Universidad Zaragoza

Year : 2019/20

27508 - Mathematics II

Syllabus Information

Academic Year: 2019/20
Subject: 27508 - Mathematics II
Faculty / School: 109 -

Degree: 449 - Degree in Finance and Accounting

ECTS: 6.0
Year: 1
Semester: Second semester
Subject Type: Basic Education
Module:

1.General information

1.1.Aims of the course

The general objectives of the mathematical subjects in this Degree are included in the following two main goals: (1) Mathematical education, (2) Training to apply Mathematics to the challenges that the students will encounter in their careers.

The subject Mathematics II supposes a step forward in these objectives which Mathematics I also dealt with. Education in Mathematics is significant not only because of the transmission of new concepts, but also because the students gain a rigorous and accurate perspective, as well as the capacity for abstraction and the scientific method that characterize Mathematics. Regarding the second goal, this subject introduces students to modelling, using the mathematical analysis approach through two different ways: classical optimization, and dynamical analysis.

1.2.Context and importance of this course in the degree

Mathematics II is a course of basic training of 6 ECTS that is taught in the second semester of the first academic year and which is the continuation of Mathematics I taught in the first semester of the same course, on whose concepts are based.

The course mathematics II is divided into two clearly distinct blocks: mathematical programming and dynamic analysis, which respond to two different points of view of economic reality. After the first, the student will know how to pose and solve a wide range of classic optimization problems: linear or nonlinear, without restrictions or with equality constraints. In the case of optimization programs in which both the objective function and the constraints are linear is used as a technique for resolution simplex method. This theme can be used to connect the traditional teaching of resolution with the use of computer programs that simplify the process of calculation and place the student in professional practice.

In the second block, dynamic analysis, it is solved differential equations and analyzed the solution. Its inclusion in the program is required because in the economic analysis it is usual that economic processes are not static, as for example: optimal economic growth.

As Mathematics is a tool and a support for other subjects that are essential in the education of the students (Microeconomics, Macroeconomics, Econometrics, etc.), Mathematics II continues the line of work of Mathematics I by bringing Mathematics closer to problems in economic scenarios, which will undoubtedly facilitate a deeper comprehension of and, as a consequence, better skills in applying Mathematics.

After passing the mathematical subjects in the Degree, the students will have worked towards attaining one of the most important goals of mathematical theory: to formulate models that explain the real world. Prospective graduates will be able to use the language of science and to understand the role played by Mathematics in the development of their thinking skills, given that the students' logical reasoning, accuracy, rigor, capacity for abstraction and skills in interpreting results will be improved. This is why the subjects of Mathematics are indispensable tools which allow the designing of appropriate models that are used for researching, describing, understanding and thinking about the realities of companies.

1.3.Recommendations to take this course

The students should have a good command of all the contents of the subject Mathematics I, taught during the first semester of the first year. They must, in any case, know the meaning and implications of the differentiability of a function and be skilled in the calculus of partial derivatives. The students also have to know how to determine the sign of a quadratic form. They must also be able to present and support an argument with a logical sequence and to connect various mathematical aspects previously learnt.

2.Learning goals

2.1.Competences

After completing the course, the student will be competent in the following skills:

1. Understand the nature of the firm and the institutions, their relation with the economic, legal, social and environmental contexts and their incidence over the financial and accounting departments of the organizations.

2. Understand the operation of the financial markets, the involved institutions, the instruments traded and their influence in the investment decisions and the financing of the organizations and persons.

3. Identify, interpret and assess the financial and accounting information of the firms and institutions to identify the strengths and weaknesses, and to advice from a technical, financial and accounting focus the decisions to be taken.

4. Capacity to elaborate financial and accounting reports, internal and external, in addition to obtain and express an independent opinion on the accounting information of an organization.

5. Capacity for synthesis and analysis.

6. Capacity for problem solving.

7. Develop collaborative attitudes and of work in multidisciplinary or multicultural teams, and to develop a critical attitude for debating.

8. Capacity for innovation in all aspects, and for adapting to new environments: social, cultural, technological.

9. Motivation for the autonomous and continued learning.

2.2.Learning goals

The student, in order to pass the course, will have to show her/his competence in the following skills:

