Universidad Zaragoza

Academic Year/course: 2021/22

28600 - Mathematics applied to building I

Syllabus Information

Academic Year: 2021/22
Subject: 28600 - Mathematics applied to building I
Faculty / School: 175 - Escuela Universitaria Politécnica de La Almunia
Degree: 422 - Bachelor's Degree in Building Engineering
ECTS: 6.0
Year: 1
Semester: First semester
Subject Type: Basic Education
Module:

1. General information

1.1. Aims of the course

The foreseen outcomes of this signature are based on the following approaches and objectives:

The basic mathematical tools and their methods are part of the different tools that professional engineers need to face and solve the different sort of problems they are going to find in the real life, therefore, among the learning outcomes, students are expected to get a good knowledge and capability for implementing numerical and analytical solutions using real calculus based on high quality softwares and computer programs. Taking this into account, this is the main reason why Engineering and Architectural students need to get the learning outcomes of this subject.
Successful students must be able to gather and implement the basic tools of this subject in any aspect related to the Engineering or Architectural area, making it into the basic tool for any other subject in their chosen degree and at the same time acquiring techniques that will improve and give them a successful professional development.

1.2. Context and importance of this course in the degree

This subject is part of the basic structure of academic knowledges required for the students to overcome with success this academic degree. It is being taught in the first semester in the first course with the main purpose of providing students new mathematical tools and skills that are going to be essentials in the good learning and successful study of the different subjects they are going to face with in higher years, such as Physics, Economy, Statistics, among others.
The main focus of this subject is to provide students high capability and skill in the comprehension, implementation and right use of the mathematical tools in any engineering problem, giving the best solution and being able to explain with it the different observed phenomena.

1.3. Recommendations to take this course

It is advisable for the students to have a good knowledge of basic integral and differential calculus along with a reasonable capability and skill using symbolic and numerical softwares.

2. Learning goals

2.1. Competences

Competences acquired by students who have passed successfully this signature:

G01: Capacity for organization and planning.
G02: Capacity for problem solving.
G03: Capacity for taking decisions.
G04: Aptitude for written and oral communication in their native language.
G05: Capacity for analysis ang giving an outline.
G06: Capacity for information management.
G07: Capacity for working as members of a team.
G08: Capacity for reasoning with rigor.
G09: Capacity for working as members of a interdisciplinary team.
G10: Capacity for working in an international context.
G11: Capacity for improvisation and adaptation facing new events.
G12: Aptitude for leadership.

G13: Positive social aptidude for social and technological innovations.
G14: Capacity for reasoning, discussion and exposition of new ideas.
G15: Communication capacity by using words and images.
G16: Capacity for seeking, analysis and selection of information.
G17: Capacity for self-taught learning.
G18: To have and understand knowledges, within a study area, that are based on the Secondary School Education but are defined at a level, resting on advanced textbooks, that include some aspects involving knowledges that are at the forefront of their study field.
G19: To apply their knowledges to their job or vocation in a professional way having the competences showed through the drawing up and debate of argumentation and by the resolution of problems within their professional field.
G20: Capacity for gathering and interpreting relevant data (within their professional field) with the purpose to form judgment and include reflections about relevant subjects such as those of social, scientific and ethics kind.
G21: Capacity for transmitting information, ideas, problems and solutions to general public with and without technical knowledge about a subject.
G22: To develope new learning skills necessaries for beginning new high level studies with self-taught independence.
CB1: Aptitude for using the acquired knowledgements related to Numerical and Infinitesimal Calculus, Linear Algebra, Analytical Geometry and Differential Calculus.

2.2. Learning goals

A student that have passed this signature must show the following results:

- Aptitude for aplying data treatment techniques and analysis.
- Knowledgement of fundamental concepts, uses and results got from the Differential and Integral Calculus.
- Comprehension of concepts about one and multidimensional variables.
- Knowlegement of integration techniques and estimation.
- Capacity for drawing up, comprehension and criticizing of reports based on analysis developed with the use of numerical, diferential, integral and matricial calculus.
- Problem solving capacity of any sort of problem that could arise in the engineering field, using in the right way those knowledgements acquired both from the Differential and Integral Calculus and the Linear Algebra.
- Comprehension of the difficulty to get the exact solution of some mathematical problems and capability to apply numerical aproximation methods in order to solve them.
- Capability for setting out and solving, with mathematical rigor, problems applied to or coming from their professional field, choosing in a critical way the best mathematical methods and the theoretical results adequated for each case.
- Comprehension of the imposibility of real problems solving using only handwritten calculations and capability for implementing and solving them using mathematical software with symbolic and numerical calculus operations.
- Capability for logical and deductive thought and also using of the appropiate mathematical language that leads them to model and set out problems of their own profesional field.

