Course	**Data Science and Artificial Intelligence**				
Subject	**Discrete Structures**				
Academic year	2023/2024	*Curricular year*	1st	*Study period*	1st semester
Type of subject	Compulsory	*Student workload (H)*	Total: 168	Contact: 60	*ECTS* 6
Professor(s)	Maria Cecília dos Santos Rosa				

☒ *Area Coordinator* ☐ *Head of Department*	Graça Maria Oliveira Tomaz

PLANNED SUBJECT DESCRIPTION

1. LEARNING OBJECTIVES

With this curricular unit it is intended that the student acquires basic knowledge of Discrete Mathematics essential to Data Science and that the learning process promotes the development of abstraction, logical-deductive reasoning, and critical thinking skills of the student.

On completion of the course unit the learner is expected to be able to

1- Know how to operate with sets.

2- Know the relationships between sets.

3- Understand the part of mathematics that deals with number theory: divisibility.

4- Know how to use the principles of mathematical induction.

5- Know how to solve linear congruences.

6- Know the basic concepts of Graph Theory and applications. Know how to solve problems involving graphs.

2. PROGRAMME

I. **Introduction to set theory**: Definition and examples; Numerical sets; Subsets; Venn diagrams; Operations with sets.

II. **Relations**: Cartesian product of sets; Relations between sets; Types of relationships and their properties; Equivalence relations; Partial order relations.

III. **The set of integers Z**: Division algorithm; Divisibility; Prime numbers; Greatest common divisor and least common multiple; Fundamental theorem of Arithmetic.

IV. **Recursion and Induction**: Notion about recursion. Recursive functions. Principles of mathematical induction. Principle of structural induction.

V. **Congruences and modular arithmetic**: Definition; Properties; Resolution of linear congruences with one variable; Linear congruency systems with one variable; Algorithm for applying the Chinese Remainder Theorem; Resolution of linear congruences with two variables; Linear congruence systems with two variables.

VI. **Graph Theory**: Basic concepts and examples. Graph terminology and special types of graphs. Properties. Graph representation: adjacency matrix and incidence matrix. Elementary operations on graphs. Planar graphs. Problems involving graphs. Principle of structural induction in graphs.

3. COHERENCE BETWEEN PROGRAMME AND OBJECTIVES

The programmatic contents of the Discrete Structures curricular unit were defined according to the objectives and competences to be acquired by the students. To provide students with the specific competences to develop in this curricular unit, there is a direct correspondence between the contents of each chapter (Chapters 1 to 6 the course contents) and the specific competences to develop (Competences 1 to 6).

4. MAIN BIBLIOGRAPHY

MANDATORY:

1. Seymour Lipschutz (1998). Set Theory and Related Topics 2nd Edition. Schaum's Outline (MacGraw-Hill). ISBN 0-07-038159-3

2. David Burton (2005) (6th Edition). Elementary number theory. MacGraw-Hill. ISBN 978-0-07-305188-8. ISBN 0-07-305188-8

3. Rosen, Kenneth. (2012). Discrete mathematics and its applications, seventh edition. ISBN 978-0-07-338309-5

4. Rosa, C. (2023) Apontamentos de Matemática Discreta, material didático elaborado para a UC de Matemática Discreta, ESTG/IPG, 2023/24.

RECOMMENDED:

1. Paul R. Halmos (2013). Undergraduate Texts in Mathematics Naive set Theory. Springer-Verlag. ISBN 978-0-387-90104-6 ISBN 978-1-4757-1645-0 (eBook) DOI 10.1007/978-1-4757-1645-0

2. Chartrand, G., & Zhang, P. (2013). A first course in graph theory. Courier Corporation. McGraw-Hill. ISBN-13:978-0-0486-48368-9, ISBN-10:0-486-48368-1

3. Weisstein (2022), Eric W. "Well Ordered Set." From *MathWorld*--A Wolfram Web Resource. https://mathworld.wolfram.com/WellOrderedSet.html

4. David S. Gunderson (2010). Handbook of Mathematical Induction: Theory and Applications. CRC Press. Print publication date: Setembro 2010, Online publication date: Janeiro 2014. Print ISBN: 9781420093643, eBook ISBN: 9781420093650, Adobe ISBN: 10.1201/9781420093650-5

5. Róbert Freud, & Edit Gyarmati (2020). Number Theory (Pure and Applied Undergraduate Texts). AMS - Editor. ISBN-13: 978-1470452759. ISBN-10: 1470452758

5. TEACHING METHODOLOGIES (INCLUDING EVALUATION)

The methodology that will meet the objectives set for the UC will be the expository and interactive class, addressing the issues in a practical and objective way, with immediate application in the resolution of exercises, involving students in their learning and eliminating errors.

Continuous assessment: Two written tests with a minimum of 5 marks in each test and a final classification (arithmetic mean) higher or equal to 10 marks, to obtain approval.

Final exam: Normal season and appeal season, with a final classification higher or equal to 10 points, for approval.

Mandatory oral exam for marks higher than 16. The use of materials, calculator or mobile phones is prohibited.

6. COHERENCE BETWEEN TEACHING METHODOLOGIES AND OBJECTIVES

Expositive lecture is in accordance with the objectives because it is necessary to present to the students the theoretical concepts of the programmatic contents.

Interactive lecture and problem solving are consistent with the objectives because small practical examples of application are presented and where students apply the theoretical concepts by solving practical problems appropriate and adjusted to each syllabus, allowing students, in a proportionate and gradual way, to acquire the necessary skills throughout the semester to obtain a pass. The teaching methodology is centred in the student, who throughout the semester will learn and apply the acquired concepts, with his autonomous work and with the help of the teacher. Thus, particular importance is given to continuous assessment, which allows the student, throughout the semester, to gradually demonstrate the skills acquired through their work.

7. ATTENDANCE

Not applicable.

8. CONTACTS AND OFFICE HOURS

Professor: Maria Cecília Rosa, cecirosa@ipg.pt, Gab. 45, ESTG

Office Hours: Wednesday: 14:30 – 16:30

Area Coordinator: Graça Tomaz, gtomaz@ipg.pt, Gab. 33, ESTG

9. OTHERS

Not applicable.

DATE

18 September 2023

SIGNATURES

Professor

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(signature)

Area Coordinator

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(signature)