Numerical computing

Academic Year: (2023 / 2024) **Review date: 28/03/2023 13:12:11**

Department assigned to the subject: Mathematics Department

Coordinating teacher: TERAN VERGARA, FERNANDO DE

Type: Electives ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Linear Algebra, Calculus I and Calculus II

LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.
CG3. Ability to design a system, component or process in the field of Industrial Technologies to meet the required specifications
CG4. Knowledge and ability to apply current legislation as well as the specifications, regulations and mandatory standards in the field of Industrial Engineering.
CG5. Adequate knowledge of the concept of company, institutional and legal framework of the company. Organisation and management of companies.
CG6. Applied knowledge of company organisation.
CG8. Knowledge and ability to apply quality principles and methods.
CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.
RA1. Knowledge and understanding: Have basic knowledge and understanding of science, mathematics and engineering within the industrial field, as well as knowledge and understanding of Mechanics, Solid and Structural Mechanics, Thermal Engineering, Fluid Mechanics, Production Systems, Electronics and Automation, Industrial Organisation and Electrical Engineering.
RA2. Engineering Analysis: To be able to identify engineering problems within the industrial field, recognise specifications, establish different resolution methods and select the most appropriate one for their solution
RA3. Engineering Design: To be able to design industrial products that comply with the required specifications, collaborating with professionals in related technologies within multidisciplinary teams.
RA4. Research and Innovation: To be able to use appropriate methods to carry out research and make innovative contributions in the field of Industrial Engineering.
RA5. Engineering Applications: To be able to apply their knowledge and understanding to solve problems and design devices or processes in the field of industrial engineering in accordance with criteria of cost, quality, safety, efficiency and respect for the environment.
RA6. Transversal Skills: To have the necessary skills for the practice of engineering in today's society.

OBJECTIVES

The student is expected to acquire and develop the ability to solve efficiently basic computational problems as those encountered in engineering by using MATLAB. More precisely:

- Learning the basics of programming with MATLAB.
- Computing accurately quadratures.
- Design and use Runge-Kutta numerical integrators to solve ordinary differential equations.
- Interpolate data by using splines.
- Discuss the existence and uniqueness of solutions of a system of linear equations.
- Solve a consistent system of linear equations using the LU factorization of a matrix.
- Obtain an orthonormal basis from an arbitrary basis of a subspace.
- Solve least-squares problems and use the QR and SVD factorizations of a matrix.
- Compute zeros of functions and solutions of nonlinear equations.
- Compute the FFT of a function.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Numbers, vectors and matrices with MATLAB.
2. Solving linear systems.
3. Interpolation.
4. Zeros of functions and roots of nonlinear equations.
5. Least squares problems.
6. Quadrature.
7. Ordinary differential equations
8. Fourier transform.

LEARNING ACTIVITIES AND METHODOLOGY

This is a "hands on" course. Students are supposed to follow the explanations of the instructor performing in real time the exercises, examples and other proposed activities. Thus the course takes place in the computer Lab and students must become acquainted with MATLAB.

The course will start learning how to program MATLAB. After and introduction to the course, every two weeks (as a general rule), one of the topics of the course will be discussed in the classroom and practices related to these topics will be proposed to the students. Usually the practices involve to solve a simple problem by writing the appropriate code.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

There will be 7-8 practices proposed to the students starting the second week of the course. These practices must be worked out by the students alone or in small groups (four people at most) and handled back to the teacher. They will contribute 50% of the final grade.

There will be a final exam that will contribute the remaining 50% of the final grade. Part of this exam will consist of questions about the practices mentioned above.

In order to pass the subject, it is mandatory to pass the final exam and to get, ate least, half of the marks in the part corresponding to the practices in the final exam.

BASIC BIBLIOGRAPHY

- Cleve Moler Numerical Computing with Matlab, SIAM, 2004

- Desmond Higham y Nicholas Higham MATLAB Guide, SIAM, 2017

- Jesús M. Sanz-Serna Diez lecciones de cálculo numérico, Universidad de Valladolid, 2010

ADDITIONAL BIBLIOGRAPHY

- G. W. Stewart Afternotes on numerical analysis, SIAM, 1996

- G. W. Stewart Afternotes goes to graduate school, SIAM, 1998

- Uri M. Ascher y Chen Greif A first course in numerical methods, SIAM, 2011