligations and contracts, property and real securities, labor legislation, tax law, and closes with the rules governing public contracting before Peru's public procurement regulator (OSCE), preparing students to interact competently with legal counsel and public authorities throughout their professional careers.

5. GOALS

- Identify the sources and structure of legal norms and apply them to resolve conflicts between competing rules.
- Explain the legal capacity and attributes of natural and legal persons relevant to professional and business activity.
- Apply the rules governing the formation, validity, and content of contracts and obligations to engineering practice.
- Apply the civil law framework of ownership, possession, and real securities to real estate and infrastructure projects.
- Recognize the employer's labor obligations throughout the life of the employment relationship.
- Determine the tax obligations applicable to an engineering firm or construction project.
- Apply the legal framework governing public contracting and the procedures administered by OSCE to compete for and execute public works.

6. COMPETENCES

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. (Familiarity)

ABET-4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. (Familiarity)

7. TOPICS

Unit 1: Sources of Law (2 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Formal sources: constitution, legislation, delegated legislation, international treaties, custom, and general principles of law • Kelsenian hierarchy of norms; constitutional supremacy; conflicts between norms; derogation and abrogation • Role of case law and judicial precedent in civil law systems vs. stare decisis in common law; doctrine as a persuasive source • Soft law instruments: codes of conduct, guidelines, recommendations, and their legal significance	• Identify the formal sources of law applicable in a given legal system and explain their hierarchical relationship [Familiarity] • Apply the hierarchy of norms to resolve conflicts between competing legal rules of different rank [Usage] • Compare the role of judicial decisions as a source of law in civil law and common law systems [Assessment]
Readings : [**RubioCorrea2009**], [**TorresVasquez2014**]	

Unit 2: Structure and Validity of Legal Norms (2 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Hart's distinction between primary duty-imposing rules and secondary power-conferring rules (recognition, change, adjudication) • Dworkin's rules vs. principles distinction; weight and balance in hard cases; integrity in law • Formal validity (enacted by competent authority), substantive validity (constitutional conformity), and sociological efficacy • Deontic operators: obligation, permission, prohibition; normative conflicts and their resolution (lex superior, lex posterior, lex specialis)	• Describe the structural difference between legal rules and legal principles and explain how each operates in legal reasoning [Familiarity] • Distinguish valid from efficacious norms and apply criteria of formal and substantive validity to a given legal provision [Usage] • Resolve normative conflicts using lex superior, lex posterior, and lex specialis criteria and justify the chosen solution [Assessment]
Readings : [**RubioCorrea2009**], [**TorresVasquez2014**]	

Unit 3: Natural Persons: Capacity and Civil Status (2 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Beginning of personhood: live birth and the protection of the conceived (nasciturus); end of personhood: death, presumption of death, and declaration of absence • Capacity to enjoy rights (capacidad de goce) vs. capacity to exercise them (capacidad de ejercicio); restrictions affecting minors and judicially interdicted persons; emancipation • Name, domicile, and civil registry (Registro Civil) as attributes of the person; acts subject to mandatory registration (birth, marriage, death) • Rights of the personality: right to life, physical integrity, honor, image, and privacy; civil remedies for their infringement	• Describe the requirements for the beginning and end of legal personhood and distinguish capacity to enjoy rights from capacity to exercise them [Familiarity] • Apply the rules on capacity to determine whether a minor or a judicially interdicted person may validly perform a given legal act [Usage] • Analyze a dispute over a person's civil status or personal rights and assess the civil remedies available [Assessment]
Readings : [**FernandezSessarego2015**]	

Unit 4: Legal Persons: Formation, Attributes, and Extinction (2 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Legal person defined and distinguished from natural persons; main types: associations, foundations, committees, and corporations of private and public law • Constitutive act and registration; attributes of the legal person: name, domicile, nationality, and patrimony autonomous from that of its members • Legal representation through organs and representatives; capacity limited by corporate purpose (objeto social); liability of representatives for acts beyond that purpose • Causes of dissolution, the liquidation process, and extinction of legal personality; protection of creditors during liquidation	• Identify the main types of legal persons recognized by civil law and describe the attributes that distinguish them from natural persons [Familiarity] • Apply the rules on legal representation and corporate purpose to determine whether an act performed by a representative binds the legal person [Usage] • Evaluate the dissolution and liquidation process of a legal person and assess the protections available to its creditors [Assessment]
Readings : [**FernandezSessarego2015**]	

Unit 5: Fundamentals of Obligations (2 hours)	
Competences Expected: ABET-2,ABET-4	
Topics	**Learning Outcomes**
• Obligation defined: legal bond (vinculum iuris), debtor and creditor, object (conduct or performance), and the patrimonial interest of the creditor • Classification by object (to give, to do, not to do), by plurality (joint, several, solidary), and by condition (pure, conditional, modal, term) • Modes of extinguishment: payment/performance, novation, compensation (set-off), confusion, remission, impossibility, and prescription • Plurality of parties: joint obligations (mancomunadas) vs. solidary obligations (solidarias); active and passive solidarity	• Describe the essential elements of a civil law obligation and classify a given obligation by its object and structure [Familiarity] • Apply the rules on modes of extinguishment to determine whether a specific obligation has been discharged [Usage] • Analyze a complex obligational relationship involving solidarity and indivisibility and determine each party's rights and duties [Assessment]
Readings : [**OsterlingCastillo2008**]	

Unit 6: Contract Formation and Validity (2 hours)	
Competences Expected: ABET-2,ABET-4	
Topics	**Learning Outcomes**
• Essential elements: offer and acceptance, free and informed consent, legal capacity of the parties, licit and possible object, and lawful cause • Vices of consent: error (substance and person), fraud (dolo), duress (intimidación), and unconscionable advantage (lesión); effect on contract validity • Absolute nullity (nulidad absoluta): grounds and effects; relative nullity/voidability (anulabilidad): grounds, confirmation, and the action for annulment • Electronic contracts: formation via digital platforms, click-wrap and browse-wrap agreements, e-signature validity under UNCITRAL Model Law	• Explain the essential elements required for a valid contract in civil law and identify the consequences when each element is absent or defective [Familiarity] • Assess whether a contract is void or voidable given a set of facts involving defective consent or lack of capacity [Usage] • Evaluate the policy rationale for distinguishing absolute from relative nullity and analyze its practical consequences for third-party rights [Assessment]
Readings : [**DeLaPuente2001**]	

Unit 7: Concept and Content of Ownership (2 hours)	
Competences Expected: ABET-2,ABET-4	
Topics	**Learning Outcomes**
• Ownership as the fullest real right: ius utendi, fruendi, abutendi; absolute, exclusive, and perpetual character; object of ownership (corporeal and incorporeal things) • Constitutional limits on ownership: social and ecological function; expropriation for public interest (requirements, indemnification, and procedure) • Neighbourhood relations: restrictions on immissions, right of passage, boundaries and encroachments; abuse of right (abuso del derecho) doctrine • Indigenous communal property and collective territorial rights under ILO Convention 169: inalienability of ancestral lands, prior consultation,	• Describe the attributes of ownership in civil law and explain the constitutional and statutory limitations on the exercise of property rights [Familiarity] • Apply the rules on neighbourhood law and abuse of right to resolve a dispute between adjoining landowners [Usage] • Evaluate the tension between the absolute character of ownership and the social function doctrine as expressed in Latin American constitutional law [Assessment]
Readings : [**AvendanoValdez2017**]	

Unit 8: Limited Real Rights: Usufruct, Easements, and Securities (2 hours)	
Competences Expected: ABET-2,ABET-4	
Topics	**Learning Outcomes**
• Usufruct: content, duration, obligations of the usufructuary (inventory, bond, conservation), and modes of extinction; use and habitation as lesser personal servitudes • Predial servitudes (servidumbres): positive and negative; apparent and non-apparent; continuous and discontinuous; creation by title, prescription, and destination • Mortgage (hipoteca): accessory character, registration requirement, enforcement by judicial sale; pledge (prenda): possession requirement, non-possessory pledge; antichresis • Fiduciary transfer (fideicomiso / patrimonio autónomo): structure as a separate estate, uses in project finance and estate planning, obligations of the trustee,	• Describe the main categories of limited real rights and explain how each affects the owner's bundle of rights [Familiarity] • Distinguish usufruct from a lease and predial easements from personal servitudes, identifying the legal consequences of each classification [Usage] • Evaluate the adequacy of a mortgage as a security device compared to a pledge in a commercial financing transaction [Assessment]
Readings : [**AvendanoValdez2017**]	

Unit 9: The Individual Employment Relationship (2 hours)	
Competences Expected: ABET-2,ABET-4	
Topics	**Learning Outcomes**
• Employment contract defined: subordination (dependencia), personal service, and remuneration; indicators of subordination: schedule, instructions, tools, exclusivity • Types: indefinite, fixed-term, part-time, seasonal, apprenticeship, telework; formal requirements and written contract obligation; probationary period • Sham contracting (desnaturalización): conversion of fixed-term to indefinite; triangular relationships: labor supply (tercerización/outsourcing), employer's joint • Non-standard forms of employment: part-time, fixed-term, temporary agency work, and telework/remote work - applicable legal frameworks, rights, and employer obligations	• Define the individual employment contract and identify the element of subordination that distinguishes it from an independent contractor relationship [Familiarity] • Identify the indicators of a sham contracting arrangement and determine whether a worker is entitled to the protections of employment law [Usage] • Analyze the legal consequences of triangular labor relationships for the principal employer's liability toward outsourced workers [Assessment]
Readings : [**NevesMujica2009**]	

Unit 10: Termination of Employment (2 hours)	
Competences Expected: ABET-2,ABET-4	
Topics	**Learning Outcomes**
• Just cause for dismissal: types (serious misconduct, poor performance, objective economic causes); procedural requirements: written notice, prior hearing • Unfair (arbitrary) dismissal: reinstatement vs. compensation options; special protection against dismissal: pregnant workers, union representatives, disabled persons • Severance pay (indemnización por años de servicios) and CTS compensation fund (compensación por tiempo de servicios): calculation, payment, and forfeiture conditions • Individual dismissal: causas justas de despido, procedural requirements (prior written notice and hearing), severance pay calculation,	• Explain the grounds for justified dismissal and the procedural steps an employer must follow before terminating an employment contract [Familiarity] • Apply severance pay rules to calculate the total liquidation benefit owed to a worker dismissed without just cause [Usage] • Assess the adequacy of special dismissal protection for vulnerable categories of workers and evaluate its effect on employer flexibility [Assessment]
Readings : [**NevesMujica2009**]	

Unit 11: Fundamentals of Taxation (4 hours)	
Competences Expected: ABET-2,ABET-4	
Topics	**Learning Outcomes**
• Tax obligation (obligación tributaria): taxable event (hecho imponible), taxpayer, tax base, and tax rate; birth, determination, and extinction of the obligation • Classification of taxes: impuestos, tasas, and contribuciones; income tax and value-added tax (IGV/VAT); municipal taxes relevant to construction and real estate (predial, alcabala) • Powers of the tax administration: assessment (fiscalización) and collection; taxpayer obligations: filing, payment, and bookkeeping; withholding obligations applicable to contractors • Tax infractions and penalties; administrative tax procedure and appeals (reclamación, apelación) before the tax administration and tax courts	• Describe the essential elements of the tax obligation and classify the main types of taxes applicable to a professional or business activity [Familiarity] • Apply income, value-added, and municipal tax rules to determine the tax obligations of an engineering firm or construction project [Usage] • Analyze a tax dispute scenario and assess the administrative remedies available against a tax administration's determination [Assessment]
Readings : [**BravoCucci2015**]	

Unit 12: Public Contracting and Concessions (6 hours)	
Competences Expected: ABET-2,ABET-4	
Topics	**Learning Outcomes**
• Principles of public procurement: publicity, competition, equal treatment, and transparency; award procedures: open tender, restricted tender, direct contracting • Exorbitant clauses of public contracts: right to modify (ius variandi), right to terminate for public interest, direction and control powers; maintenance of financial equilibrium • Concession contracts: public service concession, infrastructure concession; public-private partnerships (APP): risk allocation, investment recovery, and regulatory framework • Claims and disputes in public contracts: contractual claims mechanism, dispute boards, and administrative arbitration as alternative to judicial review of public contract conflicts	• Describe the main public procurement procedures and identify the legal principles that govern the award of public contracts [Familiarity] • Apply the rules on exorbitant clauses to assess the state's right to modify a public contract and the contractor's right to financial rebalancing [Usage] • Compare the legal regime of public contracts with private law contracts, identifying the special rules and exorbitant clauses that characterize the public contract [Assessment]
Readings : [**RetamozoLinares2019**], [**DanosOrdonez2016**]	

Unit 13: Civil and Criminal Liability of the Civil Engineer in Construction Works (6 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Contractual civil liability of the design engineer and the contractor toward the client: construction defects and hidden flaws in the work. • Extracontractual (tort) civil liability: damages to third parties and neighboring properties arising from the execution of a project (collapses, structural failures, damage to public utilities). • Negligence-based criminal liability of the civil engineer: culpable homicide and culpable injury offenses arising from the failure or collapse of a work. • The offense of endangering public safety through construction defects (Peruvian Criminal Code, Art. 273). • Peru's National Building Code (RNE) and technical standards as the objective benchmark for due diligence and professional negligence. • Distinguishing the liability of the design engineer, the contractor, and the construction supervisor. • Professional civil liability insurance and Contractor's All Risk (CAR) policies as legal risk management mechanisms.	• Identify the contractual and extracontractual civil liability scenarios a civil engineer may face when planning or executing a construction project [Usage]. • Recognize the negligence-based and public-safety criminal offenses applicable to civil engineering practice in the event of a work's failure or collapse [Usage]. • Apply the National Building Code standard to assess due diligence in professional practice [Assessment].
Readings : [**FernandezCruz2019**], [**VillavicencioTerreros2021**]	

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

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

1. COURSE

CE3G4. Soil Mechanics Applied to Transportation Roads (Elective)

2. GENERAL INFORMATION

2.1 Course	:	CE3G4. Soil Mechanics Applied to Transportation Roads
2.2 Semester	:	9^{th} Semester.
2.3 Credits	:	3
2.4 Hours	:	3 HT; 2 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Elective
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	CE3G3. Applied Geology. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Soil Mechanics Applied to Transportation Roads is the pavement-engineering course of the Geotechnical Engineering track, building on the subgrade behavior established in Soil Mechanics II to address the design, evaluation, and management of the pavement structure itself. The course first develops the design philosophy of pavements and the mechanisms by which flexible and rigid pavements fail, then covers the traffic, subgrade, and material parameters that govern pavement design, the structural design of flexible and rigid pavements using empirical and mechanistic-empirical methods, and the criteria used to decide when and how to rehabilitate an existing pavement. The course closes with the surface and structural evaluation techniques (distress surveys, roughness, and deflection testing) used to diagnose the condition of an in-service pavement, and the maintenance and rehabilitation planning that follows from that diagnosis.

5. GOALS

- Characterize subgrade, aggregate, and asphalt materials, and recognize pavement types and failure mechanisms relevant to pavement design.
- Determine the traffic, reliability, serviceability, and environmental parameters required as inputs for pavement structural design.
- Design flexible and rigid pavement structures using empirical and mechanistic-empirical methods, and select rehabilitation strategies based on established criteria.
- Conduct surface distress and roughness evaluations of in-service pavements, including pavement condition index (PCI) computation.
- Perform structural evaluation of pavements using deflection testing, and backcalculate layer moduli to assess structural capacity.
- Estimate the remaining service life of a pavement and develop maintenance and rehabilitation program plans.

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: Pavement Materials and Characterization (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Pavement types and structural components • Asphalt binder and mixture properties • Aggregate properties and gradation requirements • Subgrade characterization and stabilization • Sustainable pavement technologies and recycling	• Identify pavement types and describe their structural functions [Familiarity] • Characterize asphalt binders and design asphalt mixtures [Assessment] • Evaluate aggregate quality for pavement applications [Usage] • Assess subgrade strength and specify stabilization treatments [Assessment] • Incorporate sustainable practices and recycled materials in pavement design [Familiarity]
Readings : [**Huang2004**]	

Unit 2: Pavement Design and Management (14 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Traffic load characterization and equivalent single axle load (ESAL) computation • Design reliability, serviceability, and drainage/environmental factors in pavement design • Flexible pavement design using empirical methods • Rigid pavement design and joint systems • Mechanistic-empirical pavement design methods • Pavement performance prediction and distress mechanisms • Rehabilitation strategies and overlay design • Pavement management systems and life-cycle cost analysis	• Compute the design equivalent single axle load (ESAL) from traffic composition and growth projections [Usage] • Determine design reliability, serviceability, and drainage/environmental parameters for flexible and rigid pavement design [Assessment] • Design flexible pavements using AASHTO or equivalent methods [Assessment] • Proportion rigid pavement thickness and design joint spacing [Usage] • Apply mechanistic-empirical methods for pavement design [Usage] • Predict pavement performance and identify distress mechanisms [Assessment] • Select appropriate rehabilitation strategies and design overlays [Usage] • Implement pavement management systems and perform life-cycle analysis [Assessment]
Readings : [**Huang2004**], [**AASHTO1993**]	

Unit 3: Pavement Condition Evaluation and Maintenance Planning (10 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Visual distress surveys and pavement condition index (PCI) computation • Pavement roughness measurement and the international roughness index (IRI) • Structural evaluation using deflection testing (falling weight deflectometer, Benkelman beam) • Backcalculation of pavement layer moduli and structural capacity assessment • Remaining service life estimation and rehabilitation treatment selection • Maintenance and rehabilitation program planning and scheduling	• Conduct visual distress surveys and compute the pavement condition index (PCI) [Usage] • Explain pavement roughness measurement methods and interpret the international roughness index [Familiarity] • Perform structural evaluation of in-service pavements using deflection testing methods [Usage] • Backcalculate pavement layer moduli from deflection basin data [Assessment] • Estimate the remaining service life of a pavement and select an appropriate treatment [Assessment] • Develop maintenance and rehabilitation program plans and schedules [Usage]
Readings : [**Huang2004**], [**Hudson1997**]	

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

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

1. COURSE

CE3G5. Finite Elements Applied to Geotechnical Engineering (Elective)

2. GENERAL INFORMATION

2.1 Course	:	CE3G5. Finite Elements Applied to Geotechnical Engineering
2.2 Semester	:	9^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 HT; 2 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Elective
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	CE3G3. Applied Geology. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Finite Elements Applied to Geotechnical Engineering introduces the finite element method as a numerical tool for the analysis and design of geotechnical structures and problems that cannot be solved reliably with classical closed-form methods. Building on the shear-strength, consolidation, and design framework developed in Soil Mechanics II and the numerical modeling background introduced in Fluid Mechanics II, the course first develops the mathematical foundations of the finite element method (variational formulation, Galerkin approximation, finite element spaces, and error estimation) and then applies them to geotechnical-specific problems: boundary conditions, initial stress states, and staged-construction modeling; one-dimensional analysis of consolidation and pile-soil interaction; two-dimensional plane-strain analysis of excavations, embankments, and retaining structures; an introduction to dynamic numerical analysis of seismic geotechnical problems; and the constitutive soil models (Mohr-Coulomb, Cam-Clay, and Hardening Soil Model) that make nonlinear soil behavior tractable in finite element software. As part of the Geotechnical Engineering specialization track, the course prepares students to use modern numerical modeling tools in professional geotechnical design practice.

