COURSE: MATHEMATICS III

MATTER: Mathematical Methods of Engineering
MODULE: Specific Technology
PROGRAM TITLE: Degree on Industrial Technologies Engineering

GENERAL CHARACTERISTICS*

Type: ☐ Basic training, ☑ Compulsory, ☐ Elective
☐ Final degree project, ☐ Practicum

Duration: Semiannual **Semester/s**: 6
Number of ECTS credits: 4.5
Language/s: Spanish

DESCRIPTION

BRIEF DESCRIPTION AND JUSTIFICATION (the meaning of the course in relation to the studies. Between 100 and 200 words.)

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 (of the course made in relation to preassigned competences in this area.)

- Ability to understand and apply the basic skills such as, among others: computing, graphic expression, mechanics and materials, necessary for the practice of industrial engineering. (E2)
- Knowledge of scientific and technological subjects to enable them to learn new methods and theories, and to equip them with the versatility to adapt to new situations. (E3)
- Ability to solve problems with initiative, decision making, creativity, and critical thinking. (E4)
- Ability to develop, program and implement analytical and numerical methods for mathematical modeling in the field of industrial engineering. (E7)
- Ability to approach, mathematical modeling, analytical resolution and computational resolution of problems that arise in industrial engineering. (TE13)

PREREQUISITES* (modules, matters, courses and knowledge needed to follow the course. Can be stated that courses must have been completed.)
The competences of the earlier stages of education. Have taken Mathematics I, Mathematics II, Computer Science, Physics, Applied Mechanics and Circuit Theory

CONTENTS (as a relationship of the chapters that constitute the contents, or topics covered, of the course to a second level detail.)

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

TRAINNING ACTIVITIES* (Complete the table relating activities, workload in ECTS credits, and competences.)

Training activities	ECTS Credits	Competences
Sessions of presentation of concepts	1.4	E2, E3
Sessions for resolution of exercises, problems and cases	0.2	E4, E7, TE13
Seminars	0	
Personal mandatory activities professor-student	0	
Practical work / laboratory	0.6	E4, E7, TE13
Oral and writing presentations	0	
Personal study activities by students	1.9	E2, E3, E4, E7, TE13
Evaluation activities (exams, tests,…)	0.4	E2, E3, E4, E7, TE13
TOTAL	**4.5**	

EXPLANATION OF THE TEACHING METHODOLOGY (justifying the teaching methods used in relation to the competences and course contents. Between 100 and 200 words.)

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.

EVALUATION

EVALUATION METHODS* (Fill in the table relating evaluation methods, competences and weight in the qualification of the subject.)

Evaluation Methods	Weight	Competences
Final Exam (A)	40%	E2, E3, E4, E7, TE 13
Partials Examinations / scheduled controls (B)	30%	E2, E3, TE13
Activities done in class (C)	-	
Exercises outside of class (D)	-	
Reports work done (E)	-	
Presentations and / or oral examinations (F)	-	
Modeling, projects, etc. (G)	-	
Laboratory reports (H)	-	
Practical work / lab (I)	30%	E4, E7, TE13
Work in other centers (Practicum) (J)	-	
Participation (K)	-	

LEARNING OUTCOMES (Explanation of the achievements of students that allow competences evaluation, relating to competences and evaluation methods.)

- The student must demonstrate knowledge of basic numerical methods and know when it is possible to apply them to solve the problems. (E2, E3, E4, E7, TE13) [A, B, I].
- The student must demonstrate the ability to properly structure the process of numerical solution of a problem. (E2, E3, E4, E7, TE13) [A, I].
- 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, E3, E4, E7, TE13) [A, B, I].

QUALIFICATION (Explanation of the calculation system of qualifying the course.)
The evaluation of the course will consider the marks obtained in the practices, controls performed in the laboratory, in a series of scheduled controls 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: 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 not presented.

* These characteristics should not be changed without the approval of the responsible for higher level academic structures (matter, module and/or syllabus).

EVALUATION OF COMPETENCES (Defining expressions of calculation for each competence based on corresponding evaluations activities.)

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 E3 competence, it will be used as an indicator the qualification of the scheduled controls and theory of final exam. For the assessment of the E4 competence, is 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 TE13 competence, the indicator used is the final course grade.

TEXTBOOKS (recommended and accessible to students.)

- Chapra, Steven C. y Canale, Raymond P.; Numerical Methods for Engineers; 7th Edition (2014), McGraw-Hill Science/Engineering/Math (ISBN 978-0-07-339792-4)
- Chapra, Steven C. y Canale, Raymond P.; Métodos numéricos para ingenieros; 6a Edición (2011), McGraw-Hill (ISBN 9786071504999)
- Moler, Cleve; Numerical Computing with Matlab; 1st edition (2004); Society for Industrial & Applied Mathematics (ISBN 0898715601)
  Accessible on line in: http://www.mathworks.com/moler/
- Análisis Numérico con Aplicaciones, Curtis F. Gerald, Patrick O. Wheatley, 6ª Edición. Pearson Education. 2000
- Press, W.H., Teukolsky, S.A., Vetterling, W.T. y Flannery, B.P.; Numerical Recipes in C++: The Art of Scientific Computing; 2nd edition (Febrero 2002); Cambridge University Press; Cambridge (ISBN: 0521750334).
  Accessible on line in http://www.nr.com (main page of Numerical Recipes with all options) and in http://www.nrbook.com/a/bookcpdf.php (text of Numerical Recipes in C in pdf format)
- Press, W.H., Teukolsky, S.A., Vetterling, W.T. y Flannery, B.P.; Numerical Recipes 3rd Edition. The Art of Scientific Computing; (September 2007); Cambridge University Press; Cambridge (ISBN: 0521880688).
- Mathews, John H., Fink, Kurtis K. y Fink, Kurtis; Numerical Methods using Matlab, 4th edition, Prentice Hall (ISBN 0130652482)
- Mathews, John H. y Fink, Kurtis D.; Métodos numéricos con Matlab, 3ª edición, Prentice Hall (ISBN 8483221810)
- Constantinides, A. y Mostoufi, N.; Numerical Methods for Chemical Engineers with Matlab Applications; 1st edition (1999); Prentice Hall PTR (ISBN 0130138517)
- Ralston, Anthony y Rabinowitz, Philip; A First Course in Numerical Analysis; 2nd edition rev (2001); Dover Publications (ISBN 048641454X)
- Kiusalaas, Jaan; Numerical Methods in Engineering with MATLAB®; 2nd edition (2010); Cambridge University Press (ISBN 978-0521191333)

DOCUMENT RECORD

EARLIER CHANGES
February 10, 2013, Dr. José Javier Molins
February 13, 2012, Dr. José Javier Molins
September 16, 2011, Dr. José Javier Molins

LAST REVISION

February 2, 2015, Dr. José Javier Molins