# Course guide
# 200245 - CRIPTOL - Cryptology

**Last modified:** 11/04/2024

**Unit in charge:** School of Mathematics and Statistics
**Teaching unit:** 749 - MAT - Department of Mathematics.

**Degree:** BACHELOR'S DEGREE IN MATHEMATICS (Syllabus 2009). (Optional subject).

**Academic year:** 2024 **ECTS Credits:** 6.0 **Languages:** English

## LECTURER

**Coordinating lecturer:** CARLES PADRO LAIMON

**Others:** Primer quadrimestre:
CARLES PADRO LAIMON - M-A
JORGE LUIS VILLAR SANTOS - M-A

## PRIOR SKILLS

Some basic knowledge of algebra (group theory, finite fields, etc) and complexity theory is desirable, but not strictly required

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

**Specific:**
GM-CE2. CE-2. Solve problems in Mathematics, through basic calculation skills, taking in account tools availability and the constraints of time and resources.
GM-CE4. CE-4. Have the ability to use computational tools as an aid to mathematical processes.
GM-CE6. Ability to solve problems from academic, technical, financial and social fields through mathematical methods.

**Generical:**
GM-CB5. To have developed those learning skills necessary to undertake further interdisciplinary studies with a high degree of autonomy in scientific disciplines in which Mathematics have a significant role.
GM-CG1. CG-1. Show knowledge and proficiency in the use of mathematical language.
GM-CB4. CB-4. Have the ability to communicate their conclusions, and the knowledge and rationale underpinning these to specialist and non-specialist audiences clearly and unambiguously.
GM-CG2. CG-2. Construct rigorous proofs of some classical theorems in a variety of fields of Mathematics.
GM-CG3. CG-3. Have the ability to define new mathematical objects in terms of others already know and ability to use these objects in different contexts.
GM-CG4. CG-4. Translate into mathematical terms problems stated in non-mathematical language, and take advantage of this translation to solve them.
GM-CG6. CG-6 Detect deficiencies in their own knowledge and pass them through critical reflection and choice of the best action to extend this knowledge.

**Transversal:**
04 COE. EFFICIENT ORAL AND WRITTEN COMMUNICATION. Communicating verbally and in writing about learning outcomes, thought-building and decision-making. Taking part in debates about issues related to the own field of specialization.
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

## TEACHING METHODOLOGY

## LEARNING OBJECTIVES OF THE SUBJECT

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## STUDY LOAD

| Type | Hours | Percentage |
|---|---|---|
| Hours large group | 30,0 | 20.00 |
| Hours small group | 30,0 | 20.00 |
| Self study | 90,0 | 60.00 |

**Total learning time:** 150 h

## CONTENTS

### Introduction

**Description:**
Cryptology, cryptography and cryptanalysis. Kerckhoffs principles. Shannon theory. Ancient cryptosystems.

**Full-or-part-time:** 15h
Theory classes: 3h
Laboratory classes: 3h
Self study : 9h

### Symmetric Key Cryptography

**Description:**
Symmetric Encryption. Block ciphers. Chainning encryption modes. Practical proposals. Stream ciphers. Hash functions. Message Authentication Codes.

**Full-or-part-time:** 22h 30m
Theory classes: 4h 30m
Laboratory classes: 4h 30m
Self study : 13h 30m

### Computational Problems for Cryptography

**Description:**
Integer Factorization. Discrete Logarithm. Elliptic Curves. Subset-Sum. Codes. Lattices.

**Full-or-part-time:** 22h 30m
Theory classes: 4h 30m
Laboratory classes: 4h 30m
Self study : 13h 30m

### Public Key Cryptography

**Description:**
Key Exchange. One-way functions. Public Key Encryption. Digital Signatures. Public Key Infrastructure. Practical proposals.

**Full-or-part-time:** 22h 30m
Theory classes: 4h 30m
Laboratory classes: 4h 30m
Self study : 13h 30m

### Security Models

**Description:**
Provable Security. Security models for encryption schemes. Game sequence formalization of security proofs. Security models for digital signatures.

**Full-or-part-time:** 22h 30m
Theory classes: 4h 30m
Laboratory classes: 4h 30m
Self study : 13h 30m

### Other Cryptographic Primitives

**Description:**
Commitment Schemes. Oblivious Transfer. Secret Sharing. Zero-Knowledge proofs.

**Full-or-part-time:** 22h 30m
Theory classes: 4h 30m
Laboratory classes: 4h 30m
Self study : 13h 30m

### Advanced Topics

**Description:**
Multi-party computation. Homomorphic Encryption. Distributed Cryptography. Quantum Cryptography. Post-Quantum Cryptography.

**Full-or-part-time:** 22h 30m
Theory classes: 4h 30m
Laboratory classes: 4h 30m
Self study : 13h 30m

## GRADING SYSTEM

30% final exam, 40% final report and oral presentation, 30% deliverables

## BIBLIOGRAPHY

**Basic:**
- Delfs, Hans; Knebl, Helmut. Introduction to cryptography : principles and applications [on line]. Berlin: Springer, 2015Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=6314866. ISBN 9783662479735.
- Katz, Jonathan; Lindell, Yehuda. Introduction to modern cryptography [on line]. Boca Raton: Taylor & Francis Group, 2017Available on: https://www-taylorfrancis-com.recursos.biblioteca.upc.edu/books/mono/10.1201/9781351133036/introduction-modern-cryptography-jonathan-katz-yehuda-lindell. ISBN 9781466570269.
- Hoffstein, Jeffrey; Pipher, Jill; Silverman, Joseph H. An introduction to mathematical cryptography [on line]. New York: Springer, 2014Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-0-387-77993-5. ISBN 9781493917105.
- Galbraith, Steven D. Mathematics of public key cryptography [on line]. Cambridge University Press, 2012 [Consultation: 13/07/2022]. Available on: https://www.cambridge.org/core/books/mathematics-of-public-key-cryptography/DDDFA3874A53C4E6846EB3AB06161E43. ISBN 9781107013926.
- Koblitz, Neal. A Course in number theory and cryptography. 2nd ed. New York: Springer-Verlag, cop. 1994. ISBN 0387942939.