Teaching guide

IDENTIFICATION DETAILS

Degree:	Mathematical Engineering
Scope	Computer and Systems Engineering.
Faculty/School:	Higher Polytechnic School
Course:	DISCRETE MATHEMATICS
Type:	Basic Training
ECTS credits:	6
Year:	1
Code:	4939
Teaching period:	Second semester
Area:	Mathematics
Module:	Basic training
Teaching type:	Classroom-based
Language:	English
Total number of student study hours:	150

Teaching staff	E-mail
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SUBJECT DESCRIPTION

Se introduce la teoría de conjuntos, las relaciones, operaciones y propiedades entre conjuntos. A continuación, se estudia el concepto de función y los diferentes tipos de funciones. Se analizan seguidamente los principales conceptos de la aritmética finita y modular y su aplicación. Introduce la inducción en números naturales y se alcanza la definición recursiva de sumas y productos. Se utiliza la demostración por recursividad. A continuación, se trata la teoría de grafos y árboles. Se introduce la terminología básica sobre caminos, accesibilidad y conexiones y se pasa a calcular caminos, caminos mínimos, caminos de peso mínimo y árboles de envergadura,

para finalmente estudiar una aplicación de esta teoría.

Esta asignatura corresponde al módulo Formación Básica y, dentro de éste, a la materia Matemáticas. Se imparte en el segundo semestre del primer curso de los estudios de Grado en Ingeniería Matemática, y requiere de una dedicación de 150 horas por parte del alumno.

La asignatura trata diversas áreas de las matemáticas tales como la teoría de conjuntos, las relaciones, la aritmética finita y modular y los grafos, entre otras, de interés como fundamentos en la formación del futuro ingeniero en lo relativo al tratamiento y almacenamiento de la información en los ordenadores, al diseño y desarrollo de algoritmos, a la organización inherente a las bases de datos basada en relaciones entre conjuntos y a la base de las estructuras de datos y los sistemas operativos.

Completan estas áreas de conocimiento las relativas a recursividad e inducción, que hacen que la base matemática que proporciona esta asignatura desarrolle el rigor en el razonamiento, la capacidad de abstracción y la capacidad de formalización basada en el uso del lenguaje matemático, capacidades necesarias para el futuro ingeniero.

Esta asignatura ayuda a desarrollar el pensamiento lógico propio de la matemática que, tal como indica el Ideario de la carrera, es fundamental para la captación de conexiones y para la obtención del pensamiento verdadero. Este proceso debe realizarse dando especial importancia a la conciencia crítica, única forma de lograr el tipo de certeza que deriva de la sinergia entre matemática y método empírico.

Set theory, relations, operations and properties between sets are introduced. Next, the concept of function and the different types of functions are the concept of function and the different types of functions. The main concepts of finite and modular arithmetic, concepts of finite and modular arithmetic and their application. Induction in natural numbers is introduced, and the recursive definition of sums and products is reached. The proof by recursion is used. Next, the theory of graphs and trees is discussed. The basic terminology of paths, reachability and connections is introduced. Connections are introduced and we proceed to compute paths, minimum paths, minimum weight paths and spanning trees, to finally study an application of this theory. This subject corresponds to the Basic Training module and, within it, to the subject Mathematics. It is taught in the second semester of the first year of the Bachelor's Degree in Mathematical Engineering, and requires a dedication of 150 hours by the student. The course deals with various areas of mathematics such as set theory, relations, finite and modular arithmetic and graphs, among others. and modular arithmetic and graphs, among others, of interest as fundamentals in the training of the future engineer in the fields of computer information the processing and storage of information in computers, the design and development of algorithms, the organization and development of algorithms, the inherent organization of databases based on relations between sets, and the basis of data structures. the basis of data structures and operating systems. These areas of knowledge are completed by those related to recursion and induction, which make the mathematical basis provided by this subject develop mathematical basis provided by this subject develops rigor in reasoning, the capacity of abstraction and the capacity of formalization based on the the ability to formalize based on the use of mathematical language, necessary skills for the future engineer. Engineer. This subject helps to develop the logical thinking proper to mathematics, which, as indicated in the Ideology of the course, is fundamental to grasp connections and to obtain true thinking. of the course, is fundamental for the grasping of connections and for the attainment of true thinking. This process must be carried out giving special importance to critical awareness, the only way to achieve the kind of certainty that derives from the synergy of the synergies between the two. the synergy between mathematics and empirical method.

