

## Course guide

### 230908 - CVEC - Vector Calculus

Last modified: 24/05/2024

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

**Degree:** BACHELOR'S DEGREE IN ELECTRONIC ENGINEERING AND TELECOMMUNICATION (Syllabus 2018).  
(Compulsory subject).

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

#### LECTURER

---

**Coordinating lecturer:** CARLES PADRO LAIMON

**Others:** Segon quadrimestre:  
MARIA BRAS AMOROS - 10  
CARLES PADRO LAIMON - 10

#### PRIOR SKILLS

---

Sound command of single variable calculus

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

---

**Specific:**

CE4. (ENG) GREELEC: comprensió i domini dels conceptes bàsics de sistemes lineals i les funcions transformades i relacionades, teoria de circuits elèctrics, circuits elèctrics, principi físic de semiconductors i hfamilíes lògiques, dispositius electrònics i fotònics, tecnologia dels materials i la seva aplicació per a resolució de problmes per a l'enginyeria. (Mòdul de formació bàsica).

**Generical:**

CG3. (ENG) GREELEC: Coneixmetn de matèries bàsiques i tecnològies que el capacitin per a l'aprenentatge de nous mètodes i tecnologies, així com que el dotin d'una gran versatilitat per adaptar-se a noves situacions.

**Transversal:**

CT6. (ENG) GREELEC: APRENENTATGE AUTÒNOM: Detectar deficiències en el propi coneixement i superarles mitjançant la reflexió crítica i l'elecció de la millor actuació per ampliar coneixements.

**Basic:**

CB5. (ENG) GREELEC: Que els estudiants pugin desenvolupar habilitats d'aprenentatge per empendre estudis superiors amb un alt grau d'autonomia.

#### TEACHING METHODOLOGY

---

Lecture class- Participative class

#### LEARNING OBJECTIVES OF THE SUBJECT

---

To begin with, the concepts introduced in Càlcul 1 about functions of one real variable are generalized to several variables. More concretely, the differentiability of functions, the integration of functions and their applications as, for example, to the optimization problems.

The basic concepts of differential geometry of curves and surfaces, in the plane and in the space, are introduced with the aim to study the fundamental theorems of vectorial integration: Green's, Stokes and Gauss theorems, basics in the study of electromagnetic fields.

## STUDY LOAD

| Type              | Hours | Percentage |
|-------------------|-------|------------|
| Self study        | 85,0  | 56.67      |
| Hours large group | 65,0  | 43.33      |

**Total learning time:** 150 h

## CONTENTS

### Topology of the n-dimensional real space

**Description:**

The n-dimensional euclidean space. Euclidian distance. Balls. Interior, exterior and border of a set. Accumulation points. Open and closed sets and their properties. Bounded sets. Convergent sequences.

**Full-or-part-time:** 16h

Theory classes: 7h

Self study : 9h

### Functions of several variables

**Description:**

Scalar and vector functions. Graphic and level sets. Composition of functions. Limits: definitions, properties. Computation of limits. Direccional limits. Continuity: definition and properties. Compact and arc-connected sets. Weierstrass theorem.

**Full-or-part-time:** 14h

Theory classes: 6h

Self study : 8h

### Differentiability and local extrema

**Description:**

Definition of differentiability. Jacobian matrix. Direccional derivatives. Gradient. Chain rule. Functions of class  $C^1$ . Derivation of the inverse function. Derivation of the implicit function. Changes of variables. Polar, cilindrical and spherical coordinates. Derivatives of higher order. Schwarz theorem. Hessian matrix and Taylor formula of degree 2. Local extrema. Critical points. Saddle points. Eigenvalues criterium. Sylvester criterium.

**Full-or-part-time:** 35h

Theory classes: 15h

Self study : 20h

### Curves and surfaces

**Description:**

Regular parametrization of curves and surfaces. Geometrical applications. Curves and surfaces implicitly defined. Computation of restricted maxima and minima. Lagrange multipliers. Optimization: absolute maxima and minima.

**Full-or-part-time:** 24h

Theory classes: 10h

Self study : 14h



### Multiple integration

**Description:**

Definition and properties. Mesurable sets and sufficient and necessary condition for integrability. Fubini's theorem. Geometrical applications. Change of variables. Leibniz formula. Improper integrals.

**Full-or-part-time:** 24h

Theory classes: 10h

Self study : 14h

### Line and surface integrals

**Description:**

Line and surface integrals of a scalar function. Geometrical applications. Circulation and flux of a vector field. Path independence. Conservative fields. Computation of the scalar potential. Simply connected sets. Differential operators: rotational and divergence. Green's and Stokes theorems. Solenoidal vector fields. Computation of the vector potential. Gauss theorem.

**Full-or-part-time:** 35h

Theory classes: 15h

Self study : 20h

## GRADING SYSTEM

Evaluation: continuous, along the term, with a 40% weight, and a final test, with a 60% weight.

## BIBLIOGRAPHY

**Basic:**

- Marsden, Jerrold E.; Tromba, Anthony. Cálculo vectorial [on line]. 6a ed. Madrid: Pearson, 2018 [Consultation: 08/05/2020]. Available on: [http://www.ingebook.com/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=7634](http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=7634). ISBN 9788490355787.

**Complementary:**

- Apostol, Tom M. Calculus [on line]. 2a. ed. Barcelona [etc.]: Reverté, 1972 [Consultation: 06/11/2020]. Available on: [http://www.ingebook.com/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=8020](http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8020). ISBN 8429150013.

- Marsden, Jerrold E; Tromba, Anthony. Cálculo vectorial [on line]. 6a ed. Madrid: Pearson, 2018 [Consultation: 08/05/2020]. Available on: [http://www.ingebook.com/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=7634](http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=7634). ISBN 9788490355787.

- Spiegel, Murray R. Cálculo superior. México [etc.]: McGraw-Hill, 1969. ISBN 8485240663.

- Bombal Gordon, Fernando; Rodríguez Marín, Luis; Vera Botí, Gabriel. Problemas de análisis matemático. 2a ed. Madrid: AC, 1987-1988. ISBN 8472881024.

- Spiegel, Murray R.; Lipschutz, Seymour. ; Liu, John. Fórmulas y tablas de matemática aplicada [on line]. 4a ed. Madrid [etc.]: McGraw-Hill, 2014 [Consultation: 14/05/2020]. Available on: [http://www.ingebook.com/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=5688](http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=5688). ISBN 9786071511454.