



## National University of Engineering (UNI)

School of Civil Engineering  
Syllabus 2026-II

### 1. COURSE

CE3S2. Reinforced Concrete Design II (Mandatory)

### 2. GENERAL INFORMATION

|                            |                                                              |
|----------------------------|--------------------------------------------------------------|
| 2.1 Course                 | : CE3S2. Reinforced Concrete Design II                       |
| 2.2 Semester               | : 10 <sup>th</sup> 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 Prerequisites          | : CE2S2. Reinforced Concrete Design I. (7 <sup>th</sup> 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

| <b>Unit 1: Reinforced Concrete Design (18 hours)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Competences Expected: ABET-1,ABET-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Topics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Learning Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <ul style="list-style-type: none"> <li>• Design philosophy and limit state methodology for concrete structures</li> <li>• Flexural design of rectangular and T-beams</li> <li>• Shear and torsion design of concrete members</li> <li>• Compression members and column design</li> <li>• Slab design including one-way and two-way systems</li> <li>• Development length and splicing of reinforcement</li> <li>• Deflection control and serviceability requirements for concrete beams and slabs</li> </ul> | <ul style="list-style-type: none"> <li>• Explain limit state design philosophy and load factor combinations [Familiarity]</li> <li>• Design reinforced concrete beams for flexure and check serviceability [Assessment]</li> <li>• Calculate shear and torsional reinforcement requirements [Usage]</li> <li>• Proportion columns for axial load and biaxial bending [Assessment]</li> <li>• Design one-way and two-way slab systems with appropriate reinforcement [Usage]</li> <li>• Determine development lengths and design lap splices for reinforcing bars [Assessment]</li> <li>• Control deflections and verify serviceability requirements through adequate member sizing and reinforcement [Usage]</li> </ul> |
| <b>Readings :</b> [WM16], [ACI19], [MB21]                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| <b>Unit 2: Earth Retaining Systems (26 hours)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Competences Expected: ABET-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Topics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Learning Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <ul style="list-style-type: none"> <li>• Earth pressure theory including active and passive pressures</li> <li>• Retaining wall types and selection criteria</li> <li>• Load testing methods including static and dynamic tests</li> <li>• Anchored walls and tied-back systems</li> <li>• Mechanically stabilized earth walls and reinforced soil systems</li> <li>• Basement and foundation wall design considering top-of-wall restraint conditions</li> <li>• Counterfort and buttressed retaining wall design</li> </ul> | <ul style="list-style-type: none"> <li>• Apply lateral earth pressure theories for retaining wall design [Assessment]</li> <li>• Design gravity and cantilever retaining walls [Usage]</li> <li>• Design anchored wall systems including ground anchor capacity [Assessment]</li> <li>• Proportion mechanically stabilized earth walls and select reinforcement [Usage]</li> <li>• Design basement and foundation walls considering top restraint, surcharge, and hydrostatic loads [Assessment]</li> <li>• Design counterfort retaining walls including stem, heel, toe, and counterfort elements [Usage]</li> </ul> |
| <b>Readings :</b> [Das19], [ACI19]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| Unit 3: Seismic Detailing of Reinforced Concrete (7 hours)                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Competences Expected: ABET-1,ABET-2                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Topics                                                                                                                                                                                                                                                                                                                                                                                                    | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <ul style="list-style-type: none"> <li>• Beam-column joints and moment-resisting frame connections</li> <li>• Seismic detailing and ductile design of concrete structures</li> <li>• Design of special reinforced concrete structural walls (shear walls) for seismic lateral force resistance</li> <li>• Special seismic detailing provisions for reinforced concrete moment-resisting frames</li> </ul> | <ul style="list-style-type: none"> <li>• Detail beam-column joints for moment transfer and shear resistance [Assessment]</li> <li>• Implement seismic detailing requirements for ductile concrete frames [Assessment]</li> <li>• Design special reinforced concrete structural walls for combined axial, flexural, and shear demands under seismic loading [Assessment]</li> <li>• Apply special seismic detailing provisions to reinforced concrete moment frame members and beam-column joints [Usage]</li> </ul> |
| Readings : [WM16], [ACI19], [Moe15]                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