GOAL

The main objectives of the Discrete Mathematics course are to apply set theory and graph theory, to handle finite and modular arithmetic, to use logical and recursive methods to formalize graph theory, to handle finite and modular arithmetic, to use logical and recursive methods to formalize reasoning in a systematic way, and to prove the existence of properties of infinite sets by means of induction. and to prove the existence of properties of infinite sets by means of mathematical induction and, finally, without and, finally, to synthesize in a finite number of rules, in a recursive way, the generation of an infinite number of elements of an infinite number of elements. infinite

number of elements

PRIOR KNOWLEDGE

Level of Mathematics subjects in Science and Technology at the Baccalaureate level. Technology

COURSE SYLLABUS

Topic 1. Sets and Induction Sets, elements, and subsets Set operations Properties of set operations Boolean algebra laws Induction over N.
Topic 2. Relations, Functions, and Recursion Relations Binary relations. nnn-ary relations Equivalence relations: quotient set, partition Functions Operations between functions Types of functions Recursion Recursive definition of sets Recursive functions.
Topic 3. Order Structures Order relations Orders and ordered sets Extremes and extremal elements Lattices Boolean algebras.
Topic 4. Combinatorics.
Topic 5. Finite and Modular Arithmetic Integers Divisibility in Z. Greatest common divisor Numeration systems. Euclidean algorithm. Modular arithmetic. Linear congruence.s Systems of congruences.
Topic 6. Graph Theory. Definitions Graphs and directed graphs. Weighted graphs. Connectivity Paths and circuits. Eulerian and Hamiltonian graphs. Trees. Spanning tree. Minimum spanning tree: Kruskal's algorithm Shortest paths: Dijkstra's algorithm

EDUCATION ACTIVITIES

The methodology followed in this course aims to achieve a meaningful learning experience for students by covering the fundamental concepts and techniques of the subject. Therefore, the course combines lectures with practical classes, workshops, and project presentations to encourage student participation and interaction between students and professors. This approach fosters collaborative learning and self-learning capabilities through problem-solving strategies and intervention methodologies. Both individual and group non-classroom activities will be supervised by the professor during classes and tutorials, aiming to promote autonomous and collaborative learning. In the Basic Training module, to which this course belongs, lectures dominate to establish the foundational knowledge that will support students throughout their Bachelor’s degree in Mathematical Engineering. Classroom activities are supplemented by practical classes and workshops designed to help students assimilate and apply the acquired knowledge. Additionally, project presentations allow students to develop and practice their initiative in solving problems and case studies. On-site activities are complemented by students' independent work, sometimes done in groups to promote cooperative learning, and sometimes individually to reinforce the theoretical concepts covered in lectures and gain practical skills related to practical classes and workshops. All the study and work performed by students will be supervised and guided by the professor through individual or group tutorials. In some cases, students will present their main study or project conclusions in class, allowing for the exchange of knowledge and experiences among students. Finally, to facilitate students' access to materials and the planning of their work, as well as communication with the professor and other students, the Virtual Classroom will be used. This online learning platform provides various electronic resources to positively complement students' learning experience.

DISTRIBUTION OF WORK TIME

CLASSROOM-BASED ACTIVITY	INDEPENDENT STUDY/OUT-OF-CLASSROOM ACTIVITY
60 hours	90 hours

• Clase expositiva participativa 24h • Resolución de problemas o casos prácticos 24h • Actividades participativas grupales 6h • Seguimiento académico y actividades de evaluación 6h	• Trabajo personal y estudio autónomo 84h • Aula virtual: trabajo virtual en red, revisión y visionado de material, chats 6h

LEARNING RESULTS

SPECIFIC LEARNING RESULTS

Manejar correctamente los conceptos de la Teoría de Conjuntos, propiedades, operaciones, relaciones y estructuras.

