Universidad Zaragoza

Year : 2020/21

28705 - Mathematics applied to engineering II

Syllabus Information

Academic Year: 2020/21
Subject: 28705 - Mathematics applied to engineering II
Faculty / School: 175 - Escuela Universitaria Politécnica de La Almunia
Degree: 423 - Bachelor's Degree in Civil Engineering
ECTS: 6.0
Year: 1
Semester: Second semester
Subject Type: Basic Education
Module: ---

1.General information

1.1.Aims of the course

Basic mathematical methods belong to a wide class of tools which engineering professionals should use in order to solve the problems that may occur at work. Among the learning goals, we find the mastery of some practical and theoretical techniques leading to a direct application of the topics taken in this course to real problem solving, using realistic computational methods built in efficient and reliable software packages. Therefore, it is of utmost importance in the proper training of an engineer to acquire the learning goals covered in this course. The ultimate goal is that students integrate basic knowledge of the course in all kinds of topics related to Civil Engineering. This will allow the students to pursue more advanced courses and to acquire additional skills leading to his or her professional development.

Therefore, the foreseen outcomes of this subject are based on the following approaches and goals:

- To characterize and understand mathematical functions.
- To identify and characterize extreme points in mathematical functions.
- Mastery in various integration and differentiation techniques.
- Correct solution and comprehension of path, surface and volume integrals.
- Knowledge of the main methods in order to solve differential equations and their utility.
- Knowledge of symbolic and numeric calculus tools.
- Solution of various applied problems and expression of their resolution in a reasoned manner.
- Usage of an appropriate mathematical language.
- Presentation and discussion of data obtained by means of mathematical programs.
- Manage of scientific bibliography with critical criterium.

1.2.Context and importance of this course in the degree

This subject forms part of the block of subjects cassified as "basic formation". For a Civil Engineer is of esential interest because of several reasons.

Firstly because of its technical content. It complements and extends several principles of mathematics introduced in "Mathematics I".

On the other hand, and more generally, this subject also prepares the student to face problems using different approaches that imply logics, optimization and a scientific approach.

Those students enrolled in this subject are going to be very well prepared to face and overcome with success and academic progress the subjects of Structural Analysis and Strength of Materials, given in the following years of this academic degree, and also to implement it to different areas in the Civil Engineering their professional development.

1.3.Recommendations to take this course

The study of mathematics implies several goals and difficulties that can only be achieved through work and progress based on previous knowledge. Because of this, students must begin this subjetc with several knowledges given in the first semester of the first course of this academic degree.

In order to succeed in this subject, it is advisable for the students to have passed with success the subject given in the first semester and first course of this academic degree: "Mathematics I". In addition, it is highly advisable for the student to be familiar with symbolic computation software tools.

2.Learning goals

2.1.Competences

After succeeding in this matter through the previously indicated goals. Students will acquire several competences. Such competences can be found in:

https://academico.unizar.es/sites/academico.unizar.es/files/archivos/ofiplan/memorias/grado/ingenieria/mv_142.pdf

There can be found several competences common to the degree and several competences particular of this subject. All competences have an identification code. Below I present all the competences of this subject with their respective identification code.

Mandatory competences:

B01 - Capacity to solve mathematical problems that may arise in engineering. Ability to apply knowledges about: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and partial derivatives, numerical methods, numerical algorithmic, statistics and optimization.

General competences:

G01 - Capacity to organize and plan.

G02 - Capacity to solve problems.

G03 - Capacity to make decisions.

G04 - Aptitude for oral and written communication in the native language.

G05 - Capacity for analysis and synthesis.

G06 - Information management capacity.

G07 - Capacity to work in a team.

G08 - Capacity for critical reasoning.

G09 - Capacity to work in an interdisciplinary team.

G10 - Capacity to work in an international context.

G11 - Capacity of improvisation and adaptation in order to face new situations.

G12 - Leadership aptitude.

G13 - Positive attitude towards social and technological innovations.

G14 - Capacity for reasoning, discussion and presentation of own ideas.

G15 - Capacity of communication through words and images.

G16 - Capacity to search, analyze and choose information.