1. To have gained good skills in using mathematical language, both in comprehension and writing.
2. To be able to identify the fundamental elements of an optimization problem: variables, objective function and constraints.
3. To be able to formulate static optimization problems: unconstrained, and with equality and/or inequality constraints.
4. To know how to solve an optimization problem by the graphical method, when that is possible.
5. To be able to evaluate whether or not a mathematical programmer meets the conditions that allow it to be solved by the techniques learnt.
6. To be able to distinguish between critical points and extrema (optima).
7. To be able to discriminate between local and global optima.
8. To be able to distinguish between necessary conditions and sufficient conditions for local optimality.
9. To be able to calculate the critical points by solving the system of equations obtained by applying the first-order conditions for local optimality, both for unconstrained cases and for problems with equality constraints.
10. To know how to classify the obtained critical points by using the second-order conditions, both for unconstrained optimization programs and for problems with equality constraints.
11. To be able to apply the conditions which guarantee that an optimum is global.
12. To be able to interpret economically the Lagrange multipliers obtained in an optimization problem with equality constraints.
13. To be able to evaluate whether a mathematical program is linear. If it is, they must know how to solve it by the graphical method (when that is possible) and by the simplex algorithm.
14. When varying a parameter of a linear optimization program, the students must be able to analyze how the solution changes, without solving the new problem.
15. To be able to use some computer programs to find the solution to an optimization problem and to be able to interpret the results obtained.
16. To be able to identify a dynamic process in an economic scenario and be able to represent this process (when possible) by an ordinary differential equation.
17. To understand the concept of the solution of an ordinary differential equation and to be able to distinguish between general solution and particular solution.
18. To be able to discriminate between a first-order differential equation and a linear differential equation of order n.
19. To be able to identify whether a first-order differential equation is with separable variables, homogeneous, exact, or of linear type, and to know how to solve the equation by the appropriate method.
20. For a linear differential equation with constant coefficients, they must be able to write the complementary (homogeneous) equation and obtain its general solution.
21. To be able to find a particular solution of a linear differential equation with constant coefficients.
22. To have the know-how to calculate the general solution of a linear differential equation with constant coefficients.
23. To be able to work out the solution of a linear differential equation of order n with constant coefficients, given n initial conditions.

2.3.Importance of learning goals

They permit the comprehension of theoretical concepts and models that are part of the contents of other related subjects studied in the Degree. Mathematics is most important in this goal because it facilitates the analysis and discussion of the models and concepts studied. In this regard, it is worth mentioning that Optimization techniques allow the laying of the foundations of the two basic paradigms of Microeconomics, namely, the theory of consumer choice and the production theory. The concepts of convex set and concave/convex function, whose economic interpretations are, respectively, the diversity in consumption and the law of diminishing marginal returns, have important applications. Linear Programming is very useful in production planning problems and it allows the solving of some simple exercises of comparative statics.

Different techniques are required for the analysis of dynamic processes in continuous time, which is essential, for example, in models of economic growth. The theory of differential equations provides the necessary tools to deal with some key concepts such as trajectory over time, evolution of the system, stability, etc.

3.Assessment (1st and 2nd call)

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

The student will prove that he/she has achieved the expected learning results by means of the following assessment tasks: The evaluation will be global in both the first and second sittings.

The evaluation activities planned are of two types:

? Computer tests (PI) to be done in the computer room, in which students must apply the computer tools to the mathematical concepts developed in the course (Topics 1 to 5) with Free Software wxMaxima and GeoGebra. In the computer tests the use of the functions of these programs related to the Mathematics of the subject, the numerical and / or symbolic results obtained, as well as their interpretation and conclusions will be valued. The level of demand will be similar to that of the material seen in class.

? Written test (PE) in which students must solve various issues and theoretical, practical and practical problems related to the application of mathematical techniques presented in Topics 1 to 5. In each problem will be raised several sections in whose resolution both the mathematical approach of the problem, the use of mathematical notation and terminology, the correct numerical and / or symbolic resolution and the interpretation / comparison of the obtained results will be valued. The level of demand will be similar to that of the material seen in class.

Each test will be scored on a scale of 0 to 10 points.

The part of the subject evaluated by computer tests (PI) will have a weight of 60% in the overall score, while the part evaluated by written test (PE) will have the remaining 40%. To pass the course, a minimum of 4 points will be required in each of the parts (PI and PE) and obtain a score of 5 or more points out of 10 in the final grade. The final grade, uniquely if minimums is achieved, will be obtained as:

FINAL GRADE = 0.6 * PI + 0.4 * PE

If the minimum indicated in one of the two parts (PI) or (PE) is not equaled or exceeded, the corresponding part(s) will not be taken into account in the calculation of the final grade.

The computer part can be overcome by the students through two partial computer tests, PI1 (Topics 1 to 3) and PI2 (Topics 4 and 5) that will be done during the class period or through a single global computer test (PIG) ??that will be will perform on the dates of the official calls.

In order to be eligible for partial computer tests (PI1 and PI2) it is mandatory to participate actively and resolve the questions, exercises and tests that will be carried out in the classroom, according to the indications that the teacher responsible for each group of the subject will exhibit on the day of the presentation of it.

The written test will be done only on the dates of official calls.

To pass the computer part through partial computer tests the student must obtain at least 3 points in each of the tests, and the average score of the two tests (PI = 0.5 * PI1 + 0.5 * PI2) must be equal to or greater than 4 points The students who, even having obtained these minimum scores in the partial computer tests, want to improve their grade of the computer part for the first call may perform the global computer test (PIG), keeping the best of the two grades.

Students who have not passed the course in the first call may apply for the second call, the evaluation of which will be similar to the overall evaluation of the first call, a Computer Test (PI) + Written Test (PE).