Conocer las Relaciones de Equivalencia y su aplicación, así como las funciones y las Estructuras de Orden y sus aplicaciones.

Realizar cálculos en el marco de la aritmética finita utilizando algoritmos y utilizará la aritmética modular en los enteros a través de las congruencias

Manejar la recurrencia e inducción para la resolución de problemas. Conocer las estructuras en árbol y grafos para la representación de problemas y los algoritmos propios para la búsqueda y optimización.

LEARNING APPRAISAL SYSTEM

The evaluation system includes four types of assessments:
a. Theoretical Written Exam:
2 exams with a weight of 30% in the final grade.
b. Practical Exam: 2 exams with a weight of 30% in the final grade.
c. Practical Work and Other Assignments Related to the Subject: With a weight of 30% in the final grade.
d. Class Participation and Interest in the Subject: With a weight of 10% in the final grade.
For the first two assessments (a and b) and the practical work (c), a minimum of 5 out of 10 points is required to pass the course. At the professor's discretion, assessments a and b may be combined into a single exam. Students exempt from class attendance, either due to retaking the course or having express authorization from the Degree Direction, will be evaluated using the same types of assessments. The 10% class participation can be obtained by submitting an additional assignment assigned by the professor responsible for the subject.
Ordinary Exam Period: Students are entitled to be evaluated through a theoretical-practical exam (assessments a and b) during the ordinary exam period. Students who have not achieved the minimum grade in the theoretical-practical exams taken during the semester (if conducted) may opt for a retake during this period. Practical work completed during the course (assessment c) is part of the continuous evaluation and must be passed during the course, and it is not subject to retake during the ordinary exam period.
Extraordinary Exam Period: Students who have not achieved the minimum grade in the exam (assessments a and b) and/or in the practical work (assessment c) of the ordinary exam period may opt for a retake during the

extraordinary exam period. The final grade will be the weighted result of the previously mentioned grades, i.e., Final Grade = 0.30*a + 0.30*b + 0.3*c + 0.1*d. Class attendance and participation cannot be retaken in either exam period. **Description of Assessments**: - **Theoretical Exam**: Individual tests to evaluate the student's understanding of theoretical concepts presented, including short-answer questions, some multiple-choice or true/false questions, reflecting autonomous work based on study and individual effort. - **Practical Exam**: Individual tests to evaluate the student's ability to solve problems derived from theoretical content. These problems will be directly related to the theoretical content with a difficulty level represented by the points assigned to each problem. -
Practical Work: Conducted periodically as determined by the professor, involving problem-solving and/or questions related to the theory being taught. These assignments are individual and will be submitted and corrected to help prepare for the written exams and provide support in understanding the material. -
Attendance and Participation: Assessed based on the student's demonstrated interest through various indicators, such as attendance, punctuality, responses to individual questions posed by the professor, voluntary or professor-determined tutorials. Participation and involvement in the course represent 10% of the final grade, scored from 0 to 10, and cannot be retaken. A minimum attendance of 80% of sessions is required; otherwise, this assessment type will be scored with 0 points.
General Notes: Students have 6 attempts to pass this course. The UFV Evaluation Regulations cover all aspects related to the evaluation process and the use of exam attempts. Any fraud or plagiarism in an evaluable activity will be sanctioned according to the UFV Code of Conduct. For these purposes, "plagiarism" is considered any attempt to deceive the evaluation system, such as copying in exercises, exams, practical work, assignments, or any other type of submission, either from another student or from unauthorized materials or devices, to make the professor believe they are the student's own work.

BIBLIOGRAPHY AND OTHER RESOURCES

Basic

Kenneth Rosen Discrete Mathematics 8

Additional

OSCAR LEVIN An open introduction to Discrete Mathematics 1

Susanna Epps Discrete Mathematics and Its Applications 1