Course guide
310701 - 310701 - Fundamentals of Mathematics

Last modified: 19/09/2023

Unit in charge: Barcelona School of Building Construction
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN ARCHITECTURAL TECHNOLOGY AND BUILDING CONSTRUCTION (Syllabus 2019). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: Maria Montserrat Bruguera Padró

Others: Tuset Serra, Lluís
Pantazi, Chara

REQUIREMENTS

A laptop is required to take the continuous evaluation questionnaires in the classroom.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. FB-1 Aptitude to use the applied knowledges related with the numerical and infinitesimal calculus, linear algebra, analytic and differential geometry, and the probabilistic and statistical analysis thecniques and methods.

Transversal:
2. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.
3. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

TEACHING METHODOLOGY

The directed learning hours can be differentiated by three methodologies: big group, medium groups and small groups. The theorical clases (big group) consist on the teacher's brief explanation to introduce the general learning goals related to the basic concepts which later, through practical exercises, the students will be motivated and will be able to take part in their learning process. The support platform will be ATENEA: achieving objectives by contents, concepts, examples,... It will also give access to other material like the schedule, methods of evaluation, learning activities or bibliography. There will also be practical classes (medium groups) through the resolution of numerical exercises related to the learning objectives of each one of the contents of the subject; the intention is to incorporate some generic competences, like team work. The last leaning hours consist on doing lab practices (small group) which helps develop basic skills in symbolic computation software. It also must be considered that there are other autonomous learning hours like related readings, the resolution of the proposed problems or the self-learning questionnaires of the different contents through the virtual campus ATENEA or aCTeX software.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course, the student should be able to:

· Classify and solve determinate, indeterminate and overdeterminate equation systems.
· Use changes of reference systems.
· Do matrix calculations.
· Calculate and interpret the diagonal form of the matrix of a lineal transformation.
· Be competent using an algebraic manipulator system.
· Define the concept of functions with single and multiple variables.
· Calculate, interpret and apply partial derivatives, directional derivatives and differential matrix.
· Numerically solve elemental mathematic problems: interpolation, approximation to functions and Taylor.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	9,0	6.00
Hours large group	30,0	20.00
Hours small group	21,0	14.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

C1: Linear algebra: vectors, matrixes, vectorial spaces, and lineal transformations.

Description:
Content of the lesson:
· Determinate, indeterminate and overdeterminate linear system equation resolution.
· Scalar, vector and matrix calculations.
· Recognize if a function is or is not a linear transformation.
· Geometric interpretation of linear transformations of 2 and 3 variables.
· Linear subspace and basis
· Dot product. Orthogonal basis. Orthonormal basis. Projections.
· Formulation and geometric interpretation of reference systems changes.
· Invariant directions and matrix's diagonal form of a lineal transformation. Implementations.

Related activities:
Activities 1 to 5.
In case the student goes to re-evaluation: half of activity 11.

Full-or-part-time: 84h
Theory classes: 18h
Practical classes: 8h
Laboratory classes: 8h
Self study : 50h

C2: Single and multiple variables calculation.

Description:
Contents of the lesson:
·Real functions with single real variable, limits, continuity and derivatives.
·Derivatives calculations.
·Development of Taylor series of a function in a dot range.
·Function interpolations using plan dots.
·Real function of multiple variables.
·Concept, geometric description and calculus of contour lines, partial derivatives and directional derivatives.
·Differential concept. Jacobian matrix calculus.
·Gradient concept and geometric interpretation.
·Concept of gradient and geometric interpretation.

Related activities:
Activities carried out: 6 to 10.
In case that the student goes to re-evaluation: half of activity 11.

Full-or-part-time: 66h
Theory classes: 12h
Practical classes: 7h
Laboratory classes: 7h
Self study : 40h

ACTIVITIES

A1 A1: Theory, exercises and questionnaires (Matrices and Systems)

Description:
Students have to use the EngiMath course to consolidate high school knowledge of matrices and systems of equations. And with the tests that are proposed obtain 5% of the course grade. This will allow us to externalize the classes of the first week, which we will use to deepen and resolve doubts.
We have the support of the EngiMath@UPC+ project

Specific objectives:
At the end of the activity, students should be able to do basic matrix operations, discuss ans solve linear system equations by different methods and do Gaussian eliminations.
Reaffirm and demonstrate the learning, conceptual and practical.