G17 - Capacity of autonomous learning.

G18 - Possess and understand knowledges in an area of study based in secondary education, that are usually found at a level that, although that it is supported by advanced textbooks, also includes some aspects that involve knowledge of the state of the art of their field of study.

G19 - Apply their knowledge to their work or vocation in a professional way and possession of the competences that are usually proved through the development and defense of arguments and problem solving within their area of study.

G20 - Ability to collect and analyze relevant data (usually within their area of study) in order to make judgments that include a discussion on relevant social, scientific or ethical issues.

G21 - Transmit information, ideas, problems and solutions both to a specialized audience and to a non-specialized audience.

G22 - Develop those learning skills necessary to undertake further studies with a high degree of autonomy.

G23 - Respect fundamental rights, equality between men and women, facilities for people with disabilities and respect peace culture and democratic principles.

G24 - Promote entrepreneurship.

G25 - Knowledge of information and communication technologies

The development of the previous competences through the achievement of the goals already presented will be evaluated through the so-called learning goals.

2.2.Learning goals

In order to pass this subject, the student must show the following learning goals:

- Solve mathematical problems typical in Engineering and Architecture.
- Ability to apply acquired knowledge in calculus, geometry and differential equations.
- Correct management of numerical methods in solving mathematical problems.
- Knowledge of symbolic and numeric calculus tools.
- Scientific-mathematical thinking when approaching to mathematical questions.
- Ability to handle mathematical language.

2.3.Importance of learning goals

Arguably, the learning goals are "a statement of what the student is expected to know, understand and be able to do at the end of a learning period".

In this particular case, after passing this matter, through the learning goals, the student will acquire technical and scientific knowledge of mathematics that can be applied to other disciplines in Civil Engineering, in daily life and in professional practice.

3.Assessment (1st and 2nd call)

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

There are two different ways in order to evaluate this course.

Continuous assessment:

In order to go to this evaluation method, students must obligatorily assist to, at least, an 80% of the classroom activities (seminars, lectures, etc.). Continuous assessment activities include:

- **Midterm exams:** Voluntary midterm exams during class sessions. There will be a total of 2 of midterm exams. Their weigh in the final qualification will be of an 80%. Qualification will be between 0 and 10. In order to average qualifications, students must obtain a minimum of 4 over 10 in each of these exams. Being 5 the minimum averaged qualification of the two exams in order to average with the other continuous assessment activities. If such conditions are not satisfied, students will be excluded from continuous assessment.
- **Individual assignments:** 4 individual assignments during the course will be proposed to the students. The weight of this block will be a 20% of the final qualification. Qualification will be between 0 and 10. In order to average qualifications, students must obtain a minimum of 4 over 10 in each of these tasks. Being 5 the minimum averaged qualification of the 4 assignment tasks in order to average with the averaged midterm exams. If such conditions are not satisfied, students will be excluded from continuous assessment.

The weighted average will be done according to the following table:

Continuous assesment tasks	Weight
Individual assignments	20%
Midterm exams	80%

Global assessment:

Students who have not succeeded through continuous assessment or students interested in improving their qualification can opt for this assessment method.

Students will face a final exam that will include all the theory and practice of the course. Qualification will be between 0 and 10. Being 5 the minimum qualification in order to pass the exam. This exam will count the 100% of the final qualification.

There will be two calls for the global exam, the dates of both will be available on the EUPLA website at the beginning of the academic course. Those students who during the course have opted for the continuous assessment modality, but have been excluded from it, have failed it or simply want to improve their qualifications, can promote to the first call for global exam, all of the individual assingments, such activities will weight a 20% of the global qualification. In order to pass the subject by means of this assesssment method, students must obtain a minimum of 5 over 10 in the weighted qualification, being 5 the minimum qualification of the exam in order to average.

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 goals. It is based on participation and the active role of the student favors the development of communication and decision-making skills. A wide range of teaching and learning tasks are implemented, such as lectures, assignments, computer sessions, autonomous work, and tutorials. Students are expected to participate actively in the class throughout the semester.

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

This subject has 6 ECTS credits. This makes a total of 150 hours of effective work. The 40% of these hours (60 hours) will be developed in classroom sessions.

