DEGREE CURRICULUM

NUMERICAL METHODS

Coordination: GARCIA RODRIGUEZ, ISAAC ANTONIO

Academic year 2023-24

NUMERICAL METHODS 2023-24

Subject's general information

<table>
<tr><td>Subject name</td><td>NUMERICAL METHODS</td></tr>
<tr><td>Code</td><td>102102</td></tr>
<tr><td>Semester</td><td>1st Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Bachelor's Degree in Automation and Industrial Electronic Engineering</td><td>2</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
<tr><td>Bachelor's Degree in Energy and Sustainability Engineering</td><td>2</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
<tr><td>Bachelor's Degree in Mechanical Engineering</td><td>2</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
<tr><td>Common branch in industrial engineering programs - Lleida</td><td>2</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
<tr><td>Double bachelor's degree: Degree in Mechanical Engineering and Degree in Energy and Sustainability Engineering</td><td>2</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
</table>
</td></tr>
<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><td>PRAULA</td><td>TEORIA</td></tr>
<tr><th>Number of credits</th><td>3</td><td>3</td></tr>
<tr><th>Number of groups</th><td>4</td><td>3</td></tr>
</table>
</td></tr>
<tr><td>Coordination</td><td>GARCIA RODRIGUEZ, ISAAC ANTONIO</td></tr>
<tr><td>Department</td><td>MATHEMATICS</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>40% classroom
60% homework</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
</table>

NUMERICAL METHODS 2023-24

Language	Language Percentage of use Català 50.0 Anglès 0.0 Castellà 50.0
Distribution of credits	3 theoretical credits and 3 practical credits

NUMERICAL METHODS 2023-24

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
GARCIA RODRIGUEZ, ISAAC ANTONIO	isaac.garcia@udl.cat	16	
LATORRE IBARS, ERNEST		5	

Subject's extra information

We recommend a good basis for the subjects of first year courses Calculus and Linear Algebra. The course requires continuous work throughout the semester to achieve their goals. It is also necessary critical thinking and capacity for abstraction. You can find the following materials in the Copisteria Campus Cappont (Building Aulari) and the Virtual Campus http: \ \ cv.udl.cat Collection set of exercises, tests resolutions for previous years; Statements of Practice lab.

Learning objectives

- To use constructive methods to approximate solutions of real problems.
- To design methods to approximate efficiently, solutions to problems previously formulated mathematically.
- To study constructive methods and algorithms that allow us to obtain the solution of a problem with arbitrary precision in a finite number of steps.
- To model engineering problems that could be solved with Numerical Methods.
- To analyze effective numerical methods to approximate solutions of equations.
- To write programs in the language Octave / Matlab.

Competences

EPS1: Capacity to solve problems and prepare and defence arguments inside the area of studies.

EPS5: Capacity of abstraction and of critical, logical and mathematical thinking.

EPS6: Capacity of analysis and synthesis.

GEM1/GEEIA1/CG1: Capacity to solve mathematical problems arisen in the engineering field. Aptitude to apply knowledge on: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and in partial derivatives; numerical methods; algorithmic, numerical; statistics and optimisation.

CB2: That students know how to apply their knowledge to their work or vocation in a professional way and possess the competencies that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.

Subject contents

1. Errors, Stability and Conditioning.

1.1. Preliminaries.
1.2. Errors.
1.3. Stability.

2. Polynomial Interpolation.

2.1. Introduction.
2.2. Polynomial Interpolation.

3. Numerical Integration.

3.1. Introduction.
3.2. Newton-Cotes formulas.
3.3. Romberg method.

4. Ordinary Differential Equations.

4.1. Introduction.
4.2. One step methods.

5. Nonlinear Equations.

5.1. Introduction.
5.2. Some iterative methods.
5.3. Nonlinear systems and Newton-Raphson method.

6. Approximation of Functions.

6.1. Introduction and Theoretical Foundations.
6.2. Overdetermined linear systems.
6.3. Data linearization

Methodology

This course consists of theoretical lessons, classes and practical problems with the help of a computer. The lectures will present content, demonstrate some of the key results and also will emphasize learning objectives. Moreover, the problem classes are designed for problem solving and discussion of specific points that the student must first work independently. In practical classes will be resolved (through teamwork) engineering problems with the implementation of programs written in code Octave / Matlab.

