



## Course guides

# 310001 - 310001 - Mathematical Fundamentals of Engineering for Building Construction

Last modified: 02/04/2020

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

**Degree:** BACHELOR'S DEGREE IN BUILDING CONSTRUCTION SCIENCE AND TECHNOLOGY (Syllabus 2009).  
(Compulsory subject).  
BACHELOR'S DEGREE IN ARCHITECTURAL TECHNOLOGY AND BUILDING CONSTRUCTION (Syllabus 2015).  
(Compulsory subject).

**Academic year:** 2020    **ECTS Credits:** 6.0    **Languages:** Catalan, English, Spanish

## LECTURER

---

**Coordinating lecturer:** Maria Montserrat Bruguera Padró

**Others:** Delshams I Valdes, Amadeu  
López, Pere  
Roca Lacostena, Jordi  
  
Pantazi, Chara  
Rodríguez Jordana, Juanjo

## 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 techniques 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 learning hours consist on the one hand in theoretical clases (big group) where the faculty does a brief exposition to introduce the general learning goals related with the basic knowledge of the subject. Later through practical exercises, the faculty tries to motivate and involve the students so that they can be part of their own apprenticeship. It will be used support material through ATENEA: Learning objectives by contents, concepts, examples, schedule of evaluation and learning activities and bibliography. On the other hand there also will be practical clases (medium group) through the resolution of numerical exercises related with the learning objectives of each one of the subject contents. In these practical sessions the intention is to incorporate some generic competences, like team work. The last leaning hours consist on doing lab practices (small group) which allows to 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 exercises or the self-learning questionnaires of the different contents through virtual campus ATENEA or aCTeX software.

## LEARNING OBJECTIVES OF THE SUBJECT

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

- Classify and solve determinate, indeterminate and overdeterminate equation systems.
- Use reference systems changes.
- Do matrix calculations.
- Calculate and interpret the matrix's diagonal form of a lineal transformation.
- Be competent using an algebraic manipulator system.
- Define the concept of functions with single or 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	15,0	10.00
Self study	90,0	60.00
Hours large group	30,0	20.00
Hours small group	15,0	10.00

**Total learning time:** 150 h

## CONTENTS

### C1: Linear algebra, vectors, matrixes 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 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 carried out:

- Lab practice L1.
- Individual test (Activity 5) during the continuous assessment sessions.
- TGF (Global Final Test) with questions of C1 and C2 contents.

In case that the student needs to do a reappraisal:

At the end of the course there will be the Activity 9 with problems of the C1 and C2 contents.

#### Full-or-part-time: 84h

Theory classes: 18h

Practical classes: 8h

Laboratory classes: 8h

Self study : 50h



## C2: Single and multiple variables calculation.

### Description:

Content 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 and geometric interpretation of Hessian matrix.

### Related activities:

Activities carried out:

- Activity 3 that belongs to the directed learning laboratory (in English).
- L2 Individual laboratory test (Activity 6) during the continuous assessment sessions.
- P2 Written problem (Activity 7) about the second content.
- TFG (Final Global Test) with questions of the C1 and C2 contents.

In case that the student needs to do a reappraisal:

At the end of the course there will be the Activity 8 (TFG) and the Activity 9 which has problems of the C1 and C2 contents.

**Full-or-part-time:** 66h

Theory classes: 12h

Practical classes: 7h

Laboratory classes: 7h

Self study : 40h

## ACTIVITIES

### A1 PRACTICE 0. INTRODUCTION TO MANIPULATORS

#### Description:

Group practice carried out at the computer room and with a duration of an hour. Students should make the exercises of the support activities.

#### Specific objectives:

At the end of the activity, students should be able to do basic function and polynomial operations, elemental graphic representation and numeric representation of manipulators.

#### Material:

Example document, algebraic manipulator manual, practice formulation, exercise list to resolve and solution available in 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 techniques 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:** 3h

Practical classes: 2h

Self study: 1h



## A2 PRACTICE 1. SYMBOLIC MATRIX CALCULUS FOUNDATIONS

### Description:

Group practice carried out at the computer room and with a duration of an hour. Students should make the exercises of the support activities.

### Specific objectives:

At the end of the activity, students should be able to do basic matrix operations, discuss and solve linear system equations by different methods and do Gaussian eliminations. Furthermore, students should be able to solve matrix diagonalization and calculate coordinates and endomorphism basis change.

### Material:

Example document, algebraic manipulator manual, practice formulation, exercise list to resolve and solution available in 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 techniques 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: 3h

Practical classes: 2h

Self study: 1h

## A3 PRACTICE 2. SYMBOLIC CALCULUS FOUNDATIONS WITH SINGLE AND MULTIPLE VARIABLES.

### Description:

Group practice carried out at the computer room and with a duration of two hours (In English). Students should make the exercises of the support activities.

### Specific objectives:

At the end of the activity, students must be able to represent functions graphically, solve derivatives, to find zeros and functions and to adequately simplify all the results. He must also be able to calculate Taylor's developments. Calculate interpolated polynomials and determine the error. Calculate the gradient of a function on several variables as well as its Hessian matrix. Represent the contour lines.

