



Course guide

270400 - FM - Fundamentals of Mathematics

Last modified: 13/07/2023

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

Degree: BACHELOR'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2021). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: MONTSERRAT MAURESO SÁNCHEZ - MERCÈ MORA GINÉ

Others: Primer quadrimestre:
MONTSERRAT MAURESO SÁNCHEZ - 11, 12
MERCÈ MORA GINÉ - 11, 12

PRIOR SKILLS

It is assumed that the student has achieved the objectives and knowledge of high school mathematics prior to college.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Generical:

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

Transversal:

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.

TEACHING METHODOLOGY

The theory classes consist of exposing the theoretical contents together with examples and possible applications.

In problem classes, exercises from a list published list will be solved. Students have to prepare them in advance.

LEARNING OBJECTIVES OF THE SUBJECT

1. Know how to use the summation notation. Be able to manipulate expressions with sums.
2. Know and be able to use formal language and mathematical reasoning. Be able to understand and make demonstrations.
3. Know the language of set theory.
4. Know the equivalence relations.
5. Know what is a map and its properties.
6. Know the main objects of combinatorics.
8. Know the language of graph theory.



STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Self study	90,0	60.00
Hours small group	30,0	20.00

Total learning time: 150 h

CONTENTS

Formalism and proofs.

Description:

Summation notation. Summation manipulation. Double sums. Arithmetic and geometric progressions. Propositions. Logical connectives. Tables of truth. Quantifiers. Demonstration methods. Induction principle.

Set Theory

Description:

Sets. Cardinalities. Subsets. Representation of a subset as a binary word. Binomial numbers. Operations with sets: union, intersection, difference, complementary, Cartesian product. Power set.

Binary relations. Equivalence relations. Equivalence classes. Partitions Quotient set.

Maps. Images and anti-images. Composition. Injective, exhaustive and bijective maps. Inverse.

Combinatorics

Description:

Cardinalities. Finite and infinite sets. Pigeonhole Principle. Permutations and combinations with and without repetition. Binomial numbers. Permutations of multisets. Multinomial numbers. Inclusion-exclusion principle.

Graphs

Description:

Graphs. Representation of graphs. Degrees. Adjacency matrix. Handshaking Lemma. Isomorphisms. Operations with graphs.

Walks. Connected graphs. Distance. Cut vertices and bridges. Trees. Spanning trees.



ACTIVITIES

Summation

Description:

The student must study and assimilate the concepts explained in theory class and apply them to do the exercises indicated and that will be solved in problem classes.

Specific objectives:

1

Related competencies :

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

Full-or-part-time: 10h

Theory classes: 2h

Practical classes: 2h

Self study: 6h

Reasoning

Description:

The student must study and assimilate the concepts explained in theory class and apply them to do the exercises indicated and that will be solved in problem classes.

Specific objectives:

2

Related competencies :

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

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.

Full-or-part-time: 20h

Theory classes: 4h

Practical classes: 4h

Self study: 12h

Sets

Description:

The student must study and assimilate the concepts explained in theory class and apply them to do the exercises indicated and that will be solved in problem classes.

Specific objectives:

3

Related competencies :

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

Full-or-part-time: 18h

Theory classes: 2h

Practical classes: 4h

Self study: 12h

Equivalence relations

Description:

The student must study and assimilate the concepts explained in theory class and apply them to do the exercises indicated and that will be solved in problem classes.

Specific objectives:

4

Related competencies :

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

Full-or-part-time: 10h

Theory classes: 2h

Practical classes: 2h

Self study: 6h

Maps

Description:

The student must study and assimilate the concepts explained in theory class and apply them to do the exercises indicated and that will be solved in problem classes.

Specific objectives:

5

Related competencies :

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

Full-or-part-time: 10h

Theory classes: 2h

Practical classes: 2h

Self study: 6h

Midterm exam

Description:

Partial exam corresponding to the first part of the course.

Specific objectives:

1, 2, 3, 4

Related competencies :

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

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.

Full-or-part-time: 10h

Guided activities: 2h

Self study: 8h



Combinatorics

Description:

The student must study and assimilate the concepts explained in theory class and apply them to do the exercises indicated and that will be solved in problem classes.

Specific objectives:

6

Related competencies :

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

Full-or-part-time: 25h

Theory classes: 5h

Practical classes: 8h

Self study: 12h

Graphs

Description:

The student must study and assimilate the concepts explained in theory class and apply them to do the exercises indicated and that will be solved in problem classes.

Specific objectives:

8

Related competencies :

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

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.

Full-or-part-time: 32h

Theory classes: 8h

Practical classes: 8h

Self study: 16h



Final exam

Description:

Final exam on the contents of the second part of the course, but which may require knowledge and application of the methods seen in the first part of the course,

Specific objectives:

1, 2, 3, 4, 5, 6, 8

Related competencies :

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

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.

Full-or-part-time: 15h

Guided activities: 3h

Self study: 12h

GRADING SYSTEM

The grade for the course will be obtained from:

- a midterm exam, P;
- a final exam, F;
- valuation of work and achievement of objectives throughout the course, C.

In the midterm exam, the contents of the first part of the subject will be evaluated.

In the final exam will be evaluated mainly the contents of the second part of the subject, but it may be necessary to apply knowledge and methods previously seen .

The midterm and final exams will take place outside of class hours.

In addition, the continuous work of the student will be evaluated through questionnaires and/or delivery of exercises carried out in class or outside class hours.

The assessment of the transversal competence is included in the grades above, since the application of the competence is required to achieve the objectives of the subject.

The final grade of the course will be:

$\max(0.30 \cdot P + 0.50 \cdot F + 0.20 \cdot C, F)$

where P, F and C are the marks, up to 10, of the partial exam, the final exam and of the continued work, respectively.

The grade of the transversal competence will be in terms of the final grade:

A: final grade from 8 to 10

B: final grade from 6.5 to 7.9

C: final grade from 5 to 6.4

D: final grade from 0 to 4.9

NA: final grade NP



BIBLIOGRAPHY

Basic:

- Rosen, Kenneth H; Pérez Morales, José Manuel. Matemática discreta y sus aplicaciones. 5ª ed. Madrid [etc.]: McGraw-Hill, cop. 2004. ISBN 8448140737.
- Biggs, Norman L. Discrete mathematics. 2nd ed. Oxford [etc]: Oxford University Press, 2002. ISBN 9780198507178.
- Gimbert i Quintilla, Joan. Apropament a la teoria de grafs i als seus algorismes. [Lleida] : [Zaragoza]: Universitat de Lleida, 1998. ISBN 9788489727656.

Complementary:

- Guzmán, Miguel de. Cómo hablar, demostrar y resolver en matemáticas. Madrid: Anaya, cop. 2003. ISBN 8466726136.
- Biggs, Norman L. Matemática discreta. Barcelona: Vicens-Vives, 1994. ISBN 9788431633110.
- Gossett, Eric. Discrete mathematics with proof. 2nd ed. Hoboken: John Wiley & Sons, cop. 2009. ISBN 9780470457931.
- Comellas Padró, Francesc. Matemática discreta. Barcelona: Edicions UPC, 2001. ISBN 9788483014561.

RESOURCES

Hyperlink:

- <https://web.mat.upc.edu/fib/fm-gia/>