Program	59EC – Communications Electronic Engineering B. Eng.
	59SC – Telecommunications Systems Engineering B. Eng.
	59SO – Sound and Image Engineering B.Eng.
	59TL – Telematics Engineering B. Eng.

Course code and name

Code	595000010, 595000309, 595000109, 595000209
Name	Calculus II
Semester	S2 [(February-June)]

Credits and contact hours

ECTS Credits	6
Contact hours	60

Coordinator's name	García Luengo, Julia [julia.gluengo@upm.es]

Specific course information

Tuition language	Spanish

Description of course content

It is a basic subject that focuses on the study of functions of several real variables and complex variables. So it is a natural continuation of the course "Calculus I" and the student will add new concepts regarding the mathematical analysis in several real variables and in complex variables. The course will also provide the essential mathematical tools for the understanding and management of the fundamental concepts in Engineering.

List of topics to be covered

1. Differential calculus of functions of several real variables
    1.1. Limit and continuity of definite functions from Rn to R.
    1.2. Directional derivatives and partial derivatives of functions of several variables.
    1.3. Differentiation of defined functions from Rn to R.
    1.4. Partial derivatives of order two. Schwarz's theorem. Taylor polynomial of order 2 of functions of several variables.
    1.5. Local extrema of functions of two variables.
2. Differential calculus of vector functions
    2.1. Curves in Rn. Parameterization. Length of a curve.
    2.2. Limit and continuity of definite functions from Rn to Rm
    2.3. Differentiation of functions from Rn to Rm. Chain rule.
    2.4. Implicit function theorem.
3. Double integration
    3.1. Definition of double integral in a rectangle and in an elementary region.

3.2. Properties of integral functions.

3.3. Fubini's theorem.

3.4. Change of variable to polar coordinates.

4. curvilinear integral

4.1. Integral of a vector function along a curve in Rn.

4.2. Conservative fields in Rn. Characterization. Line integral of a gradient field.

4.3. Green's theorem.

5. Analytical functions

5.1. Complex variable functions. Derivability. Cauchy-Riemann equations.

5.2. Sequences and series of complex numbers.

5.3. Elementary functions: exponential, logarithm, trigonometric.

6. Complex integration

6.1. Definition of line integral of complex variable functions.

6.2. Independence of the path and primitive functions.

6.3. Cauchy's integral formula.

6.4. Taylor series and Laurent series of complex variable functions.

6.5. Zeros and singularities of analytical functions.

6.6. Calculation of residuals. Residual theorem.

6.7. Application of the residue theorem to the calculation of real integrals.

Prerequisites or co-requisites
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Course category in the program	
☑ **R (required)**	☐ **E (elective)** *(elective courses may not be offered every year)*

Specific goals for the course

Specific outcomes of instruction

- RA712 – To know the basic properties of the functions of several variables: limit, continuity, partial derivatives, differentiation and local extremes.
- RA716 – To know how to calculate the integral of an analytical function along a curve.
- RA715 – To know the basic properties of complex variable functions.
- RA714 – To know how to calculate the integral of vector functions along curves.
- RA713 – To know how to calculate the integral of functions of two variables in elementary domains.

Further reading and supplementary materials

- Amillo, J.; Ballesteros, F.; Guadalupe, R.; Martín, L. Cálculo, conceptos, ejercicios y sistemas de computación matemática. Mc Graw-Hill.
- Apostol, T.M. Calculus. Tomos I y II. Reverté.
- Burgos, J. Cálculo infinitesimal de varias variables. McGraw-Hill.
- Churchill, R.V.; Ward, J. Variable compleja y aplicaciones. McGraw-Hill.
- García, A.; López. A.; Rodríguez, G.; Romero, S.; De la Villa, A. Cálculo II.
- Teoría y problemas de funciones de varias variables. CLAGSA.
- Marsden, J.E.; Tromba, A.J. Cálculo vectorial. Addison-Wesley.

– Stewart, J. Cálculo multivariable. Thomson Learning.