Material:
Laptop with access to Atenea and Matlab.
Questionnaire in Atenea for the test realization.
Symbolic manipulator, Matlab, as a calculus support.
Matlab file and basic formulas form.

Delivery:
Realization of the questionnaire in Atenea.
It represents a part of the continuous evaluation (5% of the final mark of the subject).

Related competencies :
FB-01. FB-1 Aptitude to use the applied knowledges related with the numerical and infinitesimal calculus, linear algebra, analytic and differential geometry, and the probabilistic and statistical analysis thecniques and methods.
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

Full-or-part-time: 24h
Practical classes: 4h
Self study: 20h

A2 A2: CLASSES OF PROBLEMS and INDIVIDUAL QUESTIONNAIRE (VECTORIAL SPACES and LINEAL FORMS)

Description:
Problem solving class, by hand and with the use of Matlab, about vectorial spaces.
The last 60 minutes of class, resolution of an individual questionnaire at Atenea (It will be done in person, in a classroom supervised by teachers).

Specific objectives:
Reaffirm and demonstrate the learning, conceptual and practical, related to vectorial spaces.

Material:
Laptop with access to Atenea and Matlab.
Questionnaire in Atenea for the test realization.
Symbolic manipulator, Matlab, as a calculus support.
Matlab file and basic formulas form.

Delivery:
Questionnaire realitzation through Atenea
It represents a percentage of the continuous evaluation (5% on the final grade).

Related competencies :
FB-01. FB-1 Aptitude to use the applied knowledges related with the numerical and infinitesimal calculus, linear algebra, analytic and differential geometry, and the probabilistic and statistical analysis thecniques and methods.
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

Full-or-part-time: 6h
Practical classes: 3h
Self study: 3h

A3 A3: CLASSES OF PROBLEMS and INDIVIDUAL QUESTIONNAIRE (DIAGONALIZATION)

Description:
Problem solving class, by hand and using Matlab, corresponding to CONTENT 1 and mainly on diagonalization of endomorphisms.
The last 60 minutes of class, resolution of an individual questionnaire at Atenea (It will be done in person, in a classroom supervised by teachers).

Specific objectives:
Reaffirm and demonstrate the learning, conceptual and practical, related to Content 1.

Material:
Laptop with access to Atenea and Matlab.
Questionnaire in Atenea for the test realization.
Symbolic manipulator, Matlab, as a calculus support.
Matlab file and basic formulas form.

Delivery:
Delivery through Atenea
It represents a part of the continuous evaluation (5% of the final mark of the subject).

Related competencies :
FB-01. FB-1 Aptitude to use the applied knowledges related with the numerical and infinitesimal calculus, linear algebra, analytic and differential geometry, and the probabilistic and statistical analysis thecniques and methods.
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

Full-or-part-time: 6h
Practical classes: 3h
Self study: 3h

A4 TA: INDIVIDUAL EXERCISE OF CONTENT 1 PROBLEMS

Description:
Students will solve exercises with different parts regarding the lessons of content 1.
The excercise will be individual.

Specific objectives:
The student must know how to manually solve content problems 1.
The student has to be able to correctly write the resolution of the problems, justifying all the steps taken.
Also explaining if it is necessary to use algebraic manipulators to verify and complement the manual calculations.
It is also a part of the learning process to take the partial exam (PA).

Material:
The student can use calculator and algebraic manipulators (Matlab) to verify and complement the calculations made manually.

Delivery:
Document, as a report, made by hand or with a word processing program.
On paper or uploading a pdf to Atenea.

Related competencies :
FB-01. FB-1 Aptitude to use the applied knowledges related with the numerical and infinitesimal calculus, linear algebra, analytic and differential geometry, and the probabilistic and statistical analysis thecniques and methods.
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

Full-or-part-time: 4h
Self study: 4h

A5 PA: INDIVIDUAL AND ON-SITE TEST OF PROBLEMS ON CONTENT 1

Description:
Students will solve an exercise with different parts of the lessons of content 1.
The test will be individual and will be done on-site (in a classroom supervised by teachers)

Specific objectives:
Student must know how to solve the exercises of content 1.