5. GOALS

- Derive and formulate the finite element method (weak formulation, Galerkin approximation, and error estimation) for boundary value problems.
- Establish appropriate boundary conditions, initial stress states, and staged-construction sequencing for geotechnical finite element models.
- Formulate one-dimensional finite element models for consolidation and pile-soil interaction problems.
- Develop two-dimensional plane-strain finite element models for excavation, embankment, and retaining-structure design problems.
- Analyze the dynamic response of geotechnical systems using numerical dynamic analysis.
- Select and apply constitutive soil models (Mohr-Coulomb, Cam-Clay, Hardening Soil Model) appropriate to nonlinear geotechnical finite element analysis.

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: Finite Element Method (6 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Weak (variational) formulation of boundary value problems and Sobolev spaces • Galerkin method: finite-dimensional approximation spaces and the stiffness matrix • Triangular and quadrilateral finite element spaces: Lagrange elements and conformity • A priori error estimates: Céa's lemma and interpolation error bounds • A posteriori error estimates and adaptive mesh refinement	• Derive the weak formulation of an elliptic BVP and show its equivalence to the strong form [Familiarity] • Assemble the global stiffness matrix and load vector for a linear finite element discretization [Usage] • Estimate the H^1 error of a finite element solution using Céa's lemma and interpolation theory [Assessment]
Readings : [**Reddy2019**]	

Unit 2: Geotechnical Numerical Modeling and Applications (50 hours)	
Competences Expected: ABET-1,ABET-2,ABET-6	
Topics	**Learning Outcomes**
• Boundary conditions, initial stress state, and staged construction (excavation and fill sequencing) in geotechnical finite element models • Soil-structure interaction modeling: interface elements and contact behavior between soil and structural elements • One-dimensional numerical models for consolidation and axially loaded pile-soil interaction • Two-dimensional plane-strain numerical models for excavations, embankments, and retaining structures • Dynamic numerical analysis of seismic site response and soil-structure dynamic interaction • Constitutive soil models: Mohr-Coulomb, Cam-Clay, and Hardening Soil Model for nonlinear geotechnical analysis	• Explain the boundary conditions, initial stress state, and staged construction sequencing required for geotechnical finite element models [Familiarity] • Model soil-structure interaction using interface elements in a finite element mesh [Usage] • Formulate one-dimensional finite element models for consolidation and pile-soil interaction problems [Usage] • Develop two-dimensional plane-strain finite element models for excavation, embankment, and retaining-structure problems [Usage] • Analyze the dynamic response of geotechnical systems using numerical dynamic analysis [Assessment] • Select and apply appropriate constitutive soil models (Mohr-Coulomb, Cam-Clay, Hardening Soil Model) in nonlinear finite element analysis [Usage]
Readings : [**PottsZdravkovic2001**], [**ZienkiewiczTaylorZhu2013**], [**Kramer1996**]	

Unit 3: Geotechnical Earthquake Engineering (8 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	**Learning Outcomes**
• Single-degree-of-freedom dynamic systems and one-dimensional wave propagation through soil deposits • Site response and ground motion amplification • Seismic hazard analysis and design ground motions • Liquefaction susceptibility and triggering mechanisms • Cyclic stress ratio and liquefaction evaluation procedures • Effects of liquefaction on structures and infrastructure • Dynamic soil properties and laboratory testing • Design of foundations for vibrating machinery under dynamic loading • Ground improvement methods for liquefaction mitigation • Lateral spreading and flow failures • Seismically induced settlement and bearing capacity • Performance-based design for geotechnical earthquake engineering	• Formulate single-degree-of-freedom models and one-dimensional wave-propagation equations to characterize seismic wave transmission through soil deposits [Usage] • Explain site response effects and ground motion characteristics [Familiarity] • Determine design ground motions for geotechnical seismic analysis [Assessment] • Evaluate liquefaction susceptibility using field investigation data [Usage] • Calculate cyclic stress ratios and assess liquefaction potential [Assessment] • Assess the consequences of liquefaction on foundations and structures [Familiarity] • Characterize dynamic soil properties from laboratory and field tests [Usage] • Proportion machine foundations considering dynamic soil-foundation stiffness, resonance avoidance, and permissible vibration amplitudes [Assessment] • Select and design ground improvement methods to mitigate liquefaction [Assessment] • Predict lateral spreading displacements and flow failure potential [Usage] • Analyze seismically induced settlement and reduced bearing capacity [Assessment] • Implement performance-based approaches for seismic geotechnical design [Assessment]
Readings : [**Kramer1996**], [**Das2019**]	

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

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

1. COURSE

CE3G6. Earth Dams (Elective)

2. GENERAL INFORMATION

2.1 Course	:	CE3G6. Earth Dams
2.2 Semester	:	9^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 HT; 2 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Elective
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	CE3G1. Soil Dynamics. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Earth Dams is a Geotechnical Engineering track specialization elective that applies the shear strength, seepage, and slope stability framework developed in Soil Mechanics II, together with the open-channel and hydraulic-structures framework developed in Fluid Mechanics II, to the analysis, design, construction, and operational safety of embankment (earth and rockfill) dams. The course begins with the definition and typology of earth dams and the geotechnical characterization of foundation and borrow materials specific to dam projects, then develops the dam-specific investigation program – building on the general subsurface investigation techniques introduced in Soil Mechanics I – that supports embankment design. It then addresses the geotechnical design of the embankment itself: seepage control through cores, cutoffs, and grout curtains; slope stability of the dam faces under steady-state, rapid-drawdown, and seismic conditions; and filter/drain design against internal erosion. The course closes with the instrumentation and monitoring systems used to verify embankment performance, the constructive aspects of foundation treatment and fill placement, and the operational management and safety practices – surveillance, risk assessment, and emergency action planning – required over a dam's service life.

5. GOALS

- Classify earth and rockfill dam typologies and describe the zoning of an embankment dam.
- Characterize foundation and borrow materials for embankment dam design.
- Plan and interpret geotechnical investigation programs specific to dam projects, including foundation permeability testing and borrow area evaluation.
- Design seepage control measures and filter/drain systems, and evaluate the slope stability of embankment dam faces.
- Design an instrumentation and monitoring program to track dam performance throughout construction and operation.
- Apply construction quality-control practices for foundation treatment and fill placement in embankment dams.
- Evaluate dam safety management practices, including risk assessment and emergency action planning, for dam operation.

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: Earth Dams (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definition, function, and role of earth dams within water resources infrastructure • Typology of embankment dams: homogeneous and zoned earthfill/rockfill dams, and selection criteria • Dam zoning: core, shell, filters, drains, and transition zones • Site selection factors and reservoir/dam-site feasibility considerations	• Explain the function of earth dams and their role within water resources infrastructure [Familiarity] • Classify embankment dams by type and select an appropriate typology for given site and material conditions [Assessment] • Describe the zoning of an earth dam and the function of each zone (core, shell, filters, drains) [Familiarity] • Evaluate site selection factors governing dam type and location choice [Usage]
Readings : [**FellDams2015**], [**USBRSmallDams1987**]	

Unit 2: Geotechnical Characterization for Earth Dams (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Foundation geotechnical characterization: rock and soil foundation conditions for embankment dams • Characterization of borrow materials for core, shell, and filter zones • Compaction and shear strength properties of compacted fill materials • Permeability characterization of foundation and embankment materials • Dispersive soil identification and erodibility assessment for core materials	• Characterize foundation soil and rock conditions relevant to embankment dam design [Assessment] • Evaluate borrow material sources for suitability as core, shell, or filter material [Usage] • Determine compaction and shear strength properties of compacted embankment materials [Assessment] • Assess dispersive soil potential and erodibility of candidate core materials [Usage]
Readings : [**FellDams2015**], [**USBRSmallDams1987**]	

Unit 3: Site Investigation and In-Situ Testing (6 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Investigation planning and scope determination • Boring methods and subsurface exploration techniques • Sampling methods for disturbed and undisturbed samples • Standard Penetration Test and correlations • Laboratory testing program and test selection • Cone Penetration Test and piezocone testing • Vane shear test and pressuremeter testing • Geophysical methods including seismic and resistivity surveys • Groundwater monitoring and piezometer installation • Report preparation and geotechnical data presentation • In-situ permeability (Lugeon/packer) testing for foundation grouting and seepage assessment • Borrow area investigation for embankment fill material quantity and quality	• Develop appropriate site investigation programs based on project requirements [Assessment] • Select appropriate boring and exploration methods for different soil conditions [Familiarity] • Specify sampling techniques to obtain quality samples for testing [Usage] • Interpret SPT data and apply empirical correlations for design parameters [Assessment] • Design laboratory testing programs for geotechnical projects [Usage] • Analyze CPT and piezocone data for soil profiling and parameter evaluation [Assessment] • Apply vane shear and pressuremeter tests for soft clay characterization [Usage] • Utilize geophysical methods to complement traditional investigation techniques [Assessment] • Monitor groundwater conditions and interpret piezometric data [Usage] • Prepare comprehensive geotechnical investigation reports [Assessment] • Perform packer (Lugeon) testing and interpret results for foundation grouting curtain design [Usage] • Characterize borrow areas for embankment fill material quantity and quality [Assessment]
Readings : [**Das2019**], [**FellDams2015**]	

Unit 4: Geotechnical Design of Embankment Dams (12 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Seepage analysis through the embankment and foundation using flow nets and numerical methods • Seepage control measures: core design, cutoff walls, and grout curtains • Filter and drain design criteria to prevent internal erosion and piping • Slope stability analysis of upstream and downstream dam faces under static and rapid drawdown conditions • Seismic design considerations and deformation analysis for embankment dams • Freeboard determination and settlement/camber allowance in embankment design	• Analyze seepage through the embankment and foundation using flow nets or numerical seepage models [Assessment] • Design seepage control measures including impervious cores, cutoff walls, and grout curtains [Usage] • Design filter and drain zones according to piping and internal erosion criteria [Assessment] • Evaluate slope stability of dam faces under steady-state seepage, rapid drawdown, and end-of-construction conditions [Usage] • Incorporate seismic loading and deformation analysis into embankment dam design [Assessment] • Determine freeboard and settlement allowances for embankment design [Usage]
Readings : [**FellDams2015**], [**SherardDams1963**], [**USACE1902**]	

Unit 5: Dam Instrumentation and Monitoring (12 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Instrumentation planning: objectives, parameters to monitor, and instrument selection • Piezometers and pore pressure measurement systems • Settlement and deformation monitoring: surface markers, inclinometers, and extensometers • Seepage flow monitoring using weirs and flow measurement devices • Data acquisition, automation, and interpretation of monitoring records • Threshold (alert/alarm) values and performance evaluation criteria	• Plan an instrumentation program defining monitoring objectives and parameters [Usage] • Select and locate piezometers to monitor pore pressure within the embankment and foundation [Assessment] • Specify deformation monitoring instruments (markers, inclinometers, extensometers) for an embankment dam [Usage] • Monitor seepage flow and interpret trends against baseline conditions [Assessment] • Interpret monitoring data and establish threshold values for dam safety alerts [Usage]
Readings : [**Dunnicliff1993**], [**FellDams2015**]	

Unit 6: Construction of Earth Dams (8 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Foundation preparation and treatment: stripping, grouting, and cutoff trench excavation • Placement and compaction of core, filter, and shell fill materials • Field compaction quality control and acceptance testing • Construction sequencing, staged construction, and river diversion during construction • Construction-phase monitoring and as-built verification	• Specify foundation treatment methods including cut-off trench excavation and grouting [Usage] • Control fill placement and compaction to meet design specifications [Assessment] • Verify compaction quality through field acceptance testing [Usage] • Sequence embankment construction considering staged construction and river diversion [Assessment]
Readings : [**USBRSmallDams1987**], [**FellDams2015**]	

Unit 7: Operation and Safety Management of Dams (8 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Dam surveillance programs: visual inspection and periodic evaluation procedures • Risk assessment and hazard classification of dams • Emergency action plans and downstream hazard/inundation mapping • Regulatory framework and dam safety programs (e.g., Peru's ANA dam safety regulations) • Dam rehabilitation, decommissioning, and aging infrastructure management	• Conduct dam surveillance inspections and evaluate performance indicators [Usage] • Classify dam hazard potential and assess associated risks [Assessment] • Develop an emergency action plan including downstream inundation mapping [Usage] • Apply regulatory dam safety requirements to an operating dam [Assessment] • Propose rehabilitation measures for aging or deficient dam infrastructure [Usage]
Readings : [**FEMA2004**], [**FellDams2015**]	

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

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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

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

1. COURSE

CE3S7. Structural Rehabilitation and Retrofitting (Elective)

2. GENERAL INFORMATION

2.1 Course	:	CE3S7. Structural Rehabilitation and Retrofitting
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	:	Elective
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	CE3S4. Earthquake-Resistant Engineering and Disaster Prevention. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Structural Rehabilitation and Retrofitting addresses the assessment, strengthening, and retrofit of Peru's existing civil infrastructure. Building on the seismic engineering fundamentals of Earthquake-Resistant Engineering and Disaster Prevention, the course begins with the national context of Peru's aging and deficient infrastructure and a review of the seismic design code criteria that establish the baseline performance expectations against which existing structures are evaluated. Students then characterize the permanent, live, environmental, and deterioration-induced loads acting on existing structures, and study the nonlinear behavior of structural components – including hysteretic response, plastic hinge modeling, and pushover analysis – required to evaluate structural performance beyond the elastic range. The course closes with the field evaluation procedures, and the strength, ductility, durability, and serviceability rehabilitation techniques used to retrofit existing structures.

5. GOALS

- Describe the national context and condition of Peru's existing civil infrastructure and the regulatory framework applicable to its assessment and rehabilitation.
- Characterize the permanent, live, environmental, and deterioration-induced loads acting on existing structures.
- Apply nonlinear structural analysis methods, including pushover analysis and displacement-based assessment, to evaluate the performance of existing structures.
- Conduct field evaluation procedures, including nondestructive testing, to assess the condition of existing structures.
- Design strengthening and retrofit interventions to improve the strength, ductility, durability, and serviceability of existing structures.

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: National Context of Existing Civil Infrastructure (2 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Overview of Peru's existing civil infrastructure inventory and condition: buildings, bridges, and lifelines • Causes and consequences of infrastructure deficiency: aging, inadequate maintenance, unregulated construction, and seismic vulnerability • Economic, social, and risk-management implications of infrastructure rehabilitation versus replacement • Institutional and regulatory framework for the rehabilitation of existing structures in Peru	• Describe the condition and typology of Peru's existing civil infrastructure [Familiarity] • Explain the causes and consequences of infrastructure deficiency in the Peruvian context [Familiarity] • Discuss the economic and risk-management criteria used to decide between rehabilitation and replacement of existing infrastructure [Usage]
Readings : [**ASCE-IRC2021**]	

Unit 2: Seismic Design Code and Structural Configuration Criteria (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Scope and structure of the Peruvian seismic design code E.030 • Seismic hazard parameters: seismic zonation (Z), usage factor (U), and soil profile (S) • Structural systems and seismic force reduction coefficient (R) • Plan structural irregularities: torsional irregularity, re-entrant corners, and diaphragm discontinuity • Vertical structural irregularities: soft story, weak story, and mass irregularity • Structuring principles: symmetry, redundancy, hyperstaticity, and continuity • Minimum base shear and inter-story drift limits	• Explain the scope and structure of the Peruvian seismic design code E.030 [Familiarity] • Determine the seismic hazard parameters (Z, U, S) applicable to a given site [Usage] • Select the structural system and corresponding reduction coefficient R [Usage] • Classify the plan and vertical structural irregularities of a building [Assessment] • Apply structuring principles to propose a regular structural configuration [Usage] • Verify the minimum base shear and inter-story drift limits [Assessment]
Readings : [**E030-2018**]	

Unit 3: Nature and Characterization of Loads on Existing Infrastructure (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Permanent (dead) and live load characterization for existing structures • Environmental loads: wind, thermal, and differential settlement effects on infrastructure • Deterioration-induced load effects: corrosion, creep, shrinkage, and fatigue • Load history reconstruction and service load estimation for existing structures • Overload and abnormal load events: impact, blast, and accidental actions • Load combinations for structural assessment and rehabilitation design	• Characterize the permanent and live loads applicable to existing civil infrastructure [Familiarity] • Determine environmental load effects, including wind, thermal, and differential settlement, on existing structures [Usage] • Identify deterioration-induced load effects such as corrosion, creep, shrinkage, and fatigue [Assessment] • Reconstruct the load history and estimate in-service loads for an existing structure [Usage] • Recognize overload and abnormal load events relevant to infrastructure assessment [Familiarity] • Establish load combinations appropriate for structural assessment and rehabilitation design [Assessment]
Readings : [**ASCE7-22**]	

Unit 4: Nonlinear Behavior of Structures (18 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Material nonlinearity: stress-strain behavior of concrete and reinforcing steel beyond yield • Geometric nonlinearity and P-delta effects in structural response • Hysteretic behavior and energy dissipation of structural components under cyclic loading • Plastic hinge formation, hinge length, and moment-curvature relationships • Nonlinear static (pushover) analysis and capacity curve development • Displacement ductility and curvature ductility demand • Performance levels and acceptance criteria for structural and nonstructural components • Displacement-based assessment methods for existing structures	• Explain the material and geometric sources of nonlinear structural behavior [Familiarity] • Determine moment-curvature relationships and plastic hinge properties for structural members [Usage] • Perform nonlinear static (pushover) analysis to develop a structure's capacity curve [Usage] • Calculate displacement and curvature ductility demands for structural components [Assessment] • Evaluate structural and nonstructural performance levels against acceptance criteria [Assessment] • Apply displacement-based methods to assess the seismic performance of existing structures [Usage]
Readings : [**Priestley2007**]	

Unit 5: Structural Rehabilitation, Strengthening, and Retrofit (50 hours)	
Competences Expected: ABET-2,ABET-6	
Topics	**Learning Outcomes**
• Condition assessment and structural evaluation procedures • Load rating and capacity evaluation of existing structures • Concrete repair materials and techniques • Strengthening techniques using external reinforcement • FRP strengthening systems for flexure and shear • Seismic retrofit strategies for buildings and bridges • Steel jacketing and external post-tensioning • Masonry rehabilitation and historic structure preservation • Performance-based assessment and retrofit design • Nondestructive evaluation and structural health monitoring	• Conduct comprehensive condition assessments of existing structures [Assessment] • Evaluate load-carrying capacity of existing structural members [Usage] • Select appropriate concrete repair materials and application methods [Familiarity] • Design strengthening interventions using conventional techniques [Assessment] • Apply FRP systems for flexural and shear strengthening of concrete members [Usage] • Develop seismic retrofit strategies for deficient structures [Assessment] • Implement steel jacketing and external post-tensioning systems [Usage] • Rehabilitate masonry structures while preserving historic character [Assessment] • Perform performance-based assessment and design retrofit interventions [Usage] • Utilize nondestructive testing and monitoring technologies for damage assessment [Familiarity]
Readings : [**ACI562**], [**ASCE41-17**], [**FEMA356**], [**ACI440.2R-17**]	

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

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE3S9. Prestressed Concrete (Elective)

2. GENERAL INFORMATION

2.1 Course	:	CE3S9. Prestressed Concrete
2.2 Semester	:	9^{th} Semester.
2.3 Credits	:	3
2.4 Hours	:	2 HT; 2 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Elective
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	CE2S2. Reinforced Concrete Design I. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Prestressed Concrete introduces the fundamental principles, elastic analysis, and design methodology for prestressed and post-tensioned concrete members following the ACI 318 building code, building directly on the limit state design foundation established in Reinforced Concrete Design I. Students learn to analyze elastic stresses in prestressed concrete sections under service loads, evaluate composite construction combining precast members and cast-in-place concrete, and calculate immediate and time-dependent losses of prestress. The course develops the design of pretensioned and post-tensioned members for flexural, shear, and torsional strength at the ultimate limit state, the design of post-tensioned slabs including tendon layout, the analysis of statically indeterminate prestressed concrete structures, and the verification of deflection and serviceability requirements, preparing students for advanced structural design practice involving prestressed concrete elements.

