310600 - Calculus

Coordinating unit: 310 - EPSEB - Barcelona School of Building Construction
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2018
Degree: BACHELOR'S DEGREE IN GEOINFORMATION AND GEOMATICS ENGINEERING (Syllabus 2016).
(Teaching unit Compulsory)
ECTS credits: 6

Teaching staff
Coordinator: Toni Guillamon Grabolosa
Others: Toni Guillamon Grabolosa

Opening hours
Timetable: Office hours to agree

Prior skills
Basic knowledge high school level 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 previous requirements.

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 derivatives, numeric methods, numeric algorithm, statistics 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
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. Afterwards, by means of practical exercises, the student is invited to get actively involved in the learning process.

Learning objectives of the subject
At the end of the course, the student must be capable of:
310600 - Calculus

a) Develop a series of functions of one 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) Solve systems of overdetermined non-linear equations.
f) Define the concepts of double and triple integral.
g) Calculate double integral and triple integral.
h) Use variable changes for the resolution of integrals.
i) Calculate areas, moments of inertia, and centers of gravity.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>24h</th>
<th>16.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>36h</td>
<td>24.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
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</tbody>
</table>
# 310600 - Calculus

## Content

<table>
<thead>
<tr>
<th>C1 Single variable calculus</th>
<th>Learning time: 42h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h 30m</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 6h 30m</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 1h</td>
</tr>
<tr>
<td></td>
<td>Self study : 28h</td>
</tr>
</tbody>
</table>

### Description:
Review on elementary functions and derivation.
Interpolation of bidimensional datasets.
Series expansions.
Single variable integration: definition and change of variables.

### Related activities:
MV1,E1

### Specific objectives:
At the end of the activity, the student has to 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.

<table>
<thead>
<tr>
<th>C2 Multivariable differential calculus</th>
<th>Learning time: 60h</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 9h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 9h</td>
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<tr>
<td></td>
<td>Guided activities: 2h</td>
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<tr>
<td></td>
<td>Self study : 40h</td>
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</tbody>
</table>

### Description:
Scalar and vector fields.
Directional and partial derivatives.
Differential map.
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.

### Related activities:
MV2,E1,E2

### Specific objectives:
At the end of the activity, the student must be capable of:
<table>
<thead>
<tr>
<th>C3 Multivariable integral calculus</th>
<th>Learning time: 48h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 7h 30m</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 7h 30m</td>
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<tr>
<td></td>
<td>Guided activities: 1h</td>
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<tr>
<td></td>
<td>Self study : 32h</td>
</tr>
</tbody>
</table>

**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.
Integral curvilinear and conservative fields.

**Related activities:**
MV3, E2

**Specific objectives:**
At the end of the activity, the student must be capable of:
Use 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. Resolution of application exercises using a symbolic calculator as a calculation tool.
### Planning of activities

| MV1: CONTINUOUS EVALUATION. DEVIATION OF ONE-VARIABLE FUNCTIONS | Hours: 1h  
Guided activities: 1h |
|---|---|
| **Description:**  
Short 60-minutes control or problem-solving to deliver. The activity can involve working in groups, the use of mathematical software or oral presentation.  
**Support materials:**  
Individual notes of the student and of the subject available at ATENEA. Math software. Web resources linked to ATENEA.  
**Descriptions of the assignments due and their relation to the assessment:**  
The activity will be delivered in person. Its resolution can be consulted trough Atenea.  
**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. |

| MV2: CONTINUOUS EVALUATION LINEARIZE SCALAR FIELDS | Hours: 1h  
Guided activities: 1h |
|---|---|
| **Description:**  
Short 60-minutes control or problem-solving to deliver. The activity can involve working in groups, the use of mathematical software or oral presentation.  
**Support materials:**  
Individual notes of the student and of the subject available at ATENEA. Math software. Web resources linked to ATENEA.  
**Descriptions of the assignments due and their relation to the assessment:**  
The activity will be delivered in person. Its resolution can be consulted trough Atenea.  
**Specific objectives:**  
At the end of the activity the student must be capable of Calculate differential applications of functions in several variables, directional derivatives and linearize vector fields |

| E1: EVALUATION BLOCK 1 AND BLOCK 2.1 | Hours: 2h  
Theory classes: 2h |
|---|---|
| **Description:**  
Solve problems corresponding to the contents of Block 1 and Block 2.1.  
**Support materials:**  
Statement for the test. Calculator as calculation support. |
310600 - Calculus

**Descriptions of the assignments due and their relation to the assessment:**
Deliver on paper. Its resolution can be consulted through ATENEA.

