PERSONA CIÈNCIA EMPRESA
UNIVERSITAT RAMON LLULL

COURSE: NUMERICAL METHODS FOR ENGINEERS

SUBJECT MATTER: Statistics and Numerical Methods for Engineers
MODULE: Specific Technology
PROGRAM: Degree in Chemical Engineering

GENERAL CHARACTERISTICS

Type: ☐ Basic Formation, ☑ Compulsory, ☐ Elective
☐ Final Degree Project, ☐ Internship

Duration: Semestral **Semester/s**: 6
Number of ECTS credits: 5
Language/s: Spanish

DESCRIPTION

SHORT DESCRIPTION AND JUSTIFICATION

The numerical solution of problems is an essential part of the work of the engineer. It is necessary that the future professional will be able to apply the models presented in the different areas of engineering knowledge to the numerical solution of the problems that arise.

The course aims to give students the necessary tools for the use of computers and scientific software for use in solving engineering problems. These skills are essential both to facilitate further development of subjects in the studies and the future professional work.

The course includes the description of the available methods for the numerical solution of problems, and use computers and the today available software for planning and problem solving, rather than the technique resolution itself.

COMPETENCES

- To be able to understand and apply knowledge of Chemistry and Engineering for its application in the field of Chemical Engineering. (E2)
- To be able to use systems, components or processes to achieve the requirements established in the activity to be carried out in the field of Chemical Engineering. (E6)
- To be able to identify, formulate and solve basic problems in Mathematics, Chemistry, Physics, Computer Science, Biology, Economics and Graphic Expression and problems in the fields of Chemical Engineering and Chemistry. (E7)
- To be able to analyze, integrate and interpret data and information from the field of Chemical Engineering. (E8)
- Ability to problem-setting, mathematical modelling, statistical analysis and computational resolution of experiments and problems that raise in chemical engineering. (TE5)

PREREQUISITES

According to current academic teaching planning and regulations.

CONTENTS

1. Introduction
   Direct and iterative algorithms. Errors.

2. Roots of equations
   Bisection, Regula-Falsi, Secant, Newton, Muller, Brent methods. Solving systems of nonlinear equations.

3. Systems of linear equations
   Gauss, Gauss Jordan, LU, Thomas, Cholesky, Jacobi and Gauss Seidel methods.

4. Eigenvalues and eigenvectors
   Power, Jacobi, Householder, QR methods. Singular value decomposition.

5. Sort
   Direct insertion, Shell, Heapsort and Quicksort methods.

6. Curve Fitting
   Linear and nonlinear regression. Interpolation. Fourier Transform.

7. Numerical differentiation and integration
   The trapezoidal rule, Simpson 1/3 and Simpson 3/8 rules. Gauss quadrature. Improper integrals. Multiple integrals.

8. Ordinary Differential Equations
   Initial value problems. Runge-Kutta methods. Multistep methods. Systems of differential equations. Boundary value problems. Shooting method. Resolution by finite differences.

9. Partial Differential Equations
   Elliptic equations. Liebmann method. Parabolic and hyperbolic equations. Explicit, implicit, Crank-Nicolson and lines methods. ADI Method. Introduction to the finite elements method.

10. Optimization of functions
    One-dimensional and multidimensional unrestricted optimization. Simplex method of linear programming.

METHODOLOGY

LEARNING ACTIVITIES

Learning activities	ECTS Credits	Competences
Lectures	1.2 (38 h)	E2, E6
Case and Problem-Solving Sessions	0.1 (3 h)	E7, E8, TE5
Seminars	0	
Practical & Lab Work	1.0 (30 h)	E7 E8, TE5
Presentations	0	
Personal study	2.5	E2, E6, E7, E8, TE5
Assessment Tasks (Exams, Continuous Assessment...)	0.2 (6 h)	E2, E6, E7, E8, TE5
TOTAL	**5.0**	

TEACHING METHODOLOGY

The teaching methods used in the course uses an explanatory dynamic (presentation of content) where the different numerical methods are presented.

The course also has two blocks of individual practical work. In these practices, students are engaged in solving problems posed by the faculty based on real engineering cases where they apply the explained numerical methods. The activity of the practices are carried out with Matlab.

For the student's personal study, the necessary software, problems proposed for individual work, assessment tests through the learning management system, relevant documents to assist in the practical sessions and library resources are provided.

Is necessary to have a laptop for this course.

ASSESSMENT

ASSESSMENT METHODS

Assessment Methods	Weight	Competences
Final Exam	40%	E2, E6, E7, E8, TE5
Continuous Assessment Activities	30%	E2, E6, TE5
Lab or Field Work	30%	E7, E8, TE5

LEARNING OUTCOMES

- The student must demonstrate knowledge of basic numerical methods and know when it is possible to apply them to solve the problems. (E2, E6, E7, E8, TE5).
- The student must demonstrate the ability to properly structure the process of numerical solution of a problem. (E2, E6, E7, E8, TE5).
- The student must demonstrate proficiency in the proper use of software and program development with specific technical computing software for problem solving in the field of engineering. (E2, E6, E7, E8, TE5).

QUALIFICATION

The evaluation of the course will consider the marks obtained in the practices, controls performed in the laboratory, a series of scheduled controls in class and the final exam.

It is a necessary condition to pass the course have passed the practices and the final exam grade exceeds 4.5 points, in addition to schooling in all activities of the course.

In this case the final score is calculated by the following expression in all calls of the subject: 15% Rating Practices + 15% Laboratory Controls + 30% Scheduled Controls + 40% Final Exam. Otherwise the final rating is the lower of the ratings of practices or examination.

If a student fails practices should apply for recovery. For the qualification of the practices that have been failed can be taken into account in subsequent calls must be delivered in person one week before the examination of the corresponding call. Otherwise, if the student took the exam, the final grade for the course will be Absent.

ASSESSMENT OF THE COMPETENCES

For the evaluation of E2 competence it will be used as an indicator the qualification of scheduled controls and theory of final exam. For assessing E6 competence, it will be used as an indicator the qualification of practices and laboratory controls. For the assessment of E7

competence, it is used as an indicator the rating practices, laboratory controls and the practical part of the final exam. For the assessment of E8 and TE5 competencies, the indicator used is the final course grade.

BIBLIOGRAPHY

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  Accessible on line in: http://www.mathworks.com/moler/
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DOCUMENT HISTORY

PREVIOUS REVISIONS

January 25, 2018, Dr. José Javier Molins
January 30, 2017, Dr. José Javier Molins
February 1, 2016, Dr. José Javier Molins
February 2, 2015, Dr. José Javier Molins

CURRENT REVISION

January 25, 2019, Dr. José Javier Molins and Dra. Vanessa Serrano