Class work includes theory and practice sessions and laboratory experimental sessions.

Autonomous work includes personal study, problem resolution and development of practical works.

Semester consists in 15 weeks. Each week the student must work 10 hours in this subject.

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.

Teaching will be organized according to the following learning tasks:

-Lectures.

-Practice sessions.

-Computer sessions.

-Seminars.

-Tutorials.

-Exams.

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

Theory, practice and computer sessions will be developed within the classrooms indicated by the management team of the center.

Further information regarding the course will be provided on the first day of class.

If due to health reasons the in-person teaching-learning process is not possible, it shall be carried out telematically.

4.2.Learning tasks

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

- **Theory sessions:** (3 ECTS: 30 h) The theoretical concepts of the subject are explained and illustrative examples are developed as a support to the theory when necessary. The active participation of students will be promoted.
- **Practice sessions:** (1,75 ECTS: 17,5 h) Problems and practical cases are carried out, complementary to the theoretical concepts studied.The active participation of students will be promoted.
- **Computer sessions:** (1 ECTS: 10 h) Sessions dedicated to the use of varioussymbolic and numeric calculus tools.
- **Seminars:** (0.25 ECTS: 2.5 h) Tutored by teachers from other subjects of this degree with the purpose to show the students the different applications of mathematics in Civil Engineering.
- **Autonomous work and study:** (90 hours)
    - Study and understanding of the theory taught in the lectures.
    - Understanding and assimilation of the problems and practical cases solved in the practice sessions.
    - Understanding and assimilation of the informatic tools.
    - Preparation of seminars, solutions to proposed problems, etc.
    - Preparation of the written tests for continuous assessment and final exams.
- **Tutorials:** Those carried out giving individual, personalized attention with the teacher of the subject. These tutorials may be in person or online.
- **Exams:** Written assessment exams.

If due to health reasons the in-person teaching-learning process is not possible, it shall be carried out telematically.

4.3.Syllabus

This course will address the following topics:

1. Planar and spatial curves: Frenet frame; curvature and torsion.
2. Functions of several variables. Limits and continuity.
3. Partial derivatives and differential; the chain rule.
4. Extrema. Constrained extrema: the method of Lagrange multipliers.
5. Double integral; change of variables.
6. Triple integrals.
7. Line integral. Work and energy. Green's Theorem.
8. Surfaces. Surface integrals; Stokes and Gauss Theorems.
9. Ordinary Differential Equations: basic concepts, existence and uniqueness.
10. Analytic solvability.
11. Qualitative aspects: fixed points and linear stability.
12. Numerical methods: Euler, Runge-Kutta.
13. Higher orden ODE: Oscillators; resonance. Beam stability.
14. Higher-order numerical methods (FDM y FEM).
15. Introduction to Partial Differential Equations: separation of variables; vibrations.

4.4.Course planning and calendar

Week	Theme	Topic	Tests	Weight	Content
1	1	Curves			
2	2	Continuity			
3	3	Differentiability			
4		Extrema	1st test	5	Dif./Cont.
5	4	Multiple Integrals	2nd test	5	Integrals
6	5	Line Integrals			
7	6	Surface Integrals	1st Exam	40	Several V.
8	7	ODE: Introduction, 1st order			
9		Linear equations	3rd test	5	1st order ODE
10	8	Linear stability			
11	9	Numerical Methods			
12	10	Oscillators, resonance	4th test	5	ODE
13	11	Beam Stability			
14	12	PDE: Introduction			
15		Separation of variables	2nd Exam	40	ODE, PDE

Important dates, such as written exams, among other foreseen activities will be communicated to the students in the classroom or through the Moodle platform enough time in advance. Seminars will be on Friday. Such dates will be decided by the teacher and students will be informed with at least 15 days in advance in case of midterm exams and seminars and 7 days in advance in case of individual assignments.

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 theEUPLA website (http://eupla.unizar.es/).

4.5.Bibliography and recommended resources

Computer algebra systems:

- Symbolic calculus tool: Maxima

Bibliography:

http://biblos.unizar.es/br/br_citas.php?codigo=28705&year=2020