



POLITÉCNICA

INTERNATIONAL  
CAMPUS OF  
EXCELLENCE

COORDINATION PROCESS OF  
LEARNING ACTIVITIES  
PR/CL/001



E.T.S. de Ingeniería y Sistemas  
de Telecomunicación

# ANX-PR/CL/001-01

## LEARNING GUIDE

### SUBJECT

593000601 - Advanced Information Theory

### DEGREE PROGRAMME

59AI - Master Universitario En Comunicaciones Inalámbricas

### ACADEMIC YEAR & SEMESTER

2022/23 - Semester 1

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## 1. Description

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### 1.1. Subject details

<b>Name of the subject</b>	593000601 - Advanced Information Theory
<b>No of credits</b>	6 ECTS
<b>Type</b>	Compulsory
<b>Academic year of the programme</b>	First year
<b>Semester of tuition</b>	Semester 1
<b>Tuition period</b>	September-January
<b>Tuition languages</b>	English
<b>Degree programme</b>	59AI - Master Universitario en Comunicaciones Inalámbricas
<b>Centre</b>	59 - Escuela Tecnica Superior De Ingeniería Y Sistemas De Telecomunicación
<b>Academic year</b>	2022-23

## 2. Faculty

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### 2.1. Faculty members with subject teaching role

<b>Name and surname</b>	<b>Office/Room</b>	<b>Email</b>	<b>Tutoring hours *</b>
Jose Enrique Gonzalez Garcia (Subject coordinator)	8415	joseenrique.gonzalez@upm.es	Sin horario.
Cesar Diaz Martin	8210	cesar.diazm@upm.es	Sin horario.
Jose Luis Rodriguez Vazquez	8305	jl.rodriguez.vazquez@upm.es	Sin horario.

\* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

### 3. Prior knowledge recommended to take the subject

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#### 3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

#### 3.2. Other recommended learning outcomes

- Digital modulations, basic source coding and line coding.

### 4. Skills and learning outcomes \*

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#### 4.1. Skills to be learned

CB6 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación

CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio

CB8 - Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicios

CEM02 - Utilizar adecuadamente los códigos fuente, códigos de canal y códigos de encriptado que se necesiten en un sistema de comunicaciones inalámbrico.

CGI02 - Comprender el procedimiento, valor y límites del método científico, siendo capaz de identificar, localizar y obtener datos requeridos en un trabajo de investigación, de diseñar y guiar investigaciones analíticas, de modelado y experimentales, así como de evaluar datos de una manera crítica y extraer conclusiones.

CGI03 - Valorar la importancia de las fuentes documentales, manejarlas y buscar la información para el desarrollo de cualquier trabajo de investigación.

CGI04 - Leer y comprender publicaciones dentro de su ámbito de estudio/investigación, así como su catalogación y valor científico.

UPM1 - Uso de la lengua inglesa

UPM4 - Organización y planificación /

## 4.2. Learning outcomes

RA17 - RA02.- Apply the knowledge acquired to the understanding of qualitative and quantitative problems related to source coding and channel coding.

RA18 - RA03.- Choose the mathematical methods and tools necessary to tackle a problem and finds the solution.

RA20 - RA05.- Interpret data derived from empirical observations and measurements in terms of their importance and relate them to the appropriate theory.

RA19 - RA04.- Anticipate the behavior of a source code, channel code or encryption model and its influence on a telecommunication system.

RA16 - RA01.- Distinguish between channel codes, source codes and encryption models and their practical application.

\* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

## 5. Brief description of the subject and syllabus

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### 5.1. Brief description of the subject

This course is aimed to give students a knowledge on the principles for processing and transmission of information. An in-depth review of modern source coding, channel coding, and encryption techniques will be provided.

In source coding are included advanced audio and video coding.

In channel coding are included block and convolutional codes.

In cryptography techniques is included RSA algorithm.

Syllabus:

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#### 1. Information theory (4 H).

- Measure of information
- Entropy
- Channel model
- Mutual information
- Channel capacity
- Shannon's theorem

#### 2. Source coding: introduction (4+4 H). (2H Lab)

- Coding parameters
  - Source coding theorem
  - Classification of codes
  - Kraft inequality
  - Rate-distortion theory (4H)
3. Source coding: advanced audio coding (6 H). (2H Lab)
- Audio perceptual and statistic characteristics
  - Audio standards
4. Source coding: advanced video coding (8 H). (2H Lab)
- Video perceptual and statistic characteristics
  - Video standards
5. Channel coding: introduction (4 H).
- Code rate
  - Types of codes: block, convolution
  - Error control strategies: ARQ, FEC
  - Generator matrices and polynomials
6. Channel coding: Simple codes (4 H). (2H Lab)
- BCH, Reed-Muller, Reed-Solomon
  - Cyclic Redundancy Check (CRC)

- Low Density Parity Check Codes (LDPC)

- Hybrid Automatic Repeat Request (HARQ)

7. Channel coding: Concatenated codes (4 H). (2H Lab)

- Simple Concatenated Codes (SCC)

- Parallel Concatenated Convolutional Codes (PCCC): Turbo codes

- Serial Concatenated Convolutional Codes (SCCC)

8. Cryptography applied to wireless systems (6 H). (2H Lab)

- Plain text, cipher text, and key

- Symmetric-key cryptography

- Asymmetric-key cryptography

- RSA Algorithm

Lab sessions:

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P1: Basic algorithm design for source coding (2H).

