Course guide
270205 - AC2 - Advanced Algebra and Calculus

Last modified: 30/01/2024

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

Degree: BACHELOR'S DEGREE IN DATA SCIENCE AND ENGINEERING (Syllabus 2017). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 7.5 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: JAIME FRANCH BULLICH

Others: Segon quadrimestre:
CARLES BATLLE ARNAU - 11, 12
JAIME FRANCH BULLICH - 11, 12

PRIOR SKILLS

Courses on Algebra and Calculus of the first term

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE1. Skillfully use mathematical concepts and methods that underlie the problems of science and data engineering.

Generical:
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CG5. To be able to draw on fundamental knowledge and sound work methodologies acquired during the studies to adapt to the new technological scenarios of the future.

Transversal:
CT5. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically evaluate the results of such management.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.

Basic:
CB1. That students have demonstrated to possess and understand knowledge in an area of ??study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply Knowledge from the vanguard of their field of study.

TEACHING METHODOLOGY

Theory classes will be in the form of master classes in which the contents of the subject will be explained and examples and illustrative problems will also be given.
In the problem classes, problems will be solved on the topics studied in theory.

LEARNING OBJECTIVES OF THE SUBJECT

1.Extension of knowledge of Algebra and Calculus.
2.Recognize and apply the concepts of Algebra and Calculus related to multidisciplinary problems.
3.Achieve a mastery of software that allows you to solve problems of greater complexity from the knowledge acquired.

STUDY LOAD

Type	Hours	Percentage
Hours small group	30,0	16.00
Hours large group	45,0	24.00
Self study	112,5	60.00

Total learning time: 187.5 h

CONTENTS

Multiple integrals

Description:
Riemann integral of functions of several variables. Rectangle; arbitrary domains; improper integrals. Fubini's Theorem. Iterated integrals. Normal domains. Change of variables theorem. Polar and spherical coordinates. Numerical methods. Quadrature formulas. Monte Carlo mehtod.

Fourier series and Fourier transform

Description:
Spaces of funcions. Sequences and series of funcions. Trigonometric and exponential Fourier series. Parity. Fourier transform. Properties: symmetries, shift, scaling, convolution, conservation of energy. Generalized functions. Dirac Delta. Functionals. Distributions.

Quadratic forms and extrema

Description:
Quadratic forms and symmetric matrices. Definite, indefinite, semidefinite. Diagonalization. Signature. Restriction to subspaces. Gradient, Jacobian, Hessian. Local extrema of functions of several variables. Critical points. Constrained extrema. Lagrange multipliers. Global extrema on compact sets.

ACTIVITIES

Development of topic 1 of the course

Description:
Theory classes and Problems of the topic 1

Specific objectives:
1, 2, 3

Related competencies :
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CG5. To be able to draw on fundamental knowledge and sound work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CE1. Skillfully use mathematical concepts and methods that underlie the problems of science and data engineering.
CT5. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically evaluate the results of such management.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.
CB1. That students have demonstrated to possess and understand knowledge in an area of ??study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply Knowledge from the vanguard of their field of study.

Full-or-part-time: 50h
Theory classes: 12h
Practical classes: 8h
Self study: 30h

Development of topic 2 of the course

Description:
Theory and Problems classes on topic 2

Specific objectives:
1, 2, 3

Related competencies :
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CG5. To be able to draw on fundamental knowledge and sound work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CE1. Skillfully use mathematical concepts and methods that underlie the problems of science and data engineering.
CT5. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically evaluate the results of such management.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.
CB1. That students have demonstrated to possess and understand knowledge in an area of ??study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply Knowledge from the vanguard of their field of study.

Full-or-part-time: 87h 30m
Theory classes: 21h
Practical classes: 14h
Self study: 52h 30m

Development of topic 3 of the course

Description:
Theory and problem classes on topic 3

Specific objectives:
1, 2, 3

Related competencies :
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CG5. To be able to draw on fundamental knowledge and sound work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CE1. Skillfully use mathematical concepts and methods that underlie the problems of science and data engineering.
CT5. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically evaluate the results of such management.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.
CB1. That students have demonstrated to possess and understand knowledge in an area of ??study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply Knowledge from the vanguard of their field of study.

Full-or-part-time: 50h
Theory classes: 12h
Practical classes: 8h
Self study: 30h

GRADING SYSTEM

There will be two exams: a mid-course exam P (which does not release a subject) and a final exam F; in addition solved problems will have to be delivered and/or answer quizzes L.

The grade of the subject in the ordinary call will be calculated as follows:

MAX (0.6 * F + 0.3 * P; 0.9 * F) + 0.1 * L

The mark in the extraordinary call will be, in accordance with the regulations, the maximum between that of the reevaluation exam and that of the ordinary call.

BIBLIOGRAPHY

Basic:
- Chapra, S.C.; Canale, R.P. Numerical methods for engineers. 8th ed. New York: McGraw-Hill, 2021. ISBN 9781260571387.
- Gallier, Jean. Geometric methods and applications for computer scientists and engineers. 2nd ed. Springer, 2011. ISBN 9781441999603.
- Gallier, Jean; Quaintance, Jocelyn. Algebra, topology, differential calculus, and optimization theory for computer science and engineering. University of Pennsylvania. Department of Computer and Information Science, 2022.
- Brigham, E. Oran. The fast Fourier transform and its applications. Prentice-Hall, 1988. ISBN 0133075052.
- Marsden, Jerrold; Tromba, Anthony J. Vector calculus. 6th ed. W.H.Freeman, 2012. ISBN 9781429224048.

Complementary:
- Blum, A.; Hopcroft, J.; Kannan, R. Foundations of data science. Cambridge: Cambridge University Press, 2020. ISBN 9781108485067.
- Hoggar, S.G. Mathematics of digital images : creation, compression, restoration, regognition. Cambridge university press, 2006. ISBN 0521780292.
- Le Roux, Brigitte; Rouanet, Henri. Geometric data analysis. Kluwer academic publishers, 2005. ISBN 1402022352.

- McKay, David. Information theory, inference and learning algorithms. Cambridge University Press, 2003. ISBN 9780521642989.
- Zorich, Vladimir A. Mathematical analysis II. 2nd ed. Springer, 2016. ISBN 9783662489932.