



POLITÉCNICA

INTERNATIONAL  
CAMPUS OF  
EXCELLENCE

COORDINATION PROCESS OF  
LEARNING ACTIVITIES  
PR/CL/001



E.T.S. de Ingenieros de  
Telecomunicacion

# ANX-PR/CL/001-01

## LEARNING GUIDE

**SUBJECT**

**93000844 - Neurosensorial Engineering**

**DEGREE PROGRAMME**

09AQ - Master Universitario En Ingenieria De Telecomunicacion

**ACADEMIC YEAR & SEMESTER**

2023/24 - Semester 1

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## 1. Description

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### 1.1. Subject details

<b>Name of the subject</b>	93000844 - Neurosensorial Engineering
<b>No of credits</b>	6 ECTS
<b>Type</b>	Optional
<b>Academic year of the programme</b>	Second year
<b>Semester of tuition</b>	Semester 3
<b>Tuition period</b>	September-January
<b>Tuition languages</b>	English
<b>Degree programme</b>	09AQ - Master Universitario en Ingenieria de Telecomunicacion
<b>Centre</b>	09 - Escuela Tecnica Superior De Ingenieros De Telecomunicacion
<b>Academic year</b>	2023-24

## 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>
Andres De Santos Lleo (Subject coordinator)	C-227	andres.santos@upm.es	Sin horario. Contact by email: andres@die.upm.es
Ricardo De Cordoba Herralde	B-108	ricardo.cordoba@upm.es	Sin horario. Contact by email

Juan Jose Gomez Valverde	C-201.B	juanjo.gomez@upm.es	Sin horario. Contact by email
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\* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

### 3. Skills and learning outcomes \*

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#### 3.1. Skills to be learned

CE15 - Capacidad para la integración de tecnologías y sistemas propios de la Ingeniería de Telecomunicación, con carácter generalista, y en contextos más amplios y multidisciplinares como por ejemplo en bioingeniería, conversión fotovoltaica, nanotecnología, telemedicina.

CG4 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades.

CG5 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CT1 - Capacidad para comprender los contenidos de clases magistrales, conferencias y seminarios en lengua inglesa.

CT4 - Capacidad para trabajar de forma efectiva como individuo, organizando y planificando su propio trabajo, de forma independiente o como miembro de un equipo.

CT5 - Capacidad para gestionar la información, identificando las fuentes necesarias, los principales tipos de documentos técnicos y científicos, de una manera adecuada y eficiente.

### 3.2. Learning outcomes

RA62 - Conocer el funcionamiento básico de los órganos sensoriales del cuerpo humano y saber analizar el funcionamiento y las posibilidades de prótesis y ayudas para discapacitados

RA26 - Capacidad para abordar la gestión de proyectos de ingeniería como un problema ético y sistémico, de tecnología, gestión y factor humano. (CG3, CT5, CT6, CE6, CE7, CE8, CE9)

RA63 - Comprender el funcionamiento, las características principales y aplicaciones de las interfaces sensoriales basadas en habla (síntesis y reconocimiento), multisensoriales y de realidad virtual

RA10 - Saber realizar una presentación de carácter técnico, ante una audiencia de pares, que describa el trabajo realizado y sus resultados, de forma clara y bien estructurada, en el tiempo establecido, y usando un lenguaje preciso

RA60 - Capacidad para entender los fundamentos del procesamiento de información en el sistema nervioso

RA9 - Saber redactar informes técnicos sobre trabajos realizados, con una estructura, contenidos y lenguaje del nivel adecuado a un trabajo de ingeniería

RA61 - Capacidad para entender el funcionamiento básico de sistemas que interactúan directamente con el sistema nervioso como interfaces cerebro-ordenador o neuroprótesis

\* 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.

## 4. Brief description of the subject and syllabus

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### 4.1. Brief description of the subject

The course studies electronic systems that interact with the human body, in particular with the nervous system and sensory organs. That includes aids to the disabled and communication systems using speech, virtual reality and brain-computer interfaces. Examples of artificial systems that emulate biological ones will also be covered.

### 4.2. Syllabus

1. Introduction
2. The nervous system
  - 2.1. Fundamentals of information processing
  - 2.2. Functional electrical stimulation and neuroprosthesis
  - 2.3. Brain-computer interfaces
  - 2.4. Introduction to nervous system modeling - Neural networks
3. Sensory systems: physiology, aids for the disabled, artificial systems
  - 3.1. Vision
  - 3.2. Hearing
  - 3.3. Touch, pain and temperature
  - 3.4. Smell and taste
4. Multisensory user interfaces
  - 4.1. Speech synthesis and recognition
  - 4.2. Alternative and augmentative communication
  - 4.3. Virtual reality

