National University of Engineering (UNI)
School of Computer Science
Syllabus 2024-II

1. COURSE

CS353. Quantum Computing (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	CS353. Quantum Computing
2.2 Semester	:	10^{th} Semester.
2.3 Credits	:	4
2.4 Horas	:	2 HT; 3 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Mandatory
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	• CS221. Computer Systems Architecture. (4^{th} Sem) • MA307. Mathematics applied to computing. (6^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course introduces fundamental principles of quantum computing including qubits, superposition, entanglement and quantum algorithms. Students will learn to contrast classical and quantum models while exploring applications in cryptography, optimization and physical system simulation using frameworks like Qiskit or Cirq.

5. GOALS

- Understand quantum mechanics postulates applied to computing
- Implement basic quantum circuits using modern tools
- Analyze ethical and technical impacts of quantum computing

6. COMPETENCES

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

2) Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline. (Usage)

4) Recognize professional responsabilities and make informed judgments in computing practice based on legal and ethical principles. (Familiarity)

AG-C02) Ethics: Applies ethical principles and commits to professional ethics and standards of computing practice. (Familiarity)

AG-C08) Problem Analysis: Identifies, formulates, and analyzes complex computing problems. (Usage)

AG-C09) Solution Design and Development: Designs, implements, and evaluates solutions for complex computing problems. (Usage)

7. TOPICS

Unit 1: Quantum Mechanics Fundamentals (16 hours)	
Competences Expected: 1,AG-C08	
Topics	**Learning Outcomes**
• Qubits and Bloch sphere representation • Quantum mechanics postulates • Quantum gates (Hadamard, CNOT)	• Model a qubit mathematically [Usar]
Readings : [NC10], [Tea23]	

Unit 2: Quantum Algorithms (16 hours)	
Competences Expected: 2,AG-C09	
Topics	**Learning Outcomes**
• Deutsch-Jozsa algorithm • Grover's search • Shor's factorization	• Implement Grover's algorithm on a simulator [Usar]
Readings : [Pre18], [Tea23]	

Unit 3: Ethics and Applications (16 hours)	
Competences Expected: 4,AG-C02	
Topics	**Learning Outcomes**
• Post-quantum cryptography • Quantum supremacy • Ethical responsibility in quantum development	• Analyze ethical risks of RSA breaking [Familiarizarse]
Readings : [Tea19]	

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

[NC10] Michael A. Nielsen and Isaac L. Chuang. *Quantum Computation and Quantum Information*. Texto clásico para fundamentos teóricos. Cambridge University Press, 2010.

[Pre18] John Preskill. "Lecture Notes on Quantum Computation". 2018. URL: `http://theory.caltech.edu/~preskill/ph219/`.

[Tea19] Google AI Quantum Team. "Quantum Supremacy Using a Programmable Superconducting Processor". In: *Nature* 574 (2019). URL: `https://www.nature.com/articles/s41586-019-1666-5`.

[Tea23] IBM Quantum Team. *Qiskit Textbook*. Guía práctica con ejemplos en Qiskit. 2023. URL: `https://qiskit.org/textbook`.