SUBJECT TEACHING GUIDE

358 - Small Parameters in Applied Mathematics

Master's Degree in Mathematics and Computing

Academic year 2026 - 2027

1. IDENTIFYING DATA					
Degree	Master's Degree in Mathematics and Computing			Type and Year	Optional. Year 1
Faculty	Faculty of Sciences				
Discipline					
Course unit title and code	358 - Small Parameters in Applied Mathematics				
Number of ECTS credits allocated	3	Term		Semester based (2)	
Web	https://personales.unican.es/meperez/				
Language of instruction	Spanish	English Friendly	Yes	Mode of delivery	Face-to-face

Department	DPTO. MATEMATICA APLICADA Y CIENCIAS DE LA COMPUTACION
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Other lecturers	DELFINA GOMEZ GANDARILLAS

3.1 LEARNING OUTCOMES

- To get used to asymptotic analysis methods for solving problems in Mathematics, Physics and Engineering.

- To design and implement algorithms based on Numerical Methods or involving Symbolic Computation Methods.

-To Address / to face models which appear in different branches of Mathematics, Physics and Engineering (depending on the specialization of the registered students): models in which very small parameters or very large parameters arise making it difficult the usual computational treatments. These models can be of interest in fields like 'advanced materials' and 'sustainable cities and ecosystems', among others.

- Approximation to the above mentioned models from the different view points outlined in the section of Objectives: the symbolic and numerical computations are used in a second step to solve the approximate models abotained with asymptotic expansions.

4. OBJECTIVES

Treatment, by means of asymptotic expansions of certain problems of Mathematics, Physics an Engineering, in which small or large parameters arise, making it difficult to provide an approximation to the solution by means of the classical numerical computations.

Modelling and processing certain problems arising in different branches of Mathematics, Physics and Engineering depending on the specialization of the students registered: guidance through theoretical and practical classes.
A computational approach to the above mentioned problems (in the computer laboratory of the center where the subject is taught) using specific software and / or software developed by the teachers of the course.
Setting of models that can contribute to ODS 6 and 11 (purifying fluids , new coatings, multi-material structures, constructions on unstable lands, etc.)

6. COURSE ORGANIZATION

CONTENTS	
1	Asymptotic expansions technique: Boundary Layers and Matching Principles.
2	Justifying the asymptotic expansions.
3	Models of Science and Technology dependent on a small parameter. Computer simulations.

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessment	%
Supervised works depending on the degree of the students	Work	No	Yes	60,00
Continuous assessment	Others	No	Yes	40,00
TOTAL				100,00

Observations
In the case of mixed teaching, or distance teaching, due to sanitary requirements (imposed by the healthcare authorities), the continuous face-to-face or online evaluation would be preserved; the presentation of supervised works could be done electronically only in the extreme case of not being able to be face-to-face.
Observations for part-time students
Part-time students may choose between the continuous assessment and supervised works like the rest of the students (with the same percentages), or developing the software of the practical classes and submitting supervised works, together with the exhibition of works and the simulations with the software developed (at the end of the course, weight 100%).

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

A. Bensoussan, J.L. Lions, G. Papanicolau. Asymptotic Analysis for Periodic Structures; North-Holland. Amsterdam, 1987

J. Kevorkian and J. D. Cole; Perturbation Methods in Applied Mathematics, Springer-Verlag, New York,rk, 1974.

P. A. Lagerstrom; Matched Asymptotic Expansions: Ideas and Techniques, Springer-Verlag, New York, 1988.

R. E. O Malley; Introduction to Singular Perturbations, Academic Press, New York, 1974.

M. E. Pérez, Cálculo Simbólico y Numérico en Ecuaciones Diferenciales, OCW-Universidad de Cantabria, 2014

J. Sanchez-Hubert; E. Sanchez-Palencia; Introduction aux Méthodes Asymptotiques et a l'Homogénéisation. Masson, Paris, 1992