Material:
The student can bring a non-programmable calculator that does not perform symbolic calculation.

Delivery:
In paper (or uploading a scanned pdf to Atenea in case of confinement). Midterm exam. The test is worth 35% of the final grade.

Related competencies :
FB-01. FB-1 Aptitude to use the applied knowledges related with the numerical and infinitesimal calculus, linear algebra, analytic and differential geometry, and the probabilistic and statistical analysis thecniques and methods.
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

Full-or-part-time: 6h
Theory classes: 2h
Self study: 4h

A6 C1: CLASSES OF PROBLEMS and INDIVIDUAL QUESTIONNAIRE (REVIEW OF FUNCTIONS OF ONE VARIABLE)

Description:
Problem solving class, by hand and using Matlab, on review of functions of one variable.
The last 60 minutes of class, resolution of an individual questionnaire at Atenea (It will be done in person, in a classroom supervised by teachers).

Specific objectives:
Reaffirm and demonstrate the learning, conceptual and practical, relative to functions of one variable.

Material:
Laptop with access to Atenea and Matlab.
Questionnaire in Atenea for the test realization.
Symbolic manipulator, Matlab, as a calculus support.
Matlab file and basic formulas form.

Delivery:
Delivery of the questionnaire through Atenea.
It represents a part of the continuous evaluation (5% of the final grade of the course).

Related competencies :
FB-01. FB-1 Aptitude to use the applied knowledges related with the numerical and infinitesimal calculus, linear algebra, analytic and differential geometry, and the probabilistic and statistical analysis thecniques and methods.
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

Full-or-part-time: 6h
Practical classes: 3h
Self study: 3h

A7 C2: CLASSES OF PROBLEMS and INDIVIDUAL QUESTIONNAIRE (TAYLOR AND INTERPOLATION)

Description:
Problem solving class, by hand and using Matlab, corresponding to Taylor and interpolation.
The last 60 minutes of class, resolution of an individual questionnaire at Atenea (It will be done in person, in a classroom supervised by teachers).

Specific objectives:
Reaffirm and demonstrate the learning, conceptual and practical. He must also be able to calculate Taylor's developments and calculate interpolated polynomials associated to a cloud of dots and use this to approximate a determinated value.

Material:
Laptop with access to Atenea and Matlab.
Questionnaire in Atenea for the test realization.
Symbolic manipulator, Matlab, as a calculus support.
Matlab file and basic formulas form.

Delivery:
Delivery of the questionnaire through Atenea
It represents a part of the continuous evaluation (5% of the final grade of the course).

Related competencies :
FB-01. FB-1 Aptitude to use the applied knowledges related with the numerical and infinitesimal calculus, linear algebra, analytic and differential geometry, and the probabilistic and statistical analysis thecniques and methods.
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

Full-or-part-time: 6h
Practical classes: 3h
Self study: 3h

A8 C3: CLASSES OF PROBLEMS and INDIVIDUAL QUESTIONNAIRE (FUNCTIONS OF SEVERAL VARIABLES)

Description:
Problem solving class, by hand and using Matlab, on functions of several variables and explicitly defined surfaces.
The last 60 minutes of class, resolution of an individual questionnaire at Atenea (It will be done in person, in a classroom supervised by teachers).

Specific objectives:
Reaffirm and demonstrate the learning, conceptual and practical.

Material:
Laptop with access to Atenea and Matlab.
Questionnaire in Atenea for the test realization.
Symbolic manipulator, Matlab, as a calculus support.
Matlab file and basic formulas form.

Delivery:
Delivery of the questionnaire through Atenea.
It represents a part of the continuous evaluation (5% of the final grade of the course).

Related competencies :
FB-01. FB-1 Aptitude to use the applied knowledges related with the numerical and infinitesimal calculus, linear algebra, analytic and differential geometry, and the probabilistic and statistical analysis thecniques and methods.
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

Full-or-part-time: 6h
Practical classes: 3h
Self study: 3h

A9 TC: INDIVIDUAL EXERCISE OF CONTENT 2 PROBLEMS

Description:
Students will solve exercises with different parts of the lessons of content 2.
The test will be individual.