P2: Algorithm design for advanced audio coding (2H).

P3: Algorithm design for advanced video coding (2H).

P4: Algorithm design for channel coding, block and convolution codes (4H).



P5: Algorithm design for cryptography applied to wireless systems (2H).

Note: All the Lab sessions are embedded within the theory classes.

## 5.2. Syllabus

1. Information theory (4 H).
2. Source coding: introduction (4+4 H). (2H Lab)
3. Source coding: advanced audio coding (6 H). (2H Lab)
4. Source coding: advanced video coding (8 H). (2H Lab)
5. Channel coding: introduction (4 H).
6. Channel coding: Simple codes (4 H). (2H Lab)
7. Channel coding: Concatenated codes (4 H). (2H Lab)
8. Cryptography applied to wireless systems (6 H). (2H Lab)

## 6. Schedule

### 6.1. Subject schedule\*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	<b>Tema 1 y Tema 2</b> Duration: 06:00	<b>Tema 1</b> Duration: 02:00		
2	<b>Tema 2 y Tema 3</b> Duration: 08:00			
3	<b>Tema 3 y Tema 4</b> Duration: 06:00	<b>Tema 3</b> Duration: 02:00		
4	<b>Tema 4 y Tema 5</b> Duration: 05:00	<b>Tema 4</b> Duration: 02:00		<b>Entrega trabajos relacionados con temas 1, 2, 3 y 4 .</b>  Continuous assessment and final examination Presential Duration: 01:00
5	<b>Tema 5 y Tema 6</b> Duration: 06:00	<b>Tema 6</b> Duration: 02:00		
6	<b>Tema 6 y Tema 7</b> Duration: 06:00	<b>Tema 7</b> Duration: 02:00		
7	<b>Tema 8</b> Duration: 05:00	<b>Tema 8</b> Duration: 02:00		<b>Entrega trabajos relacionados con temas 5, 6, 7 y 8.</b>  Continuous assessment and final examination Presential Duration: 01:00
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

\* The schedule is based on an a priori planning of the subject; it might be modified during the academic year,

especially considering the COVID19 evolution.

## 7. Activities and assessment criteria

### 7.1. Assessment activities

#### 7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
4	Entrega trabajos relacionados con temas 1, 2, 3 y 4 .		Face-to-face	01:00	50%	5 / 10	CGI02 CGI04 CB6 CB7 CB8 UPM5 CEM02 CGI03 UPM1 UPM4
7	Entrega trabajos relacionados con temas 5, 6, 7 y 8.		Face-to-face	01:00	50%	5 / 10	CGI02 CB6 CB7 CB8 UPM5 CEM02 CGI03 UPM1 CGI04 UPM4

#### 7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
4	Entrega trabajos relacionados con temas 1, 2, 3 y 4 .		Face-to-face	01:00	50%	5 / 10	CGI02 CGI04 CB6 CB7 CB8 UPM5 CEM02 CGI03 UPM1 UPM4

7	Entrega trabajos relacionados con temas 5, 6, 7 y 8.		Face-to-face	01:00	50%	5 / 10	CGI02 CB6 CB7 CB8 UPM5 CEM02 CGI03 UPM1 CGI04 UPM4
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### 7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

## 7.2. Assessment criteria

The teachers of the different subjects will ask the students for individual or group works, which will be graded by obtaining the grade for the two main parts of the subject. These works will be related to the knowledge studied in theory and/or in the laboratory.

If any student obtains a grade lower than 5 in any of the parts, they can recover said part in an exceptional call in January.

## 8. Teaching resources

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### 8.1. Teaching resources for the subject

Name	Type	Notes
Moodle	Web resource	Files with theory, practice scripts, notes, etc.
PC + Matlab	Equipment	Necessary for the realization of laboratory practices and simulations.
Classroom with digital screen	Equipment	Necessary for the teaching of theory. How the laboratory is embedded, the classroom must have PCs with Matlab for the students.

## 9. Other information

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### 9.1. Other information about the subject

By having to teach the classes between three teachers and in only 7 weeks we have teaching 4 days a week (two hours a day). Therefore, it is possible that in the same week several topics have to be taught simultaneously.