



Teaching Guide

Identifying Data					2023/24
Subject (*)	Practical Applications of Quantum Computing	Code	614551010		
Study programme	Máster Universitario en Ciencia e Tecnoloxías de Información Cuántica				
Descriptors					
Cycle	Period	Year	Type	Credits	
Official Master's Degree	2nd four-month period	First	Optional	3	
Language	Spanish				
Teaching method	Face-to-face				
Prerequisites					
Department	Enxeñaría de ComputadoresMatemáticas				
Coordinador	Vazquez Cendon, Carlos	E-mail	carlos.vazquez.cendon@udc.es		
Lecturers	Castedo Ribas, Luis Vazquez Cendon, Carlos	E-mail	luis.castedo@udc.es carlos.vazquez.cendon@udc.es		
Web	n9.cl/1xqjg8				
General description	Quantum computing is a technology that is booming. The potential it has can mean a paradigm shift in the way of dealing with problems in today's society. Some of the working quantum computers today are already effective in solving certain highly complex problems. In this way, quantum computing is emerging as a promising path in various fields. In this subject you will see applications in finance, industry, defense and security.				

Study programme competences / results

Code	Study programme competences / results
A14	CON_14 Be aware of problem sets where quantum computing at its current stage of development can offer an advantage over classical computing: chemistry, biology, optimization, logistics, finance, etc.
B1	HD01 Analyze and break down a complex concept, examine each part and see how they fit together
B3	HD03 Compare and contrast and point out similarities and differences between two or more topics or concepts
B6	HD11 Prepare accurately the relevant questions for a specific problem.
B8	HD13 Improvise solutions in an innovative way to solve a problem.
B12	HD23 Communicate using the expected norms for the chosen medium.
B13	HD24 Actively participate in face-to-face activities in the classroom.
B14	HD31 Assign resources and responsibilities so that all members of a team can work optimally
B16	HD33 Set goals for the group to analyze the situation, decide what outcome is desired and clearly set an achievable goal.
C1	C1. Adequate oral and written expression in the official languages.
C2	C2. Mastering oral and written expression in a foreign language.
C3	C3. Using ICT in working contexts and lifelong learning.
C4	C4. Acting as a respectful citizen according to democratic cultures and human rights and with a gender perspective.
C7	C7. Developing the ability to work in interdisciplinary or transdisciplinary teams in order to offer proposals that can contribute to a sustainable environmental, economic, political and social development.
C8	C8. Valuing the importance of research, innovation and technological development for the socioeconomic and cultural progress of society.

Learning outcomes

Learning outcomes	Study programme competences / results



Know the domains of practical application of quantum computing in different sectors	AJ14	BJ1 BJ3 BJ6 BJ8 BJ12 BJ13 BJ14 BJ16	CJ1 CJ2 CJ3 CJ4 CJ7 CJ8
Know the use of quantum computing in economics and finance problems	AJ14	BJ1 BJ3 BJ6 BJ8 BJ12 BJ13 BJ14 BJ16	CJ1 CJ2 CJ3 CJ4 CJ7 CJ8
Know the use of quantum computing in problems that arise in the industry	AJ14	BJ1 BJ3 BJ6 BJ8 BJ12 BJ13 BJ14 BJ16	CJ1 CJ2 CJ3 CJ4 CJ7 CJ8
Know the use of quantum computing in relation to the military and defense sectors	AJ14	BJ1 BJ3 BJ6 BJ8 BJ12 BJ13 BJ14	CJ1 CJ2 CJ3 CJ4 CJ7 CJ8

Contents	
Topic	Sub-topic
1. Introduction to the practical applications of quantum computing	
2. Applications in economics and finance	
3. Applications in industry	
4. Defense and security applications	
5. Other applications	

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A14 B1 B3 B6 B8 B12 B13 B14 B16 C1 C2 C3 C4 C7 C8	11	0	11
ICT practicals	A14 B1 B3 B6 B8 B12 B13 B14 B16 C1 C2 C3 C4 C7 C8	4	10	14



Case study	A14 B1 B3 B6 B8 B12 B14 B16 C1 C2 C3 C4 C7 C8	6	4	10
Problem solving	A14 B1 B3 B6 B8 B12 B14 B16 C1 C2 C3 C4 C7 C8	0	10	10
Supervised projects	A14 B1 B3 B6 B8 B12 B14 B16 C1 C2 C3 C4 C7 C8	0	24	24
Personalized attention		6	0	6

(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	Presentation in the classroom of the contents of the matter
ICT practicals	Programming and use of simulators to solve examples
Case study	Presentation of use cases that arise in the different application sectors of quantum computing
Problem solving	The student is given problems to solve individually or in a group.
Supervised projects	Students are given assignments to prepare individually or in groups, which are monitored with personalized attention when necessary.

Personalized attention	
Methodologies	Description
Supervised projects	Supervised work is monitored, giving guidance and recommendations for its development

Assessment			
Methodologies	Competencies / Results	Description	Qualification
Problem solving	A14 B1 B3 B6 B8 B12 B14 B16 C1 C2 C3 C4 C7 C8	Problems of greater or lesser complexity are posed to be carried out individually or in groups, which may involve handling simulators. The student will deliver a document with its resolution.	30
Supervised projects	A14 B1 B3 B6 B8 B12 B14 B16 C1 C2 C3 C4 C7 C8	Supervised work is proposed to be carried out individually or in a group, depending on the complexity. The student must deliver a brief report on the work done and make a brief oral presentation about it, answering the teacher's questions.	70

Assessment comments

Sources of information	
Basic	<ul style="list-style-type: none"> - Gómez, A., Leita Rodríguez, A., Manzano, A., Nogueiras, M., Ordoñez, G., Vázquez, C. (2022). A survey on quantum computational finance for derivatives pricing and VaR. Archives of Computational Methods in Engineering, 29, 4137-4163. - Quantum Technology and Application Consortium ? QUTAC., Bayerstadler, A., Becquin, G. et al. (). Industry quantum computing applications.. EPJ Quantum Technol. 8, 25. - Krelina, M. (2021). Quantum technology for military applications.. EPJ Quantum Technol. 8, 24.
Complementary	

Recommendations



Subjects that it is recommended to have taken before

Introduction to Quantum Simulation/614551026
Numerical Methods in Quantum Computing/614551025
Quantum Computing Tools/614551006
Quantum Computing and Machine Learning/614551008
Quantum Computing Architectures/614551022
Programming and Implementation of Quantum Algorithms/614551007
Quantum Computing and High Performance Computing/614551009
Introduction to Quantum Computing/614551004

Subjects that are recommended to be taken simultaneously

Subjects that continue the syllabus

Master`s Dissertation/614551033

Other comments

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.