# SUBJECT TEACHING GUIDE

## G104 - Functional Analysis

## Double Degree in Physics and Mathematics
## Degree in Mathematics

## Academic year 2026 - 2027

| 1. IDENTIFYING DATA | | | | | |
|---|---|---|---|---|---|
| Degree | Double Degree in Physics and Mathematics<br>Degree in Mathematics | | | Type and Year | Optional. Year 5<br>Optional. Year 4 |
| Faculty | Faculty of Sciences | | | | |
| Discipline | Subject Area: Further Mathematical Analysis and Differential Equations<br>Mention in Pure and Applied Mathematics | | | | |
| Course unit title and code | G104 - Functional Analysis | | | | |
| Number of ECTS credits allocated | 6 | Term | | Semester based (1) | |
| Web | | | | | |
| Language of instruction | Spanish | English Friendly | No | Mode of delivery | Face-to-face |

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|---|---|
| Department | DPTO. MATEMATICAS, ESTADISTICA Y COMPUTACION |
| Name of lecturer | MANUEL GONZALEZ ORTIZ |
| E-mail | manuel.gonzalez@unican.es |
| Office | Facultad de Ciencias. Planta: + 0. DESPACHO PROFESORES (0053) |
| Other lecturers | |

### 3.1 LEARNING OUTCOMES

Show that a concrete expression defines (or not defines) a norm. Analyze the completeness of a normed space.
Prove the basic properties of a bounded operator. Compute the norm of some bounded operators. Describe the dual space of some normed spaces. Applications of the dual space. Statements and proofs of the main theorems: Hahn-Banach, Banach-Steinhaus, open mapping and closed graph.

### 4. OBJECTIVES

Basic knowledge of functional analysis.

| 6. COURSE ORGANIZATION | |
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| CONTENTS | |
| 1 | Norms on a vector space. Normed spaces. Convergence of sequences. Completeness: Banach spaces. Examples. Bounded linear operators. Norm of an operator. Dual space. Examples. Separable spaces. Finite dimensional spaces. Strictly convex norms. |
| 2 | Hahn-Banach theorem. Applications. Reflexive spaces. The conjugate operator. Examples. |
| 3 | Baire's lemma and its consequences. Banach-Steinhaus, open mapping and closed graph theorems. Applications. |

| 7. ASSESSMENT METHODS AND CRITERIA | | | | |
|---|---|---|---|---|
| Description | Type | Final Eval. | Reassessment | % |
| A two hours written exam. | Written exam | Yes | Yes | 30,00 |
| Two short exams. | Written exam | No | Yes | 70,00 |
| TOTAL | | | | 100,00 |
| Observations | | | | |
| To pass this subject, the student should pass two partial exams. Otherwise he should pass a final global exam. | | | | |
| Observations for part-time students | | | | |
| Partial time students may choose not taking the partial exams. | | | | |

| 8. BIBLIOGRAPHY AND TEACHING MATERIALS |
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| BASIC |
| A. Vera , P. Alegría. Un curso de análisis funcional; teoría y problemas. AVT 1997. |