Development plan

Timing of the contents of the subject:

NOTE: Every week include small group classes.

WEEK	METHODOLOGY	AGENDA	HOURS	INDIVIDUAL WORK HOURS
1-2	theoretical lessons/practical problems	Item 1. **Errors, stability and conditioning**	8	12

3-5	theoretical lessons/practical problems	Item 2. **Polynomial interpolation**	12	18	
6-8	theoretical lessons/practical problems	Item 3. **Numerical Integration**	12	18	
10-12	theoretical lessons/practical problems	Item 4. **Ordinary differential equations**	12	18	
13-14	theoretical lessons/practical problems	Item 5. **Nonlinear Equations**	8	12	
15-16	theoretical lessons/practical problems	Item 6. **Approximation of functions**	8	12	

Evaluation

EVALUATION OF THE COURSE NUMERICAL METHODS
Degree in Mechanical Engineering
Degree in Automation and Industrial Electronic Engineering

All evaluation activities will be face-to-face.
The course consists of two parts, a theoretical and a practical one. The theoretical part has a weight of 80% and the remaining 20% is the practical one.

Theoretical part: It consists of two written tests (controls) based on the resolution of problems. Each exam has the same weight and the note of theory is obtained by calculating the average value of the notes of the two controls. If this theory mark is equal to or greater than 4 then, and only then, the mark of practices can be added.

Practical part: Each pair of students (classmates) must submit a report where an engineering problem is solved by calculations using the computer and programming in the language Octave / Matlab. Before being corrected the delivered report the student must pass a Minimum Test, on the contrary the practical part will be failed and its mark will be 0.

Resit: You can resit the exam only for the theoretical part and the Minimum Test. The resit will be made by controls. The student has the right (not the obligation) to resit each of the failed controls. In addition, the student can not resit to climb a control mark if it is already passed. Finally, remember that the obtained mark in the resit is the final mark regardless of whether it is superior or not to the initially failed mark.

Alternative evaluation

The student who has the approval to be evaluated through alternative evaluation (see requirements and procedure in the evaluation regulations) must take a single exam of the theoretical part with all the contents of the subject.

Calculation of Final Mark: All the following marks are given on the interval [0, 10].

C1 = Mark of Control 1

C2 = Mark of Control 2

T= (C1 + C2) / 2

P = Practical mark

M = Final Mark

If T >= 4 then M = 0.8 * (C1 + C2) / 2 + 0.2 * P

If T < 4 and 0.8 * (C1 + C2) / 2 + 0.2 * P >= 5 then M = 4.9

If T < 4 and 0.8 * (C1 + C2) / 2 + 0.2 * P < 5 then M = 0.8 * (C1 + C2) / 2 + 0.2 * P

llavors

Timing and load percentage evaluation activities:

- **Week 9.** Exam Control 1 of the content developed in class from week 1 through 8. This activity contributes 40% of the total mark for the course.
- **Week 15.** Delivery of reports from the practical part. This activity contributes 20% of the total mark for the course.
- **Week 16.** Exam Control 2 of the class content developed from week 10 through 15. This activity contributes 40% of the total mark for the course.

Bibliography

Basic bibliography:

· Javier Chavarriga, Isaac A. García y Jaume Giné. *Manual de Métodos Numéricos*. Edicions de la Universitat de Lleida, Eines **35**, 1999.

· Isaac A. García y Susanna Maza. *Métodos Numéricos: Problemas Resueltos y Prácticas*. Edicions de la Universitat de Lleida. Eines **62**, 2009.

· David Kincaid y Ward Cheney. *Análisis numérico*. Ed. Addison-Wesley, Delaware, 1994.

Advanced Bibliography:

· Germund Dahlquist and Ake Bjorck. *Numerical methods*. Ed. Prentice-Hall, Englewood Cliffs, 1974.

· Eugene Isaacson and Herbert B. Keller. *Analysis of Numerical Methods*. Jhon Wiley, New York, 1966.