UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course:	CALCULUS AND DIFFERENTIAL EQUATIONS	**Code:**	57701
Type:	BASIC	**ECTS credits:**	12
Degree:	344 - CHEMICAL ENGINEERING	**Academic year:**	2022-23
Center:	1 - FACULTY OF SCIENCE AND CHEMICAL TECHNOLOGY	**Group(s):**	21
Year:	1	**Duration:**	AN
Main language:	Spanish	**Second language:**	
Use of additional languages:		**English Friendly:**	Y
Web site:		**Bilingual:**	N

Lecturer: **MARIA CRUZ NAVARRO LERIDA** - Group(s): **21**

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2. Pre-Requisites

To achieve the objectives of the subject, previous knowledge and skills are required. In particular, it is needed a basic knowledge of geometry, algebra and trigonometry, elementary mathematical operations (powers, logarithms, exponentials, fractions...), differentiation and integration of real functions and fundamentals of graphical representation.

3. Justification in the curriculum, relation to other subjects and to the profession

The mathematical concepts that are studied in this subject provide an essential tool that will be used in basic and advanced subjects of Chemical Engineering. Functions of one and several variables, geometry, differential equations, numerical calculus, numerical differential equations appear in the study, synthesis, development, design, operation and optimization of industrial processes that produce physical/chemical/biochemical changes in the materials dealt in Chemical Engineering. Calculus and differential equations are present in the planning and development of experimental, academic and professional activities in Chemical Engineering. Another important aspect of Calculus and Differential Equations is that it is a subject that helps to enhance the capacity for abstraction, rigor, analysis and synthesis that are characteristic of mathematics and necessary for any other scientific discipline.

4. Degree competences achieved in this course

Course competences

Code	Description
CB01	Prove that they have acquired and understood knowledge in a subject area that derives from general secondary education and is appropriate to a level based on advanced course books, and includes updated and cutting-edge aspects of their field of knowledge.
CB02	Apply their knowledge to their job or vocation in a professional manner and show that they have the competences to construct and justify arguments and solve problems within their subject area.
CB03	Be able to gather and process relevant information (usually within their subject area) to give opinions, including reflections on relevant social, scientific or ethical issues.
CB04	Transmit information, ideas, problems and solutions for both specialist and non-specialist audiences.
E01	Ability to solve mathematical problems that may arise in engineering. Ability to apply knowledge about: linear algebra; geometry; differential geometry; differential and integral calculation; differential equations and partial derivatives; numerical methods; numerical algorithm; statistics and optimization.
G03	Ability to solve problems with initiative, decision making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Chemical Engineering.
G12	Knowledge of Information and Communication Technologies (ICT).
G13	Proper oral and written communication
G14	ethical commitment and professional ethics
G17	Synthesis capacity
G19	Ability to analyze and solve problems
G20	Ability to learn and work autonomously
G22	Creativity and initiative
G26	Obtaining skills in interpersonal relationships.

5. Objectives or Learning Outcomes

Course learning outcomes

Description

To know the main approaches for resolution using numerical methods, use at the user level some software packages of statistics, data processing, mathematical calculation and visualization, propose algorithms and program using a high-level programming language, visualize functions, geometric figures and data, design experiments, analyze data and interpret results.

To get used to teamwork, express yourself correctly orally and in writing in Spanish and English and behave respectfully.

To know how functions and data are approached through developments in power series and Fourier and its applications.

To know the fundamentals of plane and spatial geometry.

To know the fundamentals and applications of optimization.

To know how to derive, integrate and represent functions of one and several variables, as well as the meaning and applications of the derivative and the integral.
To know how to model chemical engineering processes using ordinary differential equations and partial derivatives, solve them and interpret results.
To know how to use the language of Mathematics.

6. Units / Contents

Unit 1: Differential and Integral Calculus in one variable
- **Unit 1.1** Introduction to successions, numerical series and power functions.
- **Unit 1.2** Limits and continuity. Derivation.
- **Unit 1.3** Taylor and Fourier series. Function approximation.
- **Unit 1.4** Growth. Extremes. Concavity.
- **Unit 1.5** Calculus of primitives. Defined integral.
- **Unit 1.6** Improper integral.
- **Unit 1.7** Matlab practice. Graphical representation, derivation, integration and function approximation.

Unit 2: Geometry
- **Unit 2.1** Reference systems.
- **Unit 2.2** Curves. Conics.
- **Unit 2.3** Surfaces. Quadrics.
- **Unit 2.4** Matlab practice. Scientific and technological applications.

Unit 3: Differential Calculus in several variables
- **Unit 3.1** First notions on several variables functions.
- **Unit 3.2** Limits and continuity.
- **Unit 3.3** Partial and directional derivatives. The differential of a function.
- **Unit 3.4** The chain rule.
- **Unit 3.5** Taylor series.
- **Unit 3.6** Optimization. Extremes. Lagrange multipliers method.
- **Unit 3.7** Differential operators.
- **Unit 3.8** Matlab practice. Graphical representation, derivation and optimization.

