Course guide
310600 - 310600 - Calculus

Last modified: 13/02/2025

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

Degree: BACHELOR'S DEGREE IN GEOINFORMATION AND GEOMATICS ENGINEERING (Syllabus 2016). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan, English

LECTURER

Coordinating lecturer: Amadeu Delshams

Others: Chara Pantazi

PRIOR SKILLS

Basic high school level knowledge for the calculation of limits, continuity and derivation of functions of a variable. Calculation of primitives of functions of a variable and calculation of the defined integral and its applications. Graphic representation of functions in a variable.

REQUIREMENTS

No prerequisites.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Capacity for the resolution of mathematic problems that can be set out in engineering. Aptitude to apply the knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and in partial derivates, numeric methods, numeric algorithm, stadistics and optimization.
2. (ENG) Determinar, mesurar, avaluar i representar el terreny, objectes tridimensionals, punts i trajectòries.
3. (ENG) Planificació, projecte, direcció, execució i gestió de processos de mesura, sistemes d'informació, explotació d'imatges, posicionament i navegació; modelització, representació i visualització de la informació territorial en, sota i sobre la superfície terrestre.

Transversal:
4. 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 hours of supervised learning consist of theoretical sessions that start with a brief presentation by the teacher about general abilities related to the more basic concepts of the subject. Afterwards, by means of practical exercises, the student is invited to get actively involved in the learning process.

Support material is used in the form of a detailed teaching plan, through ATENEA: learning objectives by content, concepts, examples, programming of assessment and directed learning activities and bibliography. On the other hand, they also consist of doing problem classes (medium group) by solving numerical exercises or problems, related to the specific learning objectives of each of the subject's contents. Gradually, the student will be introduced to the use of symbolic and numerical calculation software. In general, after each session, tasks outside the classroom are proposed, which must be worked on either individually or in groups and which form the basis of the guided activities. It is also necessary to consider other hours of independent learning such as those dedicated to guided readings, solving proposed problems or self-learning quizzes of the different contents through the ATENEA virtual campus.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course, the student must be capable of:
a) Develop a series of functions of a variable.
b) Interpolate two-dimensional data sets.
c) Define the concept of differentiable function of several variables.
d) Calculate, interpret and apply partial derivatives, directional derivatives, the differential matrix and the Hessian.
e) Develop and linealize vectorial fields.
f) Solve systems of overdetermined non-linear equations.
g) Define the concepts of double and triple integral
h) Use variable changes for the resolution of integrals.
i) Calculate double integral and triple integral.
j) Calculate areas, moments of inertia, and centers of gravity.

STUDY LOAD

Type	Hours	Percentage
Hours large group	24,0	16.00
Hours medium group	36,0	24.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

C1 Single variable calculus

Description:
Review on elementary functions and derivation.
Interpolation of two-dimensional data.
Series expansions.
Single variable integration: definition and change of variables.

Specific objectives:
At the end of the activity, the student must be capable of:
a) Choose and use suitable methods to interpolate bidimensional datasets.
b) Expand single variable functions and control its error.
c) Compute, at a basic level, integrals of single variable functions.

Related activities:
T1,L1,L2,E1

Full-or-part-time: 42h
Theory classes: 6h 30m
Practical classes: 6h 30m
Self study : 29h

C2 Multivariable differential calculus

Description:
Scalar and vector fields.
Directional and partial derivatives.
Differential application.
Linearization of vector fields.
Optimization in several variables. Extrema.
Least square method. Overdetermined systems of nonlinear equations.
Composition of vector fields. Chain's rule.
Implicit derivation.

Specific objectives:
At the end of the activity, the student must be capable of:
Calculate directional and partial derivatives, gradients, differential matrix and hessian. Problems of optimization in several variables and conditioned ends. Calculate the linearization of vector fields and propose and solve least-squared problems. Calculate the differential matrix of the composition of functions. Calculate the derivatives of implicitly defined functions. Resolution of application exercises using a symbolic calculator as a calculation tool.

