



Teaching Guide

Identifying Data					2023/24
Subject (*)	Quantum Computing and High Performance Computing		Code	614551009	
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 Computadores				
Coordinador	Andrade Canosa, Diego	E-mail	diego.andrade@udc.es		
Lecturers	Andrade Canosa, Diego Martin Santamaria, Maria Jose	E-mail	diego.andrade@udc.es maria.martin.santamaria@udc.es		
Web	https://quantummastergalicia.es				
General description	<p>O advenimiento da computación cuántica suporá un incremento sen precedentes na capacidade de cómputo da informática de consumo. Trasladar estas melloras á computación de altas prestacións (HPC) abrirá un potencial de desenvolvemento sen precedentes a certas aplicacións estratéxicas (dinámica de fluídos computacional, adestramentos de IA, aplicacións financeiras a gran escala, bioinformática, etc...). Para iso, esta materia explicará como deseñar solucións HPC que permitan integrar a gran escala computación clásica de altas prestacións, entrada/saída masiva e aceleradores cuánticos. Por outra banda, é necesario aprender a detectar oportunidades para aplicar esta clase de solucións en problemas resoltos con solucións clásicas HPC. Finalmente, a avaliación do rendemento permitiranos identifica pescozos de botella no rendemento como paso previo a aplicar diferentes optimizacións.</p>				

Study programme competences / results

Code	Study programme competences / results
A15	CON_15 Have knowledge of high-level aspects of quantum computing: learning quantum machines, quantum simulators, architectures, etc.
B1	HD01 Analyze and break down a complex concept, examine each part and see how they fit together
B2	HD02 Classify and identify types or groups, showing how each category is different from the others
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.
C5	C5. Understanding the importance of entrepreneurial culture and the useful means for enterprising people.
C6	C6. Acquiring skills for healthy lifestyles, and healthy habits and routines.
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.
C9	C9. Ability to manage times and resources: developing plans, prioritizing activities, identifying critical points, establishing goals and accomplishing them.

Learning outcomes



Learning outcomes	Study programme competences / results		
Conocer los algoritmos y estrategias de computación clásica inspirados en computación cuántica: redes tensoriales, estados producto de matrices, etc.	AJ15	BJ1 BJ2 BJ3 BJ6 BJ8 BJ12 BJ13 BJ14 BJ16	CJ1 CJ2 CJ3 CJ4 CJ5 CJ6 CJ7 CJ8 CJ9
Conocer y saber aplicar aspectos avanzados de computación cuántica: aprendizaje cuántico, arquitectura cuántica eficiente, modo de operación de los aceleradores cuánticos, computación de altas prestaciones, sistemas cuánticos basados en reglas y aplicaciones a cálculo numérico.	AJ15	BJ1 BJ2 BJ3	CJ9
Conocer escenarios de aplicación práctica de la computación cuántica en problemas de interés científico, tecnológico y financiero. Identificar de dominios que exhiban ventaja cuántica. Conocer las instituciones y empresas que son actores en la computación cuántica, adquiriendo una perspectiva de la agenda que es razonable esperar en los próximos años.	AJ15	BJ1 BJ2 BJ3	CJ1 CJ2 CJ5 CJ6 CJ9

Contents	
Topic	Sub-topic
Fundamentos da Computación de Altas Prestacións (HPC)	.
Arquitectura das Unidades de Procesamiento Cuántico	.
Integración de Computación Clásica e Cuántica en contornas HPC	.
Casos de uso de computación cuántica en contornas HPC	.
Avaliación de rendemento en Computación Cuántica	.

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Problem solving	B1 C3	5	10	15
Laboratory practice	B3 C1 C2	10	10	20
Objective test	B3 C1	2	4	6
Supervised projects	A15 B1 B2	2	8	10
Oral presentation	C4 C5 C6 C9	2	2	4
Guest lecture / keynote speech	A15 B1 B2 B3 B6 B8 B12 B13 B14 B16 C1 C2 C5 C6 C7 C8 C9	10	10	20
Personalized attention		0		0

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

Methodologies	
Methodologies	Description
Problem solving	Proposta e solución de pequenos problemas relacionados coa materia
Laboratory practice	Supostos prácticos que implican o uso de ferramentas e métodos aprendidos durante o mestrado ou nesta materia
Objective test	Proba escrita que avalía a adquisición de certos coñecementos da materia polo alumnado



Supervised projects	Realización de traballos académicamente dirixidos
Oral presentation	Presentación oral dun traballo relacionado cos contidos da materia
Guest lecture / keynote speech	Explicación dirixida polo docente e que implica a exposición dun tema e a discusión posterior co alumnado

Personalized attention

Methodologies	Description
Laboratory practice Supervised projects	Durante as sesións prácticas o docente fará unha breve explicación introdutoria. Durante o período de traballo do alumnado fará un seguimento e asesoramento personalizado do traballo.

Assessment

Methodologies	Competencies / Results	Description	Qualification
Laboratory practice	B3 C1 C2	Haberá varios entregables asociados as prácticas que serán avaliados	30
Objective test	B3 C1	Haberá unha proba final na que se avaliará por escrito o desempeño do alumnado	30
Supervised projects	A15 B1 B2	Realización de traballos dirixidos por parte do alumnado	20
Oral presentation	C4 C5 C6 C9	Presentación oral dun tema ante o profesorado e o resto dos estudantes	20

Assessment comments

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Sources of information

Basic	<ul style="list-style-type: none">- Noson S. Yanofsky (2008). Quantum Computing for Computer Scientists. Cambridge University Press- Jack D. Hidary (2021). Quantum Computing: An Applied Approach. Springer- Martin Ruefenacht (2022). Bringing quantum acceleration to supercomputers. Leibniz-Rechenzentrum- Travis S. Humble (2021). Quantum Computers for High-Performance Computing. IEEE
Complementary	

Recommendations

Subjects that it is recommended to have taken before

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Subjects that are recommended to be taken simultaneously

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Subjects that continue the syllabus

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Other comments

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(*)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.