National University of Engineering (UNI)
School of Computer Science
Sillabus 2023-I

1. COURSE

CS211. Theory of Computation (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CS211. Theory of Computation
2.2 Semester	:	4^{to} Semestre.
2.3 Credits	:	4
2.4 Horas	:	2 HT; 4 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Mandatory
2.7 Learning modality	:	Blended
2.8 Prerrequisites	:	CS1D2. Discrete Structures II. (2^{nd} Sem) CS1D2. Discrete Structures II. (2^{nd} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course emphasizes formal languages, computer models and computability, as well as the fundamentals of computational complexity and complete NP problems.

5. GOALS

- That the student learn the fundamental concepts of the theory of formal languages.

6. COMPETENCES

1) Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions. (**Assessment**)

6) Apply computer science theory and software development fundamentals to produce computing-based solutions. (**Assessment**)

7. TOPICS

<table>
<tr><td colspan="2">Unit 1: Basic Automata Computability and Complexity (20)</td></tr>
<tr><td colspan="2">Competences Expected:</td></tr>
<tr><td>Topics</td><td>Learning Outcomes</td></tr>
<tr><td>

Finite-state machines
Regular expressions
The halting problem
Context-free grammars
Introduction to the P and NP classes and the P vs. NP problem
Introduction to the NP-complete class and exemplary NP-complete problems (e.g., SAT, Knapsack)
Turing machines, or an equivalent formal model of universal computation
Nondeterministic Turing machines
Chomsky hierarchy
The Church-Turing thesis
Computability
Rice's Theorem
Examples of uncomputable functions
Implications of uncomputability

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Discuss the concept of finite state machines [Assessment]
Design a deterministic finite state machine to accept a specified language [Assessment]
Generate a regular expression to represent a specified language [Assessment]
Explain why the halting problem has no algorithmic solution [Assessment]
Design a context-free grammar to represent a specified language [Assessment]
Define the classes P and NP [Assessment]
Explain the significance of NP-completeness [Assessment]
Explain the Church-Turing thesis and its significance [Familiarity]
Explain Rice's Theorem and its significance [Familiarity]
Provide examples of uncomputable functions [Familiarity]
Prove that a problem is uncomputable by reducing a classic known uncomputable problem to it [Familiarity]

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<tr><td colspan="2">Readings : [Jmartin10], [Linz11], [Sip12]</td></tr>
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<table>
<tr><td colspan="2">Unit 2: Advanced Computational Complexity (20)</td></tr>
<tr><td colspan="2">Competences Expected:</td></tr>
<tr><td>Topics</td><td>Learning Outcomes</td></tr>
<tr><td>

Review of the classes P and NP; introduce P-space and EXP
Polynomial hierarchy
NP-completeness (Cook's theorem)
Classic NP-complete problems
Reduction Techniques

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Define the classes P and NP (Also appears in AL/Basic Automata, Computability, and Complexity) [Assessment]
Define the P-space class and its relation to the EXP class [Assessment]
Explain the significance of NP-completeness (Also appears in AL/Basic Automata, Computability, and Complexity) [Assessment]
Provide examples of classic NP-complete problems [Assessment]
Prove that a problem is NP-complete by reducing a classic known NP-complete problem to it [Assessment]

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<tr><td colspan="2">Readings : [Jmartin10], [Linz11], [Sip12], [Hopcroft93]</td></tr>
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Unit 3: Advanced Automata Theory and Computability (20)	
Competences Expected:	
Topics	**Learning Outcomes**
• Sets and languages – Regular languages – Review of deterministic finite automata (DFAs) – Nondeterministic finite automata (NFAs) – Equivalence of DFAs and NFAs – Review of regular expressions; their equivalence to finite automata – Closure properties – Proving languages non-regular, via the pumping lemma or alternative means • Context-free languages – Push-down automata (PDAs) – Relationship of PDAs and context-free grammars – Properties of context-free languages	• Determine a language's place in the Chomsky hierarchy (regular, context-free, recursively enumerable) [Assessment] • Convert among equivalently powerful notations for a language, including among DFAs, NFAs, and regular expressions, and between PDAs and CFGs [Assessment]
Readings : [**Hopcroft93**], [Bro93]	

8. WORKPLAN

8.1 Methodology

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

8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

9. EVALUATION SYSTEM

********* EVALUATION MISSING ********

10. BASIC BIBLIOGRAPHY

[Bro93] J. Glenn Brookshear. *Teoría de la Computación*. Addison Wesley Iberoamericana, 1993.

[Sip12] Michael Sipser. *Introduction to the Theory of Computation (third edition)*. Publisher: Cengage Learning, 2012.