UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course: MATHEMATICAL AND COMPUTATIONAL TOOLS FOR CIVIL ENG
Code: 38301
Type: BASIC
ECTS credits: 6
Degree: 345 - UNDERGRADUATE DEGREE PROGRAMME IN CIVIL ENGINEERING
Academic year: 2023-24
Center: 603 - E.T.S. CIVIL ENGINEERS OF CR
Group(s): 20
Year: 1
Duration: First semester
Main language: Spanish
Second language: English
Use of additional languages:
English Friendly: Y
Web site:
Bilingual: N

Lecturer: **GABRIEL FERNANDEZ CALVO** - Group(s): **20**

Building/Office	Department	Phone number	Email	Office hours
Politecnico 2-D31	MATEMÁTICAS	6218	gabriel.fernandez@uclm.es	Monday and Wednesday, from 16:30 h to 19:30 h

Lecturer: **CRISTINA SOLARES MARTINEZ** - Group(s): **20**

Building/Office	Department	Phone number	Email	Office hours
Edificio Politécnico/2-D32	MATEMÁTICAS	3255	cristina.solares@uclm.es	Tuesday 16.00-19.00 h and Thursday 16.00-19.00 h

2. Pre-Requisites

Students must have basic knowledge and competences in mathematics and information and communication technologies, which are assumed to be guaranteed by the training they have obtained prior to their access to the University.

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

In this course, mathematical and computer concepts are studied. They constitute an essential part of the training of a future engineer. Topics of Geometry, Numerical Methods, Computer Programming and Optimization are addressed, which are basic for the proper development of subsequent subjects of the Degree such as: Mathematical Instruments for Engineering II, Differential Equations, Hydraulic Engineering, Structures Calculation, Graphical-Cartographic Expression in Engineering, etc. This course will provide students with a useful toolbox of techniques, both analytical and computational, which are essential to solve a large number of engineering problems employing mathematical methods. Additionally, it will help the student understand the underlying elements of commercial software that will be used during the later professional activity, enabling the future engineer to use them critically.

4. Degree competences achieved in this course

Course competences

Code	Description
CE01	Students can apply their knowledge in the practical solution of civil engineering problems, with capacity for the analysis and definition of the problem, the proposal of alternatives and their critical evaluation, choosing the optimal solution with technical arguments and with capacity of defense against third parties.
CE02	Students have the ability to broaden their knowledge and solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study. Self-study ability, to undertake further studies with a high degree of autonomy
CE04	Students have the ability to solve mathematical problems that may arise in engineering. Ability to apply knowledge of: linear algebra; geometry; differential geometry; differential and integral calculus; differential and partial derivative equations; numerical methods; numerical algorithms; statistics and optimization.
CE06	Students have a basic knowledge of the use and programming of computers, operating systems, databases and software with engineering application.
CG01	Students achieve general knowledge of Information and Communication Technologies (ICT).

5. Objectives or Learning Outcomes

Course learning outcomes

Description

Students are familiar with computer use: operative systems, databases, programming languages, and software applied to civil engineering.

Students are able to express correctly both orally and in writing and, in particular, they can use the language of mathematics as a way of expressing accurately the quantities and operations in civil engineering. Students get used to teamwork and behave respectfully.

Students use mathematical and computer tools to pose and solve civil engineering problems.

Students know the fundamentals and applications of Affine and Euclidean Geometry.

Students know the fundamentals and applications of Optimization in the field of civil engineering.

Students learn the most important approximations for numerical method resolution, use some statistical, data processing, mathematical calculation and visualization software packages at user level, develop algorithms and program using a high-level programming language, visualize functions, geometric shapes and data, design experiments, analyze data, and interpret results.

6. Units / Contents

Unit 1: INTRODUCTION TO PROGRAMMING. SYMBOLIC COMPUTATION WITH MATLAB

Unit 1.1 Introduction. Starting in Matlab.