5. GOALS

- Apply elastic theory to analyze stresses in prestressed concrete sections under service loads.
- Design composite prestressed concrete sections combining precast members and cast-in-place concrete.
- Calculate immediate and time-dependent losses of prestress.
- Design prestressed concrete members for flexural strength at the ultimate limit state.
- Design prestressed concrete members for shear and torsion strength.
- Design post-tensioned slabs and beams, including tendon layout.
- Analyze statically indeterminate prestressed concrete structures, including secondary moments, and control deflections.

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)

7. TOPICS

Unit 1: Seismic Detailing of Reinforced Concrete (16 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Beam-column joints and moment-resisting frame connections • Seismic detailing and ductile design of concrete structures • Design of special reinforced concrete structural walls (shear walls) for seismic lateral force resistance • Special seismic detailing provisions for reinforced concrete moment-resisting frames	• Detail beam-column joints for moment transfer and shear resistance [Assessment] • Implement seismic detailing requirements for ductile concrete frames [Assessment] • Design special reinforced concrete structural walls for combined axial, flexural, and shear demands under seismic loading [Assessment] • Apply special seismic detailing provisions to reinforced concrete moment frame members and beam-column joints [Usage]
Readings : [**Nawy2010**], [**Nilson1987**], [**ACI31819**], [**LinBurns1981**]	

Unit 2: Prestressed Concrete Analysis (16 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Prestressed concrete principles and pre-tensioning methods • Elastic analysis of stresses in prestressed concrete sections under service loads • Composite prestressed concrete sections: precast members with cast-in-place topping • Immediate and time-dependent losses of prestress	• Apply prestressing principles to design pre-tensioned members [Usage] • Analyze stresses in prestressed concrete sections under service loads using elastic theory [Usage] • Design composite prestressed concrete sections combining precast members and cast-in-place concrete [Assessment] • Calculate immediate and time-dependent losses of prestress [Usage]
Readings : [**Nawy2010**], [**Nilson1987**], [**ACI31819**], [**LinBurns1981**]	

Unit 3: Prestressed Concrete Design (20 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Post-tensioned concrete systems and tendon design • Deflection control and serviceability requirements • Flexural strength of prestressed concrete members at ultimate limit state • Shear and torsion design of prestressed concrete members • Statically indeterminate prestressed concrete structures, including secondary moments	• Design post-tensioned slabs and beams including tendon layout [Assessment] • Control deflections through appropriate member sizing and reinforcement [Usage] • Design prestressed concrete members for flexural strength at the ultimate limit state [Assessment] • Design prestressed concrete members for shear and torsion strength [Assessment] • Analyze statically indeterminate prestressed concrete structures, including secondary moments [Assessment]
Readings : [**Nawy2010**], [**Nilson1987**], [**ACI31819**], [**LinBurns1981**]	

8. WORKPLAN

8.1 Methodology

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8.2 Theory Sessions

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE3C11. Sanitary and Electrical Installations (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3C11. Sanitary and Electrical Installations
2.2 Semester	:	10^{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 Prerrequisites	:	CE3H1. Fluid Mechanics II. (6^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Sanitary and Electrical Installations covers the design of sanitary installations (water supply and wastewater and stormwater drainage) and electrical installations (installed power, maximum demand, lighting, and grounding) within a building.

5. GOALS

- Design the water supply system and the wastewater and stormwater drainage system of a building.
- Determine the installed power and maximum demand of a residential electrical installation applying current regulations.
- Apply complementary concepts of lighting, grounding, and electricity tariffs to the design of electrical installations.

6. COMPETENCES

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)

7. TOPICS

Unit 1: Water Supply System in Building Sanitary Installations (17 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Importance and scope of sanitary installations in a building • Cold water system design: demand allowance, pressures, and pipe sizing • Hot water system design and other building water uses • Cisterns, elevated tanks, and water pumping systems	• Explain the importance and scope of sanitary installations in a building [Familiarity] • Design a building's cold and hot water system, determining demand allowance, pressures, and pipe sizing [Usage] • Size cisterns, elevated tanks, and water pumping systems for a building [Assessment]
Readings : [**IS010**]	

Unit 2: Drainage System in Building Sanitary Installations (13 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Wastewater drainage system design • Building stormwater drainage system design • Sanitary venting systems and traps for odor control	• Design a building's wastewater and stormwater drainage system [Usage] • Apply sanitary venting and odor control criteria to the design of a drainage system [Assessment]
Readings : [**IS010**]	

Unit 3: Building Electrical Installations (26 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Importance and scope of electrical installations in a building • Determination of installed power per applicable standards • Maximum demand calculation and demand factors • Design of branch circuits and feeders • Basic lighting design concepts for buildings • Grounding systems • Electricity tariffs and service billing	• Explain the importance of electrical installations in a building [Familiarity] • Determine the installed power of a building per current standards [Usage] • Calculate the maximum demand of a building applying the corresponding demand factors [Assessment] • Design the branch circuits and feeders of a residential electrical installation [Usage] • Apply lighting and grounding concepts to the design of an electrical installation [Assessment]
Readings : [**CNE2011**]	

8. WORKPLAN

8.1 Methodology

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE3C9. Integrated Construction Management (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3C9. Integrated Construction Management
2.2 Semester	:	10^{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 Prerrequisites	:	CE3C2. Construction Technology II. (9^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Integrated Construction Management covers quality management systems (ISO 9001), environmental management (ISO 14001), and occupational health and safety (ISO 45001) on construction sites, as well as their integration and joint auditing. The course includes on-site environmental management, sustainability and impact mitigation, occupational health and safety according to Peruvian regulations, and concludes with project optimization and project closure.

5. GOALS

- Apply the fundamentals of quality management (ISO 9001) to the control of processes and materials on site.
- Manage the environmental impacts of a construction project and apply sustainability and mitigation measures.
- Apply Peruvian occupational health and safety regulations (G.050) and emergency prevention and response protocols.
- Integrate quality, environmental, and occupational health and safety management systems, and optimize project closure.

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: Quality Management (28 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**], [**PMI2021**]	

Unit 2: Integrated Quality, Environmental, and Safety Management Systems (12 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Common high-level structure (Annex SL) shared by ISO 9001, 14001, and 45001: aligned clauses for context, leadership, planning, support, operation, performance evaluation, and improvement • Integrated management policy and objectives spanning quality, environmental, and OH&S goals; a single integrated management manual and shared documented information • Integrated internal and external audit programs covering multiple standards in a single audit cycle: combined checklists, joint findings, and non-conformance tracking • Synergies between the three systems (shared risk-based thinking, PDCA cycle, documented information) versus potential conflicts (competing priorities, resource allocation), and approaches to resolve them	• Explain the common high-level structure shared by ISO 9001, 14001, and 45001 and how it enables management system integration [Familiarity] • Design an integrated audit checklist covering quality, environmental, and occupational health and safety requirements for a construction site [Usage] • Evaluate the effectiveness of an integrated management system on a construction project, identifying synergies and unresolved conflicts between its component systems [Assessment]
Readings : [**ISO9001**], [**ISO14001**], [**ISO45001**]	

Unit 3: Environmental Impact Assessment and Sustainability Metrics (12 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: Air Quality and Pollution Control Engineering (12 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Atmospheric structure, composition, and basic meteorology • Pollutant types, sources, and health/environmental effects • Monitoring techniques and ambient air quality standards • Dispersion modeling fundamentals and Gaussian plume model • Control technologies for particulate matter: cyclones, baghouses, and ESPs • Gaseous pollutant control: absorption, adsorption, and catalytic systems • Mobile source emissions and control strategies • Indoor air quality and ventilation • Climate change and greenhouse gas mitigation engineering	• Describe the major classes of air pollutants, their sources, and impacts [Familiarity] • Apply the Gaussian plume model to estimate ground-level concentrations from a point source [Usage] • Select appropriate particulate control devices based on particle size distribution and efficiency requirements [Assessment] • Interpret ambient air quality monitoring data relative to regulatory standards [Familiarity] • Design a basic absorption tower for removing a gaseous pollutant from a flue gas stream [Assessment] • Explain the engineering approaches for controlling emissions from mobile sources [Familiarity] • Evaluate indoor air quality parameters and propose mitigation measures for a building [Assessment] • Propose engineering strategies for reducing greenhouse gas emissions from an industrial facility [Usage]
Readings : [**Davis2010**]	

Unit 5: Construction Safety, Health, and Risk Management (24 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 6: Lean Construction and Integrated Project Delivery (IPD) (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Lean thinking principles: value, value stream, flow, pull, perfection • Identification and elimination of the eight wastes in construction • Last Planner System (LPS) for production planning and control • Visual management tools: 5S, Kanban, and Andon • Integrated Project Delivery (IPD) principles and multi-party agreements • Target Value Delivery (TVD) and Set-Based Design • Collaboration technologies and Big Room co-location • Performance measurement: Percent Plan Complete (PPC), Takt time • Culture change and implementation strategies for lean transformation	• Define the seven (or eight) types of waste (Muda) in a construction context [Familiarity] • Apply the Last Planner System to develop a reliable weekly work plan [Usage] • Identify opportunities to apply visual management (5S) on a construction site [Assessment] • Explain how Integrated Project Delivery (IPD) aligns goals and shares risk among project stakeholders [Familiarity] • Use Target Value Delivery principles to guide design decisions within a cost target [Assessment] • Facilitate a collaborative pull planning session with multiple trades [Usage] • Calculate and interpret Percent Plan Complete (PPC) as a lean performance metric [Assessment] • Develop a basic implementation plan for introducing lean practices to a project team [Assessment]
Readings : [**Ballard2000**]	

Unit 7: Key Performance Indicators (6 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Selecting KPIs: relevance to project objectives, measurability, and actionability • Balanced metric sets: leading and lagging indicators, outcome and output metrics • Setting KPI thresholds and alert levels for triggering corrective action • Reviewing and adapting the KPI set as the project evolves and stakeholder priorities shift	• Define a balanced KPI set for monitoring a project across multiple performance dimensions [Usage] • Evaluate a given set of KPIs for balance, relevance, and potential for metric dysfunction [Assessment] • Design a KPI review cycle that keeps performance metrics aligned with evolving project objectives [Assessment]
Readings : [**PMI2021**]	

Unit 8: Kickoff and Closure Activities (6 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Project kickoff: aligning team and stakeholders on objectives, approach, and working agreements • Phase transition activities: reviews, approvals, and handoffs between phases • Project closure: final deliverable acceptance, lessons learned, and team release • Integrating lessons learned from closure into organizational knowledge assets	• Conduct an effective project kickoff that aligns team and stakeholders on goals and approach [Usage] • Execute project closure activities including final acceptance and lessons learned archiving [Usage] • Design a comprehensive project closure checklist ensuring all administrative, contractual, and knowledge capture obligations are met [Assessment]
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

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

1. COURSE

CE3G7. Professional Competencies Workshop - Geotechnical (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3G7. Professional Competencies Workshop - Geotechnical
2.2 Semester	:	10^{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 Prerrequisites	:	CE3G2. Soil Mechanics Applied to Foundations. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Professional Competencies Workshop is the capstone/synthesis course of the Geotechnical Engineering specialization track. It integrates, around real project scenarios, the shear-strength and stress-distribution framework and the site investigation and in-situ testing techniques developed earlier in the track with the four principal design domains of geotechnical practice: slope stability and landslide mitigation, geotechnical earthquake engineering and liquefaction, shallow and deep foundation design, earth retaining systems, ground improvement and geosynthetics engineering, and the geotechnical design of earth and rockfill dams – including dam typology selection and the geotechnical characterization of foundation and borrow materials that supports that design. Rather than introducing new content, the workshop revisits and applies, at a professional level of integration, the knowledge units developed throughout the specialization's preceding courses.

5. GOALS

- Plan and interpret geotechnical site investigation programs and apply shear strength and stress distribution principles to characterize project sites.
- Analyze slope stability and design landslide mitigation and stabilization measures.
- Evaluate seismic hazards and liquefaction potential and design mitigation measures for geotechnical earthquake engineering problems.
- Design shallow and deep foundations and earth retaining systems for representative structures.
- Select and design ground improvement and geosynthetic solutions for problematic ground conditions.
- Select an embankment dam typology and apply geotechnical characterization and design methods to size an earth or rockfill dam.

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: Site Investigation and In-Situ Testing (9 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Investigation planning and scope determination • Boring methods and subsurface exploration techniques • Sampling methods for disturbed and undisturbed samples • Standard Penetration Test and correlations • Laboratory testing program and test selection • Cone Penetration Test and piezocone testing • Vane shear test and pressuremeter testing • Geophysical methods including seismic and resistivity surveys • Groundwater monitoring and piezometer installation • Report preparation and geotechnical data presentation • In-situ permeability (Lugeon/packer) testing for foundation grouting and seepage assessment • Borrow area investigation for embankment fill material quantity and quality	• Develop appropriate site investigation programs based on project requirements [Assessment] • Select appropriate boring and exploration methods for different soil conditions [Familiarity] • Specify sampling techniques to obtain quality samples for testing [Usage] • Interpret SPT data and apply empirical correlations for design parameters [Assessment] • Design laboratory testing programs for geotechnical projects [Usage] • Analyze CPT and piezocone data for soil profiling and parameter evaluation [Assessment] • Apply vane shear and pressuremeter tests for soft clay characterization [Usage] • Utilize geophysical methods to complement traditional investigation techniques [Assessment] • Monitor groundwater conditions and interpret piezometric data [Usage] • Prepare comprehensive geotechnical investigation reports [Assessment] • Perform packer (Lugeon) testing and interpret results for foundation grouting curtain design [Usage] • Characterize borrow areas for embankment fill material quantity and quality [Assessment]
Readings : [**Das2019**]	

Unit 2: Shear Strength and Consolidation (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Shear strength of soils and Mohr-Coulomb failure criterion • Direct shear and triaxial testing methods • Drained and undrained shear strength behavior • Consolidation theory and settlement analysis • Time-rate of consolidation and degree of consolidation • Stress distribution in soil masses using elastic theory • Critical state soil mechanics concepts • Residual shear strength and sensitivity of clays • Secondary compression and creep behavior • Anisotropy and stress path effects on soil behavior	• Apply Mohr-Coulomb criterion to determine shear strength parameters [Familiarity] • Interpret direct shear and triaxial test results [Assessment] • Distinguish between drained and undrained loading conditions [Usage] • Calculate consolidation settlement using one-dimensional theory [Assessment] • Predict time-rate of settlement for consolidating soils [Usage] • Compute stress distribution beneath loaded areas using Boussinesq theory [Assessment] • Explain critical state concepts and their application to soil behavior [Familiarity] • Evaluate residual strength and sensitivity for slope stability problems [Assessment] • Estimate secondary compression for highly plastic soils [Usage] • Analyze the effects of stress paths and anisotropy on soil response [Familiarity]
Readings : [**Das2019**]	

Unit 3: Slope Stability Analysis and Stabilization (12 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Infinite slope analysis for simple geometries • Method of slices and limit equilibrium analysis • Circular and non-circular failure surfaces • Factor of safety determination and acceptance criteria • Stability charts and simplified methods • Landslide types and failure mechanisms • Seismic slope stability and pseudo-static analysis • Stabilization methods including drainage and reinforcement • Monitoring systems and early warning for unstable slopes • Probabilistic slope stability analysis	• Perform infinite slope stability analysis for uniform slopes [Assessment] • Apply method of slices to analyze slope stability [Usage] • Analyze slopes with circular and non-circular failure surfaces [Assessment] • Calculate factors of safety and interpret results [Usage] • Use stability charts for rapid slope evaluation [Assessment] • Identify landslide types and their characteristic features [Familiarity] • Evaluate seismic stability using pseudo-static methods [Usage] • Design slope stabilization measures for specific failure modes [Assessment] • Implement monitoring systems for potentially unstable slopes [Usage] • Conduct probabilistic stability analysis considering parameter uncertainty [Assessment]
Readings : [**DuncanWright2014**]	

