UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Course guide
230336 - QTC - Quantum Technologies for Cybersecurity: Networks and Systems

Last modified: 17/05/2023

Unit in charge:	Barcelona School of Telecommunications Engineering
Teaching unit:	230 - ETSETB - Barcelona School of Telecommunications Engineering.
Degree:	BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Optional subject).
	BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2022   **ECTS Credits:** 2.0   **Languages:** English

LECTURER

Coordinating lecturer:	Consultar aquí / See here:
	https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura
Others:	Consultar aquí / See here:
	https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS

Solid knowledge of linear algebra, information & probability theory, telecommunication systems.

TEACHING METHODOLOGY

- Expositive and participative lectures together with example exercises solved in-class.
- Learning based on problems and projects solved individually or in groups by the student.

LEARNING OBJECTIVES OF THE SUBJECT

This seminar combines the theoretical principles of quantum information and technologies applied to quantum cybersecurity.

Objectives:
1. Understand the basic implementation principles of quantum information and technologies, applied to quantum cybersecurity and secure systems.
2. Ability to critically analyze the strengths and weaknesses of various quantum cybersecurity solutions.
3. Familiarization with the current hardware and infrastructures for real-world quantum systems, in terms of security, efficiency, and scalability.
4. Awareness of the potential applications of cybersecurity quantum technologies in various fields, such as cryptography, networking and communication systems.

STUDY LOAD

Type	Hours	Percentage
Self study	30,0	60.00
Hours large group	20,0	40.00

Total learning time: 50 h

CONTENTS

Quantum Technologies for Cybersecurity: Networks and Systems

Description:
The "Quantum Technologies for Cybersecurity: Networks and Systems" seminar aims to provide participants with a comprehensive understanding of quantum technology and its applications in cybersecurity. The seminar is divided into seven sessions, each focusing on different aspects of quantum technology and cybersecurity: Introduction to Quantum Technologies for cybersecurity, Quantum implementation aspects, Key building blocs, Quantum Technologies Ecosystem, Quantum hardware and Systems, Quantum Security: Networking and Systems, and Quantum cybersecurity perspective.

The topics proposed for the seminar, such as fundamental practical quantum physics and quantum cybersecurity applied to general communication systems and networks, provide a unique and valuable learning experience for students.

Introduction to Quantum Technologies for cybersecurity
Description:
a) The Quantum technology revolution: Quantum supremacy/detectability and Implications (Risk and opportunities) to Cybersecurity.
b) Overview of Quantum Technology application domains: Information, Computing, Communication and Sensing, Cybersecurity.
Full-or-part-time: 7h
Theory classes: 3h
Self-study: 4h

Quantum implementation aspects
Description:
a) Quantum Information principal pillars: qubit, state-vector, superposition, measurement, interference, entanglement and no-cloning.
b) Common quantum limitations and challenges: noise and loss, indistinguishability, decoherence and fidelity.
Full-or-part-time: 8h
Theory classes: 3h
Self-study: 5h

Key building blocks
Description:
a) Eavesdropping detection: Quantum key distribution - fiber & free-space, polarization and phase encoding, discrete and continuous variables.
b) Other building blocks: teleportation and entanglement-swapping.
Full-or-part-time: 8h
Theory classes: 3h
Self-study: 5h

Quantum Technologies Ecosystem
Description:
a) Migration to Post-quantum cryptography.
b) Telecommunication systems quantum cybersecurity.
Full-or-part-time: 9h
Theory classes: 3h
Self-study: 6h

Quantum hardware and systems
Description:
a) Quantum Hardware: sources, transformation modules, detectors, time-tagging units, coincidence detectors.
b) Quantum Systems: random number generators, memories, routers, repeaters and firewalls.
Full-or-part-time: 8h
Theory classes: 3h
Self-study: 5h

Quantum Security: Networking and Systems
Description:
a) Quantum internet: networking and routing.

b) Quantum secure systems: authentication and password identification.
Full-or-part-time: 8h
Theory classes: 3h
Self-study: 5h

Quantum cybersecurity perspective
Description:
a) In-class mapping of the ecosystem of quantum technologies for cybersecurity.
b) Markets and application domains.
Full-or-part-time: 2h
Theory classes: 2h
Self-study: 0h

Full-or-part-time: 50h
Theory classes: 20h
Self study : 30h

GRADING SYSTEM

- Participation in class (20%).
- Problems and/or group or individual presentation (80%).

BIBLIOGRAPHY

Basic:
- Meter, R. V.. Quantum Networking. Frist edition. London, UK: John Wiley & Sons, Inc., 2014. ISBN 9781848215375.
- Rohde, P. P. The quantum internet: the second quantum revolution. Cambridge: Cambridge University Press, 2021. ISBN 9781108491457.
- Desurvire, Emmanuel. Classical and quantum information theory: an introduction for the telecom scientist [on line]. First edition. Cambridge ; New York: Cambridge University Press, 2009 [Consultation: 17/07/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=424585. ISBN 9780521881715.
- Witte, M.. Quantum Cybersecurity: The Rise of a New Era. Inkstall Solutions LLP, 2023. ISBN 9798379032180.

Complementary:
- Sergienko, A. V.. Quantum Communications and Cryptography. London, UK: Taylor & Francis, 2006. ISBN 9780849336843.
- Nielsen, Michael A; Chuang, Isaac L. Quantum computation and quantum information . 10th anniversary ed. Cambridge, UK : Cambridge University Press, cop. 2010. ISBN 9781107002173.
- Barnett, S. M.. Quantum information. First edition. Oxford, UK: Oxford University Press, ISBN 9780198527633.
- Fox, Mark. Quantum optics : an introduction . Oxford ; New York : Oxford University Press, cop. 2006. ISBN 9780198566731.

RESOURCES

Other resources:
Scripts Python with examples and exercises available at: https://github.com/marcjofreProf/SeminarQuantumTechnologiesCybersecurity