

## DISCRETE MATHEMATICS

**Grado en Computación e Inteligencia Artificial / Bachelor in  
Computer Science and Artificial Intelligence BCSAI SEP-2025  
DM-CSAI.1.M.A**

Area Mathematics

Number of sessions: 30

Academic year: 25-26

Degree course: FIRST

Number of credits: 6.0

Semester: 1º

Category: BASIC

Language: English

Professor: **SIMÓN ISAZA**

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Simón Isaza has a PhD. In mathematical research by Complutense University of Madrid. He completed these studies founded by an FPI scholarship and graduated "cum laude". His thesis "CW Decompositions of Algebraic Curves and Milnor Fibers of Non-Isolated Quasi-Ordinary Singularities" treated about subjects in Topology and Theory of Singularities. He has worked in teaching and research at the National University of Colombia, Complutense University, and currently at IE University. He also has experience as financial risk consultant at KPMG. He is passionate about Technology, Economics, and knowledge in general.

### Office Hours

Office hours will be on request. Please contact at:

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## SUBJECT DESCRIPTION

In this course, you will be introduced to some basic concepts of logic, such as propositional and predicate logic, proof methods, set theory, functions, and relations, along with algebraic concepts like integer representation and modular arithmetic. These are core topics in programming and fundamental areas of mathematics with a wide range of applications. As such, they are essential to both computer science and artificial intelligence.

Throughout the course, these concepts will be developed in relation to programming, with theory explained alongside real-world examples. In this way, you will gain, on the one hand, knowledge that is essential for understanding computer algorithms and a wide variety of applications, and on the other, a mental framework that will enable you to apply structured mathematical thinking to solve real-life problems.

## LEARNING OBJECTIVES

- To understand and be able to use the basic concepts of propositional logic, predicate logic, and proof methods.
- To understand and learn to apply the main concepts of set theory.
- To become familiar with basic algebraic tools used in programming.
- To understand the different kinds of relations and orderings and their importance in programming.
- To acquire a basic knowledge of languages, grammars and finite-state machines.

## TEACHING METHODOLOGY

IE University teaching method is defined by its collaborative, active, and applied nature. Students actively participate in the whole process to build their knowledge and sharpen their skills. Professor's main role is to lead and guide students to achieve the learning objectives of the course. This is done by engaging in a diverse range of teaching techniques and different types of learning activities such as the following:

Learning Activity	Weighting	Estimated time a student should dedicate to prepare for and participate in
Lectures	30.0 %	45.0 hours
Discussions	3.3 %	5.0 hours
Exercises in class, Asynchronous sessions, Field Work	33.3 %	50.0 hours
Group work	33.3 %	50.0 hours
TOTAL	100.0 %	150.0 hours

## AI POLICY

### Restricted use of GenAI

In today's world, generative artificial intelligence (GenAI) is changing how we work, study and, in general, how we get things done. However, in the context of this course, the use of GenAI is not permitted, unless it is otherwise stated by the instructor. The use of GenAI tools would jeopardize the students' ability to acquire fundamental knowledge or skills of this course.

If a student is found to have used AI-generated content for any form of assessment, it will be considered academic misconduct, and the student might fail the respective assignment or the course.

## PROGRAM

Disclaimer: The following description of the material covered is tentative. An attempt will be made to cover all listed topics. However, the pace in the classes will depend on the group performance.

The prerequisite for this course is a solid understanding of basic arithmetic and algebra as covered in high school, including topics such as fractions, exponents, radicals, logarithms, factorization, quadratic equations, systems of equations, and inequalities.

Modules:

Module 1: Propositional Logic, Predicate Logic and Proofs

Module 2: Set Theory

Module 3: Relations

Module 4: Arithmetic

Module 5: Modeling Computation

### SESSION 1 (LIVE IN-PERSON)

#### Module 1/5: Propositional Logic, Predicate Logic and Proofs

Introduction to the course

Topics:

- Fundamentals of propositional logic and its applications to Computer Science (DMIA Chapter 1, pp. 1-25)

### SESSION 2 (LIVE IN-PERSON)

#### Module 1/5: Propositional Logic, Predicate Logic and Proofs

Topics:

- Fundamentals of propositional logic and its applications to Computer Science (DMIA Chapter 1, pp. 1-25) (Continued)
- Propositional equivalences (DMIA; Chapter 1; pp 25 – 36).

### SESSION 3 (LIVE IN-PERSON)

#### Module 1/5: Propositional Logic, Predicate Logic and Proofs

Topics:

- Predicate logic: Predicates and Quantifiers (DMIA; Chapter 1; pp 40-57).

