Program	59EC – Communications Electronic Engineering B. Eng. 59SC – Telecommunications Systems Engineering B. Eng. 59SO – Sound and Image Engineering B.Eng. 59TL – Telematics Engineering B. Eng.

Course code and name	
Code	595040537
Name	Introduction to Quantum Computing
Semester	S6 [(February-June)]

Credits and contact hours	
ECTS Credits	4,5
Contact hours	45

Coordinator's name	Delgado López, Rafael [rafael.delgado@upm.es]

Specific course information

Description of course content

List of topics to be covered

1.- Introduction to quantum physics and quantum computing.
- Quantum states.
- From the bit to the qbit.
- Kroneker (or tensor) product.
- Computational basis.

2.- Entangled states. Hermitian operators.
- The spin 1/2 system. The Bloch sphere.
- Hermitian operators and observables.

3.- Quantum gates: Pauli, Hadamard, CNOT and Toffoli gates.
Unitary matrix notation and operation over qubit states of:
1-qubit quantum gate: Pauli gate
2-qubits quantum gates: Hadamard and CNOT
3-qubits quantum gate: Toffoli gate

4.- Quantum circuits. Introduction to qiskit framework
- Introduction to quantum gate notation and basic quantum circuits.
- Usage of Quirk (Quantum Circuit Simulator).
- Construction of a Toffoli gate by means of CNOT gates.
- Quantum teleportation. Simple quantum circuits for increasing and decreasing.
- A very basic introduction to the “de-facto” standard (Python) qiskit framework.

5.- Quantum annealing

• Introduction to the concept of quantum annealing. • Introduction to the Satisfiability Problem (SAT). • Choice of Hamiltonians and interpolation functions to solve a SAT problem via quantum annealing. Simulation of simple quantum annealing in qiskit.
Prerequisites or co-requisites
- Algebra / Linear Algebra
Course category in the program

☐ **R (required)**	☑ **E (elective)** *(elective courses may not be offered every year)*

Specific goals for the course
Specific outcomes of instruction
RA104 – To understand security threats to data infrastructures and risk analysis methodologies. RA105 – To design and apply data infrastructure protection techniques. RA106 – To know the legislation on data protection.

Further reading and supplementary materials
– Moodle Web resources

Teaching methodology			
_X_ **lectures**	_X_ **problem solving sessions**	_X_ **collaborative actions**	_X_ **laboratory sessions**
Other:			