Unit 4: Geotechnical Earthquake Engineering (15 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Single-degree-of-freedom dynamic systems and one-dimensional wave propagation through soil deposits • Site response and ground motion amplification • Seismic hazard analysis and design ground motions • Liquefaction susceptibility and triggering mechanisms • Cyclic stress ratio and liquefaction evaluation procedures • Effects of liquefaction on structures and infrastructure • Dynamic soil properties and laboratory testing • Design of foundations for vibrating machinery under dynamic loading • Ground improvement methods for liquefaction mitigation • Lateral spreading and flow failures • Seismically induced settlement and bearing capacity • Performance-based design for geotechnical earthquake engineering	• Formulate single-degree-of-freedom models and one-dimensional wave-propagation equations to characterize seismic wave transmission through soil deposits [Usage] • Explain site response effects and ground motion characteristics [Familiarity] • Determine design ground motions for geotechnical seismic analysis [Assessment] • Evaluate liquefaction susceptibility using field investigation data [Usage] • Calculate cyclic stress ratios and assess liquefaction potential [Assessment] • Assess the consequences of liquefaction on foundations and structures [Familiarity] • Characterize dynamic soil properties from laboratory and field tests [Usage] • Proportion machine foundations considering dynamic soil-foundation stiffness, resonance avoidance, and permissible vibration amplitudes [Assessment] • Select and design ground improvement methods to mitigate liquefaction [Assessment] • Predict lateral spreading displacements and flow failure potential [Usage] • Analyze seismically induced settlement and reduced bearing capacity [Assessment] • Implement performance-based approaches for seismic geotechnical design [Assessment]
Readings : [**Kramer1996**], [**Das2019**]	

Unit 5: Bearing Capacity and Design (9 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Bearing capacity theory and failure mechanisms • Ultimate bearing capacity equations for various conditions • Settlement analysis using elastic and consolidation methods • Isolated spread footing design • Combined footings and strap footings • Allowable bearing pressure and factor of safety selection • Mat foundation analysis and design • Eccentric and inclined loading effects • Soil-structure interaction effects • Differential settlement and tolerable limits • Continuous (strip) footing design for basement and foundation walls	• Explain bearing capacity failure mechanisms in shallow foundations [Familiarity] • Calculate ultimate bearing capacity using Terzaghi and Meyerhof equations [Assessment] • Predict total and differential settlements for shallow foundations [Usage] • Design isolated spread footings for gravity loads [Assessment] • Proportion combined and strap footings for column arrangements [Usage] • Determine allowable bearing pressures based on strength and settlement criteria [Assessment] • Analyze mat foundations using conventional and finite element methods [Assessment] • Evaluate bearing capacity under eccentric and inclined loading [Usage] • Consider soil-structure interaction in foundation design [Familiarity] • Assess differential settlement and apply tolerable settlement criteria [Assessment] • Design continuous strip footings for basement and foundation walls [Usage]
Readings : [**Coduto2001**], [**Das2019**]	

Unit 6: Ground Improvement Techniques (6 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Compaction methods including dynamic and vibratory techniques • Stone columns and vibro-replacement methods • Preloading and vertical drains for soft ground treatment • Deep mixing and jet grouting techniques • Chemical stabilization and grouting methods	• Select appropriate ground improvement methods for specific soil conditions [Familiarity] • Design stone column systems for settlement reduction [Assessment] • Calculate consolidation time reduction using vertical drains [Usage] • Identify geosynthetic types and their engineering applications [Familiarity] • Proportion reinforcement for mechanically stabilized earth structures [Assessment]
Readings : [**Koerner2012**], [**Das2019**]	

Unit 7: Deep Foundations (5 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Pile types and installation methods • Axial capacity of single piles in cohesive and cohesionless soils • Lateral load capacity and p-y method • Pile group behavior and group efficiency • Drilled shaft design and construction considerations • Negative skin friction and downdrag forces	• Select appropriate pile types based on soil conditions and loading [Familiarity] • Calculate axial capacity of piles using static methods [Assessment] • Analyze laterally loaded piles using p-y curves [Usage] • Evaluate pile group capacity and settlement [Assessment] • Design drilled shaft foundations including shaft diameter and reinforcement [Usage] • Interpret pile load test results and verify design assumptions [Assessment]
Readings : [**Coduto2001**], [**Das2019**]	

Unit 8: Earth Retaining Systems (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Earth pressure theory including active and passive pressures • Retaining wall types and selection criteria • Load testing methods including static and dynamic tests • Anchored walls and tied-back systems • Mechanically stabilized earth walls and reinforced soil systems • Basement and foundation wall design considering top-of-wall restraint conditions • Counterfort and buttressed retaining wall design	• Apply lateral earth pressure theories for retaining wall design [Assessment] • Design gravity and cantilever retaining walls [Usage] • Design anchored wall systems including ground anchor capacity [Assessment] • Proportion mechanically stabilized earth walls and select reinforcement [Usage] • Design basement and foundation walls considering top restraint, surcharge, and hydrostatic loads [Assessment] • Design counterfort retaining walls including stem, heel, toe, and counterfort elements [Usage]
Readings : [**Das2019**], [**Coduto2001**]	

Unit 9: Earth Dams (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definition, function, and role of earth dams within water resources infrastructure • Typology of embankment dams: homogeneous and zoned earthfill/rockfill dams, and selection criteria • Dam zoning: core, shell, filters, drains, and transition zones • Site selection factors and reservoir/dam-site feasibility considerations	• Explain the function of earth dams and their role within water resources infrastructure [Familiarity] • Classify embankment dams by type and select an appropriate typology for given site and material conditions [Assessment] • Describe the zoning of an earth dam and the function of each zone (core, shell, filters, drains) [Familiarity] • Evaluate site selection factors governing dam type and location choice [Usage]
Readings : [**FellDams2015**], [**USBRSmallDams1987**]	

Unit 10: Geotechnical Characterization for Earth Dams (5 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Foundation geotechnical characterization: rock and soil foundation conditions for embankment dams • Characterization of borrow materials for core, shell, and filter zones • Compaction and shear strength properties of compacted fill materials • Permeability characterization of foundation and embankment materials • Dispersive soil identification and erodibility assessment for core materials	• Characterize foundation soil and rock conditions relevant to embankment dam design [Assessment] • Evaluate borrow material sources for suitability as core, shell, or filter material [Usage] • Determine compaction and shear strength properties of compacted embankment materials [Assessment] • Assess dispersive soil potential and erodibility of candidate core materials [Usage]
Readings : [**FellDams2015**], [**USBRSmallDams1987**]	

Unit 11: Geotechnical Design of Embankment Dams (9 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Seepage analysis through the embankment and foundation using flow nets and numerical methods • Seepage control measures: core design, cutoff walls, and grout curtains • Filter and drain design criteria to prevent internal erosion and piping • Slope stability analysis of upstream and downstream dam faces under static and rapid drawdown conditions • Seismic design considerations and deformation analysis for embankment dams • Freeboard determination and settlement/camber allowance in embankment design	• Analyze seepage through the embankment and foundation using flow nets or numerical seepage models [Assessment] • Design seepage control measures including impervious cores, cutoff walls, and grout curtains [Usage] • Design filter and drain zones according to piping and internal erosion criteria [Assessment] • Evaluate slope stability of dam faces under steady-state seepage, rapid drawdown, and end-of-construction conditions [Usage] • Incorporate seismic loading and deformation analysis into embankment dam design [Assessment] • Determine freeboard and settlement allowances for embankment design [Usage]
Readings : [**FellDams2015**], [**SherardDams1963**], [**USACE1902**]	

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

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

1. COURSE

CE3H5. Fluvial Hydraulics (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3H5. Fluvial Hydraulics
2.2 Semester	:	10^{th} Semester.
2.3 Credits	:	4
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 Prerrequisites	:	CE3H2. General Hydrology. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Introduction to Fluvial Hydraulics covers the behavior of natural channels under the action of flow and sediment transport: from basin erosion and sediment properties, through the calculation of bed load, suspended load, and total load, to the analysis of scour and fluvial morphology using tools such as the Lane balance. The course culminates with the design of channel stabilization and bank protection works, reservoir sedimentation management, and an introduction to river navigation.

5. GOALS

- Analyze bed load, suspended load, and total sediment transport in alluvial channels.
- Calculate general and local scour, and analyze the morphology and stability of river channels.
- Design channel stabilization works and bank protection structures.
- Evaluate reservoir sedimentation and the fundamentals of river navigation.

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)

7. TOPICS

Unit 1: Introduction to Fluvial Hydraulics (2 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Scope and objectives of the Fluvial Hydraulics course.	• Describe the scope of river engineering and its role in water resources engineering [Familiarizarse].
Readings : [**Julien2010**]	

Unit 2: Sediment Transport in Alluvial Channels (22 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Watershed erosion and sediment yield • Physical properties of sediment: size, shape, density, and fall velocity • Flow in sand and gravel channels and associated bedforms • Flow resistance in alluvial channels • Incipient motion condition and design of erodible channels • Fundamentals and techniques for measuring sediment transport • Bed load sediment transport • Suspended load sediment transport • Sediment entry into intakes and diversion structures • Total sediment load transport formulas	• Explain watershed erosion processes and their relation to sediment yield [Familiarity] • Classify sediments by their physical properties and estimate their fall velocity [Usage] • Determine the incipient motion condition for a given alluvial channel [Assessment] • Calculate flow resistance in an alluvial channel accounting for bedforms [Usage] • Estimate bed load and suspended load transport rates using standard formulas [Assessment] • Apply total sediment load formulas to an alluvial channel design problem [Usage] • Evaluate sediment entry into an intake and propose exclusion measures [Assessment]
Readings : [**Julien2010**], [**GarciaASCE2008**]	

Unit 3: Open Channel Flow and River Mechanics (8 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Channel flow classification and hydraulic elements • Energy and momentum principles in open channels • Uniform flow and Manning's equation • Critical flow and specific energy concepts • Gradually varied flow profiles • Hydraulic jump and rapidly varied flow • Channel design for stable conveyance • Sediment transport in open channels • River morphology and channel stability • Scour analysis and protection measures	• Classify open channel flow regimes and calculate hydraulic elements [Familiarity] • Apply energy and momentum equations to solve channel flow problems [Assessment] • Calculate normal depth and discharge using Manning's equation [Usage] • Determine critical depth and analyze specific energy relationships [Assessment] • Compute gradually varied flow profiles using standard methods [Usage] • Analyze hydraulic jumps and calculate energy dissipation [Assessment] • Design stable channels with appropriate cross-sections and linings [Usage] • Estimate sediment transport rates in alluvial channels [Assessment] • Evaluate river channel stability and bank erosion potential [Familiarity] • Predict scour depths at hydraulic structures and design protection [Assessment]
Readings : [**Chow1959**]	

Unit 4: Design of Hydraulic Structures (2 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Dam types and selection criteria • Spillway hydraulics and design • Weir and gate flow equations • Energy dissipation and stilling basin design • Culvert hydraulics and design • Dam safety analysis and risk assessment • Outlet works and control structures • Fish passage facilities and environmental hydraulics • Cavitation analysis and prevention • Physical hydraulic modeling and scale effects	• Classify dam types and select appropriate configurations for site conditions [Familiarity] • Design spillways for flood discharge capacity [Assessment] • Calculate discharge over weirs and through gates [Usage] • Proportion energy dissipation structures and stilling basins [Assessment] • Analyze culvert hydraulics for inlet and outlet control [Usage] • Perform dam safety evaluations and hazard classification [Assessment] • Design outlet works including intake structures and conduits [Usage] • Incorporate fish passage requirements in hydraulic structure design [Assessment] • Evaluate cavitation potential and design preventive measures [Usage] • Interpret physical model results and apply scale corrections [Assessment]
Readings : [**Novak2007**]	

Unit 5: Scour and Fluvial Morphology (26 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Scour fundamentals and long-term bed elevation changes • Computation of general scour • Local scour from contractions, bends, and confluences • Local scour at bridge piers and abutments • Fluvial morphology cycles and processes • Shape, geometry, and stability of alluvial channels • Lane balance: qualitative channel response and modeling • Interaction between highway infrastructure and natural streams	• Calculate the general scour depth in a channel reach [Assessment] • Determine local scour from contraction and at bridge piers and abutments [Usage] • Analyze long-term bed elevation changes in a fluvial reach [Assessment] • Describe the cycles and processes governing alluvial channel morphology [Familiarity] • Apply the Lane balance to predict the qualitative response of a channel to changes in its variables [Usage] • Evaluate interaction problems between highway infrastructure and natural streams [Assessment]
Readings : [**GarciaASCE2008**], [**Julien2010**]	

Unit 6: River Engineering (24 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Channel stabilization: design criteria and examples • Control structures for riverbank protection • Design of riprap, gabions, and protective filters • Practical design considerations for river protection works • Reservoir sedimentation and dead storage volume • Trap efficiency and management of reservoir sedimentation • Analytical fundamentals of river navigation • River navigation paradigms and port conditioning	• Design a channel stabilization structure for a given reach [Usage] • Select and size bank protection structures (riprap, gabions, filters) [Assessment] • Apply practical design considerations to a conceptual river protection case [Usage] • Estimate the dead storage volume and useful life of a reservoir due to sedimentation [Assessment] • Evaluate the sediment trap efficiency of a reservoir and propose management measures [Usage] • Explain the analytical fundamentals of river navigation and its port conditioning [Familiarity]
Readings : [**GarciaASCE2008**]	

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.

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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

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

1. COURSE

CE3H6. Irrigation and hydropower (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3H6. Irrigation and hydropower
2.2 Semester	:	10^{th} Semester.
2.3 Credits	:	4
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 Prerrequisites	:	CE3H4. Water Resources. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Irrigation and Hydropower addresses the comprehensive design of irrigation projects and small-scale hydropower schemes: from the context of Peruvian agriculture and the soil-water-plant relationship, the estimation of evapotranspiration and agricultural water demand, to the hydraulic sizing of dams and reservoirs, the design of intake structures (diversion weirs, desanders) and conveyance structures (canals), the agronomic and hydraulic design of gravity and pressurized irrigation systems (including drip irrigation), and agricultural drainage. The course also covers the fundamentals of run-of-river small hydropower schemes, including penstock design and turbine selection, and concludes with the evaluation of irrigation and hydropower projects from environmental, social, and economic perspectives.

5. GOALS

- Estimate agricultural water demand based on the soil-water-plant relationship and crop evapotranspiration.
- Size dams, reservoirs, and intake and conveyance structures for an irrigation project.
- Design gravity and pressurized irrigation systems, including the agronomic and hydraulic design of drip irrigation.
- Design an agricultural drainage system to control waterlogging and soil salinity.
- Design the layout of a small-scale hydropower scheme and select an appropriate turbine for given head and flow conditions.
- Evaluate irrigation and hydropower projects considering environmental, social, and economic criteria.

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)

7. TOPICS

Unit 1: Agriculture in Peru and Description of an Irrigation Project (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Context and current status of irrigated agriculture in Peru. • Components and general description of an irrigation project.	• Describe the context of irrigated agriculture in Peru and its main challenges [Familiarizarse]. • Identify the main components of an irrigation project [Familiarizarse].
Readings : [**Chambouleyron2005**]	

Unit 2: Agricultural Water Demand (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Soil-water-plant relationships and soil water availability • Estimation of reference and crop evapotranspiration • Crop water requirement and crop coefficients • Water supply-and-demand balance for an irrigation project • Irrigation scheduling and cropping calendars • Irrigation efficiency at the field, conveyance, and system level	• Explain the soil-water-plant relationship and its effect on water availability for crops [Familiarity] • Calculate reference and crop evapotranspiration using standard methods [Usage] • Estimate a crop's water requirement throughout its growth cycle [Assessment] • Develop the water supply-and-demand balance for an irrigation project [Usage] • Design an irrigation schedule accounting for the cropping calendar [Assessment] • Evaluate the irrigation efficiency of a system and propose improvements [Usage]
Readings : [**Allen1998**], [**Chambouleyron2005**]	

Unit 3: Design of Hydraulic Structures (12 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Dam types and selection criteria • Spillway hydraulics and design • Weir and gate flow equations • Energy dissipation and stilling basin design • Culvert hydraulics and design • Dam safety analysis and risk assessment • Outlet works and control structures • Fish passage facilities and environmental hydraulics • Cavitation analysis and prevention • Physical hydraulic modeling and scale effects	• Classify dam types and select appropriate configurations for site conditions [Familiarity] • Design spillways for flood discharge capacity [Assessment] • Calculate discharge over weirs and through gates [Usage] • Proportion energy dissipation structures and stilling basins [Assessment] • Analyze culvert hydraulics for inlet and outlet control [Usage] • Perform dam safety evaluations and hazard classification [Assessment] • Design outlet works including intake structures and conduits [Usage] • Incorporate fish passage requirements in hydraulic structure design [Assessment] • Evaluate cavitation potential and design preventive measures [Usage] • Interpret physical model results and apply scale corrections [Assessment]
Readings : [**Novak2007**]	

Unit 4: Open Channel Flow and River Mechanics (9 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Channel flow classification and hydraulic elements • Energy and momentum principles in open channels • Uniform flow and Manning's equation • Critical flow and specific energy concepts • Gradually varied flow profiles • Hydraulic jump and rapidly varied flow • Channel design for stable conveyance • Sediment transport in open channels • River morphology and channel stability • Scour analysis and protection measures	• Classify open channel flow regimes and calculate hydraulic elements [Familiarity] • Apply energy and momentum equations to solve channel flow problems [Assessment] • Calculate normal depth and discharge using Manning's equation [Usage] • Determine critical depth and analyze specific energy relationships [Assessment] • Compute gradually varied flow profiles using standard methods [Usage] • Analyze hydraulic jumps and calculate energy dissipation [Assessment] • Design stable channels with appropriate cross-sections and linings [Usage] • Estimate sediment transport rates in alluvial channels [Assessment] • Evaluate river channel stability and bank erosion potential [Familiarity] • Predict scour depths at hydraulic structures and design protection [Assessment]
Readings : [**Chow1959**]	