Unit 4: Integral calculus in several variables
- **Unit 4.1** Double integral.
- **Unit 4.2** Triple integral.
- **Unit 4.3** Line integral.
- **Unit 4.4** Surface integral.
- **Unit 4.5** Integral theorems: Green, Divergence, Stokes.
- **Unit 4.6** Matlab practice. Scientific and technological applications.

Unit 5: Ordinary differential equations
- **Unit 5.1** First order ODE: separable variable and linear equations.
- **Unit 5.2** Higher order ODE with constant coefficients.
- **Unit 5.3** Matlab practice. Numerical solutions of ODE. Scientific and technological applications.

Unit 6: Systems of ordinary differential equations
- **Unit 6.1** First order linear systems of ODE with constant coefficients.
- **Unit 6.2** Laplace transformation.
- **Unit 6.3** Matlab practice. Numerical solution of ODE systems. Scientific and technological applications.

Unit 7: Numerical solution of ODE and ODE systems
- **Unit 7.1** Introduction.
- **Unit 7.2** Euler's method. Formulation and error analysis.
- **Unit 7.3** Methods of higher order: one step (Runge-Kutta) and multi-step (AB and BDF).
- **Unit 7.4** Rigid problems.
- **Unit 7.5** Perspectives of other methods.
- **Unit 7.6** Matlab practice. Numerical implementation. Scientific and technological applications.

Unit 8: Qualitative properties of ODE and ODE systems
- **Unit 8.1** Equilibrium points. Atractors.
- **Unit 8.2** Linear stability.
- **Unit 8.3** Phase space.
- **Unit 8.4** Matlab practice. Scientific and technological applications.

Unit 9: Partial Differential Equations
- **Unit 9.1** Introduction.
- **Unit 9.2** Analytical solution of PDE. Method of separation of variables.
- **Unit 9.3** Visualization of solutions for relevant PDE.
- **Unit 9.4** Matlab practice. Scientific and technological applications.

7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-SITE]	Lectures		2.2	55	N	-	Theoretical classes and resolution of exercises and problems
Problem solving and/or case studies [ON-SITE]	Guided or supervised work		1.24	31	N	-	Resolution of problems and exercises in class under supervision
Progress test [ON-SITE]	Assessment tests		0.16	4	Y	Y	Delivery of problems solved by the student individually in class.
							Resolution of problems in class

Computer room practice [ON-SITE]	Practical or hands-on activities		0.8	20	Y	Y	using computational techniques. Delivery of practices solved by the students individually
Mid-term test [ON-SITE]	Assessment tests		0.32	8	Y	Y	Four mid-term tests will be carried out consisting of solving a series of exercises.
Final test [ON-SITE]	Assessment tests		0.12	3	Y	Y	There will be a final exam with all the contents. The exam will consist of solving a series of exercises from each block.
Study and Exam Preparation [OFF-SITE]	Self-study		7.16	179	N	-	Individual study, problems/practices and exam preparation.
		Total:	**12**	**300**			
		Total credits of in-class work: 4.84					**Total class time hours: 121**
		Total credits of out of class work: 7.16					**Total hours of out of class work: 179**

As: Assessable training activity
Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

8. Evaluation criteria and Grading System

Evaluation System	Continuous assessment	Non-continuous evaluation*	Description
Final test	0.00%	90.00%	There will be an exam of the four blocks: CI (calculus I), CII (calculus II), EDI (Differential Eq. I), and EDII (Differential Eq. II).
Assessment of activities done in the computer labs	10.00%	10.00%	MATLAB tests will be performed for each of the four blocks: CI (calculus I), CII (calculus II), EDI (Differential Eq. I), and EDII (Differential Eq. II)
Progress Tests	20.00%	0.00%	There will be 3 progress tests: for CI CII, EDI, and one delivery for EDII
Mid-term tests	70.00%	0.00%	There will be 4 mid-term tests, one from each block.
Total:	**100.00%**	**100.00%**	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject , an ordinary and an extraordinary one (evaluating 100% of the competences).

Evaluation criteria for the final exam:

Continuous assessment:

There will be an exam with all the contents or the contents not passed. The exam will consist of solving a series of exercises from each block.
It will constitute 90% of the grade. The remaining 10% corresponds to MATLAB tests.
Evaluation criteria:
1. Correction of the problem statement.
2. Correction of the solution.
3. Correction of written expression.
Concept errors and errors in basic mathematical operations will imply penalties.
The subject will be passed if the final grade is equal to or greater than 5.

