NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ENVIRONMENTAL ENGINEERING
SANITARY ENGINEERING PROGRAM

EC311 – REINFORCED CONCRETE

I. GENERAL INFORMATION

CODE	**:**	EC311 Reinforced Concrete
SEMESTER	**:**	8
CREDITS	**:**	5
HOURS PER WEEK	**:**	6 (Theory, Practice)
PREREQUISTES	**:**	EC122 Strength of Materials II
CONDITION	**:**	Mandatory

II. COURSE DESCRIPTION

The course prepares students for the analysis and design of concrete structures. Students analyze and calculate the resistance of concrete to different one-axial and bi-axial solicitations: tension, compression, shear, bending, and torsion. Students analyze the materials and processes for concrete and reinforced concrete fabrication, and evaluate the quality of reinforce concrete.

II. COURSE OUTCOMES

At the end of the course, students:

1. Identify characteristics of materials making up the base for reinforced concrete.
2. Understand the behavior and identify the characteristics of base materials forming reinforced concrete.
3. Apply procedures and methodologies for designing and analyzing reinforced concrete structures subject to tension, bending, shear, bending compression and bending shear taking into consideration Peruvian norms on reinforced concrete, ACI regulations, as well as other relevant codes.
4. Verify the application of service requirements for reinforced concrete elements and structures: deflection and cracking control.
5. Evaluate the quality of reinforced concrete, satisfying giving requirements.

III. LEARNING UNITS

1. PROPERTIES OF CONCRETE

Concrete permeability / Concrete temperature problems / Freezing and thaw processes in the concrete, weathering influences and causes / Concrete resistance / Compression resistance / Tensile strength due to diametrical compression / Flexural strength / Concrete resistance nature / Water-cement relation / Design water / Design water / Effective water / Factors modifying resistance.

2. DESIGN OF CONCRETE MORTARS

Basic considerations in mortar design / Description. Factors having influence / Essential requirements and ratio expressions. Types of concrete mortars. Steps for designing a mortar. Criteria in the selection of design values / Design of concrete mortars: ACI methods, aggregate fineness modulus, Fuller's curve / Procedures and applications.

3. PROPERTIES OF REINFORCED CONCRETE
A brief history of the concrete / Plain concrete / Components of concrete: cement, water, aggregates and admixtures / Concrete mixing, transport and placing / Concrete and steel properties / Volumetric changes / Steel: Stress-strain curves, modulus of elasticity / Axial load – tension – compression.

4. FLEXION
Loads combination NTE 060 (Peru) – ACI (USA) codes / Flexion: Elastic – rupture method / Simply reinforces sections / Dual reinforced sections / Coefficient method / Solid and ribbed slabs / T beams.

5. SHEAR
Shear and diagonal tension / Shear stress. Contribution of concrete and steel.

6. SERVICE CONDITION AND FLEXOCOMPRESSION
Cracking. Bond and anchor. Deflections. Columns. Biaxial bending compression. Introduction to foundations.

7. CONCRETE QUALITY CONTROL
Average resistance. General criteria. Statistic fundamentals. Results interpretations. Characteristic resistance. Destructive and nondestructive testing. Acceptance and rejection green and hardened concrete. Elasticity and plastic flow. Strain and cracking. Cracking interpretation.

IV. METHODOLOGY

The course takes place in theory and practice sessions. In the theory sessions, the teacher presents concepts and applications. In practice sessions, various problems are solved and their solution analyzed. Students visit different construction works in Lima city to analyze reinforced concrete buildings. At the end of the course, students complete a project and defend it. Student's active participation is promoted.

V. GRADING FORMULA

The Final Grade PF is calculated as follows:

PF = (EP + 2 EF + PC) / 4

EP: Mid-term Exam EF: Final Exam
PC: Practical Work

VI. BIBLIOGRAPHY

1. **ARTHUR NILSON, GEORGE WINTER**
   Concrete Structures Design
   Reverte Editorial
2. **R. PARK, T. PAULAY**
   Reinforced Concrete Structures
   Limusa Editorial
3. **G. CUEVAS, F. ROBLES**
   Fundamental Aspects of Reinforced Concrete
   Limusa Editorial