Unit 5: Irrigation Systems Design (33 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Types of irrigation intake works • Headworks design • Desander design • Other structures of the irrigation conveyance and distribution system • Design of gravity irrigation systems • Design of pressurized (technified) irrigation systems • Agronomic design of drip irrigation • Hydraulic design of drip irrigation: laterals, distribution lines, and emitters	• Select the appropriate intake work type for the conditions of an irrigation project [Usage] • Design a headworks structure and its associated desander [Assessment] • Design a gravity irrigation system for a given field [Usage] • Compare pressurized irrigation alternatives against gravity irrigation [Assessment] • Perform the agronomic design of a drip irrigation system [Usage] • Hydraulically design the lateral and distribution lines of a drip irrigation system [Assessment]
Readings : [**Chambouleyron2005**], [**Karmeli1975**]	

Unit 6: Economic, Financial and Social Evaluation of Water Resources Projects (9 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Economic evaluation indicators: Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit-Cost ratio • Selecting among project alternatives by comparing economic indicators • Sensitivity analysis to variations in costs, benefits, and discount rate • Funding sources and financial structuring of water projects • User payment capacity and tariff schemes • Cost allocation among beneficiaries in multipurpose projects • Social evaluation of projects: exchange theory and shadow prices • Distributional impacts and equity in project social evaluation	• Calculate NPV, IRR, and Benefit-Cost ratio for a water resources project [Usage] • Select among project alternatives based on compared economic indicators [Assessment] • Perform a sensitivity analysis of project profitability to changes in key variables [Usage] • Evaluate funding sources and tariff schemes based on user payment capacity [Assessment] • Allocate costs among beneficiaries in a multipurpose project [Usage] • Apply social evaluation principles to estimate a project's net benefit to society [Assessment]
Readings : [**Blank2017**]	

Unit 7: Agricultural and Subsurface Drainage (9 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Waterlogging and salinity: causes and the need for agricultural drainage • Design of subsurface (tile/pipe) drainage systems: drain spacing and depth • Design of surface and open-ditch drainage systems for irrigated fields • Salinity control through drainage and the leaching requirement • Drainage water collection, disposal, and reuse	• Explain the causes of waterlogging and soil salinity in irrigated land [Familiarity] • Design a subsurface drainage system, determining drain spacing and depth [Usage] • Size a surface drainage network for an irrigated field [Assessment] • Calculate the leaching requirement needed to control soil salinity [Usage] • Propose a drainage water collection and disposal scheme for an irrigation project [Assessment]
Readings : [**Ritzema1994**]	

Unit 8: Small-Scale Hydropower Engineering (15 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Hydropower potential estimation from head and flow-duration curves • Run-of-river small hydropower scheme layout: intake, forebay, penstock, powerhouse, and tailrace • Penstock design: diameter selection, head losses, and water-hammer considerations • Turbine type selection (Pelton, Francis, Kaplan, cross-flow) based on head and flow • Grid connection, electromechanical equipment fundamentals, and off-grid rural electrification schemes	• Explain the concept of hydropower potential and the use of flow-duration curves [Familiarity] • Estimate the hydropower potential of a river reach or irrigation canal drop structure [Usage] • Design the layout of a run-of-river small hydropower scheme [Assessment] • Select an appropriate turbine type for given head and flow conditions [Usage] • Design a penstock accounting for head losses and water-hammer effects [Assessment]
Readings : [**Penche2010**]	

Unit 9: Environmental Impact Assessment and Sustainability Metrics (3 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**]	

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

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

1. COURSE

CE3H9. Hydraulic and Hydrology Engineering Workshop (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3H9. Hydraulic and Hydrology Engineering Workshop
2.2 Semester	:	10^{th} Semester.
2.3 Credits	:	3
2.4 Hours	:	
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Mandatory
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	CE3H2. General Hydrology. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Hydraulic and Hydrological Engineering Workshop is an applied course on dam design: it begins with hydraulic planning (water availability and demand, reservoir sizing methods) and then covers the engineering and structural design of gravity concrete dams, hollow gravity dams, earthfill dams, and rockfill dams, including stability and seepage analysis, and the design of associated intake, diversion, and control structures.

5. GOALS

- Estimate water availability and demand for reservoir planning.
- Size reservoir capacity using simulation methods and stochastic analysis (Ripple, range, Markov chains).
- Design concrete dams (gravity and hollow gravity) and earthfill and rockfill dams, including stability and seepage analysis.
- Design the associated intake, diversion, and control structures for a dam project.

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)

7. TOPICS

Unit 1: Hydrologic Cycle and Water Balance (5 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Hydrologic cycle and water balance concepts • Precipitation measurement and analysis • Evaporation and evapotranspiration estimation • Infiltration theory and rainfall-runoff processes	• Explain the hydrologic cycle and quantify water balance components [Familiarity] • Analyze precipitation data and develop depth-area-duration relationships [Assessment] • Estimate evaporation and evapotranspiration using empirical methods [Usage] • Apply infiltration models to estimate runoff from rainfall events [Assessment]
Readings : [**ChowMaidmentMays1988**], [**Loucks2017**]	

Unit 2: Surface Hydrology and Watershed Modeling (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Hydrograph analysis and unit hydrograph method • Watershed modeling and hydrologic simulation • Streamflow measurement and gauging techniques	• Derive unit hydrographs and synthesize runoff hydrographs [Usage] • Develop watershed models using software tools for hydrologic simulation [Usage] • Conduct streamflow measurements and interpret flow duration curves [Assessment]
Readings : [**ChowMaidmentMays1988**], [**Loucks2017**]	

Unit 3: Flood Frequency Analysis and Climate Change (3 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Flood frequency analysis and design storms • Hydrologic routing methods for channels and reservoirs • Climate change impacts on hydrologic systems	• Perform flood frequency analysis using statistical methods [Assessment] • Route flood hydrographs through channels and reservoirs [Usage] • Evaluate climate change impacts on watershed hydrology and design implications [Assessment]
Readings : [**ChowMaidmentMays1988**], [**Loucks2017**]	

Unit 4: Design of Hydraulic Structures (66 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Dam types and selection criteria • Spillway hydraulics and design • Weir and gate flow equations • Energy dissipation and stilling basin design • Culvert hydraulics and design • Dam safety analysis and risk assessment • Outlet works and control structures • Fish passage facilities and environmental hydraulics • Cavitation analysis and prevention • Physical hydraulic modeling and scale effects	• Classify dam types and select appropriate configurations for site conditions [Familiarity] • Design spillways for flood discharge capacity [Assessment] • Calculate discharge over weirs and through gates [Usage] • Proportion energy dissipation structures and stilling basins [Assessment] • Analyze culvert hydraulics for inlet and outlet control [Usage] • Perform dam safety evaluations and hazard classification [Assessment] • Design outlet works including intake structures and conduits [Usage] • Incorporate fish passage requirements in hydraulic structure design [Assessment] • Evaluate cavitation potential and design preventive measures [Usage] • Interpret physical model results and apply scale corrections [Assessment]
Readings : [**Novak2007**], [**USBR1987**]	

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

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE3S10. Seismic Design of Civil Engineering Works (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3S10. Seismic Design of Civil Engineering Works
2.2 Semester	:	10^{th} Semester.
2.3 Credits	:	4
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 Prerrequisites	:	CE3S4. Earthquake-Resistant Engineering and Disaster Prevention. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Seismic Design of Civil Engineering Works introduces the seismic analysis and reinforced concrete design of special/industrial civil engineering structures – free-standing chimneys and liquid-storage tanks – extending the seismological, code, and structural-dynamics fundamentals from Earthquake-Resistant Engineering to structures whose seismic behavior differs fundamentally from that of buildings. The course opens with the professional and regulatory context of civil engineering works, framing the elevated public-safety risk profile of special/industrial structures, then reviews the seismic phenomenon, the Peruvian seismic design code, and the fundamentals of structural dynamics before applying them to the seismic analysis and reinforced concrete design of chimneys – modeled as equivalent cantilever systems – and liquid-storage tanks, whose seismic response is governed by the hydrodynamic impulsive-convective interaction between the contained liquid and the tank walls, following ACI 307 and ACI 350.3.

5. GOALS

- Explain the professional and regulatory context of civil engineering works, with emphasis on the public-safety risk profile of special/industrial structures.
- Explain the seismic phenomenon and apply the Peruvian seismic design code to determine seismic hazard parameters and structural configuration criteria.
- Analyze the dynamic response of structural systems subjected to earthquake ground motion.
- Analyze the seismic behavior of free-standing chimneys and design their reinforced concrete shell for seismic loading according to ACI 307.
- Analyze the hydrodynamic seismic response of liquid-storage tanks and design their reinforced concrete walls and base for seismic-induced hydrodynamic pressures according to ACI 350.3.

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)

7. TOPICS

Unit 1: Professional and Regulatory Context (12 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Typology of civil engineering works: buildings, transportation and hydraulic infrastructure, and special/industrial structures (chimneys, tanks, silos) • Peruvian regulatory framework (Reglamento Nacional de Edificaciones) and applicable international standards (ACI, ASCE) for special/industrial structures • Professional responsibility and public-safety risk considerations specific to special/industrial structures under seismic hazard • Design process and stakeholders involved in a special/industrial structures project: owner, design engineer, and regulatory authority	• Classify civil engineering works by typology and identify the regulatory framework applicable to special/industrial structures [Familiarity] • Explain the professional responsibility and public-safety risk considerations specific to the design of special/industrial structures [Familiarity] • Describe the design process and the stakeholders involved in a special/industrial structures project [Usage]
Readings : [**E030-2018**]	

Unit 2: Seismology and Natural Hazards (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Plate tectonics and earthquake generation mechanisms through fault rupture • Seismic waves: types (P, S, surface) and their propagation • Magnitude (seismic moment) and intensity (Modified Mercalli) scales • Historical seismicity and subduction tectonic context of Peru • Typology of natural disasters: seismic, volcanic, tsunami, and mass movement • Disaster risk management: prevention, mitigation, preparedness, and response (SINAGERD framework) • Seismological instrumentation: seismographs, accelerographs, and national monitoring networks	• Explain plate tectonics and earthquake generation mechanisms through fault rupture [Familiarity] • Differentiate types of seismic waves and their effects on buildings [Usage] • Interpret and distinguish between earthquake magnitude and intensity scales [Usage] • Describe the historical seismicity and subduction context of Peru [Familiarity] • Classify the main types of natural disasters affecting Peruvian territory [Familiarity] • Analyze the disaster risk management framework for earthquake prevention and response [Assessment]
Readings : [**Bolt2005**], [**Kramer1996**]	

Unit 3: Seismic Design Code and Structural Configuration Criteria (6 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Scope and structure of the Peruvian seismic design code E.030 • Seismic hazard parameters: seismic zonation (Z), usage factor (U), and soil profile (S) • Structural systems and seismic force reduction coefficient (R) • Plan structural irregularities: torsional irregularity, re-entrant corners, and diaphragm discontinuity • Vertical structural irregularities: soft story, weak story, and mass irregularity • Structuring principles: symmetry, redundancy, hyperstaticity, and continuity • Minimum base shear and inter-story drift limits	• Explain the scope and structure of the Peruvian seismic design code E.030 [Familiarity] • Determine the seismic hazard parameters (Z, U, S) applicable to a given site [Usage] • Select the structural system and corresponding reduction coefficient R [Usage] • Classify the plan and vertical structural irregularities of a building [Assessment] • Apply structuring principles to propose a regular structural configuration [Usage] • Verify the minimum base shear and inter-story drift limits [Assessment]
Readings : [**E030-2018**], [**BazanMeli2002**]	

Unit 4: Structural Dynamics and Earthquake Engineering (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Single-degree-of-freedom systems and free vibration • Forced vibration and harmonic excitation • Damping models and energy dissipation mechanisms • Response spectrum analysis • Earthquake ground motion characteristics and seismicity • Multi-degree-of-freedom systems and modal analysis • Time-history analysis and numerical integration methods • Seismic design philosophy and capacity design principles • Base isolation and energy dissipation devices • Performance-based seismic design methodology	• Analyze free vibration of single-degree-of-freedom systems and determine natural frequencies [Assessment] • Calculate structural response to harmonic and periodic loads [Usage] • Explain the role of damping in reducing dynamic response [Familiarity] • Apply response spectrum method for seismic analysis [Usage] • Interpret earthquake ground motion parameters and seismic hazard maps [Familiarity] • Perform modal analysis for multi-degree-of-freedom systems [Assessment] • Conduct time-history analysis using numerical integration techniques [Usage] • Design structures following capacity design and ductile detailing principles [Assessment] • Evaluate the effectiveness of base isolation and damping systems [Familiarity] • Implement performance-based seismic design procedures [Assessment]
Readings : [**Chopra2017**]	

Unit 5: Industrial Structures: Chimneys and Tanks (48 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Dynamic idealization of a free-standing chimney as an equivalent cantilever stick model • Seismic force and overturning moment distribution along the height of a chimney per ACI 307 • Flexural and shear design of reinforced concrete chimney shell sections under seismic loading • Seismic reinforcement detailing for chimney shells, openings, and construction joints • Housner's impulsive-convective two-mass model for the hydrodynamic seismic response of liquid-storage tanks • Impulsive and convective (sloshing) hydrodynamic pressure distribution on tank walls and base per ACI 350.3 • Design of reinforced concrete tank walls and base slab for seismic-induced hydrodynamic pressures • Sloshing wave height, freeboard requirements, and anchorage design for storage tanks	• Explain the dynamic idealization of a free-standing chimney as an equivalent cantilever stick model for seismic analysis [Familiarity] • Determine the seismic force and overturning moment distribution along the height of a reinforced concrete chimney [Usage] • Design the reinforced concrete shell section of a chimney for flexure and shear under seismic loading [Assessment] • Detail seismic reinforcement for chimney shells, openings, and construction joints [Usage] • Explain Housner's impulsive-convective mass model for the hydrodynamic seismic response of liquid-storage tanks [Familiarity] • Determine impulsive and convective hydrodynamic pressure distributions on tank walls and base [Usage] • Design reinforced concrete tank walls and base slab for seismic-induced hydrodynamic pressures [Assessment] • Calculate sloshing wave height and freeboard requirements, and design anchorage for a storage tank [Usage]
Readings : [**ACI307-22**], [**ACI3503-20**], [**Housner1963**]	

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.

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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

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

1. COURSE

CE3S12. Research Workshop (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3S12. Research Workshop
2.2 Semester	:	10^{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 Prerrequisites	:	BMI201. Methodology of Engineering Research. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Research Workshop introduces students to the fundamentals of engineering research methodology in preparation for capstone-level research work in Civil Engineering. Students learn to identify a research idea and formulate a research problem, build the theoretical and conceptual framework that supports a study, formulate testable hypotheses and operationalize the variables involved, select and justify an appropriate type and design of research, and collect and analyze data to answer a civil engineering research question. The course also reinforces the professional ethics and technical communication skills required to conduct and disseminate engineering research responsibly.

5. GOALS

- Formulate a well-defined civil engineering research idea and problem statement grounded in a real technical need.
- Build a theoretical framework through systematic literature review and critical synthesis of prior research.
- Formulate testable research hypotheses and operationalize the variables of a civil engineering study.
- Select and justify an appropriate type and design of research (quantitative, qualitative, or mixed methods) for a given research problem.
- Collect and statistically analyze data to answer a civil engineering research question.
- Apply engineering ethics and produce clear technical communication throughout the research process.
- The deliverables for this course are:

  Midterm: Research idea, problem statement, and theoretical framework document.

  Final: Complete research proposal including hypotheses, variables, research type and design, and a preliminary data collection and analysis plan.

6. COMPETENCES

ABET-3) An ability to communicate effectively with a range of audiences. (Usage)

ABET-4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. (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: Research Design and Methodologies (28 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Formulating research questions in architecture: descriptive, relational, causal; turning design problems into researchable questions • Choosing a research methodology: quantitative (hypothesis testing, statistical), qualitative (interpretive, case study), mixed methods, • Validity and reliability in architectural research: internal validity, external validity (generalizability), construct validity, • Research ethics in architectural research: informed consent, privacy (anonymization of building users), institutional review board (IRB) protocols, • Mixed methods research: sequential (qualitative then quantitative) and concurrent designs; integrating qualitative findings (user interviews) with quantitative data (occupancy	• Describe the main research methodologies in architecture - quantitative, qualitative, mixed methods, practice-based - and explain their appropriate applications [Familiarity] • Develop a research design for an architectural inquiry, including research question, literature review, methodology selection, data collection protocol, and analysis plan [Usage] • Evaluate the research design of a published architectural study for validity, reliability, and ethical soundness, identifying methodological strengths and weaknesses [Assessment]
Readings : [**Creswell2018**], [**LeedyOrmrod2019**]	

Unit 2: Theoretical Framework and Literature Review (16 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Systematic search of scientific and technical literature: specialized databases (Scopus, Web of Science, ASCE Library), keywords, and Boolean operators • Critical reading and synthesis of scientific articles, technical standards, and prior research reports • Building the conceptual and theoretical framework: defining key concepts, relationships between variables, and reference theoretical models • Identifying knowledge gaps (research gap) and justifying the originality of the proposed contribution • Bibliographic reference management and citation styles (APA, IEEE) using tools such as Zotero or Mendeley	• Explain the structure and purpose of a theoretical framework within a civil engineering research project [Familiarity] • Conduct a systematic search of scientific and technical literature on a chosen research topic using specialized databases [Usage] • Synthesize the state of the art of a research topic into a coherent theoretical framework that identifies a knowledge gap [Assessment]
Readings : [**BoothColombWilliams2016**], [**Creswell2018**]	

Unit 3: Research Hypotheses and Variables (16 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Types of hypotheses: null, alternative, directional, and non-directional, and their relationship to research questions • Classification of variables: independent, dependent, control, and confounding • Operationalizing variables: defining measurable indicators and measurement scales (nominal, ordinal, interval, ratio) • Relationship between hypotheses, variables, and statistical significance tests: significance level, Type I and Type II error • Graphical representation of the relationship between variables through conceptual or operational models	• Distinguish between null and alternative hypotheses, and between independent, dependent, and control variables, in a civil engineering research problem [Familiarity] • Formulate a testable research hypothesis and operationalize its variables for a specific problem in the chosen specialization area [Usage] • Evaluate the consistency between the theoretical framework, the stated hypothesis, and the proposed data-collection design [Assessment]
Readings : [**MontgomeryRunger2018**], [**Kumar2019**]	

