



**NATIONAL UNIVERSITY OF ENGINEERING  
COLLEGE OF SCIENCES  
MATHEMATICS PROGRAM**

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**CM313 – MULTIVARIABLE REAL FUNCTIONS I I**

**I. GENERAL INFORMATION**

<b>CODE</b>	: CM313 Multivariable Real Functions I
<b>SEMESTER</b>	: 5
<b>CREDITS</b>	: 4
<b>HOURS PER WEEK</b>	: 6 (Theory – Practice – Seminar)
<b>PREREQUISITES</b>	: CM214 Real Variable Functions
<b>CONDITION</b>	: Mandatory

**II. COURSE DESCRIPTION**

To present the analysis in several real variables as a fundamental tool for topology courses. Develop the analysis in several variables from the analytical and geometric point of view.

**III. LEARNING UNITS**

**1. Topology in the Euclidean Space**

Successions in the Euclidean space in  $\mathbb{R}^n$ . Accumulation Point / Continuous Applications. Homeomorphisms / Limits. Properties / Open Sets / Closed Sets / Compact Sets. Distance between two sets; diameter. Connectivity.

**2. Paths in the Euclidean Space**

Differential Paths / Integral of a Path / Theorems (Chain Rule, Fundamental Theorem of the Calculation, Theorem of the Average Value, etc.) / Rectifiable Paths / Length of arc cone parameter. Curvature and Torsion. Function-angle.

**3. Real Functions of n Variables**

Partial Derivatives / Directional Derivatives / Differentiable Functions / Differential of a Function / Gradient of a Differentiable Function / Leibniz's Rule / Schwarz's Theorem / Taylor's Formula: Critical points / Theorems of the Implicit Function / Global Theorem of the Implicit Function / Lagrange multiplier

**4. Curvilinear Integrals**

First-grade Differential Forms / Stieltjes Integral. Integral of a form along a path / Paths Juxtaposition; Inverse path / Exact forms and closed forms / Homotopy. Curvilinear integrals and homotopy. Cohomology / Kronecker formula.

#### **IV. BIBLIOGRAPHY**

- Elon Lages Lima, Curso de Análise, Vol. 2, Prometo Euclides.
- Tom M. Apostol, Calculus, Vol. 2, Editorial Reverté, S. A.
- Tom M. Apostol, Análisis Matemático Reverté, S. A