Unit 1.2 Algebra and Calculus with Matlab. Variables. Arithmetic operations. Elementary functions. Definition of functions. Creating vectors and matrices with Matlab. Mathematical operations with vectors and matrices. Operations with matrices. Equations and systems of equations. Limits of functions. Derivatives. Integrals. Series.

Unit 1.3 Graphics with Matlab. Two-dimensional plots. Three-dimensional plots.

Unit 1.4 Programming in Matlab. Relational and logical operators. Loops. Conditional statements. Importing and exporting data. Applications.

Unit 2: NUMERICAL METHODS WITH MATLAB

Unit 2.1 Numerical Solution of Linear Systems. Using MATLAB for solving linear systems of equations. Direct methods: Gauss and LU decomposition. Iterative methods.

Unit 2.2 Numerical Solution of Nonlinear Equations. Using MATLAB for solving nonlinear equations. Bisection, regula falsi, Newton-Raphson and secant methods.

Unit 2.3 Polynomial Interpolation. Using MATLAB for data interpolation. Lagrange polynomials. Cubic splines.

Unit 2.4 Numerical Differentiation and Integration. Using MATLAB to numerically evaluate derivatives and integrals. Finite difference formulas. Numerical quadrature. Trapezoidal and Simpson rules.

Unit 3: ANALYTIC GEOMETRY

Unit 3.1 Affine and Euclidean Geometry in the Plane. Affine plane. Points and vectors. Coordinate system. Transformation of the coordinate system. The straight line. Equations of the straight line. Relative positions of two straight lines. The Euclidean plane. Distances in the Euclidean plane. Angle of two straight lines. Families of lines. Concurrent lines. Area of a triangle. Bisectors of two lines. Calculation of geometric places.

Unit 3.2 The circle. Equation of the circle. Lines tangent to a circle. Circle through three points. Power of a point with respect to a circle. Radical axis. Calculation of locus.

Unit 3.3 Conics. Definition and equations. Metric invariants of conics. Metric classification. Lines tangent to conics. Center and asymptotes. Vertices, foci and directrices. Focal equation of a conic. Standard form equation. The ellipse. The hyperbola. The parabola. Rotations and general equation of second degree. Calculation of locus.

Unit 3.4 Affine and Euclidean Geometry in the space. The affine space. Points and vectors. Coordinate systems. Transformation of the coordinate system. The plane. Equations of the plane. The straight line. Equations of the straight line. Relative position of straight lines and planes. The euclidean space. Distances in the euclidean space. Area of a triangle. Angle of two straight lines. Angle of straight and a plane. Angle of two planes.

Unit 3.5 Quadric surfaces. The quadratic surfaces. Classification of the second degree surfaces. Invariant. Ellipsoid. Hyperboloid of a leaf. Hyperboloid with two leaves. Elliptical cone. Elliptic paraboloid. Hyperbolic paraboloid. Elliptical, parabolic and hyperbolic cylinder. Representation of the quadrics.

Unit 4: OPTIMIZATION WITH GAMS

Unit 4.1 The Gams tool. Introduction. Definition of sets. Data entry: scalars, vectors and matrices. Variables. Equations. Models and resolution.

Unit 4.2 Linear Programming and Applications. Introduction to linear programming. Models and examples of linear programming: the transport problem, the network flow problem, etc .; Problem formulation. Linear programming problem in standard form. Basic solutions. Duality. Resolution of linear programming problems. Examples of linear programming in GAMS.

