University of Engineering and Technology
School of Computer Science
Syllabus of Course – Academic Period 2017-I

1. Code and Name: CS1D2. Discrete Structures II
2. Credits: 4
3. Hours of theory and Lab: 2 HT; 4 HP;
4. Professor(s)
Meetings after coordination with the professor
5. Bibliography

[Gri97] R. Grimaldi. *Matemáticas Discretas y Combinatoria*. Addison Wesley Iberoamericana, 1997.

[Joh99] Richard Johnsonbaugh. *Matemáticas Discretas*. Prentice Hall, México, 1999.

[Mic98] Elias Micha. *Matemáticas Discretas*. Limusa, 1998.

[Ros07] Kenneth H. Rosen. *Discrete Mathematics and Its Applications*. 7 ed. Mc Graw Hill, 2007.

6. Information about the course

(a) **Brief description about the course** In order to understand the advanced computational techniques, the students must have a strong knowledge of the Various discrete structures, structures that will be implemented and used in the laboratory in the programming language..

(b) **Prerrequisites:** CS1D1. Estructuras Discretas I. (1^{er} Sem)

(c) **Type of Course:** Mandatory

7. Competences

- That the student is able to model computer science problems using graphs and trees related to data structures
- That the student apply efficient travel strategies to be able to search data in an optimal way

8. Contribution to Outcomes

a) An ability to apply knowledge of mathematics, science. (**Familiarity**)

i) An ability to use the techniques, skills, and modern computing tools necessary for computing practice. (**Familiarity**)

j) Apply the mathematical basis, principles of algorithms and the theory of Computer Science in the modeling and design of computational systems in such a way as to demonstrate understanding of the equilibrium points involved in the chosen option. (**Familiarity**)

9. Competences (IEEE)

C1. An intellectual understanding and the ability to apply mathematical foundations and computer science theory.⇒ **Outcome a**

C20. Ability to connect theory and skills learned in academia to real-world occurrences explaining their relevance and utility.⇒ **Outcome i**

C24. Understanding the need for lifelong learning and improving skills and abilities.⇒ **Outcome j**

10. List of topics

1. Basics of Counting

2. Graphs and Trees

3. Discrete Probability

11. Methodology and Evaluation
Methodology:

Theory Sessions:
The development of the theoretical sessions is focused on the student, through his active participation, solving problems related to the course with the individual contributions and discussing real cases of the industry. The students will develop throughout the course a project of application of the tools received in a company.

Lab Sessions:
Practical sessions are held in the laboratory. Laboratory practices are performed in teams to strengthen their communication. At the beginning of each laboratory the development of the practice is explained and at the end the main conclusions of the activity in group form are highlighted.

Oral Presentations :
Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

Reading:
Throughout the course different readings are provided, which are evaluated. The average of the notes in the readings is considered as the mark of a qualified practice. The use of the UTEC Online virtual campus allows each student to access the course information, and interact outside the classroom with the teacher and with the other students.
Evaluation System:
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12. Content

<table>
<tr><td colspan="2">Unit 1: Basics of Counting (25)</td></tr>
<tr><td colspan="2">Competences Expected: C1</td></tr>
<tr><td>Learning Outcomes</td><td>Topics</td></tr>
<tr><td>• Apply counting arguments, including sum and product rules, inclusion-exclusion principle and arithmetic/geometric progressions [Familiarity]
• Apply the pigeonhole principle in the context of a formal proof [Familiarity]
• Compute permutations and combinations of a set, and interpret the meaning in the context of the particular application [Familiarity]
• Map real-world applications to appropriate counting formalisms, such as determining the number of ways to arrange people around a table, subject to constraints on the seating arrangement, or the number of ways to determine certain hands in cards (eg, a full house) [Familiarity]
• Solve a variety of basic recurrence relations [Familiarity]
• Analyze a problem to determine underlying recurrence relations [Familiarity]
• Perform computations involving modular arithmetic [Familiarity]</td><td>• Counting arguments
– Set cardinality and counting
– Sum and product rule
– Inclusion-exclusion principle
– Arithmetic and geometric progressions
• The pigeonhole principle
• Permutations and combinations
– Basic definitions
– Pascal's identity
– The binomial theorem
• Solving recurrence relations
– An example of a simple recurrence relation, such as Fibonacci numbers
– Other examples, showing a variety of solutions
• Basic modular arithmetic</td></tr>
<tr><td colspan="2">Readings : [Gri97]</td></tr>
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Unit 2: Graphs and Trees (25)

Competences Expected: C1

Learning Outcomes	Topics
• Illustrate by example the basic terminology of graph theory, and some of the properties and special cases of each type of graph/tree [Familiarity] • Demonstrate different traversal methods for trees and graphs, including pre, post, and in-order traversal of trees [Familiarity] • Model a variety of real-world problems in computer science using appropriate forms of graphs and trees, such as representing a network topology or the organization of a hierarchical file system [Familiarity] • Show how concepts from graphs and trees appear in data structures, algorithms, proof techniques (structural induction), and counting [Familiarity] • Explain how to construct a spanning tree of a graph [Familiarity] • Determine if two graphs are isomorphic [Familiarity]	• Trees – Properties – Traversal strategies • Undirected graphs • Directed graphs • Weighted graphs • Spanning trees/forests • Graph isomorphism

Readings : [Joh99]

Unit 3: Discrete Probability (10)

Competences Expected: C20

Learning Outcomes	Topics
• Calculate probabilities of events and expectations of random variables for elementary problems such as games of chance [Familiarity] • Differentiate between dependent and independent events [Familiarity] • Identify a case of the binomial distribution and compute a probability using that distribution [Familiarity] • Apply Bayes theorem to determine conditional probabilities in a problem [Familiarity] • Apply the tools of probability to solve problems such as the average case analysis of algorithms or analyzing hashing [Familiarity] • Compute the variance for a given probability distribution [Familiarity] • Explain how events that are independent can be conditionally dependent (and vice-versa) Identify real-world examples of such cases [Familiarity]	• Finite probability space, events • Axioms of probability and probability measures • Conditional probability, Bayes' theorem • Independence • Integer random variables (Bernoulli, binomial) • Expectation, including Linearity of Expectation • Variance • Conditional Independence

Readings : [Mic98], [Ros07]