Unit 4: Quantitative Methods in Architectural Research (12 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Survey design for architectural research: sampling methods (probability, convenience), questionnaire design (Likert scales, semantic differential), response rate optimization, • Experimental designs: true experiments (random assignment, control group), quasi-experiments (non-randomized, pre-post, time series), • Descriptive statistics: measures of central tendency (mean, median, mode), dispersion (standard deviation, range, interquartile range), • Inferential statistics: hypothesis testing (t-test, ANOVA, chi-square), correlation and regression (linear, multiple), and interpretation of p-values • Instrumentation for quantitative data collection: environmental sensors (temperature, light, CO_2), occupancy counters, objective performance measures (task completion time	• Describe the main quantitative methods in architectural research - surveys, experiments, quasi-experiments - [Familiarity] • Design a survey or experiment to test a hypothesis about the effect of a design variable (lighting, color, layout) on user satisfaction, task performance, or behavior [Usage] • Evaluate a quantitative architectural study for sampling validity, statistical analysis appropriateness, and correct interpretation of p-values and effect sizes [Assessment]
Readings : [**MontgomeryRunger2018**], [**Creswell2018**]	

Unit 5: Engineering Ethics and Professional Responsibility (4 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Ethical theories: utilitarianism, duty ethics, virtue ethics • Professional codes of conduct (e.g., ASCE, NSPE) and their fundamental canons • Engineer's paramount responsibility to public safety, health, and welfare • Ethical dilemmas in practice: conflicts of interest, whistleblowing, gift-giving • Ethical decision-making frameworks and case study analysis • Global engineering ethics and cross-cultural challenges • Ethical obligations for sustainable development and environmental stewardship • Ethical implications of emerging technologies (AI, automation, data privacy) • Ethical conduct in dispute resolution and litigation	• Explain the primary tenets of the engineer's code of ethics [Familiarity] • Apply an ethical decision-making framework to a hypothetical engineering scenario [Assessment] • Identify conflicts of interest and other common ethical pitfalls in project work [Familiarity] • Analyze a historical engineering failure case from an ethical perspective [Assessment] • Evaluate the ethical dimensions of a project with significant social or environmental impacts in a different cultural context [Assessment] • Articulate the ethical argument for incorporating sustainability into all engineering work [Familiarity] • Discuss the ethical responsibilities related to data collection and use in smart infrastructure projects [Assessment] • Describe the role of ethics in alternative dispute resolution processes [Familiarity]
Readings : [**HarrisEthics2013**], [**FleddermannEthics2020**]	

Unit 6: Written and Technical Communication (3 hours)	
Competences Expected: ABET-3	
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 : [**GurakLannon2013**]	

Unit 7: Oral Presentation and Professional Communication (3 hours)	
Competences Expected: ABET-3	
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 : [**GurakLannon2013**]	

Unit 8: Digital and Collaborative Communication (2 hours)	
Competences Expected: ABET-3	
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 : [**GurakLannon2013**]	

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

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

1. COURSE

CE3S2. Reinforced Concrete Design II (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3S2. Reinforced Concrete Design II
2.2 Semester	:	10^{th} Semester.
2.3 Credits	:	4
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 Prerrequisites	:	CE2S2. Reinforced Concrete Design I. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Reinforced Concrete Design II builds directly on Reinforced Concrete Design I, extending limit state design methodology to the structuring and design of building slab systems, seismic-resistant reinforced concrete structural walls (shear walls) and special moment frame provisions, and the use of structural analysis software for three-dimensional building modeling. The course also develops earth-retaining structure design, including basement walls, anchored walls, gravity walls, and cantilever and counterfort retaining walls, together with advanced shallow foundation design covering isolated, combined, connected, eccentric, and continuous footings. Through progressive, integrated design exercises, students apply current design codes to produce a complete seismic-resistant reinforced concrete building design, preparing them for advanced structural and earthquake-resistant design coursework.

5. GOALS

- Structure reinforced concrete buildings and design one-way (precast) and two-way reinforced concrete slab systems.
- Design special reinforced concrete structural walls (shear walls) for seismic lateral force resistance.
- Apply special seismic detailing provisions to reinforced concrete moment-resisting frames.
- Build and analyze three-dimensional structural models of reinforced concrete buildings using structural analysis software.
- Design earth-retaining structures, including basement walls, anchored walls, gravity walls, and cantilever and counterfort retaining walls.
- Design shallow foundations, including isolated, combined, connected, eccentric, and continuous footings.

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)

7. TOPICS

Unit 1: Reinforced Concrete Design (18 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Design philosophy and limit state methodology for concrete structures • Flexural design of rectangular and T-beams • Shear and torsion design of concrete members • Compression members and column design • Slab design including one-way and two-way systems • Development length and splicing of reinforcement • Deflection control and serviceability requirements for concrete beams and slabs	• Explain limit state design philosophy and load factor combinations [Familiarity] • Design reinforced concrete beams for flexure and check serviceability [Assessment] • Calculate shear and torsional reinforcement requirements [Usage] • Proportion columns for axial load and biaxial bending [Assessment] • Design one-way and two-way slab systems with appropriate reinforcement [Usage] • Determine development lengths and design lap splices for reinforcing bars [Assessment] • Control deflections and verify serviceability requirements through adequate member sizing and reinforcement [Usage]
Readings : [**Wight2016**], [**ACI31819**], [**McCormac2021**]	

Unit 2: Earth Retaining Systems (26 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Earth pressure theory including active and passive pressures • Retaining wall types and selection criteria • Load testing methods including static and dynamic tests • Anchored walls and tied-back systems • Mechanically stabilized earth walls and reinforced soil systems • Basement and foundation wall design considering top-of-wall restraint conditions • Counterfort and buttressed retaining wall design	• Apply lateral earth pressure theories for retaining wall design [Assessment] • Design gravity and cantilever retaining walls [Usage] • Design anchored wall systems including ground anchor capacity [Assessment] • Proportion mechanically stabilized earth walls and select reinforcement [Usage] • Design basement and foundation walls considering top restraint, surcharge, and hydrostatic loads [Assessment] • Design counterfort retaining walls including stem, heel, toe, and counterfort elements [Usage]
Readings : [**Das2019**], [**ACI31819**]	

Unit 3: Seismic Detailing of Reinforced Concrete (7 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Beam-column joints and moment-resisting frame connections • Seismic detailing and ductile design of concrete structures • Design of special reinforced concrete structural walls (shear walls) for seismic lateral force resistance • Special seismic detailing provisions for reinforced concrete moment-resisting frames	• Detail beam-column joints for moment transfer and shear resistance [Assessment] • Implement seismic detailing requirements for ductile concrete frames [Assessment] • Design special reinforced concrete structural walls for combined axial, flexural, and shear demands under seismic loading [Assessment] • Apply special seismic detailing provisions to reinforced concrete moment frame members and beam-column joints [Usage]
Readings : [**Wight2016**], [**ACI31819**], [**Moehle2015**]	

Unit 4: Prestressed Concrete Analysis (7 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Prestressed concrete principles and pre-tensioning methods • Elastic analysis of stresses in prestressed concrete sections under service loads • Composite prestressed concrete sections: precast members with cast-in-place topping • Immediate and time-dependent losses of prestress	• Apply prestressing principles to design pre-tensioned members [Usage] • Analyze stresses in prestressed concrete sections under service loads using elastic theory [Usage] • Design composite prestressed concrete sections combining precast members and cast-in-place concrete [Assessment] • Calculate immediate and time-dependent losses of prestress [Usage]
Readings : [**Wight2016**], [**ACI31819**], [**Moehle2015**]	

Unit 5: Prestressed Concrete Design (8 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Post-tensioned concrete systems and tendon design • Deflection control and serviceability requirements • Flexural strength of prestressed concrete members at ultimate limit state • Shear and torsion design of prestressed concrete members • Statically indeterminate prestressed concrete structures, including secondary moments	• Design post-tensioned slabs and beams including tendon layout [Assessment] • Control deflections through appropriate member sizing and reinforcement [Usage] • Design prestressed concrete members for flexural strength at the ultimate limit state [Assessment] • Design prestressed concrete members for shear and torsion strength [Assessment] • Analyze statically indeterminate prestressed concrete structures, including secondary moments [Assessment]
Readings : [**Wight2016**], [**ACI31819**], [**Moehle2015**]	

Unit 6: Building Structural Analysis and Modeling Practicum (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Overview of case-study buildings: geometry, structural systems, and load paths • Development of plane frame and truss models of real buildings using stiffness-method-based structural analysis software • Application of static and seismic response-spectrum analysis to representative building case studies • Presentation and peer discussion of structural analysis results and their design implications • Definition of geometry, materials, sections, and boundary conditions for a three-dimensional building model in commercial structural analysis software (ETABS, Midas Gen) • Assignment of gravity, seismic, and wind loads and their combinations to a three-dimensional building model • Static and dynamic (modal) analysis of building models and interpretation of results, including story drifts, member forces, and vibration periods • Verification of software-generated results against simplified hand calculations and code checks	• Model real building structural systems for stiffness-method-based static and seismic analysis using structural analysis software [Usage] • Interpret and validate computer-generated analysis results against expected structural behavior [Assessment] • Present and defend structural analysis results and their design implications to peers [Usage] • Assign gravity, seismic, and wind loads and load combinations to a three-dimensional building model in commercial structural analysis software [Usage] • Interpret dynamic analysis results, including story drifts, member forces, and vibration periods [Assessment] • Verify software-generated results against simplified hand calculations [Assessment]
Readings : [**Wight2016**]	

Unit 7: Bearing Capacity and Design (26 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Bearing capacity theory and failure mechanisms • Ultimate bearing capacity equations for various conditions • Settlement analysis using elastic and consolidation methods • Isolated spread footing design • Combined footings and strap footings • Allowable bearing pressure and factor of safety selection • Mat foundation analysis and design • Eccentric and inclined loading effects • Soil-structure interaction effects • Differential settlement and tolerable limits • Continuous (strip) footing design for basement and foundation walls	• Explain bearing capacity failure mechanisms in shallow foundations [Familiarity] • Calculate ultimate bearing capacity using Terzaghi and Meyerhof equations [Assessment] • Predict total and differential settlements for shallow foundations [Usage] • Design isolated spread footings for gravity loads [Assessment] • Proportion combined and strap footings for column arrangements [Usage] • Determine allowable bearing pressures based on strength and settlement criteria [Assessment] • Analyze mat foundations using conventional and finite element methods [Assessment] • Evaluate bearing capacity under eccentric and inclined loading [Usage] • Consider soil-structure interaction in foundation design [Familiarity] • Assess differential settlement and apply tolerable settlement criteria [Assessment] • Design continuous strip footings for basement and foundation walls [Usage]
Readings : [**Coduto2001**], [**Das2019**]	

Unit 8: Integrated Structural Design Project (12 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Progressive design exercise integrating slab, structural wall, and foundation design for a multi-story reinforced concrete building • Coordination of structural design decisions with the architectural and geotechnical constraints of the project • Structural design documentation, including calculation memoranda and design drawings	• Develop a progressive, integrated structural design for a reinforced concrete building incorporating slabs, structural walls, and foundations [Assessment] • Apply course content cumulatively to solve realistic, open-ended design problems under code and site constraints [Assessment] • Prepare structural calculation documentation communicating design decisions [Usage]
Readings : [**Wight2016**], [**ACI31819**]	

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

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

1. COURSE

CE3S6. Masonry, Adobe, and Timber (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3S6. Masonry, Adobe, and Timber
2.2 Semester	:	10^{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 Prerrequisites	:	CE3S4. Earthquake-Resistant Engineering and Disaster Prevention. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Masonry, Adobe, and Timber covers the seismic-resistant design of low-rise buildings using the structural systems most widely used in Peruvian construction: structural masonry, adobe, and timber. Building on the seismic engineering fundamentals from Earthquake-Resistant Engineering, the course develops a design studio that applies material selection criteria, seismic code requirements, and structural detailing to complete building design projects in masonry, adobe, and timber.

5. GOALS

- Formulate the design process for a low-rise building, integrating site conditions, material selection, and applicable Peruvian building codes.
- Design structural and non-structural masonry walls for gravity and seismic loads.
- Design adobe walls and specify seismic reinforcement techniques according to Standard E.080.
- Design timber structural elements and connections for buildings and light structures.

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)

7. TOPICS

Unit 1: Design Process for Low-Rise Buildings (12 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Site and soil recognition, project requirements, and applicable regulatory framework (E.030, E.070, E.080, E.010) • Criteria for selecting a structural system among masonry, adobe, and timber based on site conditions, materials availability, and seismic hazard • Integration of the structural design with the architectural layout of a building project	• Describe the design process of a low-rise building, identifying site conditions and the applicable Peruvian regulatory framework [Familiarity] • Select an appropriate structural system for a building project based on site conditions, materials, and seismic hazard [Usage] • Formulate the scope and requirements of a building project that integrates masonry, adobe, or timber systems [Assessment]
Readings : [**PMI2021**], [**E030**]	

Unit 2: Masonry Structural Design (22 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Masonry materials, units, and mortar properties • Unreinforced masonry wall design for compression and flexure • Reinforced masonry design and detailing • Seismic design of masonry and timber structures	• Identify masonry unit types and specify appropriate mortar for applications [Familiarity] • Design unreinforced masonry walls for gravity and lateral loads [Assessment] • Proportion reinforced masonry elements and specify reinforcement details [Usage] • Implement seismic design provisions for masonry and timber buildings [Usage]
Readings : [**Drysdale2008**], [**E070**]	

Unit 3: Timber and Light-Gauge Steel Framing Design (33 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Timber properties, grading, and design values • Sawn lumber and glued-laminated timber design • Timber connections including nails, bolts, and metal connectors • Cold-formed steel members and sectional properties • Light-gauge steel framing systems and design • Engineered wood products including I-joists and structural composite lumber	• Select timber species and grades based on structural requirements [Familiarity] • Design timber beams, columns, and combined loading members [Assessment] • Specify timber connections and calculate their capacity [Usage] • Calculate effective section properties for cold-formed steel members [Assessment] • Design light-gauge steel wall studs and floor joists [Usage] • Apply engineered wood products in floor and roof systems [Assessment]
Readings : [**Breyer2015**], [**E010**]	

Unit 4: Adobe Structural Design (17 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Adobe as a structural material: mechanical properties and seismic behavior • Adobe wall design for gravity loads and verification of thickness and slenderness per Standard E.080 • Seismic reinforcement techniques for adobe construction: meshes, geomeshes, and horizontal and vertical reinforcement	• Characterize the mechanical properties of adobe and its seismic behavior [Familiarity] • Design adobe walls according to the thickness, slenderness, and geometric requirements of Standard E.080 [Assessment] • Specify seismic reinforcement techniques for new and existing adobe buildings [Usage]
Readings : [**Blondet2003**], [**E080**]	

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

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE3T5. Transportation Planning (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3T5. Transportation Planning
2.2 Semester	:	10^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE3T4. Traffic Engineering and Urban Road Design. (9^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Transportation Planning is the planning- and economics-focused course of the Vialidad, Geomatica y Transporte track, building on the traffic engineering and urban road design foundations established in Traffic Engineering and Urban Road Design (CE3T4) to address how transportation systems are planned, financed, and managed at the network and regional scale. The course opens with a brief review of traffic operations and management – arterial signal coordination, freeway operations, traffic simulation, and roundabout design – bridging the facility-level analysis of CE3T4 with the systems-level perspective that follows. It then develops the transportation planning process and travel demand forecasting methods, including the four-step model, activity-based approaches, and economic evaluation of transportation investments. Building on this planning foundation, the course covers the economic appraisal and financing of transportation infrastructure, including benefit-cost analysis, public-private partnerships, and road pricing and funding mechanisms. The course continues with freight transportation and logistics, covering freight demand modeling, logistics network design, intermodal terminals, and urban freight distribution, and closes with public transit systems planning, covering transit route and network planning, mode selection and service design, fare policy integration, and transit accessibility – providing the planning and economic-analysis foundation required for professional practice in transportation systems planning.

5. GOALS

- Explain the transportation planning process, travel demand forecasting methods, and the institutional framework governing multimodal transportation systems.
- Apply economic appraisal methods (NPV, IRR, benefit-cost analysis) to evaluate transportation infrastructure investments, and recognize infrastructure financing, public-private partnerships, and road pricing mechanisms.
- Analyze traffic operations problems, including arterial signal coordination, freeway performance, traffic simulation, and roundabout design, building on the traffic engineering foundations of CE3T4.
- Model freight demand and design logistics networks for freight transportation systems, including intermodal terminals and urban freight distribution strategies.
- Plan and design public transit route networks, select appropriate transit modes and service characteristics, and design fare policy and accessibility strategies.
- Incorporate sustainability, equity, and public participation considerations into transportation planning and economic decision-making.

