NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ENVIRONMENTAL ENGINEERING
SANITARY ENGINEERING PROGRAM

EC211 - STRUCTURAL ANALYSIS I

I. GENERAL INFORMATION

CODE	**:**	EC211
SEMESTER	**:**	7
CREDITS	**:**	5
HOURS PER WEEK	**:**	6 (Theory – Practice)
PREREQUISITES	**:**	EC122 Strength of Materials II
CONDITION	**:**	Compulsory

II. COURSE DESCRIPTION

This course trains students on the principles of the relationship between structures analysis and design, the analysis of displacements of several types of structures as a response to several solicitation applying energy methods for the solution to isostatic and hyperstatic structures. It deals with topics such as axial solicitations of bending shear force and torsion in structures, and responses in terms of stress and strain. During the course, students become aware of the importance of learning the structures action and the loads function in structures and its analysis through the force method, Castigliano's second theorem and iterative method.

III. COURSE OUTCOMES

1. Identify the characteristics of several types of structures and value the rigor and the objectivity of the theories exposed in the course.
2. Apply the knowledge and skills in science and mathematics to solve problems.
3. Understand that the structures' analysis and design must go together in the activity of the civil engineer.
4. Analyze the adequate use of the fundamentals and relate different procedures of the structural analysis with the principles of the applied mechanics.
5. Adequately use materials, taking into consideration their characteristics of resistance and deformability.
6. Apply energy methods in the solution to problems of isostatic and hyperstatic structures, related to a certain type of solicitation or solicitations.

IV. LEARNING UNITS

1. STRUCTURES DETERMINATION AND STABILITY – STRAIN ENERGY

Stability: External, internal and general stability / Structures determination: External, internal and general for several types of structures / Structural Isostatic change: Forms of Isostatic change / Strain energy: Clapeyron's law / Strain energy for every concept: Application to several types of structures.

2. ENERGY METHODS FOR CALCULATING LINEAR AND ANGULAR DISPLACEMENTS

Castigliano's first theorem: Linear and angular displacements in structures due to normal force, shear force, bending and torsion / No-load point displacement / Unit load method: Displacements in arc, bar, composite and continuous structures / Applications to find linear and angular displacements / Betti's theorem and Maxwell's theorem.

3. FORCE METHOD (FLEXIBILITY METHOD)
Undetermined structures analysis / Force method: Method Expression / Applications in continuous, reticular and arc structures / Applications in arc, articulated, composite and continuous structures.

4. CASTIGLIANO'S SECOND THEOREM
Castigliano's second theorem: Explanation of the theorem / Application sin undetermined structures: arc, articulated, composite and continuous.

5. CONTINUOUS STRUCTURES ANALYSIS
Main definitions / Angular deformation method: explanation and main equations: Fundamental hypotheses / Application to structures with mobile and revolving nodes / Symmetrical continuous structures.

6. MOMENT DISTRIBUTION METHOD
Moment distribution method / Applications to rigidly framed structures with mobile and revolving nodes / Applications to continuous structures with intermediate ball and socket joint.

7. KANI'S METHOD
Kani's method: fundamental equations for mobile and revolving nodes / Applications to continuous rigidly framed structures: Shear force and bending moment diagrams / Continuous structures with articulated elements / Analysis of continuous structures of various heights with bars embedment and articulation / Applications to continuous rigidly framed structures with lateral loads.

8. TAKABEYA'S METHOD
Fundamental equations / Applications / Scalar focus of the stiffness and flexibility methods.

VI. METHODOLOGY

The course is carried out in theory and practice sessions. In theory sessions, the instructor introduces the analysis and the deduction of various theories in the learning process where students participate either individually or in work groups to solve problems. The instructor exposes and gives examples to complement students' activity. Students' learning is complemented with papers and problems given by the instructor in the classroom. The instructor provides offprints about theory and the solutions to several formulated problems.

VII. EVALUATION FORMULA

The average grade PF is calculated as follows:

$$PF = 0.3\,EP + 0.4\,EF + 0.3\,PP$$

EP: Mid-Term Exam EF: Final Exam
PP: Average of six quizzes

VIII. BIBLIOGRAPHY

1. **HIBBELER R.C.**
   Structural Analysis
   Prentice Hall Ed., 2003

2. **KENNEETH M. LEET AND CHIA MING VANG**
   Structural Analysis
   Mc. Graw Hill Ed., 2006