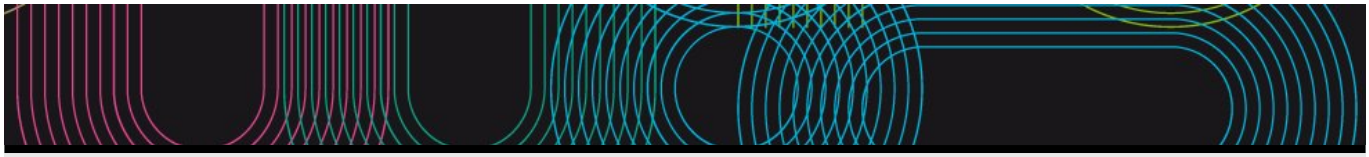

IDENTIFYING DATA				
Photonic technologies for quantum communication				
Subject	Photonic technologies for quantum communication			
Code	V05M198V01110			
Study programme	(*)Máster Universitario en Ciencia e Tecnoloxías de Información Cuántica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	3	Optional	1st	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Salgueiro Piñeiro, José Ramón			
Lecturers	Michinel Álvarez, Humberto Javier Salgueiro Piñeiro, José Ramón			
E-mail	jrs@uvigo.es			
Web	http://quantummastergalicia.es			
General description	(*)A asignatura proporciona os coñecementos básicos sobre dispositivos electrónicos e fotónicos necesarios nun enlace de comunicacións cuántico: láseres e outras fontes ópticas así coma fotodetectores. Tamén se estudan as características e modelos dos canais de transmisión por fibra óptica e no espazo libre			

Training and Learning Results	
Code	
A6	Know and understand the nature of the physical platforms for the processing of quantum information in photonic systems: quantum optics, integrated optical systems, opto-atomic systems, detection and measurement systems, semiconductor photonics.
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.
B7	To have knowledge of quantum optics and the role and properties of light and its manipulation in quantum information processing and communications.
B11	Knowledge of quantum communications, theoretical principles and experimental implementations, both terrestrial and aerial and via satellite.
B13	To be aware of the physical and technical limitations of the implementation of quantum information treatment systems: noise, decoherence, etc., as well as the mitigation or correction strategies that are proposed.
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
Knowledge of the basic aspects of optical sources and their applications to communications	A6 A11 B7 C1 C2 C3

Knowledge of the basics of optical communication channels, particularly optical fibres	A6 A11 B7 B13 C1 C2 C3
Knowledge of the basics of electromagnetic wave propagation through vacuum and homogeneous media	A6 A11 B7 B13 C1 C2 C3
Knowledge of single-photon production and detection techniques.	A6 A11 B7 B11 B13 C1 C2 C3
Knowledge of the quantum coding methods for the information and their applications to communications cryptography	A6 A11 B7 B11 B13 C1 C2 C3

Contents

Topic	
1. Optical sources	Einstein□s theory of radiation. Quantum theory of radiation. Lifetime of excited states. Absorption and stimulated emission. Rabi Frequency and coherent population oscillations. Linewith and broadening mechanisms. Rate equations in laser systems Gain coefficient. Homogeneous and inhomogeneous gain saturation. Laser cavities and modes. Lasing threshold and mode amplification Diode lasers fundamentals
2. Channels of transmission	Information channels of information. Codification formats. Wave propagation in homogeneous dielectric media. Gaussian beams. Optical fibres. Propagation modes. Dispersion in optical fibres. Attenuation in optical fibres.
3. Production snd detection of single photons	Photon source characteristics and characterization methods. Overview of single photon sources: parametric down conversion, four wave mixing, quantum dots. Weak coherent pulses vs single photons. Single photon detectors: photomultiplier tubes, semiconductor-based detectors, superconductor-based detectors. Optical coherent detection .
4. Main experimental platforms of QKD.	Discrete variable QKD: polarization, phase and time encoding. Continuos variable QKD: Gaussian modulation, quadrature-amplitude modulation. Fiber based QKD vs Free space QKD. Measurement device independent QKD and Twin field QKD. Device-Independent QKD.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	15	0	15
Problem solving	10	50	60

*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 lecturer presents the contents of the subject projecting the supporting graphical material and attending the questions asked by the students during the presentation.
Problem solving	The lecturer proposes different problems during the lessons, covering the contents of the subject. The students work on such problems on their own with the support of the lecturers.

Personalized assistance

Methodologies	Description
Lecturing	The lecturer answers the questions made by the students during the lesson presentation.
Problem solving	The lecturer attends the student in a personal session to answer the questions and doubts that may arise during the resolution of the problems. Attention may be life, by email or by videoconference at student request.

Assessment

	Description	Qualification	Training and Learning Results		
Lecturing	Questions or simple exercises will be proposed and asked to deliver in before an specified date	30	A6 A11	B7 B11 B13	C1 C2 C3
Problem solving	Students will have to submit, before a dead line, some of the problems proposed along the semester. The total qualification of 70% will be shared among the number of required problems which will not be less than two in order not to overpass a 35% of weight each.	70			

Other comments on the Evaluation

The student has the right to opt for the global assessment according to the procedure and the deadline established by the centre for each call._In such a case the students will take a written examination which may contain problems, exercises and questions related to the different topics of the subject.

If a student does submit none of the problems he/she will receive "not presented" mark.

Second assessment evaluation and End-of-program evaluation: both will be done in the same way as the first assessment evaluation. The students should submit the exercises and problems before the date of the official examination.

Sources of information

Basic Bibliography

Sibley, M., **Optical communications components and systems**, 3ª, Cham Springer, 2020

Svelto, O., **Principles of lasers**, 5ª, ilustrada, Springer Science & Business Media, 2010

Migdall, A. Polyakov, S. V., Fan, J., Bienfang, J. C., **Single photon generation and detection**, Academic Press;, 2013

Complementary Bibliography

Martín Pereda, J. A., **Sistemas y redes ópticas de comunicaciones**, Pearson Prentice Hall, 2004

Capmany, J., **Fundamentos de comunicaciones ópticas**, Síntesis, 1998

Cerullo, G., Longhi,S., Nisoli, M., Stagira, S., Svelto, O., **Problems in Laser Physics**, Springer Science & Business Media, 2012, 2012

Wolf, R., **Quantum Key Distribution**, Springer Science & Business Media, 2012, 2021

Feihu Xu et al., **Secure quantum key distribution with realistic devices**, Rev. Mod. Phys. 92, 025002 □ Published 26 May, 2020

Stefano Pirandola et al., **Advances in Quantum Cryptography**, Adv. Opt. Photon. 12, 1012-1236, 2020

Eleni Diamanti et al., **Practical challenges in quantum key distribution**, Quantum Information 2, 16025, 2016

Recommendations