Specific objectives:
The student must know how to manually solve content problems 1.
The student will have to correctly write the resolution of the problems, justifying all the steps taken.
Also explaining if it is necessary to use algebraic manipulators to verify and complement the manual calculations.
It is also an apprenticeship to take the partial exam (PC).

Material:
The student can use calculator and algebraic manipulators (Matlab) to verify and complement the calculations made manually.

Delivery:
Document, as a report, made by hand or with a word processing program.
On paper or uploading a pdf to Atenea.

Related competencies :
FB-01. FB-1 Aptitude to use the applied knowledges related with the numerical and infinitesimal calculus, linear algebra, analytic and differential geometry, and the probabilistic and statistical analysis thecniques and methods.
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

Full-or-part-time: 4h
Self study: 4h

A10 PC: INDIVIDUAL TEST OF EXERCISES ABOUT CONTENT 2 PROBLEMS

Description:
Students will solve an exercise with different parts about the aspects studied in content 2.
The test will be individual and will be done in person (in a classroom supervised by teachers).

Specific objectives:
Students must manually solve an exercise about content 2.

Material:
Non-programmable calculator without symbolic calculation can be used.

Delivery:
On paper (or uploading a scanned pdf to Atenea in case of confinement). Midterm exam.
The test represents a 35% of the subject.

Related competencies :
FB-01. FB-1 Aptitude to use the applied knowledges related with the numerical and infinitesimal calculus, linear algebra, analytic and differential geometry, and the probabilistic and statistical analysis thecniques and methods.
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

Full-or-part-time: 6h
Theory classes: 2h
Self study: 4h

A11 Re-evaluation exam

Description:
Exam of problems about contents 1 and 2.
According to the regulations of the school the students can do the re-evaluation if their mark is between 3.5 and 4.9.

Full-or-part-time: 13h 40m
Theory classes: 4h
Self study: 9h 40m

GRADING SYSTEM

The grading system is based on continuous evaluation.
It is done in 6 questionnaires A1, A2, A3, C1, C2, C3 a midterm exam halfway through the course (PA) and another midterm exam at the end (PC). Half of the tests correspond to Block 1 (Algebra) and the other half to Block 2 (Calculus).

Calculation of the Final Grade
Nf=((A1 + A2 + A3)*5 + PA*35 + (C1 + C2 + C3)*5 + PC*35)/100
Partial exam = PA
Partial exam = PC

Nf: final grade.

TA: problem solving on content 1 (before the PA midterm)
TC: problem solving on content 2 (before the PC midterm)

Ai and Ci: grades from the ATENEA questionnaires that will be taken in class.
Ai Block 1 questionnaires [weeks 2, 3, 5] (before PA)
Ci Block 2 questionnaire [weeks 8, 9, 11] (after PA and before PC)

All grades are calculated out of 10.

The re-evaluation exam will consist of a single exam on problems of contents 1 and 2.

EXAMINATION RULES.

. If some of the practices or questionnaires are not done, they will be considered as not graded and marked automatically as a 0.

. In the questionnaires some teaching material may be used(specific files and formularies).

. In the midterm and final exams only a calculator may be used.

BIBLIOGRAPHY

Basic:
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- Larson, R. E.; Hostetler, R. P.; Edwards, B.H. Cálculo. 8a ed. Mc Graw-Hill, 2006.
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- Courant, R.; John, F. Introducción al cálculo y al análisis matemático. Mexico: Limusa, 1988.
- Finney, R.L. [et al.]. Calculus : a graphing approach. Mexico: Addison-Wesley, 1993.
- Aubanell, A; Benseny, A.; Delshams, A. Eines bàsiques de càlcul numèric. Barcelona: Servei Pub. UAB, 1991.
- Cheney, W.; Kincaid, D. Numerical mathematics and computing. 6a ed. Belmont: Brooks/Cole Publishing Co, 2008.

RESOURCES

Hyperlink:
- EngiMath. Resource

Other resources:
Material Available in ATENEA