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

<table>
<thead>
<tr>
<th>MV3: CONTINUOUS EVALUATION. OPTIMIZATION OF VARIOUS VARIABLES.</th>
<th>Hours: 1h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Guided activities: 1h</td>
</tr>
<tr>
<td>Short 60-minutes control or problem-solving to deliver. The activity can involve working in groups, the use of mathematical software or oral presentation.</td>
<td></td>
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<tr>
<td><strong>Support materials:</strong></td>
<td></td>
</tr>
<tr>
<td>Individual notes of the student and of the subject available at ATENEA. Math software. Web resources linked to ATENEA.</td>
<td></td>
</tr>
<tr>
<td><strong>Descriptions of the assignments due and their relation to the assessment:</strong></td>
<td></td>
</tr>
<tr>
<td>The activity will be delivered in person. Its resolution can be consulted through Atenea.</td>
<td></td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td></td>
</tr>
<tr>
<td>At the end of the activity the student must be able to solve integration problems develop at the class.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>MV4. CONTINUOUS EVALUATION. INTEGRATION OF VARIOUS VARIABLES.</th>
<th>Hours: 1h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Guided activities: 1h</td>
</tr>
<tr>
<td>Short 60-minutes control or problem-solving to deliver. The activity can involve working in groups, the use of mathematical software or oral presentation.</td>
<td></td>
</tr>
<tr>
<td><strong>Support materials:</strong></td>
<td></td>
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<tr>
<td>Individual notes of the student and of the subject available at ATENEA. Math software. Web resources linked to ATENEA.</td>
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<td><strong>Descriptions of the assignments due and their relation to the assessment:</strong></td>
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<tr>
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<td></td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td></td>
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<tr>
<td>At the end of the activity the student must be able to solve integration problems develop at the class.</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E2: EVALUATION BLOCK 2.2 AND 3</th>
<th>Hours: 2h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td>Solve related problems to the contents of Block 2.2 and Block 3.</td>
<td></td>
</tr>
</tbody>
</table>
Reevaluation

<table>
<thead>
<tr>
<th>Description:</th>
<th>Hours: 1h</th>
</tr>
</thead>
<tbody>
<tr>
<td>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). Both proofs will be held according to the official EPSEB exams' agenda.</td>
<td>Guided activities: 1h</td>
</tr>
</tbody>
</table>

Support materials:
- Statement of the exam.
- Calculator as a support tool (optional).

Descriptions of the assignments due and their relation to the assessment:
- On paper.
- Resolution will be published on ATENEA.

Specific objectives:
- All the objectives of the course.

Qualification system

Six evaluation activities will be carried out: 3 controls of continuous assessment or directed activities (MV1, MV2, MV3, MV4), 5% each, 1 control dedicated to Block 1 and part of Block 2 (E1) in the first period of exams, 40%, and 1 part dedicated to Block 2 and Block 3 (E2), 40%. The sequential order of the tests will be: MV1, MV2, E1, MV3, MV4, E2. In the reevaluation, two tests will be offered: E1-E2-R and R, which will count 50% of the total assessment each.

Calculation of the final note:
\[ N_f = \frac{5 \times (MV1 + MV2 + MV3 + MV4) + 40 \times E1 + 40 \times E2}{100}. \]

All the grades are over 10. The assistance will be evaluated and the classwork. In every test, a very special emphasis will be put on the student's ability to express his/her knowledge in written and oral form (generic competence associated to the course)

Regulations for carrying out activities

1) If one of the evaluation test is not done, will be graded as zero.
2) In the lab tests, the teaching material can be used as available at 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.
310600 - Calculus

Bibliography

Basic:


Complementary:


Others 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

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

IPAL a ATENEA

Resource

Audiovisual material

Sage (www.sagemath.org)

Computer material

Maple