Related activities:
T1,L3,T2,E1,E2

Full-or-part-time: 60h
Theory classes: 9h
Practical classes: 9h
Self study : 42h

C3 Multivariable integral calculus

Description:
Double integral.
Calculation of the double integral.
Change of variables.
Calculation of areas of flat surfaces.
Triple integral.
Calculation of the triple integral.
Moments of inertia and center of gravity of a solid body.
Curvilinear integral and conservative fields.

Specific objectives:
At the end of the activity, the student must be capable of:
Using all the calculus resources needed to calculate double and triple integrals and apply it to the special cases of calculation of areas and moments of inertia and center of gravity of a solid body. Identify a conservative field. Calculate curvilinear integrals and potential functions. Resolve application exercises using a symbolic calculator as a calculation tool.

Related activities:
L4,T2,E2

Full-or-part-time: 48h
Theory classes: 7h 30m
Practical classes: 7h 30m
Self study : 33h

ACTIVITIES

T1

Description:
Individual or group work, delivery of certain exercises, or short 60-minute control

Specific objectives:
At the end of the activity the student must have the material related to the concepts of function derivation in a variable, its physical and geometrical interpretation and be able to develop functions of one variable in Taylor series. Also calculate differential applications of functions in several variables, directional derivatives and linearize vector fields.

Material:
Wording

Delivery:
Atenea

Full-or-part-time: 1h
Theory classes: 1h

L1: CONTINUOUS EVALUATION. DEVARIATION OF ONE-VARIABLE FUNCTIONS

Description:
Short 60-minute test or problems to deliver. The activity can involve working in groups, the use of matlab or oral presentation.

Specific objectives:
At the end of the activity the student must be able to consolidate the concepts of derived from function in a variable, its physical and geometrical interpretation and be able to develop functions of one variable in Taylor series.

Material:
Individual notes of the student and of the subject available on ATENEA. Matlab. Web resources linked to ATENEA and wikis.

Delivery:
The activity will be delivered through Atenea.

Related competencies :
CEM1. Capacity for the resolution of mathematic problems that can be set out in engineering. Aptitude to apply the knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and in partial derivates, numeric methods, numeric algorithm, stadistics and optimization.
CT5. (ENG) Determinar, mesurar, avaluar i representar el terreny, objectes tridimensionals, punts i trajectòries.
CT8. (ENG) Planificació, projecte, direcció, execució i gestió de processos de mesura, sistemes d'informació, explotació d'imatges, posicionament i navegació; modelització, representació i visualització de la informació territorial en, sota i sobre la superfície terrestre.
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: 1h
Self study: 1h

E1: EVALUATION BLOCK 1 AND BLOCK 2.1

Description:
Solve problems corresponding to the contents of Block 1 and Block 2.1.

Specific objectives:
At the end of the activity, the student must be able to prove their competence in solving application problems of the content in the block 1 and 2.1

Material:
Statement for the test.
Calculator as calculation support (optional).

Delivery:
Delivery on paper.
Its resolution can be consulted through ATENEA.

Related competencies :
CEM1. Capacity for the resolution of mathematic problems that can be set out in engineering. Aptitude to apply the knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and in partial derivates, numeric methods, numeric algorithm, stadistics and optimization.
CT5. (ENG) Determinar, mesurar, avaluar i representar el terreny, objectes tridimensionals, punts i trajectòries.
CT8. (ENG) Planificació, projecte, direcció, execució i gestió de processos de mesura, sistemes d'informació, explotació d'imatges, posicionament i navegació; modelització, representació i visualització de la informació territorial en, sota i sobre la superfície terrestre.
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Full-or-part-time: 2h
Theory classes: 2h

L2: CONTINUOUS EVALUATION LINEARIZATION OF SCALAR FIELDS

Description:
Short 60-minute control or problems to deliver. The activity can involve working in groups, the use of matlab or oral presentation.

