



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 Ingeniería de Telecomunicacion

### ACADEMIC YEAR & SEMESTER

2019/20 - 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>	2019-20

## 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

\* 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

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

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

\* 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	Face-to-face classroom activities	Face-to-face laboratory activities	Other face-to-face activities	Assessment activities
1	<b>Module 1</b> Duration: 02:00 Lecture  <b>Module 1</b> Duration: 02:00 Cooperative activities			
2	<b>Module 2.1</b> Duration: 04:00 Lecture			
3	<b>Module 2.2</b> Duration: 04:00 Lecture			
4	<b>Module 2.3</b> Duration: 04:00 Lecture			
5	<b>Module 2.4</b> Duration: 03:00 Lecture  <b>Module 2.4</b> Duration: 01:00 Problem-solving class			
6	<b>Module 3.1</b> Duration: 04:00 Lecture			<b>Participation and exercises in the class room</b> Other assessment Continuous assessment Duration: 00:00
7	<b>Teamwork preparation</b> Duration: 02:00 Cooperative activities			<b>1st partial exam</b> Written test Continuous assessment Duration: 02:00
8	<b>Module 3.2</b> Duration: 04:00 Lecture			
9	<b>Module 3.2</b> Duration: 04:00 Lecture			
10	<b>Module 3.3</b> Duration: 02:00 Lecture  <b>Module 3.4</b> Duration: 02:00 Lecture			

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

The independent study hours are training activities during which students should spend time on individual study or individual assignments.

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 subject schedule is based on a previous theoretical planning of the subject plan and might go through experience some unexpected changes along throughout the academic year.



## 6. Activities and assessment criteria

### 6.1. Assessment activities

#### 6.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
6	Participation and exercises in the class room	Other assessment	Face-to-face	00:00	5%	/ 10	CE15
7	1st partial exam	Written test	Face-to-face	02:00	35%	2 / 10	CT1 CE15
12	Participation and exercises in the class room	Other assessment	Face-to-face	00:00	5%	/ 10	CE15
14	Teamwork	Group work	Face-to-face	04:00	20%	2 / 10	CG5 CT4 CG4 CT5 CE15
15	2nd partial exam	Written test	Face-to-face	02:00	35%	2 / 10	CT5 CT1 CE15

#### 6.1.2. Final 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 CG4 CT5 CE15
15	Final exam	Written test	Face-to-face	04:00	80%	2 / 10	CT5 CT1 CE15

#### 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	CT4 CG4 CT5 CE15 CG5
Final exam	Written test	Face-to-face	04:00	80%	2 / 10	CT5 CT1 CE15

## 6.2. Assessment criteria

Students will be qualified through continuous evaluation by default. According to the "Normativa de Evaluación del Aprendizaje de la Universidad Politécnica de Madrid", students willing to renounce to continuous evaluation must present a written application in the School's Secretary before the end of the 3rd week of the semester.

Evaluation will assess if students have acquired all the competences of the subject. Thus, evaluation through final assessment will be carried out considering all the evaluation techniques used in continuous evaluation (EX, ET, TG, etc.), 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.

Extraordinary examination will be carried out exclusively by the final examination method.

Continuous evaluation:

This is the default and the recommended method. It comprises:

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

Final assessment:

The students that renounce to continuous evaluation (by presenting the written application on time) will be

evaluated with a final exam plus the written and oral presentation of the teamwork (in the same conditions and dates that the other students)

## 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