### SESSION 4 (LIVE IN-PERSON)

#### Module 1/5: Propositional Logic, Predicate Logic and Proofs

Topics:

- Predicates and quantifiers (DMIA; Chapter 1; pp 51 – 57).
- Nested quantifiers (DMIA; Chapter 1; pp 60 - 72)

### SESSION 5 (LIVE IN-PERSON)

### **Lab Session**

The students will find propositions for given truth tables using the disjunctive normal form and Karnaugh tables. Once the expressions are minimal, the students will implement the circuit using the Logisim software (open-source).

### **SESSION 6 (LIVE IN-PERSON)**

#### **Module 1/5: Propositional Logic, Predicate Logic and Proofs**

Topics:

- Introduction to proofs (DMIA; Chapter 1; pp 80 – 92).

### **SESSION 7 (LIVE IN-PERSON)**

#### **Module 1/5: Propositional Logic, Predicate Logic and Proofs**

Topics:

- Proof Methods and Strategy (DMIA; Chapter 1; 96-110)

### **SESSION 8 (LIVE IN-PERSON)**

#### **Module 1/5: Propositional Logic, Predicate Logic and Proofs**

Topics:

- Proof Methods and Strategy (DMIA; Chapter 1; 96-110) (Continuation)

### **SESSION 9 (LIVE IN-PERSON)**

#### **Module 2/5: Set Theory**

Topics:

- Sets: theory and operations (DMIA; Chapter 2; pp 115 – 138).

### **SESSION 10 (LIVE IN-PERSON)**

#### **Module 2/5: Set Theory**

Topics:

- Sets: theory and operations (DMIA; Chapter 2; pp 115 – 138). (Continuation)

### **SESSION 11 (LIVE IN-PERSON)**

#### **Module 2/5: Set Theory**

Topics:

- Introduction to Functions
- Types of function (DMIA; Chapter 2; pp 138 – 156)

### **SESSION 12 (LIVE IN-PERSON)**

#### **Module 2/5: Set Theory**

Topics:

- Types of functions (DMIA; Chapter 2; pp 138 – 156)

## **SESSION 13 (LIVE IN-PERSON)**

### **Module 2/5: Set Theory**

#### **Topics:**

Practice Exercises for functions.

Book Chapters : Discrete Mathematics and Its Applications; Chapter 2; pp 138 – 156 (See Bibliography)

## **SESSION 14 (LIVE IN-PERSON)**

Review for the Midterm Exam.

## **SESSION 15 (LIVE IN-PERSON)**

### **Midterm Exam.**

Scope: Modules 1 & 2.

## **SESSION 16 (LIVE IN-PERSON)**

### **Module 3/5: Relations**

#### **Topics:**

- Introduction to relations
- Relations and functions
- Representing relations

## **SESSION 17 (LIVE IN-PERSON)**

### **Module 3/5: Relations**

#### **Topics:**

- Properties of relations (reflexivity, antirreflexivity, symmetry, antisymmetry, transitivity)
- Closures of relations (reflexive closure, symmetric closure and transitive closure)

## **SESSION 18 (LIVE IN-PERSON)**

### **Module 3/5: Relations**

#### **Topics:**

- Graphs (types of graphs, graph representation).
- Applications of graphs
- Graph paths. Euler and Hamilton paths

## **SESSION 19 (LIVE IN-PERSON)**

### **Lab Session**

The students will learn how to express relations using the declarative language programming Prolog. They will explore the classic example of a family tree represented as a series of facts and rules, and work through queries of increasing complexity.

## **SESSION 20 (LIVE IN-PERSON)**

#### **Module 4/5: Arithmetic**

- Sequences and Sums (DMIA; Chapter 2; pp 156 – 170).

### **SESSION 21 (LIVE IN-PERSON)**

#### **Module 4/5: Arithmetic**

Topics:

- Divisibility and Modular Arithmetic (DMIA, Chapter 4, pp 251-259).

### **SESSION 22 (LIVE IN-PERSON)**

#### **Module 4/5: Arithmetic**

Topics:

- Integer Representation (DMIA, Chapter 4, pp 260-265)
- Operations for different integer representations (DMIA, Chapter 4, pp 265-260)

### **SESSION 23 (LIVE IN-PERSON)**

#### **Module 4/5: Arithmetic**

Topics:

- Applications of number theory (hash maps, cryptographic hash functions, proof of work, cryptography).

### **SESSION 24 (LIVE IN-PERSON)**

#### **Lab Session**

The students will implement some basic arithmetic algorithms in python.