Specific objectives:
At the end of the activity the student must be capable of calculating differential applications of functions in several variables, directional derivatives and linearize vector fields

Material:
Individual notes of the student and of the subject available on ATENEA. Matlab. Web resources linked to ATENEA and wikis.

Delivery:
The activity will be delivered through Atenea.

Related competencies :
CEM1. Capacity for the resolution of mathematic problems that can be set out in engineering. Aptitude to apply the knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and in partial derivates, numeric methods, numeric algorithm, stadistics and optimization.
CT5. (ENG) Determinar, mesurar, avaluar i representar el terreny, objectes tridimensionals, punts i trajectòries.
CT8. (ENG) Planificació, projecte, direcció, execució i gestió de processos de mesura, sistemes d'informació, explotació d'imatges, posicionament i navegació; modelització, representació i visualització de la informació territorial en, sota i sobre la superfície terrestre.
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Full-or-part-time: 1h
Self study: 1h

L3: CONTINUOUS EVALUATION. OPTIMIZATION OF VARIOUS VARIABLES.

Description:
Short 60-minute control or problems to deliver. The activity can involve working in groups, the use of matlab or oral presentation.

Specific objectives:
At the end of the activity the student must be able to solve integration problems developed at the time in class.

Material:
Individual notes of the student and of the subject available on ATENEA. Matlab. Web resources linked to ATENEA and wikis.

Delivery:
The activity will be delivered using Atenea.

Full-or-part-time: 1h
Self study: 1h

T2

Description:
Individual or group work, delivery of certain exercises, or short 60-minute control

Specific objectives:
At the end of the activity the student must have the material and must be able to solve integration problems developed at the time in class.

Material:
Wording

Delivery:
Atenea

Full-or-part-time: 1h
Theory classes: 1h

L4. CONTINUOUS EVALUATION. INTEGRATION OF VARIOUS VARIABLES.

Description:
Short 60-minute control or problems to deliver. The activity can involve working in groups, the use of matlab or oral presentation.

Specific objectives:
At the end of the activity the student must be able to solve integration problems developed at the time in class.

Material:
Individual notes of the student and of the subject available on ATENEA. Matlab. Web resources linked to ATENEA and wikis.

Delivery:
The activity will be delivered through Atenea

Related competencies :
CEM1. Capacity for the resolution of mathematic problems that can be set out in engineering. Aptitude to apply the knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and in partial derivates, numeric methods, numeric algorithm, stadistics and optimization.
CT5. (ENG) Determinar, mesurar, avaluar i representar el terreny, objectes tridimensionals, punts i trajectòries.
CT8. (ENG) Planificació, projecte, direcció, execució i gestió de processos de mesura, sistemes d'informació, explotació d'imatges, posicionament i navegació; modelització, representació i visualització de la informació territorial en, sota i sobre la superfície terrestre.
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Full-or-part-time: 1h
Self study: 1h

E2: EVALUATION BLOCK 2.2 AND 3

Description:
Solve related problems to the contents of Block 2.2 and Block 3.

Specific objectives:
At the end of the activity, The student must be able to show their competence in solving application problems of contents of Block 2.2. and Block 3.

Material:
Prompt for the test.
Calculator as calculation support (optional).

Delivery:
Delivery on paper.
Its resolution can be consulted through ATENEA.

Related competencies :
CEM1. Capacity for the resolution of mathematic problems that can be set out in engineering. Aptitude to apply the knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and in partial derivates, numeric methods, numeric algorithm, stadistics and optimization.
CT5. (ENG) Determinar, mesurar, avaluar i representar el terreny, objectes tridimensionals, punts i trajectòries.
CT8. (ENG) Planificació, projecte, direcció, execució i gestió de processos de mesura, sistemes d'informació, explotació d'imatges, posicionament i navegació; modelització, representació i visualització de la informació territorial en, sota i sobre la superfície terrestre.
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Full-or-part-time: 2h
Theory classes: 2h

Reevaluation

Description:
Solving problems that correspond to the contents of the previous evaluation activities: E1 (Blocks 1 and 2.1) and E2 (Blocks 2.2 and 3). The exams will be held according to the official EPSEB exam agenda.

