FACULTAD DE
CIENCIAS QUÍMICAS

MATHEMATICS

COURSE GUIDE

BSc Chemistry

Academic Year 2023-2024

UNIVERSIDAD
COMPLUTENSE
MADRID

I.- IDENTIFICATION

COURSE NAME:	**Mathematics**
CHARACTER:	**Mandatory**
SUBJECT:	**Mathematics**
MODULUS:	**Basic**
DEGREE:	**Bachelor in Chemistry**
SEMESTER/TERM TAUGHT:	**First term (first year)**
DEPARTAMENT:	**Department of Applied Mathematics and Mathematical Analysis**

LECTURER:

Group E		
Theory **Seminar** **Tutorial**	**Lecturer:** **Department:** **Office:** **e-mail:**	ROSA PARDO Applied Mathematics and Mathematical Analysis QB-648 rpardo@ucm.es

II.- OBJECTIVES

■ GENERAL OBJECTIVES

This subject is the first contact of the student at the university with the language of science, Mathematics. Therefore, the main target is to train the student to atain the essential skills for using and understanding this language, while achieving fundamental knowledge on differential and integral calculus, as well as the control of its main techniques.

■ SPECIFIC OBJECTIVES

- Knowledge and control of the technique of derivation and integration of functions of one and several variables.
- Knowledge of the approximation of functions by means of series of powers.
- Solutions of differential equations.

III.- MODULE PREREQUISITES AND RECOMMENDATIONS

■ PREVIOUS KNOWLEDGE:

The knowledge described in the official programs of the subjects of Mathematics in the pre-university academic courses for a science student. In particular, it is recommended to know the derivation, integration, and graphical representation of functions of a real variable.

■ RECOMMENDATIONS:

In case the student do not possess the required prerequisites, it is strongly recommended to acquire them before starting this lecture.

IV.- CONTENTS

■ BRIEF DESCRIPTION:

Functions of one and several variables. Derivation, integration, and graphical representation. Power series. Convergence criteria. Taylor, Series expansion. Differential equations.

■ SYLLABUS:

1. **Differential Calculus**
- Differentiation rules. Derivative of inverse functions. Chain rule. Implicit differentiation.
- Tangent lines. Classification of critical points.
- Graphical representation of functions of one variable.
- Level curves. Graphical representation of functions of two variables.
- Partial derivatives. Gradient vector and tangent plane. The Hessian matrix; classification of critical points. Constrained maximum and minimum; Lagrange multipliers.
- Exact differential. Finding *a* potential function of a conservative vector field.

2. Integral Calculus

- Primitive of a function. Integration by parts, changes of variable, rational functions.
- Fundamental theorem of calculus.
- Multiple integrals. Fubini's theorem. Change of Variable, the Jacobian matrix. Polar coordinates.
- Applications of the integral.

3. Power Series

– Convergence criteria.
– Expansion of a function in power series. Radius of convergence

4. Differential equations

- Elementary methods of resolution. Separation of variables, exact equations, integrating factor, linear equations.
- Second order linear equations. Undetermined coefficients and power series solutions.

V.- COMPETENCES

GENERAL:

- **CG6:** To analyse and solve qualitative and quantitative problems..
- **CG7:** To recognise, analyse new problems developping strategies for their resolution.

SPECIFIC:

- **CE26-M1:** To use the language of mathematics.
- **CE26-M2:** To derive functions of one and several variables.
- **CE26-M3:** To represent functions of one and several variables graphically.
- **CE26-M4:** To integrate functions of one and several variables.
- **CE26-M5:** To expand functions power series.
- **CE27-M1:** To solve differential equations.

GENERIC:

- **CT2:** To work in team.
- **CT3:** To show criticism (including self-criticism) towards any kind of reasoning.
- **CT4:** To be able to adapt to new situations.

VI.- LEARNING OUTCOMES

Having passed the course, students should be able to:

- Precisely handle the mathematical language (symbols, formulas, equations, ...).
- Calculate the derivatives of functions of one and several variables.
- Classify the critical points of one and two variable functions.
- Calculate the maximum and minimum of a function of one and several variables.
- Graphically represent functions of one and two variables.
- Know the concept of integral and its relationship with the concepts of area and volume.
- Use correctly the properties of the integral and the fundamental theorems of the calculation.
- Use the most usual integration methods in the calculation of primitives of functions of one and several variables.

- Handle the most common criteria of convergence of numerical series.
- Calculate the Taylor developments of a function.
- Calculate the radius of convergence of a series of powers.
- Manage the methods of solving ordinary differential equations of the most common first order.
- Apply the technique of indeterminate coefficients for the resolution of linear second-order equations with constant coefficients.
- Obtain solutions in the form of power series for linear differential equations.