Non-continuous evaluation:

There will be an exam with all the contents. The exam will consist of solving a series of exercises from each block.
It will constitute 90% of the grade. The remaining 10% corresponds to MATLAB tests.
Evaluation criteria:
1. Correction of the problem statement.
2. Correction of the solution.
3. Correction of written expression.
Concept errors and errors in basic mathematical operations will imply penalties.
The subject will be passed if the final grade is equal to or greater than 5.

Specifications for the resit/retake exam:

There will be an exam with all the contents or the contents not passed. The exam will consist of solving a series of exercises from each block.
It will constitute 90% of the grade. The remaining 10% corresponds to MATLAB tests.
Evaluation criteria:
1. Correction of the problem statement.
2. Correction of the solution.
3. Correction of written expression.
Concept errors and errors in basic mathematical operations will imply penalties.
The subject will be passed if the final grade is equal to or greater than 5.

9. Assignments, course calendar and important dates

Not related to the syllabus/contents

Hours	**hours**

Unit 1 (de 9): Differential and Integral Calculus in one variable

Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	7
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	3
Progress test [PRESENCIAL][Assessment tests]	1
Computer room practice [PRESENCIAL][Practical or hands-on activities]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	22

Unit 2 (de 9): Geometry	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	4
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	2
Computer room practice [PRESENCIAL][Practical or hands-on activities]	1
Mid-term test [PRESENCIAL][Assessment tests]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	15
Unit 3 (de 9): Differential Calculus in several variables	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	9
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	5
Progress test [PRESENCIAL][Assessment tests]	1
Computer room practice [PRESENCIAL][Practical or hands-on activities]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	30
Unit 4 (de 9): Integral calculus in several variables	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	8
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	4
Computer room practice [PRESENCIAL][Practical or hands-on activities]	1
Mid-term test [PRESENCIAL][Assessment tests]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	22
Unit 5 (de 9): Ordinary differential equations	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	5
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	3
Progress test [PRESENCIAL][Assessment tests]	1
Computer room practice [PRESENCIAL][Practical or hands-on activities]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	15
Unit 6 (de 9): Systems of ordinary differential equations	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	6
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	3
Computer room practice [PRESENCIAL][Practical or hands-on activities]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	15
Unit 7 (de 9): Numerical solution of ODE and ODE systems	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	6
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	4
Computer room practice [PRESENCIAL][Practical or hands-on activities]	4
Mid-term test [PRESENCIAL][Assessment tests]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	20
Unit 8 (de 9): Qualitative properties of ODE and ODE systems	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	2
Progress test [PRESENCIAL][Assessment tests]	1
Computer room practice [PRESENCIAL][Practical or hands-on activities]	1
Study and Exam Preparation [AUTÓNOMA][Self-study]	10
Unit 9 (de 9): Partial Differential Equations	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	7
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	5
Computer room practice [PRESENCIAL][Practical or hands-on activities]	5
Mid-term test [PRESENCIAL][Assessment tests]	2
Final test [PRESENCIAL][Assessment tests]	3
Study and Exam Preparation [AUTÓNOMA][Self-study]	30
Global activity	
Activities	**hours**
Mid-term test [PRESENCIAL][Assessment tests]	8
Computer room practice [PRESENCIAL][Practical or hands-on activities]	20
Final test [PRESENCIAL][Assessment tests]	3
Study and Exam Preparation [AUTÓNOMA][Self-study]	179
Class Attendance (theory) [PRESENCIAL][Lectures]	55
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	31
Progress test [PRESENCIAL][Assessment tests]	4
Total horas:	300

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	City	ISBN	Year	Description

J. Stewart	Calculus	Cengage Learning	2018
J. Stewart	Multivariable Calculus	Cengage Learning	2018
G. B. Thomas Jr.	Calculus (Single variable)	Pearson-Prentice Hall	2015
G. B. Thomas Jr	Calculus (multivariable)	Pearson-Prentice Hall	2017
D. G. Zill, W. S. Wright	Single Variable Calculus: Early Transcendentals	Jones and Bartlett	2011
D. G. Zill, W. S. Wright	Multivariable Calculus	Jones and Bartlett	2011
R. Larson B. Edwards	Calculus	Cengage Learning	2013
J. Rogawski	Calculus (multivariable)	W. H. Freeman	2012
D. G. Zill	Differential equations with boundary value problems	Cengage Learning	2018
H. Herrero, A. Díaz Cano	Informática aplicada a las Ciencias y a la Ingeniería con MATLAB		2000
A. Gilat	MATLAB. An introduction with Applications	John Wiley & Sons	2011
B. H. Han, D. T. Valentine	Essential MATLAB for Engineers and Scientists	Elsevier	2017
R. Larson B. Edwards	Multivariable Calculus	Cengage Learning	2013
J. Rogawski	Calculus (multivariable)	W. H. Freeman	2012
C. H. Edwards, D. E. Penney	Differential Equations and Boundary Value Problems: Computing and Modeling	Pearson	2019
D. G. Zill	Differential equations with modeling applications	Cengage Learning	2018