2.3. Importance of learning goals

The learning outcomes of this signature are expressed:

- through the resolution of mathematical problems that couls arise in the Engineering of Building fields,
- in the knowledgement and reflexive use numerical and symbolic mathematical tools, and
- in the use of numerical methods in the resolution of some mathematical problems.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

Students must show the foreseen learning outcomes through the following assessment activities:

A. Presential course

Progressive assessment

Two written exams are going to be taken during the course, based on theoretical and practical aspects of this signature:

Written exam 1: it will be taken within the 8th week of the course in progress and are going to be based on the topic of Differential and Integral Calculus. This assessment has a 40% grade of the final mark.

Written exam 2: it will be taken within the 15th week of the course in progress and are going to be based on the topic of Linear Algebra. This assessment has a 40% grade of the final mark.

Participation assessments:

Through out the course four participation exams are going to be taken with a 5% grade of the final mark. They are going to be based on practical mathematical exercises or questionnaire evaluations programmed through the virtual platform MOODLE.

These participation assessments have a 20% grade of the final mark.

Individual assignments

Students must hand in an individual assignment that grades 10% of the final mark. Here are going to be assessed:

- the mastering and the right use of the mathematical software commands used for problem solving,
- the right resolution of proposed problems, mathematical methods and strategies used in order to solve them,
- the code quality used for problem solving,
- the right interpretation of the obtained results,
- the capacity for choosing the appropriate method for problem solving,
- clear explanations and reasonings according to the presented questions,
- the results and quality of the assignment handed in,
- the quality and coordinationation in the exposition of the assignment presentation,
- the language used in this written work, and
- the quality of the reference books used in the assignment redaction.

Students are going to pass this signature if the arithmetical mean of the following joint activities: the whole written and participation assessments and the individual assignment, gives a 5.0 mark.

Final Exam

Those students who did not pass this signature by the Progressive Assessment method have to take the final exam on the dates defined by the centre and the University of Zaragoza. These examinations are obligatory and also equivalent to the written assessments with a 100% grade of the final mark.

Evalutation criteria:

In the written assessments and final examination are going to be assessed:

- the comprehension of the mathematical concepts used for problem solving,
- the right use of strategies and steps for problem solving,
- clear and detailed explanations for problem solving,
- the right use of the mathematical terminology and notation. The code used to get the solution of a problem must be provided and explained in detailed way, expressing clearly the results obtained.
- Clear, tidy and organized exposition of the results obtained.

In order to take part in the Progressive Assessment, all students should have, at least, an 80% attendance to all the presential activities proposed in this subject.

B. Non presential course

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodology followed in this course is oriented towards the achievement of the learning objectives. A wide range of teaching and learning tasks are implemented, such as theory sessions, practice sessions, tutorials, and autonomous work and study.

A strong interaction between the teacher and the student is promoted. This interaction is brought into being through a division of work and responsibilities between the students and the teacher. Nevertheless, it must be taken into account that, to a certain degree, students can set their learning pace based on their own needs and availability, following the guidelines set by the teacher.

The current course "Matemática Aplicada a la Edificación I" is conceived as a stand-alone combination of contents, yet organized into two fundamental and complementary forms, which are: the theoretical concepts of each teaching unit and the solving of problems or resolution of questions, at the same time supported by other activities.

Here, the practical and theoretical classes are combined with the continuous use of high quality free and open-source software, which allows a deeper comprehension and quick visualization of new mathematical tools and concepts.

Regarding to the slides, proposed exercise photocopies, laboratory session guides and other materials used in class, all of them are going to be available on the Moodle platform of this course.