VII. – WORKING HOURS, DISTRIBUTED BY ACTIVITY

The subject of Mathematics is a subject of the Basic Module of the Degree in Chemistry, with an allocation of 9 credits that are taught throughout the first term. The dedication of the student to this subject will be, according to ECTS criteria, 225 hours a year, distributed as follows:

Actividad	Joint work (hours)	Self study (hours)	Credits
Lectures	49	91	5,6
Seminars	18	22	1,6
Tutorials	3	4	0,3
Preparation of exams	6	32	1,5
Total	**76**	**149**	**9**

VIII.- METHODOLOGY

At the start of the course, during the first class, the student will be informed by the Lecturer the content of this course.

Exercises will be published on the virtual campus in order to encourage the students to try to solve them individually.

The so called seminars and tutorials are lectures, dedicated to the resolution of the exercises.

IX.- BIBLIOGRAPHY

- **BASIC:**
  - RODRÍGUEZ SALAZAR, S.: *"Matemáticas para estudiantes de Químicas"*, Síntesis, 2007.

- FERREIRA, R. y RODRIGUEZ SALAZAR, S.: "Ecuaciones diferenciales y cálculo vectorial", Garceta, 2013
- STEINER, ERICH: *"The Chemistry Maths Book"*, Oxford University Press, 2008.
- SALAS–HILLE: *"Calculus : one and several variables",* John Wiley, 2006.
- ZILL, D. G.: "*A FIRST COURSE IN DIFFERENTIAL EQUATIONS with Modeling Applications*", Grupo editorial Iberoamericana, 1994.

■ **COMPLEMENTARY:**

- BOYCE, W.; Di PRYMA, R. C.: "*Elementary Differential Equations and Boundary Value Problems*", John Wiley & Sons, 2.017.
- LÓPEZ-GÓMEZ, J.: "*Ecuaciones diferenciales y variable compleja: problemas y ejercicios resueltos",* Prentice Hall, Madrid, 2002.

X.- ASSESSMENT PROCEDURE

30% of the mark will come from short exams during the course and 70% from a 3 hour end of semester exam.

■ **EXAMS:** **100%**

- Two short exams will be hold during the course (30% of the final score).
- The **final exam** will contribute 70% to the final score

The evaluation concerns subjects CG6, CG7, CE26, CE27, CT2, CT3 y CT4.

■ **RESIT EXAMINATION IN JULY:** **100%**

- If a student fails the exams, the student has to attend a resit exam, which will last for three hours, concerning all the subjects of the course and will take place in July. This exam corresponds to 100% of the final mark.

The students will be informed about the results of the 1 hour exams in due time which would allow the students to prepare the exam and also to organize their other studies accordingly. In any case, the students will be informed about their qualification in a period which should not exceed 20 days after the exam.

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ACTIVITIES SCHEDULE

UNITS	ACTIVITY	HOURS	GROUPS	START	END
1. Differencial Calculus	Lectures	11	1	1st Week	3rd Week
	Exercises	4	1		
2. Integral Calculus	Lectures	14	1	4th Week	7th Week
	Exercises	6	1		
3. Power series	Lectures	7	1	8th Week	9th Week
	Exercises	3	1		
4. Differencial Equations	Lectures	17	1	10th Week	14th Week
	Exercises	8	1		
	Written Exams	6		Determined by the «Faculty (School)»	

* The supervised tutorials/activities are subject to possible modification depending on the complete organization of the course

SUMMARY OF THE ACTIVITIES

Lecture activities	Associated Competences	Lecturer Activity	Student Activity	Assessment procedure	P/V	NP	Total	C
Classes for theory	CG6, CG7 CE26, CE27 CT2, CT3, CT4	Outlining the subjects of the lectures.	Listing, understanding, planning questions. Note taking, for clarifying doubts.	Short and long exams.	49	149		70% + 30%
Classes for exercises		Apply the theory learned to the resolutions of exercises.	Presenting solution to exercises. Planning of questions. Presentations on the blackboard.	Short and long exams.	18			
Tutorials	CG6, CG7 CE26, CE27 CT2, CT3, CT4	Help the student to organise his studies.	Consulting the lecturer about the difficulties the student may encounter, both conceptual and methodological, when studying the subject.	Mandatory attendance on assigned days.	3			
Exams		Proposal, surveillance and correction of the exam. Assessment of the student.	Preparation and accomplishment.	Short and long exams.	6			
P/V : In class or Virtual; NP: Self studies; C: evaluation								

ecturer considers: using the activity registration tool for each session (Zoom), the name of the attendees (Google Meet), signature sheet enabled in the VC as a questionnaire, analysis of downloads made by students in the VC, etc.