Universidad Francisco de Vitoria UFV Madrid

Teaching guide

IDENTIFICATION DETAILS

Degree:	Awarded Degree in Quantum Computing (Awarded Degree associated with Mathematical Engineering)
Field of Knowledge:	Engineering and Architecture
Faculty/School:	Senior Polytechnic School
Course:	Classic and Quantum Computing Models
Type:	Compulsory Internal
ECTS credits:	3
Year:	2
Code:	49512
Teaching period:	Fourth semester
Teaching type:	Classroom-based
Language:	English
Total number of student study hours:	75

Teaching staff	E-mail
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SUBJECT DESCRIPTION

The purpose of this course is to provide the first steps in the understanding of Quantum Computing. It has a fundamentally informative purpose of the main concepts behind this new paradigm, such as superposition, entanglement and interference.

Similarly, an introduction to quantum algorithms is given and a number of hot spots in this subject such as quantum supremacy are presented or universal quantum computers vs quantum annealing computers

GOAL

The objective of this subject is to stablish the QC foundations for the students to develop and complete their roadmap in Quantum Computer in next courses.

PRIOR KNOWLEDGE

It is needed knowledge about Linear Algebra and Quantum Physics. Students will get this knowledge through two different subjects in first semester.

COURSE SYLLABUS

1.QC foundations
-Classical computing
-Motivation of QC
-Definition of QC
-Status: HW, SW, Solutions and QC ecosystem
-Our lab platform: Composer and Qiskit
2.Physics, Maths and engineering fundamentals for QC
-Quantum States
-Dirac notation: Bras and kets
-Quantum Ports
3.Superposition, Entanglement and interference
-Superposition and Hadamard port.
-Entanglement and CNOT port
-Interference and importance in QC
-How works together superposition, entanglement and interference
4.QC Algorithms
-Algorithms “zoo”
-Berstein-Vazirani algorithm
-Other remarkable algorithms: Grover’s and Shor’s algorithms
5.Introduction to programming in QC
-“Hybrid programming”: Classical and quantum programming together
-A program language with QPUs: Qiskit
-Labs with Qiskit
6.Hot topics in QC
-Quantum supremacy
-Universal quantum computers vs quantum annealing computers
-Other topics (security, education roadmap, hybrid computing etc)

EDUCATION ACTIVITIES

In this course the following training activities will be carried out:
- Autonomous work: the student will have to face the understanding of the problem in an autonomous way to then present his conclusions to the team. In many problems, the solution will not be unique and the presentation of individual proposals is welcome.
- Teamwork: the student will learn to reconcile their solutions or proposals with the team's proposals, being necessary to reconcile both for the benefit of a higher goal such as the good of the team.
- Writing technical documents: the student will learn the techniques and standards for writing professional technical documents.
- Presentation: each of the projects must be presented by the team, using presentations, tools, videos, models or any other didactic instrument deemed appropriate.

DISTRIBUTION OF WORK TIME

CLASSROOM-BASED ACTIVITY	INDEPENDENT STUDY/OUT-OF-CLASSROOM ACTIVITY
30 hours	45 hours
Practical and theoretical classes by the teachers of the course.	personal and autonomous home work 45h

28h Evaluation 2h	

SKILLS

LEARNING RESULTS

Understand why the importance of Quantum computing to overcome limitations of “Classical computing”

Understand principles of QC (qubits and Quantum physics phenomena) and the importance of multidisciplinary characteristic of QC about needed knowledge of HW, SW, Solutions and QC ecosystem.

Understand the importance of Quantum Algorithms into the QC arena and know the most important ones such as Grover’s, Bernstein and Shor

Run the first accesses and programs with real quantum computers through tools such as Composer and Qiskit

Being able to explain Quantum computing and being sort of “quantum evangelist” about the importance of second quantum revolution.

LEARNING APPRAISAL SYSTEM

a) First exam: 20 % : QC foundations, Physics, maths and engineering, superposition, entanglement and interference
b) Team work: 10 %: Preparation and presentation of one “Hot QC topic”
c) Final exam: 60%: It will compass all the subject chapters
d) Class attendance, participation, interest in the subject, etc.: 10%

BIBLIOGRAPHY AND OTHER RESOURCES

Basic

This subject will be prepared mainly with the materials that professors will provide to students via the university platform and references in different internet academic and QC provider sites.

Additional

Regarding labs, this will be done with IBM Cloud Quantum Computing platform (https://quantum-computing.ibm.com/). Within this platform will be done practices with tools such as IBM Quantum Composer and IBM qiskit.