## 5. Schedule

### 5.1. Subject schedule\*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	<b>Module 1</b> Duration: 01:00 Lecture  <b>Module 2.1</b> Duration: 03:00 Lecture			
2	<b>Module 2.2</b> Duration: 04:00 Lecture			
3	<b>Module 2.3</b> Duration: 04:00 Lecture			<b>Participation and exercises in the class room</b> Other assessment Continuous assessment Presential Duration: 00:00
4	<b>Module 3.1</b> Duration: 04:00 Lecture			
5	<b>Module 3.1</b> Duration: 04:00 Lecture			
6	<b>Teamwork preparation</b> Duration: 02:00 Cooperative activities			<b>1st partial exam</b> Written test Continuous assessment Presential Duration: 02:00
7	<b>Module 2.4</b> Duration: 02:00 Lecture  <b>Module 3.2</b> Duration: 02:00 Lecture			
8	<b>Module 3.2</b> Duration: 04:00 Lecture			
9	<b>Module 3.3</b> Duration: 02:00 Lecture  <b>Module 3.4</b> Duration: 02:00 Lecture			

10	<b>Module 4.1</b> Duration: 04:00 Lecture			
11	<b>Module 4.1</b> Duration: 04:00 Lecture			<b>Participation and exercises in the class room</b> Other assessment Continuous assessment Presential Duration: 00:00
12	<b>Module 4.2</b> Duration: 02:00 Lecture  <b>Module 4.3</b> Duration: 02:00 Lecture			
13	<b>Teamwork preparation</b> Duration: 02:00 Cooperative activities			<b>2nd partial exam</b> Written test Continuous assessment Presential Duration: 02:00
14				<b>Teamwork</b> Group work Continuous assessment Presential Duration: 04:00  <b>Teamwork</b> Group work Final examination Presential Duration: 04:00
15				
16				
17				<b>Final exam</b> Written test Final examination Presential Duration: 04:00

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.



## 6. Activities and assessment criteria

### 6.1. Assessment activities

#### 6.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
3	Participation and exercises in the class room	Other assessment	Face-to-face	00:00	5%	0 / 10	CE15
6	1st partial exam	Written test	Face-to-face	02:00	35%	0 / 10	CT1 CE15
11	Participation and exercises in the class room	Other assessment	Face-to-face	00:00	5%	0 / 10	CE15
13	2nd partial exam	Written test	Face-to-face	02:00	35%	0 / 10	CE15 CT5 CT1
14	Teamwork	Group work	Face-to-face	04:00	20%	2 / 10	CG5 CT4 CE15 CG4 CT5

#### 6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
14	Teamwork	Group work	Face-to-face	04:00	20%	2 / 10	CG5 CT4 CE15 CG4 CT5
17	Final exam	Written test	Face-to-face	04:00	80%	5 / 10	CE15 CT5 CT1

#### 6.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Teamwork	Group work	Face-to-face	04:00	20%	2 / 10	CG5 CT4 CE15 CG4 CT5
Final exam	Written test	Face-to-face	04:00	80%	5 / 10	CE15 CT5 CT1

## 6.2. Assessment criteria

The course will be passed when a grade higher than or equal to 5 points out of a total of 10 is obtained, provided that the minimum grade has been obtained in the activities that do have a minimum requirement (otherwise the grade cannot be higher than 4.5)

Evaluation will assess whether the students have acquired all the competences of the subject. Thus, evaluation through final or extraordinary assessments will be carried out considering all the evaluation techniques used in continuous evaluation and will be celebrated in the exam period approved by Junta de Escuela for the current academic semester and year. Evaluation activities that assess learning outcomes that cannot be evaluated through a single exam can be carried out along the semester.

Specifically, the evaluation will include the realization and presentation of a team work as a mandatory activity not recoverable, since the work must be presented in public to all the students and everybody must participate in the debate that arises (competences CT4 and CG4). Thus at the end of each oral presentation a debate will be initiated during which students must demonstrate that they have understood the sentences written in their work.

### Progressive evaluation:

This is the recommended method. It includes:

- Participation and exercises during the classes (10%)
- 1st partial exam (35%)
- 2nd partial exam (35%)
- Teamwork: written text and oral presentation of a case study selected by the students in teams of two (20%)

## Global exam

To take a final exam the students must have previously presented the written and oral teamwork (with the same regulations and dates of the progressive evaluation).

The global evaluation exam will deal with the entire syllabus of the course. A written request to take this exam must be presented at least two weeks before the scheduled date.

## Extraordinary (re-sit) assessment

To take this exam the students must have previously presented the written and oral teamwork (with the same regulations and dates of the progressive evaluation).

This exam will deal with the entire syllabus of the course.

## 7. Teaching resources

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### 7.1. Teaching resources for the subject

Name	Type	Notes
Neuroscience. Exploring the brain	Bibliography	M. Bear, B. Connors, M. Paradiso. Neuroscience. Exploring the brain. Lippincott Williams & Wilkins. (3rd ed.). 2006. ISBN: 978-0781760034
Slides used in the classes	Web resource	Available in moodle
Neural engineering	Bibliography	Supplementary material  B. He. Neural Engineering (2nd ed.). Springer- Verlag. 2013. ISBN: 978-1461452263
Neuroscience	Bibliography	Supplementary material  D. Purves et al. Neuroscience. Palgrave Macmillan (5th ed.). 2012. ISBN: 978-0878939671

## 8. Other information

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### 8.1. Other information about the subject

This course is related to United Nations' Sustainable Development Goals, in particular goal SDG3: Ensure healthy lives and promote well-being for all at all ages; goal SDG4: Quality education, and goal SDG9: industry, innovation & infrastructure