| Unit 4: Prestressed Concrete Analysis (7 hours)                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Competences Expected: ABET-1,ABET-2                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Topics                                                                                                                                                                                                                                                                                                                                                                 | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <ul style="list-style-type: none"> <li>• Prestressed concrete principles and pre-tensioning methods</li> <li>• Elastic analysis of stresses in prestressed concrete sections under service loads</li> <li>• Composite prestressed concrete sections: precast members with cast-in-place topping</li> <li>• Immediate and time-dependent losses of prestress</li> </ul> | <ul style="list-style-type: none"> <li>• Apply prestressing principles to design pre-tensioned members [Usage]</li> <li>• Analyze stresses in prestressed concrete sections under service loads using elastic theory [Usage]</li> <li>• Design composite prestressed concrete sections combining precast members and cast-in-place concrete [Assessment]</li> <li>• Calculate immediate and time-dependent losses of prestress [Usage]</li> </ul> |
| Readings : [WM16], [ACI19], [Moe15]                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| Unit 5: Prestressed Concrete Design (8 hours)                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Competences Expected: ABET-1,ABET-2                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Topics                                                                                                                                                                                                                                                                                                                                                                                                                        | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <ul style="list-style-type: none"> <li>• Post-tensioned concrete systems and tendon design</li> <li>• Deflection control and serviceability requirements</li> <li>• Flexural strength of prestressed concrete members at ultimate limit state</li> <li>• Shear and torsion design of prestressed concrete members</li> <li>• Statically indeterminate prestressed concrete structures, including secondary moments</li> </ul> | <ul style="list-style-type: none"> <li>• Design post-tensioned slabs and beams including tendon layout [Assessment]</li> <li>• Control deflections through appropriate member sizing and reinforcement [Usage]</li> <li>• Design prestressed concrete members for flexural strength at the ultimate limit state [Assessment]</li> <li>• Design prestressed concrete members for shear and torsion strength [Assessment]</li> <li>• Analyze statically indeterminate prestressed concrete structures, including secondary moments [Assessment]</li> </ul> |
| Readings : [WM16], [ACI19], [Moe15]                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| Unit 6: Building Structural Analysis and Modeling Practicum (4 hours)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Competences Expected: ABET-2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <ul style="list-style-type: none"> <li>• Overview of case-study buildings: geometry, structural systems, and load paths</li> <li>• Development of plane frame and truss models of real buildings using stiffness-method-based structural analysis software</li> <li>• Application of static and seismic response-spectrum analysis to representative building case studies</li> <li>• Presentation and peer discussion of structural analysis results and their design implications</li> <li>• Definition of geometry, materials, sections, and boundary conditions for a three-dimensional building model in commercial structural analysis software (ETABS, Midas Gen)</li> <li>• Assignment of gravity, seismic, and wind loads and their combinations to a three-dimensional building model</li> <li>• Static and dynamic (modal) analysis of building models and interpretation of results, including story drifts, member forces, and vibration periods</li> <li>• Verification of software-generated results against simplified hand calculations and code checks</li> </ul> | <ul style="list-style-type: none"> <li>• Model real building structural systems for stiffness-method-based static and seismic analysis using structural analysis software [Usage]</li> <li>• Interpret and validate computer-generated analysis results against expected structural behavior [Assessment]</li> <li>• Present and defend structural analysis results and their design implications to peers [Usage]</li> <li>• Assign gravity, seismic, and wind loads and load combinations to a three-dimensional building model in commercial structural analysis software [Usage]</li> <li>• Interpret dynamic analysis results, including story drifts, member forces, and vibration periods [Assessment]</li> <li>• Verify software-generated results against simplified hand calculations [Assessment]</li> </ul> |
| Readings : [WM16]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| Unit 7: Bearing Capacity and Design (26 hours)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Competences Expected: ABET-2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <ul style="list-style-type: none"> <li>• Bearing capacity theory and failure mechanisms</li> <li>• Ultimate bearing capacity equations for various conditions</li> <li>• Settlement analysis using elastic and consolidation methods</li> <li>• Isolated spread footing design</li> <li>• Combined footings and strap footings</li> <li>• Allowable bearing pressure and factor of safety selection</li> <li>• Mat foundation analysis and design</li> <li>• Eccentric and inclined loading effects</li> <li>• Soil-structure interaction effects</li> <li>• Differential settlement and tolerable limits</li> <li>• Continuous (strip) footing design for basement and foundation walls</li> </ul> | <ul style="list-style-type: none"> <li>• Explain bearing capacity failure mechanisms in shallow foundations [Familiarity]</li> <li>• Calculate ultimate bearing capacity using Terzaghi and Meyerhof equations [Assessment]</li> <li>• Predict total and differential settlements for shallow foundations [Usage]</li> <li>• Design isolated spread footings for gravity loads [Assessment]</li> <li>• Proportion combined and strap footings for column arrangements [Usage]</li> <li>• Determine allowable bearing pressures based on strength and settlement criteria [Assessment]</li> <li>• Analyze mat foundations using conventional and finite element methods [Assessment]</li> <li>• Evaluate bearing capacity under eccentric and inclined loading [Usage]</li> <li>• Consider soil-structure interaction in foundation design [Familiarity]</li> <li>• Assess differential settlement and apply tolerable settlement criteria [Assessment]</li> <li>• Design continuous strip footings for basement and foundation walls [Usage]</li> </ul> |
| Readings : [Cod01], [Das19]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| Unit 8: Integrated Structural Design Project (12 hours)                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Competences Expected: ABET-1,ABET-2                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Topics                                                                                                                                                                                                                                                                                                                                                                                                            | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <ul style="list-style-type: none"> <li>• Progressive design exercise integrating slab, structural wall, and foundation design for a multi-story reinforced concrete building</li> <li>• Coordination of structural design decisions with the architectural and geotechnical constraints of the project</li> <li>• Structural design documentation, including calculation memoranda and design drawings</li> </ul> | <ul style="list-style-type: none"> <li>• Develop a progressive, integrated structural design for a reinforced concrete building incorporating slabs, structural walls, and foundations [Assessment]</li> <li>• Apply course content cumulatively to solve realistic, open-ended design problems under code and site constraints [Assessment]</li> <li>• Prepare structural calculation documentation communicating design decisions [Usage]</li> </ul> |
| Readings : [WM16], [ACI19]                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

## 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

- [Cod01] Donald P. Coduto. *Foundation Design: Principles and Practices*. 2nd. Prentice Hall, 2001.
- [Moe15] Jack P. Moehle. *Seismic Design of Reinforced Concrete Buildings*. McGraw-Hill Education, 2015.
- [WM16] James K. Wight and James G. MacGregor. *Reinforced Concrete: Mechanics and Design*. 7th. Pearson, 2016.
- [ACI19] ACI Committee 318. *Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary*. Tech. rep. American Concrete Institute, 2019.
- [Das19] Braja M. Das. *Principles of Geotechnical Engineering*. 9th. Cengage Learning, 2019.
- [MB21] Jack C. McCormac and Russell H. Brown. *Design of Reinforced Concrete*. 10th. Wiley, 2021.