### **SESSION 25 (LIVE IN-PERSON)**

#### **Module 5/5: Modeling Computation**

Topics:

- Languages and Grammars (DMIA, Chapter 13, pp 885-898)

### **SESSION 26 (LIVE IN-PERSON)**

#### **Module 5/5: Modeling Computation**

Topics:

- Finite-State Machine with Output (DMIA, Chapter 13, pp 899-903)
- Practice exercises.

### **SESSION 27 (LIVE IN-PERSON)**

#### **Module 5/5: Modeling Computation**

Topics:

- Finite-State Machine with no Output (DMIA, Chapter 13, pp 903-913)

- Practice exercises.

## **SESSION 28 (LIVE IN-PERSON)**

### **Final Project Presentations**

The students present their final projects through 15 min presentations (10 min for presentation and 5 min questions from the professor).

## **SESSION 29 (LIVE IN-PERSON)**

Review for the final exam.

## **SESSION 30 (LIVE IN-PERSON)**

**Final Exam.**

## **EVALUATION CRITERIA**

A minimum grade of 3.5 in the final exam is required to pass the course. If a student's grade in the final exam does not reach the threshold of 3.5, the student will fail the course, even if the grade in the course exceeds 5.0.

The date of the midterm is tentative and might change depending on the pace of the class. Please do not make any travel plans near the midterm date without first consulting your professor. The exact date of the midterm will be announced at least two weeks in advance. Note that the dates for the final exam and any retake exams are fixed and cannot be rescheduled.

<b>criteria</b>	<b>percentage</b>	<b>Learning Objectives</b>	<b>Comments</b>
Final Exam	40 %		
Group Presentation	10 %		
Individual work	10 %		
Group Work	10 %		
Intermediate tests	30 %		

## **RE-SIT / RE-TAKE POLICY**

Each student has four chances to pass any given course distributed over two consecutive academic years: ordinary call exams and extraordinary call exams (re-sits) in June/July.

Students who do not comply with the 80% attendance rule during the semester will fail both calls for this Academic Year (ordinary and extraordinary) and have to re-take the course (i.e., re-enroll) in the next Academic Year.

Evaluation criteria:

- Students failing the course in the ordinary call (during the semester) will have to re-sit the exam in June / July (except those not complying with the attendance rule, who will not have that opportunity and must directly re-enroll in the course on the next Academic Year).
- The extraordinary call exams in June / July (re-sits) require your physical presence at the campus you are enrolled in (Segovia or Madrid). There is no possibility to change the date, location or format of any exam, under any circumstances. Dates and location of the June / July re-sit exams will be posted in advance. Please take this into consideration when planning your

summer.

- The June / July re-sit exam will consist of a comprehensive exam. Your final grade for the course will depend on the performance in this exam only; continuous evaluation over the semester will not be taken into consideration. Students will have to achieve the minimum passing grade of 5 and can obtain a maximum grade of 8.0 (out of 10.0) – i.e., “notable” in the in the re-sit exam.
- Retakers: Students who failed the subject on a previous Academic Year and are now re-enrolled as re-takers in a course will be needed to check the syllabus of the assigned professor, as well as contact the professor individually, regarding the specific evaluation criteria for them as retakers in the course during that semester (ordinary call of that Academic Year).

The maximum grade that may be obtained in the retake exam (3rd call) is 10.0.

After ordinary and extraordinary call exams are graded by the professor, you will have a possibility to attend a review session for that exam and course grade. Please be available to attend the session in order to clarify any concerns you might have regarding your exam. Your professor will inform you about the time and place of the review session. Any grade appeals require that the student attended the review session prior to appealing.

Students failing more than 18 ECTS credits in the academic year after the June-July re-sits will be asked to leave the Program. Please, make sure to prepare yourself well for the exams in order to pass your failed subjects.

In case you decide to skip the opportunity to re-sit for an exam during the June / July extraordinary call, you will need to enroll in that course again for the next Academic Year as a re-taker and pay the corresponding extra cost. As you know, students have a total of four allowed calls to pass a given subject or course, in order to remain in the program.

## **BIBLIOGRAPHY**

### **Recommended**

- Rosen, Kenneth H. *Discrete Mathematics and its Applications*. McGraw Hill Education. ISBN 9780070681880 (Digital)

## **BEHAVIOR RULES**

Please, check the University's Code of Conduct [here](#). The Program Director may provide further indications.

## **ATTENDANCE POLICY**

Please, check the University's Attendance Policy [here](#). The Program Director may provide further indications.

## **ETHICAL POLICY**

Please, check the University's Ethics Code [here](#). The Program Director may

provide further indications.

