



National University of Engineering (UNI)
School of Civil Engineering
Syllabus 2026-II

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 Prerequisites	: CE2M2. Mechanics of Materials II. (5 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 : [Hib18], [Kas20], [MN13]	

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 : [Hib18], [Kas20], [MN13]	

Unit 3: Classical Displacement Methods (18 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	Learning Outcomes
• Slope-deflection method for continuous beams and frames • Moment distribution method	• Use slope-deflection equations to solve continuous beam and frame problems [Assessment] • Perform moment distribution analysis for indeterminate structures [Usage]
Readings : [Hib18], [Kas20], [MN13]	

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

- [MN13] Jack C. McCormac and James K. Nelson. *Structural Analysis: Using Classical and Matrix Methods*. 5th. Wiley, 2013.
- [Hib18] Russell C. Hibbeler. *Structural Analysis*. 10th. Pearson, 2018.
- [Kas20] Aslam Kassimali. *Structural Analysis*. 6th. Cengage Learning, 2020.