It should be noted that academic courses close evaluation processes, which means that no merits can be claimed from a course for evaluations of subsequent academic courses.

The evaluation of the fifth and sixth calls for proposals will be carried out in accordance whit the University of Zaragoza Rules of Learning Evaluation Procedure, which was approved by agreement of the Consejo de Gobierno on 22 December 2010.

Evaluation Criteria

Students will be assessed on whether they have acquired the learning outcomes mentioned above. In particular, they will be assessed on the following aspects:

1. Correct mathematical writing.
2. Logical reasoning in the posing and solving of the problems.
3. Reference to the theoretical results used, when relevant.
4. The choice of the most appropriate method for the solving of problems.
5. Clarity in the application of mathematical concepts and procedures.
6. Computations carried out with care.

7. The correct expression of the results obtained when solving problems.

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 lectures, practice sessions, autonomous work, study and assessment tasks.

The objective of this subject is that the students should develop the analytical skills, rigor and intuition needed for using mathematical concepts and results and that they should be able to apply these abilities to the analysis of problems of an economic nature. Therefore, the teaching should aim to provide students with a solid mathematical knowledge and to train them in a way of reasoning that will allow them thereafter to successfully solve a wide variety of questions in an economic scenario.

Students are expected to participate actively in class throughout the semester.

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

4.2.Learning tasks

The course includes the following learning tasks:

- Lectures (1.2 ECTS credits,30 hours), which the professor will present the concepts and results corresponding to the contents. At the same time, some exercises will be solved with the participation of the students to help them comprehend the theoretical concepts presented. These classes are face-to-face and will be given to the full group.
- Practice sessions, (1.2 ECTS credits (30 hours each subgroup), in which the students will apply the theoretical results in order to solve, with the teacher's help, more complete exercises, and problems of an economic nature. Problem sheets will be available for the students and the teacher will announce in advance the problems that will be solved in each practical lesson so that the students can prepare them beforehand. These classes are face-to-face and will be given separately to each subgroup.
- Seminars (practical classes P6), subject to availability professors staff, in which may consist of a number of different activities designed to support the learning process, including: follow-up of some simple projects that had been assigned to small teams of students and the presentation of these projects; answering questions that students may have regarding some of the contents taught; solving problems of an economic nature by using some of the mathematical tools taught during the classes, etc. These seminars may also be devoted to the teaching of more advanced topics, intended for the students interested in learning some further mathematical tools that would allow them to deal with more general problems. In this way, the students are shown that both Mathematics and Economics are vibrant sciences with many facets to be studied. Both, the splitting in two of the group in the practical sessions and the P6 activities will be subject to the availability of professors. Attendance at practical classes P6, which may include computer practice if the global schedule allows it.
- Autonomous work: 3.6 ECTS credits.

4.3.Syllabus

The course will address the following topics:

Topic 1: Mathematical programs

- 1.1. General formulation of a mathematical program. Classification.
- 1.2. Definitions and properties. Weierstrass' Theorem.
- 1.3. Graphical solving.
- 1.4. Introduction to convexity:
    - 1.4.1. Convex sets. Definition and properties.
    - 1.4.2. Convex and concave functions. Definitions and properties.
    - 1.4.3. Convex programs.

Topic 2: Programming without constraints

- 2.1. Problem formulation.
- 2.2. Local optima:
    - 2.2.1. First order conditions for the existence of a local optimum.
    - 2.2.2. Second order conditions for the existence of a local optimum.
- 2.3. Global optima: convex programs.

Topic 3: Programming with equality constraints

- 3.1. Problem formulation.

- 3.2. Local optima:
    - 3.2.1. First order conditions for the existence of a local optimum.
    - 3.2.2. Second order conditions for the existence of a local optimum.
- 3.3. Global optima: convex programs and Weierstrass' Theorem.
- 3.4. Economic interpretation of the Lagrange's multipliers.

Topic 4: Linear programming

- 4.1. Formulation of a problem of linear programming.
- 4.2. Solutions of a linear program. Basic feasible solutions.
- 4.3. Characterization of the optimal basic feasible solutions. Simplex' Algorithm.
- 4.4. Introduction to the sensitivity analysis.
- 4.5. Introduction to the dual program.

Topic 5: Introduction to ordinary differential equations

- 5.1. Introduction to the dynamical analysis.
- 5.2. Concept of differential equation, solution and types of solution.
- 5.3. First order ordinary differential equations:
    - 5.3.1. Separable equations.
    - 5.3.2. Linear first order equations.
- 5.4. Linear differential equations of order n with constant coefficients.
- 5.5. Qualitative analysis: equilibrium points and stability.

4.4.Course planning and calendar

Further information concerning the timetable, classroom, office hours, assessment dates, midterm exams, final exam and other details regarding this course, will be provided on the first day of class or please refer to the Faculty of Economics and Business website (https://econz.unizar.es/).

4.5.Bibliography and recommended resources