Specific objectives:
All the objectives of the course.

Material:
Exam prompt.
Calculator as a support tool (optional).

Delivery:
On paper.
Resolution will be published on ATENEA.

Full-or-part-time: 1h
Self study: 1h

GRADING SYSTEM

Ten evaluation activities will be carried out: 6 controls of continuous assessment or directed activities (L1, L2, L3, L4,T1, T2), 5% each, Attendance and Participation in the first part of the course (A1) worth 5%, 1 control dedicated to Block 1 and part of Block 2 (E1) in the mid-term exam period, 30%, and 1 part dedicated to Block 2 and Block 3 (E2), worth 30%, Attendance and Participation in the second part of the course (A2) worth 5%. The sequential order of the tests will be: L1, L2, T1, E1, L3, L4, T2, E2. The re-evaluation exam will consist of all the material.

Calculation of the final note:
Nf=(5*(L1+L2+L3+L4+T1+T2+A1+A2)+30*E1+30*E2)/100.

All grades are calculated over 10. In all these tests, very special emphasis will be placed on the student's ability to express their knowledge orally and in writing (generic competence associated with the subject).

EXAMINATION RULES.

1) If one of the evaluation tests is not done, it will be graded as a zero.
2) In the lab tests, the teaching material can be used as available on the intranet.
3) In the problem test, a calculator can be used, but it is not necessary.
4) Coherence and rigour will be assessed in the written presentation of all the activities.

BIBLIOGRAPHY

Basic:
- Holly Moore. MATLAB para ingenieros [on line]. México: Pearson Educación, 2007 [Consultation: 12/02/2025]. Available on: https://discovery.upc.edu/permalink/34CSUC_UPC/18e7aks/alma991003343919706711. ISBN 9789702610823.
- Etter, Dolores M. Solución de problemas de ingeniería con MATLAB. 2a. México: Prentice-Hall Hispanoamericana, 1998. ISBN 9701701119.
- Bruguera, Montserrat [et al.]. Curs de matemàtiques: àlgebra lineal i càlcul infinitesimal [on line]. Barcelona: EPSEB, 2003 [Consultation: 12/02/2025]. Available on: http://hdl.handle.net/2117/369137.
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- Finney, Ross L. Calculus : a graphing approach. Mexico: Addison-Wesley, 1993. ISBN 0201569035.

Complementary:
- Courant, Richard ; John, Fritz. Introducción al cálculo y al análisis matemático. Mexico: Limusa, 1978. ISBN 9681806345.
- Deminovich, B.P. ; Baranenkov, G. Problemas y ejercicios de análisis matemático. 11a ed. Madrid: Paraninfo, 1993. ISBN 8428300496.
- Pérez López, César. Matlab y sus aplicaciones en las ciencias y la ingenieria [on line]. Madrid [etc.]: Prentice Hall, cop. 2002 [Consultation: 12/02/2025]. Available on: https://discovery.upc.edu/permalink/34CSUC_UPC/18e7aks/alma991002496709706711. ISBN 8420535370.

RESOURCES

Computer material:
- Matlab. Resource

Hyperlink:
- ATENEA (http://atenea.upc.edu/moodle/). Entorn virtual de docència de la UPC desenvolupat utilitzant com a base tecnològica la plataforma de programari obert Moodle.
- Tutories de fase inicial (estudiants amb nivell baix de matemàtiques). (ENG) Resum teòrics, problemes resolts i problemes proposats de temes preliminars. http://atenea.upc.edu

Other resources:
In the digital campus (ATENEA) a logbook of the subject will be included, which briefly summarizes the content of each class, the tasks emanated and the resources to carry them out or consolidate the learning.