### Material:

Example document, algebraic manipulator manual, practice formulation, exercise list to resolve and solution available in 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 techniques 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.

03 TLG. 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.

### Full-or-part-time: 6h

Practical classes: 2h

Self study: 4h



#### A4 P1: INDIVIDUAL TEST PROBLEMS OF THE CONTENT 1

**Description:**

Students will solve an exercise with different parts of the lessons of content 1.

**Specific objectives:**

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

**Material:**

Students can bring calculator.

**Delivery:**

In paper. Partial exam. The test is worth 30% 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 techniques 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: 5h**

Practical classes: 1h

Self study: 4h

#### A5 L2: INDIVIDUAL TEST OF CONTINUOUS ASSESSMENT ON THE LABORATORY (CONTENT 1)

**Description:**

Solve problems of the CONTENT 1

**Specific objectives:**

Show that the students has learnt the contents of content 1.

**Material:**

Wording for the test realization.

Symbolic manipulator as a calculus support.

Maple form and document.

**Delivery:**

Delivery through Atenea

It represents a 10% on the final grade and of the continuous assessment.

**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 techniques 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: 5h**

Practical classes: 1h

Self study: 4h



#### A6 P2 INDIVIDUAL TEST OF EXERCISES ABOUT CONTENT 2

**Description:**

Students will solve an exercise with different parts about the aspects studied in content 2. Final exam.

**Specific objectives:**

Students must solve an exercise about content 2.

**Material:**

Calculator can be used.

**Delivery:**

On paper

The test represents a 30% 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 techniques 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:** 5h

Theory classes: 1h

Self study: 4h

#### A7 L2: LABORATORY INDIVIDUAL TEST OF CONTINUOUS ASSESSMENT (CONTENT 2)

**Description:**

Solve problems of the CONTENT 2

**Specific objectives:**

Show that the students has learnt the contents of content 2.

**Material:**

Wording for the test solving.

Symbolic manipulator as a calculus support.

Maple form and document.

**Delivery:**

ATENEA

The test is worth a 10% 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 techniques and methods.

03 TLG. 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.

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:** 5h

Theory classes: 1h

Self study: 4h



## A8 GLOBAL SUBJECT TEST

**Description:**

Multiple-choice test relative to all the lessons of the course (content 1 and 2)

**Specific objectives:**

Students must be able to answer the test.

**Material:**

The test and a calculator. It can be done on the lab room.

**Delivery:**

The test can be done on the lab room.

It represents the 20% 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 techniques 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:** 13h

Practical classes: 2h

Self study: 11h

## A9 Re-evaluation

**Description:**

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

**Full-or-part-time:** 11h 40m

Theory classes: 2h

Self study: 9h 40m

## GRADING SYSTEM

---

The grading system consists on two lab practices L1 and L2, a midterm exam (which has a P1 problems part) and a final exam (which has a P2 problems part and a TGF test part). The First Contents Block (Algebra) has two evaluating exercises: L1 (lab test) and the midterm exam P1 (resolution of a problem). The Second Contents Block (Calculus) has also two evaluating exercises: L2 (lab test) and the final exam which contents a P2 problem (resolution of a problem) and a final global test where there can be considered theoretical and practical aspects of the subject (Final Global Test) and the First and Second Contents Blocks will be evaluated.

Calculation of the Final Grade

$$Nf = (L1 * 10 + P1 * 30 + L2 * 10 + P2 * 30 + TGF * 20) / 100$$

Midterm exam= P1

Final exam= P2+TGF

Nf: Final Grade.

Pi: Notes of the Problems

P1: Problem resolution [Activity 5 (Week after the midterm)]

P2: Problem resolution about the content 2 [Activity 7 (day after the Final exam)]

Li: Laboratory notes.

L1 [Activity 5; the week after the midterms]

L2 [Activity 6; last class week]

TGF: Final Global Exam [Activity 8: the day of the final exam]

All grades are based on 10.

The re-evaluation test will consists in a unique problems test and questions about the contents 1 and 2.

## EXAMINATION RULES.

---

- . If some of the lab practices or exam tests is not done, it will be considered as not rated.
- . In calculus lab practices it can be used limited teaching material (specific files and formularies).
- . In the midterm and final exams it only can be brought a calculator.

## BIBLIOGRAPHY

---

### Basic:

- Bruguera, M. ; [et al.]. Curs de matemàtiques : àlgebra lineal i càlcul infinitesimal. Barcelona: EPSEB, 2003.
- Larson, R. E.; Hostetler, R. P.; Edwards, B.H. Cálculo. 8a ed. Mc Graw-Hill, 2006.
- Noble, B. ; Daniel, J. W. Applied linear algebra. 3rd ed. Mexico: Prentice-Hall International, 1988. ISBN 0135936098.
- 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

---

### Other resources:

Material Available in ATENEA