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)

7. TOPICS

Unit 1: Traffic Operations and Management (5 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Arterial analysis and signal coordination • Freeway operations and bottleneck analysis • Traffic simulation and microsimulation modeling • Incident management and traffic management centers • Roundabout design and capacity analysis	• Develop coordinated signal systems for arterial corridors [Usage] • Evaluate freeway performance and identify operational bottlenecks [Assessment] • Utilize traffic simulation models for complex operational analysis [Usage] • Implement incident management strategies and traffic management operations [Assessment] • Design roundabouts and analyze their operational performance [Usage]
Readings : [**Roess2011**], [**HCM2022**]	

Unit 2: Transportation Planning and Economics (15 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Transportation planning process and institutional framework • Travel demand modeling and forecasting methods • Four-step travel demand model • Data collection methods for transportation planning • Economic evaluation and benefit-cost analysis • Activity-based modeling and advanced forecasting techniques • Multimodal transportation planning and integration • Sustainable transportation and environmental considerations • Public participation and stakeholder engagement • Performance measures and system monitoring	• Explain the transportation planning process and institutional relationships [Familiarity] • Apply travel demand forecasting methods to predict future travel patterns [Assessment] • Implement the four-step travel demand model for regional analysis [Usage] • Design data collection programs for transportation studies [Assessment] • Conduct benefit-cost analysis for transportation projects [Usage] • Utilize activity-based models for advanced travel demand analysis [Assessment] • Develop integrated multimodal transportation plans [Usage] • Incorporate sustainability principles into transportation planning [Assessment] • Facilitate public participation processes in transportation planning [Familiarity] • Establish performance measures and monitoring systems for transportation networks [Assessment]
Readings : [**Meyer2001**], [**Ortuzar2011**]	

Unit 3: Transportation Economics and Finance (15 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Economic appraisal methods for transportation projects (NPV, IRR, benefit-cost ratio) • Transportation infrastructure financing and public-private partnerships • Road pricing, congestion pricing, and value capture mechanisms • Transit subsidies and funding mechanisms	• Appraise a transportation project using NPV, IRR, and benefit-cost ratio methods [Usage] • Describe infrastructure financing mechanisms, including public-private partnerships [Familiarity] • Evaluate road pricing and value capture mechanisms for a transportation corridor [Assessment] • Explain transit subsidy structures and funding mechanisms [Familiarity]
Readings : [**Boardman2018**], [**Button2010**]	

Unit 4: Freight Transportation and Logistics (15 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Freight demand modeling and commodity flow analysis • Freight supply chain and logistics network design • Intermodal freight terminals and transfer facilities • Urban freight distribution and last-mile delivery	• Model freight demand and commodity flows for a region [Usage] • Design a logistics network for freight supply chains [Usage] • Describe the role of intermodal freight terminals in a logistics network [Familiarity] • Propose urban freight distribution strategies to reduce last-mile delivery impacts [Assessment]
Readings : [**Ballou2004**]	

Unit 5: Public Transit Systems Planning (20 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Public transit route and network planning • Transit mode selection (bus, BRT, light rail, metro) and service design • Fare policy and multimodal fare integration • Transit accessibility and first/last-mile connections	• Plan a transit route and network for a given service area [Usage] • Select an appropriate transit mode and design its service characteristics [Assessment] • Describe fare policy options and multimodal fare integration approaches [Familiarity] • Improve transit accessibility through first/last-mile connection strategies [Usage]
Readings : [**Vuchic2007**], [**TCRP2013**]	

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

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

1. COURSE

CE3T6. Pavement Engineering (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3T6. Pavement Engineering
2.2 Semester	:	10^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE2T5. Highway Geometric Design. (9^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Pavement Engineering is the pavement design and management course of the Vialidad, Geomática y Transporte (DAVG) track, building on the cross-section, subgrade, and earthwork concepts introduced in Highway Geometric Design (CE2T5) to address how flexible and rigid pavement structures are characterized, designed, evaluated, and managed throughout their service life. The course opens with pavement materials and characterization, covering pavement types and structural components, asphalt binder and mixture properties, aggregate properties and gradation requirements, and sustainable pavement technologies and recycling. It then develops pavement design and management, covering traffic load characterization and the design equivalent single axle load (ESAL), flexible pavement design using empirical methods, rigid pavement design and joint systems, and mechanistic-empirical design methods. Building on this design foundation, the course covers pavement condition evaluation and maintenance planning, including performance prediction and deterioration mechanisms, visual distress surveys and the pavement condition index (PCI), roughness measurement, structural evaluation using deflection testing, and maintenance and rehabilitation program planning. The course closes with road and bridge asset management, covering inventory and condition assessment, deterioration models and prioritization criteria, and life-cycle cost analysis for network-level preservation – providing the materials, design, evaluation, and asset-management foundation required for professional practice in pavement engineering.

5. GOALS

- Characterize asphalt binders and mixtures, evaluate aggregate quality, and apply sustainable pavement technologies and recycling.
- Compute the design equivalent single axle load (ESAL) from traffic composition and growth projections.
- Design flexible pavements using empirical methods and rigid pavements with appropriate joint systems.
- Apply mechanistic-empirical methods for pavement design and predict pavement performance and distress mechanisms.
- Conduct visual distress surveys, compute the pavement condition index (PCI), and perform structural evaluation using deflection testing.
- Develop maintenance and rehabilitation program plans based on remaining service life estimation.
- Apply condition indices, deterioration models, and life-cycle cost analysis to plan and budget road and bridge asset management programs.

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: Pavement Materials and Characterization (10 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Pavement types and structural components • Asphalt binder and mixture properties • Aggregate properties and gradation requirements • Subgrade characterization and stabilization • Sustainable pavement technologies and recycling	• Identify pavement types and describe their structural functions [Familiarity] • Characterize asphalt binders and design asphalt mixtures [Assessment] • Evaluate aggregate quality for pavement applications [Usage] • Assess subgrade strength and specify stabilization treatments [Assessment] • Incorporate sustainable practices and recycled materials in pavement design [Familiarity]
Readings : [**Roberts1996AsphaltMixtures**], [**MTCSuelosPavimentos2014**]	

Unit 2: Pavement Design and Management (44 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Traffic load characterization and equivalent single axle load (ESAL) computation • Design reliability, serviceability, and drainage/environmental factors in pavement design • Flexible pavement design using empirical methods • Rigid pavement design and joint systems • Mechanistic-empirical pavement design methods • Pavement performance prediction and distress mechanisms • Rehabilitation strategies and overlay design • Pavement management systems and life-cycle cost analysis	• Compute the design equivalent single axle load (ESAL) from traffic composition and growth projections [Usage] • Determine design reliability, serviceability, and drainage/environmental parameters for flexible and rigid pavement design [Assessment] • Design flexible pavements using AASHTO or equivalent methods [Assessment] • Proportion rigid pavement thickness and design joint spacing [Usage] • Apply mechanistic-empirical methods for pavement design [Usage] • Predict pavement performance and identify distress mechanisms [Assessment] • Select appropriate rehabilitation strategies and design overlays [Usage] • Implement pavement management systems and perform life-cycle analysis [Assessment]
Readings : [**Huang2004**], [**AASHTO1993PavementGuide**]	

Unit 3: Pavement Condition Evaluation and Maintenance Planning (15 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Visual distress surveys and pavement condition index (PCI) computation • Pavement roughness measurement and the international roughness index (IRI) • Structural evaluation using deflection testing (falling weight deflectometer, Benkelman beam) • Backcalculation of pavement layer moduli and structural capacity assessment • Remaining service life estimation and rehabilitation treatment selection • Maintenance and rehabilitation program planning and scheduling	• Conduct visual distress surveys and compute the pavement condition index (PCI) [Usage] • Explain pavement roughness measurement methods and interpret the international roughness index [Familiarity] • Perform structural evaluation of in-service pavements using deflection testing methods [Usage] • Backcalculate pavement layer moduli from deflection basin data [Assessment] • Estimate the remaining service life of a pavement and select an appropriate treatment [Assessment] • Develop maintenance and rehabilitation program plans and schedules [Usage]
Readings : [**Shahin2005PavementManagement**], [**ASTMD6433**]	

Unit 4: Road and Bridge Asset Management (5 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Inventory, inspection, and condition assessment of roads and bridges • Condition indices, deterioration models, and prioritization criteria for maintenance and rehabilitation programs • Life-cycle cost analysis and budgeting for road and bridge network preservation	• Describe the fundamentals of an infrastructure asset management system for roads and bridges [Familiarity] • Apply condition indices and prioritization criteria to plan maintenance and rehabilitation actions for a road or bridge network [Usage] • Analyze life-cycle cost to budget preservation programs for road and bridge infrastructure [Assessment]
Readings : [**Shahin2005PavementManagement**], [**Huang2004**]	

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

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE3T7. Ports (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3T7. Ports
2.2 Semester	:	10^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	CE2T5. Highway Geometric Design. (9^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Ports is the port-engineering course of the Road, Geomatics, and Transport Engineering track, extending the geometric and alignment design principles developed in Road Design (CE2T5) to the planning and design of maritime port facilities. The course opens by situating the port within the national and regional multimodal transport and logistics system, then develops a port master plan and the terminal design criteria that follow from it. It covers the maritime hydraulics (wave mechanics, tides and currents, and design metocean conditions) that govern every subsequent design decision, the dredging and bathymetric surveying needed to establish and maintain navigable depths, and the geotechnical site investigation required to characterize foundation conditions. Building on this foundation, the course addresses the structural design of a port's exterior works (breakwaters and coastal protection) and interior works (quay walls, berths, mooring, and fendering systems), the selection and layout of cargo-handling equipment and yard facilities, and the operational, safety, and environmental management practices that keep a port functioning once built.

5. GOALS

- Develop a port master plan, situating a port within a national or regional multimodal transport and logistics system and forecasting cargo and vessel traffic demand.
- Analyze wave generation, propagation, and transformation, and select design metocean conditions for port facilities.
- Process bathymetric survey data and design access channels and turning basins, and evaluate site investigation data for foundation design.
- Design breakwaters and coastal protection works for specified wave conditions.
- Design quay walls, berths, mooring systems, and fender systems for specified vessel, soil, and loading conditions.
- Select cargo-handling equipment and plan yard layout and container terminal capacity for projected throughput.
- Analyze terminal capacity and throughput, and evaluate port security, safety, and environmental management practices.

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: Port Planning (14 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	**Learning Outcomes**
• Port master planning process • Site selection criteria for port development • Port system planning within national and regional logistics networks • Cargo and vessel traffic demand forecasting	• Develop a port master plan [Usage] • Evaluate candidate sites for port development [Assessment] • Describe how a port fits within a national or regional logistics network [Familiarity] • Forecast cargo and vessel traffic demand [Usage]
Readings : [**Tsinker2004**], [**Agerschou2004**]	

Unit 2: Maritime Hydraulics for Ports (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Wave generation, propagation, and transformation analysis • Tide and current characterization for port design • Harbor agitation and resonance (seiche) analysis • Design metocean conditions and return-period selection	• Analyze wave generation, propagation, and transformation at a port site [Usage] • Characterize tides and currents relevant to port design [Familiarity] • Assess harbor agitation and resonance risk for a proposed layout [Assessment] • Select design metocean conditions for a given return period [Usage]
Readings : [**USACECEM2002**]	

Unit 3: Dredging and Bathymetry (2 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Access channel and turning basin design • Dredging equipment and methods selection • Disposal and beneficial reuse of dredged material • Bathymetric survey principles and data processing	• Design an access channel and turning basin for a design vessel [Usage] • Select appropriate dredging equipment and methods for given site conditions [Assessment] • Evaluate disposal and beneficial reuse options for dredged material [Familiarity] • Process bathymetric survey data to support channel design [Usage]
Readings : [**Agerschou2004**], [**USACEDredging1983**]	

Unit 4: Breakwater and Coastal Structures (12 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Breakwater design fundamentals • Revetments and shore protection works • Armor layer stability and unit sizing • Rubble-mound versus vertical breakwater selection	• Design a breakwater cross-section for specified wave conditions [Usage] • Describe revetment and shore protection alternatives [Familiarity] • Size armor layer units for hydraulic stability [Usage] • Select between rubble-mound and vertical breakwater types for a given site [Assessment]
Readings : [**USACECEM2002**]	

Unit 5: Berth and Quay Design (16 hours)	
Competences Expected: ABET-2,ABET-6	
Topics	**Learning Outcomes**
• Quay wall design (gravity, sheet pile, and piled structures) • Berth dimensioning for design vessel classes • Mooring systems and bollard layout • Fender system selection and energy absorption design	• Design a quay wall for specified soil and loading conditions [Assessment] • Dimension a berth for a design vessel class [Usage] • Lay out a mooring system and bollard arrangement [Usage] • Specify a fender system based on berthing energy absorption requirements [Assessment]
Readings : [**Thoresen2018**]	

Unit 6: Cargo Handling and Yard Design (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Cargo handling equipment (ship-to-shore cranes, yard cranes, conveyors) • Yard layout and storage capacity planning • Container terminal design and throughput sizing • Bulk and break-bulk cargo facility design	• Select cargo handling equipment appropriate to a given cargo type [Familiarity] • Plan yard layout and storage capacity for projected throughput [Usage] • Size a container terminal for projected throughput [Usage] • Describe design requirements for bulk and break-bulk cargo facilities [Familiarity]
Readings : [**Thoresen2018**]	

Unit 7: Port Operations, Safety, and Environmental Management (4 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Terminal capacity and throughput analysis • Intermodal integration with inland logistics chains • Port facility security under the ISPS Code • Port environmental management and sustainability	• Analyze terminal capacity and throughput [Assessment] • Describe intermodal integration with inland logistics chains [Familiarity] • Explain port facility security requirements under the ISPS Code [Familiarity] • Assess port environmental management and sustainability practices [Assessment]
Readings : [**Tsinker2004**]	

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

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

1. COURSE

CE3T9. Research Workshop (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE3T9. Research Workshop
2.2 Semester	:	10^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	3 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 Prerrequisites	:	• BMI201. Methodology of Engineering Research. (8^{th} Sem) • CE3T8. Professional Competencies Workshop - Transportation. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Research Workshop introduces students to the fundamentals of engineering research methodology in preparation for capstone-level research work in the Vialidad, Geomática y Transporte (DAVG) track of Civil Engineering. Building on the methodology established in Research Methodology in Engineering (BMI201) and the professional competencies developed in the Professional Competencies Workshop - Vialidad (CE3T8), students learn to identify a research idea and formulate a research problem drawn from roadway design, pavement engineering, traffic and transportation engineering, or geomatics; build the theoretical and conceptual framework that supports a study; formulate testable hypotheses and operationalize the variables involved; select and justify an appropriate type and design of research; and collect and analyze data to answer a transportation or geomatics engineering research question. The course also reinforces the professional ethics and technical communication skills required to conduct and disseminate engineering research responsibly.

5. GOALS

- Formulate a well-defined research idea and problem statement in Vialidad, Geomática, or Transporte engineering grounded in a real technical need.
- Build a theoretical framework through systematic literature review and critical synthesis of prior research in roadway, pavement, traffic, transportation, or geomatics engineering.
- Formulate testable research hypotheses and operationalize the variables of a transportation or geomatics engineering study.
- Select and justify an appropriate type and design of research (quantitative, qualitative, or mixed methods) for a given research problem.
- Collect and statistically analyze data to answer a Vialidad, Geomática, or Transporte engineering research question.
- Apply engineering ethics and produce clear technical communication throughout the research process.
- The deliverables for this course are:

  Midterm: Research idea, problem statement, and theoretical framework document.

  Final: Complete research proposal including hypotheses, variables, research type and design, and a preliminary data collection and analysis plan.

6. COMPETENCES

ABET-3) An ability to communicate effectively with a range of audiences. (Usage)

ABET-4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. (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: Research Design and Methodologies (28 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Formulating research questions in architecture: descriptive, relational, causal; turning design problems into researchable questions • Choosing a research methodology: quantitative (hypothesis testing, statistical), qualitative (interpretive, case study), mixed methods, • Validity and reliability in architectural research: internal validity, external validity (generalizability), construct validity, • Research ethics in architectural research: informed consent, privacy (anonymization of building users), institutional review board (IRB) protocols, • Mixed methods research: sequential (qualitative then quantitative) and concurrent designs; integrating qualitative findings (user interviews) with quantitative data (occupancy	• Describe the main research methodologies in architecture - quantitative, qualitative, mixed methods, practice-based - and explain their appropriate applications [Familiarity] • Develop a research design for an architectural inquiry, including research question, literature review, methodology selection, data collection protocol, and analysis plan [Usage] • Evaluate the research design of a published architectural study for validity, reliability, and ethical soundness, identifying methodological strengths and weaknesses [Assessment]
Readings : [**Creswell2018**], [**LeedyOrmrod2019**]	

Unit 2: Theoretical Framework and Literature Review (16 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Systematic search of scientific and technical literature: specialized databases (Scopus, Web of Science, ASCE Library), keywords, and Boolean operators • Critical reading and synthesis of scientific articles, technical standards, and prior research reports • Building the conceptual and theoretical framework: defining key concepts, relationships between variables, and reference theoretical models • Identifying knowledge gaps (research gap) and justifying the originality of the proposed contribution • Bibliographic reference management and citation styles (APA, IEEE) using tools such as Zotero or Mendeley	• Explain the structure and purpose of a theoretical framework within a civil engineering research project [Familiarity] • Conduct a systematic search of scientific and technical literature on a chosen research topic using specialized databases [Usage] • Synthesize the state of the art of a research topic into a coherent theoretical framework that identifies a knowledge gap [Assessment]
Readings : [**BoothColombWilliams2016**], [**Creswell2018**]	

Unit 3: Research Hypotheses and Variables (16 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Types of hypotheses: null, alternative, directional, and non-directional, and their relationship to research questions • Classification of variables: independent, dependent, control, and confounding • Operationalizing variables: defining measurable indicators and measurement scales (nominal, ordinal, interval, ratio) • Relationship between hypotheses, variables, and statistical significance tests: significance level, Type I and Type II error • Graphical representation of the relationship between variables through conceptual or operational models	• Distinguish between null and alternative hypotheses, and between independent, dependent, and control variables, in a civil engineering research problem [Familiarity] • Formulate a testable research hypothesis and operationalize its variables for a specific problem in the chosen specialization area [Usage] • Evaluate the consistency between the theoretical framework, the stated hypothesis, and the proposed data-collection design [Assessment]
Readings : [**MontgomeryRunger2018**], [**Kumar2019**]	

Unit 4: Quantitative Methods in Architectural Research (12 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Survey design for architectural research: sampling methods (probability, convenience), questionnaire design (Likert scales, semantic differential), response rate optimization, • Experimental designs: true experiments (random assignment, control group), quasi-experiments (non-randomized, pre-post, time series), • Descriptive statistics: measures of central tendency (mean, median, mode), dispersion (standard deviation, range, interquartile range), • Inferential statistics: hypothesis testing (t-test, ANOVA, chi-square), correlation and regression (linear, multiple), and interpretation of p-values • Instrumentation for quantitative data collection: environmental sensors (temperature, light, CO_2), occupancy counters, objective performance measures (task completion time	• Describe the main quantitative methods in architectural research - surveys, experiments, quasi-experiments - [Familiarity] • Design a survey or experiment to test a hypothesis about the effect of a design variable (lighting, color, layout) on user satisfaction, task performance, or behavior [Usage] • Evaluate a quantitative architectural study for sampling validity, statistical analysis appropriateness, and correct interpretation of p-values and effect sizes [Assessment]
Readings : [**MontgomeryRunger2018**], [**Creswell2018**]	

Unit 5: Engineering Ethics and Professional Responsibility (4 hours)	
Competences Expected: ABET-4	
Topics	**Learning Outcomes**
• Ethical theories: utilitarianism, duty ethics, virtue ethics • Professional codes of conduct (e.g., ASCE, NSPE) and their fundamental canons • Engineer's paramount responsibility to public safety, health, and welfare • Ethical dilemmas in practice: conflicts of interest, whistleblowing, gift-giving • Ethical decision-making frameworks and case study analysis • Global engineering ethics and cross-cultural challenges • Ethical obligations for sustainable development and environmental stewardship • Ethical implications of emerging technologies (AI, automation, data privacy) • Ethical conduct in dispute resolution and litigation	• Explain the primary tenets of the engineer's code of ethics [Familiarity] • Apply an ethical decision-making framework to a hypothetical engineering scenario [Assessment] • Identify conflicts of interest and other common ethical pitfalls in project work [Familiarity] • Analyze a historical engineering failure case from an ethical perspective [Assessment] • Evaluate the ethical dimensions of a project with significant social or environmental impacts in a different cultural context [Assessment] • Articulate the ethical argument for incorporating sustainability into all engineering work [Familiarity] • Discuss the ethical responsibilities related to data collection and use in smart infrastructure projects [Assessment] • Describe the role of ethics in alternative dispute resolution processes [Familiarity]
Readings : [**HarrisEthics2013**], [**FleddermannEthics2020**]	

Unit 6: Written and Technical Communication (3 hours)	
Competences Expected: ABET-3	
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 : [**GurakLannon2013**]	

Unit 7: Oral Presentation and Professional Communication (3 hours)	
Competences Expected: ABET-3	
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 : [**GurakLannon2013**]	

Unit 8: Digital and Collaborative Communication (2 hours)	
Competences Expected: ABET-3	
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 : [**GurakLannon2013**]	

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.