Material	Format
Topic theory notes Topic problems	Paper/repository

Topic theory notes Topic presentations Topic problems Related links	Digital/Moodle, E-mail
Educational software	Open source wxMaxima and Octave

If classroom teaching were not posssible due to health reasons, it would be carried out on-line.

4.2. Learning tasks

This 6 ECTS (150 hours) course is organized as follows:

Face-to-face generic activities:

- **Theory sessions** (2 ECTS: 20 hours). Theoretical activities carried out mainly through exposition by the teacher, where the theoretical supports of the course are displayed, highlighting the fundamental, structuring them in topics and or sections, interrelating them.
- **Practice sessions** (1.77 ECTS: 17.7 hours). Problems and practical cases are carried out complementary to the theoretical concepts studied.
- **Exams** (8 hours). 1 hour per test.

Generic non-class activities: (1.5 ECTS: 15 h)

- Study and understanding of the theory taught in the lectures.
- Understanding and assimilation of the problems and practical cases solved in the practical classes.
- Preparation of seminars, solutions to proposed problems, etc.
- Preparation of the written tests for continuous assessment and final exams.
- **Individual Tutorials**: Those carried out giving individual, personalized attention with a teacher from the department. These tutorials may be in person or online.
- **Autonomous work and study** (90 hours).

4.3. Syllabus

This course will address the following topics:

Topic 0. Introduction to the open-source software Maxima and revision of real functions of real variables

Topic 1. Limits and Continuity of functions

- Limits, indeterminate forms, equivalence functions
- Continuity and discontinuity of functions
- Classical theorems
- Bisection method

Topic 2. The derivative

- The derivative, the tangent (straight) line, properties and rules
- The chain rule
- Implicit differentiation, inverse function and parametric functions
- Newton's Method
- Classical theorems: Rolle, Mean value and L'Hôpital
- Taylor polynomials and approximations
- Interpolation and numerical differentiation
- Monotonic function, increasing and decreasing functions, concavity and convexity of functions

Topic 3. Integration

- Riemmann Integral and its basic properties
- Antiderivatives and indefinite integration
- Fundamental theorems of Calculus
- Improper integrals
- Geometric applications

- Numerical integration

Topic 4. System of linear equations

- Groups, rings and fields
- System of linear equations: elementary operations
- Gaussian elimination and rank of a matrix
- Theorems of characterization (Rouché-Frobenius)
- Determinants
- Numerical Gaussian elimination, condition number
- Decompositions: LU, QR and Cholesky
- Iterative methods

Topic 5. Vector spaces with inner products

- Linearly independent sets, dimension and basis
- Subspaces of vector spaces
- Inner product
- Length, angles and orhtogonality
- Orthogonal subspaces and sets
- Orthogonal projection and optimal approximation

Topic 6. Diagonalization

- Eigenvalues and eigenvectors
- Spectral decomposition and polynomials of matrices
- Normal matrices
- Numerical methods for approximating eigenvalues
- Compatible matrices
- Singular value decomposition (SVD)

4.4. Course planning and calendar

This course has 6 ECTS credits, which represents 150 hours of student work in the subject during the semester, in other words, 10 hours per week for 15 weeks of class.

A summary of a weekly timetable guide can be seen in the following table. These figures are obtained from the subject file in the Accreditation Report of the degree, taking into account the level of experimentation considered for the said subject is moderate.

Activity	Weekly school hour
Lectures	6
Other activities	3

Week	Topic	Contents	Test	Weight	Then
1	1	Maxima - functions	First test	5%	Limits - C
2	2	Limits - Continuity			
3		The derivative			
4	3	Taylor	Second test	5%	The der
5		Interpolation			
6		Integration			
7	4	Applications	First written exam	40%	Infinitesim
8		Numerical integration			
9		System of linear equations			

10	5	Determinants	Third test	5%	Linear s
11		Numerical Linear Algebra			
12	6	Vector spaces	Fourth test	5%	Vector s
13		Optimal approximation			
14	7	Diagonalization	Second written exam	40%	Linear A
15		Singular value decomposition			

The dates of the final exams will be those that are officially published at Distribución de Exámenes (https://eupla.unizar.es/asuntos-academicos/examenes). Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course will be provided on the first day of class or please refer to the Faculty of EUPLA website and Moodle.

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=28600