



Course Guide: Stages 1, 2 and 3

MATHEMATICS



CHEMISTRY DEGREE
COMPLUTENSE UNIVERSITY OF MADRID
ACADEMIC YEAR 2020-2021



STAGE 1. FACE-TO-FACE

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:

Grupo D		
Theory Seminar Tutorial	Lecturer:	ROSA PARDO
	Department:	Applied Mathematics and Mathematical Analysis
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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 attain 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 developing 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 PRIMA, R. C.: “*Elementary Differential Equations and Boundary Value Problems*”, John Wiley & Sons, 2017.
- 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 a short exam during the course and 70% from a 3 hour end of semester exam.

■ EXAMS:

100%

- A 1 hour exam will be held during the course (30% of the final score).
 - The **final exam** will last 3 hours and 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 exam in due time which would allow the students to prepare the exam and also to organize his 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.



ACTIVITIES SCHEDULE

UNITS	ACTIVITY	HOURS	GROUPS	START	END
1. Differential 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. Differential 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%
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			30%
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



STAGE 2- BLENDED

VIII.- METHODOLOGY

• **Classes for theory and seminars** taught by the Lecturer in the usual regime, as in Stage 1, and with the same content. Following the principle of maximum attendance approved by the UCM Rectorate, the session will be followed in person by the students in the classroom, up to full capacity considering social distance. Students located in classrooms equipped with cameras, and that do not fit in the classroom, will follow the session virtually, either from their home or in public use areas enabled by the Faculty for this purpose, which will be duly publicized in the CV. For classrooms that do not have a camera, a rotating shift of face-to-face students will be established in the classroom, according to the ID number. This procedure may be modified by the Lecturer throughout the course, as he deems appropriate, to adjust the capacity of the classroom with the students attending to his class. Whenever possible, the class will be recorded with Collaborate or with any other computer tool available by the students, so that it can be followed both synchronously and asynchronously.

- The Lectures material used will be the class presentations enabled in the UCM Virtual Campus also used in Stage 1, as well as videos related to the subject and other types of materials that the Lecturers of the subject consider of relevance and interest. All the material will be available to students in advance through the Virtual Campus for use.

- The telematic means used so that students without face-to-face in the classroom virtually follow the sessions will be the platforms: Collaborate available in the CV, Google Meet, Microsoft Teams or Zoom. The Lecturer will keep such a session open to maintain a direct and fluid relationship with the students who attend virtually, thus being able to simultaneously project the Power Point presentation and follow the traditional explanations given on the board.

• **Individual Tutorials** will be held by video conference and / or email.

• **Monitoring of students**

In the part of Lectures that is done in person, the same techniques used in a traditional way will be followed. In the virtual Lectures part, the monitoring will be carried out by various techniques, as the Lecturer considers: using the activity registration tool



for each session (Collaborate), the name of the attendees (Google Meet), signature sheet enabled in the CV as a questionnaire, analysis of downloads made by students in the CV, etc.

X.- ASSESSMENT PROCEDURE

Virtual exams will be carried out with the final mark described in Stage 1.

STAGE 3 (FULLY VIRTUAL)

VIII.- METHODOLOGY

- **Virtual classes for theory** will be held, files on the Campus with the theoretical content of the topic and presentations of explanatory notes and / or audio from the Lecturer will be published. Also, online classes will be taught using platforms such as Collaborate available in the VC, Google Meet, Microsoft Teams or Zoom and the sessions will be recorded, which allow the students to participate and interact with the Lecturer.
- The **virtual seminars** will consist of the complete and detailed development of a set of selected problems, the statements of which have already been distributed on the virtual campus so that the student tries to solve them on his own once the theory has been explained and prior to the resolution by from the Lecturer.
- **Virtual tutorials** will be scheduled for the resolution of doubts and will be carried out individually or in small groups, which can be held at different times than the established class time using different platforms such as Collaborate, Skype, Zoom, Hangout, or through the virtual Campus chat or by email addressed directly to the Lecturer.
- **Monitoring of students**
It will be carried out in the same way as described in Stage 2 for virtual Lectures.



X.- ASSESSMENT PROCEDURE

Virtual exams will be carried out with the final mark described in Stage 1.

- **Identification of students:** before the exam, students must submit a commitment document accepting the rules for the test. The text of the document will be provided by the Lecturer, either by email or through the Virtual Campus.

The specific rules for conducting the test refer to the obligation of the student to be connected through the platform decided for each exam (Collaborate, Google Meet, etc. ...) with a camera (either from the computer or from the mobile phone) and accept that the sessions will be recorded.

- **Type of exam:** designed on the Virtual Campus, through the Task and / or Questionnaire tools.

- **Monitoring of students during the test:** during the test, students must have connected a camera (computer or mobile) that makes it possible to verify at all times by the Lecturer, compliance with the rules.

- **Review of exams:** students who wish to review will contact the Lecturers in their group via email and the individual review schedule will be established through Collaborate / Google Meet. Reviews will also be recorded.

On the other hand, the Lecturer may require the student to review and interactively discuss their exam within the period established for their review, which will be notified in the CV.

- **Mechanism used for the documentation / recording of assessment tests for subsequent viewing and evidence:**

The Lecturer will keep the files (in the electronic format specified) of the exam exercise sent by the student, with the partial grades he deems appropriate.

It will also keep the recordings of the exam sessions, as well as the recordings of the exam reviews, with the limitations established by the UCM, for later viewing if necessary. These recordings will be stored with the necessary security measures in UCM equipment and will be deleted after a reasonable time.