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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

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE403. Capstone project II (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CE403. Capstone project II
2.2 Semester	:	10^{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 Prerrequisites	:	CE402. Capstone project I. (9^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Este curso tiene por objetivo que el alumno desarrolle su propuesta técnica y sus experimentos en base al estado del arte ya levantado previamente. Es la etapa de consolidación donde se define el aporte original o la aplicación novedosa de la ingeniería civil que dará lugar a su tesis profesional.

5. GOALS

- Que el alumno esté en la capacidad de presentar formalmente su proyecto de tesis con el marco teórico y levantamiento bibliográfico completo.
- Que el alumno desarrolle su propuesta de investigación (metodología, diseño experimental o modelamiento).
- Los entregables de este curso son:

  Avance parcial: Plan de tesis detallado que incluye motivación, definición del problema, objetivos, cronograma y avances de la propuesta técnica (uso/mejora de métodos existentes).

  Final: Plan de tesis en etapa avanzada y borrador de tesis incluyendo capítulos de propuesta y resultados experimentales preliminares.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Assessment)

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. (Assessment)

ABET-3) An ability to communicate effectively with a range of audiences. (Assessment)

ABET-4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. (Assessment)

ABET-5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. (Assessment)

7. TOPICS

Unit 1: Proyecto de Tesis (30 hours)	
Competences Expected: ABET-1,ABET-2,ABET-3,ABET-4,ABET-5	
Topics	**Learning Outcomes**
• Estructuración formal del Proyecto de Tesis. • Definición de la metodología de investigación aplicada.	• Aplicar el formato institucional para el plan de tesis [Evaluar]. • Concluir el plan del proyecto de tesis con objetivos medibles [Evaluar]. • Presentar el estado del arte del tema de tesis al 50% [Evaluar].
Readings : [**Yin2018**], [**Meredith1993**]	

Unit 2: Avance de Tesis (30 hours)	
Competences Expected: ABET-1,ABET-2,ABET-3,ABET-4,ABET-5	
Topics	**Learning Outcomes**
• Desarrollo de la propuesta técnica. • Ejecución de ensayos o simulaciones numéricas.	• Dominar el formato de tesis de la Universidad utilizando LaTeX [Evaluar]. • Concluir el capítulo del Marco Teórico y Trabajos Relacionados [Evaluar]. • Presentar resultados (formales o estadísticos) de experimentos orientados a su tema de tesis [Evaluar].
Readings : [**ASTM_Research**]	

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.

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9. EVALUATION SYSTEM

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE2C7. Business Organization and Management (Elective)

2. GENERAL INFORMATION

2.1 Course	:	CE2C7. Business Organization and Management
2.2 Semester	:	10^{th} Semester.
2.3 Credits	:	3
2.4 Hours	:	2 HT; 2 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Elective
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	CE2C8. Business Management in Construction I. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Business Organization and Management introduces the fundamentals of business administration: business types and structure, management and leadership, organization and organizational behavior, logistics, accounting, production, and marketing, as a foundation for the management of construction companies.

5. GOALS

- Distinguish the types and structures of companies and their legal implications.
- Apply principles of organization, management, and leadership to a company.
- Understand the processes of logistics, accounting, production, and marketing in a company.

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: Organizational Behavior (8 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Motivation theories: Maslow's hierarchy, Herzberg's two-factor theory, expectancy theory, and self-determination theory • Team formation, group roles, cohesion, diversity, and performance in organizational settings • Organizational culture: dimensions, formation, cultural change, and its impact on performance • Sources of organizational conflict, conflict resolution strategies, and negotiation fundamentals	• Explain major motivation theories and their implications for managerial practice [Familiarity] • Analyze team dynamics and cultural factors affecting organizational performance [Usage] • Design an intervention to address a specific organizational behavior challenge [Assessment]
Readings : [**Robbins2017**]	

Unit 2: Business Entity Law (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Legal forms: sole proprietorship, general/limited partnership, LLC, and corporation; comparative liability and taxation • Corporate formation, articles of incorporation, shareholder rights, board duties (fiduciary duty of care and loyalty) • Agency relationships in business: actual and apparent authority, principal-agent duties, and vicarious liability • Mergers, acquisitions, and dissolution: legal process, shareholder approval, due diligence, and winding-up procedures	• Compare the liability, tax, and governance characteristics of different business entity forms [Familiarity] • Analyze the legal implications of a business transaction from the perspective of agency law [Usage] • Select the appropriate legal entity form for a new business venture, justifying the choice on legal and strategic grounds [Assessment]
Readings : [**Robbins2017**]	

Unit 3: Strategic Management (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• External and internal analysis using PESTEL, Porter's Five Forces, and SWOT frameworks • Generic strategies (cost leadership, differentiation, focus) and their application to competitive positioning • Strategy implementation: organizational alignment, balanced scorecard, and performance management systems • Corporate-level strategy: diversification, vertical integration, mergers and acquisitions, and portfolio management	• Describe the strategic management process and the role of environmental analysis in strategy formulation [Familiarity] • Apply competitive strategy frameworks to analyze the strategic position of a real organization [Usage] • Evaluate the coherence and feasibility of a corporate strategy using analytical frameworks [Assessment]
Readings : [**Robbins2017**]	

Unit 4: Business Model Design and Validation (6 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Business Model Canvas: nine building blocks (customer segments, value propositions, channels, revenue streams, key resources, key activities, key partnerships, cost structure) • Customer discovery and validation: problem interviews, solution interviews, and pivot vs. persevere decisions • Minimum viable product (MVP): design principles, lean experimentation, and build-measure-learn feedback loop • Platform business models and network effects: multi-sided platforms, winner-take-all dynamics, and monetization strategies for digital platforms	• Describe the components of the Business Model Canvas and explain how they interact to create and deliver value [Familiarity] • Design a business model canvas for a new venture idea and identify key assumptions to test [Usage] • Evaluate a startup's business model for internal consistency and market viability [Assessment]
Readings : [**Osterwalder2010**]	

Unit 5: Leadership Theory and Practice (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Leadership theories: trait, behavioral (Ohio State, Michigan), situational (Hersey-Blanchard), and contingency (Fiedler) models • Transformational and transactional leadership: vision, inspiration, intellectual stimulation, and individualized consideration • Emotional intelligence dimensions (self-awareness, empathy, social skills) and their relevance to leadership effectiveness • Ethical and servant leadership: leader as steward, moral courage, values-based decision-making, and community service orientation	• Compare major leadership theories and identify the contextual conditions favoring each approach [Familiarity] • Apply situational leadership principles to diagnose leader behavior appropriate for a given team context [Usage] • Evaluate a leader's effectiveness using multiple theoretical lenses including transformational and ethical leadership criteria [Assessment]
Readings : [**Robbins2017**]	

Unit 6: Inventory Management and Logistics (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Economic order quantity (EOQ): derivation, assumptions, extensions, and total inventory cost minimization • Reorder point models, safety stock calculation, and service level determination under demand uncertainty • Logistics management: transportation modes, warehousing, distribution network design, and 3PL providers • ABC inventory classification: Pareto principle applied to inventory value, cycle counting policy, and selective control strategies	• Explain the trade-offs between ordering costs and holding costs in inventory management [Familiarity] • Calculate EOQ, reorder points, and safety stock for a product with specified demand parameters [Usage] • Evaluate the inventory and logistics performance of a supply chain and recommend improvements [Assessment]
Readings : [**Heizer2020**]	

Unit 7: Financial Accounting and Reporting (4 hours)	
Competences Expected: ABET-6	
Topics	**Learning Outcomes**
• Accounting equation (Assets = Liabilities + Equity), double-entry bookkeeping, and the chart of accounts • The accounting cycle: journalizing, posting, trial balance, adjusting entries, closing entries, and financial statement preparation • Income statement, balance sheet, statement of cash flows, and statement of changes in equity: structure and content • Ratio analysis and financial statement interpretation: liquidity, solvency, profitability, and efficiency ratios for decision-making	• Explain the accounting equation and the logic of double-entry bookkeeping [Familiarity] • Prepare journal entries and basic financial statements for a simple business entity [Usage] • Analyze the financial position and performance of a firm using its financial statements [Assessment]
Readings : [**Weygandt2018**]	

Unit 8: Operations Strategy and Process Design (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Competitive priorities in operations: cost, quality, speed, flexibility, and dependability • Process types: job shop, batch, assembly line, and continuous flow; process selection and product-process matrix • Capacity measurement, capacity planning strategies (lead, lag, match), and bottleneck analysis • Facility layout types (product, process, fixed-position, cellular) and layout efficiency measures	• Describe the main competitive priorities in operations and explain how process type selection reflects strategic objectives [Familiarity] • Apply capacity planning methods and bottleneck analysis to improve throughput in a production system [Usage] • Design a facility layout for a specified production environment and evaluate its efficiency [Assessment]
Readings : [**Heizer2020**]	

Unit 9: Marketing Mix Strategy (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Product decisions: product mix, product life cycle, new product development, and packaging • Pricing methods: cost-based, competition-based, value-based, and dynamic pricing; price elasticity • Distribution channel design: direct and indirect channels, channel conflict, logistics, and omnichannel retailing • Integrated marketing communications: advertising, sales promotion, public relations, personal selling, and direct marketing	• Identify the components of the marketing mix and explain how they are integrated to create customer value [Familiarity] • Apply pricing and channel strategies to a specific product/market combination [Usage] • Design an integrated marketing communication plan aligned with a given marketing strategy [Assessment]
Readings : [**Kotler2016**]	

Unit 10: Human Resource Management (6 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Workforce planning, job analysis, recruitment channels, and selection methods (interviews, testing, assessment centers) • Compensation structures (base pay, incentives, benefits) and performance appraisal methods • Training needs assessment, onboarding, career development, and succession planning • Document control and records management: filing systems, correspondence control, document version/traceability, and retention policies supporting HR and administrative functions	• Describe the core HR functions of recruitment, compensation, and training within an organization [Familiarity] • Design a recruitment and selection process for a specified position and organizational context [Usage] • Evaluate an organization's document control and records management practices against administrative best practices [Assessment]
Readings : [**DeCenzo2019**]	

Unit 11: Corporate Governance (4 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Agency theory: principal-agent problem, information asymmetry, moral hazard, and alignment mechanisms • Board of directors: composition, independence, committees, fiduciary duties, and board effectiveness • Corporate governance codes and regulation: Sarbanes-Oxley, OECD Principles, and ESG reporting requirements • ESG and stakeholder governance models: environmental, social, and governance criteria, materiality assessment, and multi-stakeholder accountability	• Explain the agency problem and the governance mechanisms designed to align managerial and shareholder interests [Familiarity] • Analyze the governance structure of a corporation and identify potential weaknesses [Usage] • Evaluate the effectiveness of corporate governance practices against best-practice standards [Assessment]
Readings : [**Robbins2017**]	

8. WORKPLAN

8.1 Methodology

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8.2 Theory Sessions

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8.3 Practical Sessions

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9. EVALUATION SYSTEM

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

10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE3C13. Project Planning and Control (Elective)

2. GENERAL INFORMATION

2.1 Course	:	CE3C13. Project Planning and Control
2.2 Semester	:	10^{th} Semester.
2.3 Credits	:	4
2.4 Hours	:	2 HT; 2 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Elective
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	CE3C5. Costs and Budgeting in Civil Engineering. (9^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Project Planning and Control introduces strategic planning and management plans according to the PMBOK guide, project planning, scheduling, and control using the Critical Path Method (CPM) and 4D/5D modeling, project management and control philosophies, and the soft and managerial skills necessary to lead project teams.

5. GOALS

- Apply strategic planning and management plans according to the PMBOK guide to a construction project.
- Plan, schedule, and control a project using the Critical Path Method (CPM) and 4D/5D modeling tools.
- Apply management philosophies to the control of construction projects.
- Develop soft and managerial skills in communication, leadership, teamwork, and conflict resolution.

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)

7. TOPICS

Unit 1: Planning Principles (16 hours)	
Competences Expected: ABET-2	
Topics	**Learning Outcomes**
• Planning as an ongoing and iterative activity throughout the project life cycle • Just-enough planning: balancing detail with flexibility based on uncertainty • Relationship between planning depth and the selected development approach • Adaptive planning: rolling wave, progressive elaboration, and iterative refinement	• Describe the principles of iterative and just-enough planning in PMBoK 7th edition [Familiarity] • Apply adaptive planning principles to a project with high uncertainty and evolving requirements [Assessment] • Evaluate whether a project's planning approach provides sufficient detail and flexibility for its uncertainty level [Assessment]
Readings : [**PMI2021**]	

Unit 2: Project Planning, Scheduling, and Control (CPM, 4D/5D) (16 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 3: Lean Construction and Integrated Project Delivery (IPD) (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Lean thinking principles: value, value stream, flow, pull, perfection • Identification and elimination of the eight wastes in construction • Last Planner System (LPS) for production planning and control • Visual management tools: 5S, Kanban, and Andon • Integrated Project Delivery (IPD) principles and multi-party agreements • Target Value Delivery (TVD) and Set-Based Design • Collaboration technologies and Big Room co-location • Performance measurement: Percent Plan Complete (PPC), Takt time • Culture change and implementation strategies for lean transformation	• Define the seven (or eight) types of waste (Muda) in a construction context [Familiarity] • Apply the Last Planner System to develop a reliable weekly work plan [Usage] • Identify opportunities to apply visual management (5S) on a construction site [Assessment] • Explain how Integrated Project Delivery (IPD) aligns goals and shares risk among project stakeholders [Familiarity] • Use Target Value Delivery principles to guide design decisions within a cost target [Assessment] • Facilitate a collaborative pull planning session with multiple trades [Usage] • Calculate and interpret Percent Plan Complete (PPC) as a lean performance metric [Assessment] • Develop a basic implementation plan for introducing lean practices to a project team [Assessment]
Readings : [**Ballard2000**]	

Unit 4: Leadership, Team Dynamics, and Stakeholder Management (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Leadership styles, traits, and the difference between leadership and management • Team dynamics: forming, storming, norming, performing stages and roles • Conflict resolution strategies and negotiation • Stakeholder identification, analysis, and engagement planning • Motivation theories and their application to engineering teams • Cultural intelligence and leading diverse, global teams • Change management and leading organizational transformation • Emotional intelligence and its role in effective leadership • Ethical leadership and creating an ethical organizational culture	• Describe different leadership styles and identify situations where each might be effective [Familiarity] • Diagnose the stage of development of a project team and propose appropriate interventions [Assessment] • Resolve a simulated interpersonal conflict within a project team using a structured approach [Usage] • Develop a stakeholder engagement plan for a project with community opposition [Assessment] • Adapt communication and leadership approach when working with a team from a different cultural background [Assessment] • Explain the key steps in a change management process for implementing a new technology [Familiarity] • Evaluate one's own emotional intelligence and identify areas for development [Assessment] • Model ethical leadership behavior in a team-based project simulation [Usage]
Readings : [**Robbins2017**]	

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10. BASIC BIBLIOGRAPHY

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

1. COURSE

CE3C14. Sustainable and Resilient Infrastructure (Elective)

2. GENERAL INFORMATION

2.1 Course	:	CE3C14. Sustainable and Resilient Infrastructure
2.2 Semester	:	10^{th} Semester.
2.3 Credits	:	3
2.4 Hours	:	2 HT; 1 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Elective
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	• CE2C1. Materials Technology. (3^{rd} Sem) • CE2C2. Construction Technology I. (8^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Sustainable Infrastructure covers the principles, planning, design, materials, and management of sustainable infrastructure: the triple bottom line, life-cycle thinking, resource efficiency, the circular economy, and the social, economic, and governance dimensions of sustainable infrastructure projects.

5. GOALS

- Apply the principles of sustainable infrastructure to the planning, design, materials, and operation of construction projects.
- Evaluate the sustainable performance of an infrastructure project and its governance.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Usage)

7. TOPICS

Unit 1: Foundational Sustainability Principles and Triple Bottom Line (15 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Triple bottom line (TBL) framework and sustainability metrics • Life-cycle thinking and stage-gate analysis for infrastructure projects • Regenerative design and net-positive impact goals	• Define the three pillars of the triple bottom line and give an infrastructure-related example for each [Familiarity] • Apply life-cycle thinking to compare the long-term impacts of two alternative paving materials [Assessment] • Develop a project goal for achieving a net-positive environmental impact [Assessment]
Readings : [**Kibert2016**]	

Unit 2: Resource Efficiency and Circular Economy (15 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Resource efficiency: energy, water, and material consumption minimization • Circular economy principles: reduce, reuse, recycle, recover (R4) • Sustainable procurement and supply chain management	• Calculate the embodied energy or water footprint of a simple structural component [Usage] • Explain how circular economy principles can be applied to construction and demolition waste [Familiarity]
Readings : [**Kibert2016**]	

Unit 3: Social, Economic, and Governance Dimensions of Sustainable Infrastructure (16 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Social sustainability: equity, accessibility, and community well-being • Economic sustainability: life-cycle costing and total cost of ownership • Policy frameworks and green rating systems (e.g., Envision, LEED for Infrastructure)	• Evaluate the social equity implications of a proposed transportation project [Assessment] • Perform a life-cycle cost analysis to justify a higher initial investment in a durable material [Usage] • Use a green infrastructure rating system checklist to assess a project's sustainability performance [Familiarity]
Readings : [**Kibert2016**]	

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