



IDENTIFYING DATA

Quantum communications via satellite

Subject	Quantum communications via satellite			
Code	V05M198V01216			
Study programme	(*)Máster Universitario en Ciencia e tecnoloxías de información cuántica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	3	Optional	1st	2nd
Teaching language	#EnglishFriendly			
Department				
Coordinator	Mosquera Nartallo, Carlos			
Lecturers	Aguado Agelet, Fernando Antonio Mosquera Nartallo, Carlos			
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Web	http://moovi.uvigo.gal			
General description	This course covers the technological framework of quantum communications based on satellite links, with special emphasis on the optical channel and all the involved subsystems.			

Training and Learning Results

Code	
A11	Acquiring a solid foundation on quantum theory gives information on its application in quantum communications, as well as on the technology of two photonic devices used in quantum communications, both terrestrial and aerial and via satellite.
A12	Acquire skills for the design and estimation of resources that allow the development of quantum communication channels and networks and distributed computing. Know the state of development and current implementation of quantum networks, and the plans for their expansion.
A13	Know the strategies of quantum cryptography and its feasibility and solvency in the context of the quantum internet, the quantum chain of blocks and secret communications, acquiring a panoramic vision of two actors that will be essential in their deployment.
B11	Knowledge of quantum communications, theoretical principles and experimental implementations, both terrestrial and aerial and via satellite.
B12	To have knowledge about quantum cryptography, its theoretical bases, existing implementations and the challenges they face.
C1	To analyze and break down a complex concept, examine each part and see how they fit together
C2	To classify and identify types or groups, showing how each category is different from the others
C3	To compare and contrast and point out similarities and differences between two or more topics or concepts

Expected results from this subject

Expected results from this subject	Training and Learning Results
New	A11 A12 B11 B12 C1 C2
New	A13 B11 C3

Contents

Topic	
1. Introduction to satellite quantum communications	1.1 Introduction to the architecture of a space system 1.2 Orbits 1.3 Engineering of systems and space standards
2. Architecture of space systems for quantum communications	2.1 Main architectures for quantum communications 2.2 Integration with the quantum ground network
3. Optical communications through satellite links	3.1 Principles of signal transmission 3.2 Characterisation of the atmospheric channel 3.3 Computation of link budget
4. Subsystems of satellite quantum communications	4.1 Transmitters and optical receptors 4.2 Optical elements 4.3 Telescopes 4.4 Adaptive optics 4.5 Systems for pointing, acquisition and tracking
5. Examples of QKD systems	5.1 Main experimental platforms for satellite QKD 5.2 Use cases

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	16	32	48
Problem solving	4	8	12
Practices through ICT	5	8	13
Objective questions exam	0	2	2

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

Methodologies

	Description
Lecturing	The main elements of a satellite communication system will be presented, with focus on the architecture, channel and subsystems that are specific of the optical and quantum communication.
Problem solving	Different problems will be proposed that entail the use of mathematical software and/or the search for information on specific aspects of space quantum communication systems.
Practices through ICT	Different aspects of satellite communications will be addressed by making use of specific simulation software.

Personalized assistance

Methodologies	Description
Lecturing	Support will be offered during office hours and by e-mail. For contact information, go to https://www.uvigo.gal/en/university/administration-staff/pdi/carlos-mosquera-nartallo
Problem solving	Support will be offered during office hours and by e-mail. For contact information, go to https://www.uvigo.gal/en/university/administration-staff/pdi/carlos-mosquera-nartallo
Practices through ICT	Support will be offered during office hours and by e-mail. For contact information, go to https://www.uvigo.gal/en/university/administration-staff/pdi/carlos-mosquera-nartallo

Assessment

	Description	Qualification	Training and Learning Results	
Problem solving	Weekly homework will be proposed, and evaluated if delivered within the allocated deadline.	40		C1 C2 C3
Practices through ICT	A report must be turned in relation to those practical tasks which make use of specific software for some aspects of satellite quantum communication systems.	40	A12	
Objective questions exam	Final exam with short questions and exercises	20	A11 A13	B11 B12

Other comments on the Evaluation

The final exam will be graded for the 100% of the course in those cases for which no deliverables have been turned in for grading purposes. Similarly, the grade of the course will be based exclusively on the final exam if the student opts out of the continuous evaluation track within the first month of course activities.

Sources of information**Basic Bibliography****Complementary Bibliography**

Uysal, M and Capsoni, C and Ghassemlooy, Z and Boucouvalas, A and Udvary, E, **Optical wireless communications - an emerging technology**, Springer, 2016

<https://ecss.nl/>, **European Cooperation for Space Standardization**,

<http://www.sme-smad.com/>, **New SMAD (Libro de referencia en misiones espaciales)**,

Howard D. Curtis, **Orbital Mechanics for Engineering Students**, 978-0-08-097747-8, Elsevier, 2014

Recommendations