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	CE01 CE04 CE06	1.32	33	N	-	
Class Attendance (practical) [ON-SITE]	Problem solving and exercises	CE01 CE04 CE06	0.56	14	N	-	
Problem solving and/or case studies [ON-SITE]	Problem solving and exercises	CE01 CE04 CE06 CG01	0.24	6	Y	N	
Final test [ON-SITE]	Assessment tests	CE01 CE02 CE04 CE06	0.2	5	Y	Y	
Study and Exam Preparation [OFF-SITE]	Self-study	CE01 CE02 CE04 CE06 CG01	3.6	90	N	-	
Individual tutoring sessions [ON-SITE]		CE01 CE02 CE04 CE06 CG01	0.04	1	N	-	
Group tutoring sessions [ON-SITE]		CE01 CE02 CE04 CE06 CG01	0.04	1	N	-	
		Total:	**6**	**150**			
		Total credits of in-class work: 2.4					**Total class time hours: 60**
		Total credits of out of class work: 3.6					**Total hours of out of class work: 90**

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	60.00%	100.00%	The test includes the partial examinations and the ordinary / extraordinary examinations
Assessment of problem solving and/or case studies	40.00%	0.00%	It includes exercises and problems that the students will solve individually or in groups. Includes practical exercises in the computer room.
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:

The minimum grade in the final exam is 4 out of 10. The assessment of each of the four blocks is made up of: 60% of the exam and 40% of problem solving, cases and/or practices. The minimum grade to pass the ordinary and extraordinary calls is 5 out of 10. Those partial exams with a minimum mark of 4 will be kept for the ordinary and extraordinary calls. Scores achieved in problem solving, cases and/or practices will be kept for the ordinary and extraordinary calls. All the assessable activities that have been carried out during the course are recovered. All the assessable activities, that have been carried out during the course, will be kept for the next year. There are three partial exams.

Non-continuous evaluation:

The student will have to do a global exam that will include all the course content. To pass the course, the student must obtain at least a 5 out of 10, which will constitute 100% of his/her grade.

Unless stated otherwise, continuous evaluation criteria will be applied to all students.

Anyone choosing non-continuous assessment must notify it to the lecturer within the class period of the subject. The option is only available if the student¿s participation in evaluation activities (from the continuous assessment) has not reached 50% of the total evaluation for the subject.

For the retake exam, the assessment type used for the final exam will remain valid.

Specifications for the resit/retake exam:

Same that in final exam.

Specifications for the second resit / retake exam:

The student will have to do a global exam that will include all the course content. To pass the course, the student must obtain at least a 5 out of 10, which will constitute 100% of his/her grade.

9. Assignments, course calendar and important dates

Not related to the syllabus/contents

Hours	**hours**
Unit 1 (de 4): INTRODUCTION TO PROGRAMMING. SYMBOLIC COMPUTATION WITH MATLAB	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	4.5
Class Attendance (practical) [PRESENCIAL][Problem solving and exercises]	2.5
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	1.5
Final test [PRESENCIAL][Assessment tests]	1
Study and Exam Preparation [AUTÓNOMA][Self-study]	15
Group tutoring sessions [PRESENCIAL][]	.5
Unit 2 (de 4): NUMERICAL METHODS WITH MATLAB	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	9
Class Attendance (practical) [PRESENCIAL][Problem solving and exercises]	2.5
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	1.5
Final test [PRESENCIAL][Assessment tests]	1.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	22.5
Individual tutoring sessions [PRESENCIAL][]	.5
Unit 3 (de 4): ANALYTIC GEOMETRY	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	15
Class Attendance (practical) [PRESENCIAL][Problem solving and exercises]	6
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	2
Final test [PRESENCIAL][Assessment tests]	1.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	37.5
Individual tutoring sessions [PRESENCIAL][]	.5
Unit 4 (de 4): OPTIMIZATION WITH GAMS	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	4.5
Class Attendance (practical) [PRESENCIAL][Problem solving and exercises]	3
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	1
Final test [PRESENCIAL][Assessment tests]	1
Study and Exam Preparation [AUTÓNOMA][Self-study]	15
Group tutoring sessions [PRESENCIAL][]	.5
Global activity	
Activities	**hours**
Final test [PRESENCIAL][Assessment tests]	5
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	6
Class Attendance (theory) [PRESENCIAL][Lectures]	33
Class Attendance (practical) [PRESENCIAL][Problem solving and exercises]	14
Study and Exam Preparation [AUTÓNOMA][Self-study]	90
Individual tutoring sessions [PRESENCIAL][]	1
Group tutoring sessions [PRESENCIAL][]	1
Total horas:	150

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
Herrero, H., Díaz, A.	Informática Aplicada a las Ciencias y a las Ingenierías	E.T.S.I.I., UCLM		84-699-3038-9	2004	
Kiusalaas, Jaan	Numerical Methods in Engineering with MATLAB	Cambridge University Press		978-1-107-12057-0	2016	
Mataix Plana, José Luis	Problemas de geometria analitica	Dossat		84-237-0218-9	1976	
Mocholi Arce, Manuel	Decisiones de optimización	Tirant Lo Blanch		84-8002-349-X	1996	
Moore, Holly	MATLAB for Engineers	Pearson Education		978-1-292-23120-4	2019	
Pérez López, C.	MATLAB Symbolic Algebra and Calculus Tools	Springer		978-1-4842-0344-6	2014	
Pérez, CésarPérez López	Matlab y sus aplicaciones en las ciencias y la ingeniería	Prentice Hall		84-205-3537-0	2002	
Zapata, R.B. y Díaz Montes, L.A.	Métodos Numéricos en Excel y Matlab con Aplicaciones en Ingeniería	Universidad de Antioquía		978-958-714-953-1	2020	
Quintela Estévez, Peregrina	Introducción a matlab y sus aplicaciones: una guía sencilla	Universidades, Servicio de Publicaciones e Interca		84-8121-656-9	1997	
Rodríguez, J.	Teoría y Práctica de Geometría Analítica	", E.T.S. de Ingenieros de Caminos, Canales y Puertos, Santander.			1991	
Suarez, Luis E.	Introducción a la Programación en Matlab: Para Ingenieros Civiles y Mecánicos	CreateSpace Independent Publishing Platform		9781490482392	2013	
Attaway, Stormy	MATLAB : A Practical Introduction to Programming and Problem Solving	Butterworth-Heinemann		978-0-12-815479-3	2019	
Bazaraa, M. S. y otros	Linear programming and network flows	John Wiley & Sons, Inc., Publication		0-471-48599-3	2010	
Hernandez, E.	Algebra y Geometría	Addison-Wesley			2003	
Bueno Orovio, Alfonso	Herramientas informáticas de las matemáticas en ingeniería	UCLM, E.T.S. Ingenieros Industriales		84-608-0233-7	2005	
Burden, R. L., Faires, J. D., and Burden, A.M.	Numerical Analysis	Cengage Learning	Boston	978-1-305-25366-7	2016	
Burgos Román, Juan de	Curvas y superficies : [Definiciones, Teoremas y Resultados]	García-Maroto		978-84-936299-3-9	2008	
Castillo, E. y otros	Formulación y Resolución de Modelos de Programación Matemática en Ingeniería y Ciencia	UCLM		84-600-9751-X	2002	
Castrillón, M. y otros	Fundamentos de informática y programación para ingeniería: e	Paraninfo		978-84-9732-846-3	2011	
Chapra, S. C. y Canale, R.P.	Métodos Numéricos para Ingenieros	McGraw-Hill		978-607-15-1294-9	2015	
Cordero, A., Hueso, J.L., Martínez. E., Torregrosa, J.R.,	Problemas Resueltos de Métodos Numéricos	International Thomson Editores		84-9732-409-9	2006	
García, I.A., Maza, S.	Métodos Numéricos: Problemas Resueltos y Prácticas	Universitat de Lleida		978-84-8409-329-9	2009	
Xue, D	Matlab Programming: Mathematical Problem Solutions	De Gruyter		978-3-11-066356-3	2020	
Granero Rodríguez, Francisco	Algebra y geometría analítica	McGraw-Hill		84-7615-029-6	1994	
Heinhold, Josef	Algebra lineal y geometría analítica	Reverté		84-291-5046-3 (O.C.)	1980	