



POLITÉCNICA

INTERNATIONAL
CAMPUS OF
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COORDINATION PROCESS OF
LEARNING ACTIVITIES
PR/CL/001



E.T.S. de Ingenieros de
Telecomunicacion

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000974 - Advanced Methods In Medical Signals And Images

DEGREE PROGRAMME

09AU - Master Universitario En Ingenieria Biomedica

ACADEMIC YEAR & SEMESTER

2023/24 - Semester 1

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1. Description

1.1. Subject details

Name of the subject	93000974 - Advanced Methods In Medical Signals And Images
No of credits	3 ECTS
Type	Optional
Academic year of the programme	First year
Semester of tuition	Semester 1
Tuition period	September-January
Tuition languages	English
Degree programme	09AU - Master Universitario en Ingenieria Biomedica
Centre	09 - Escuela Tecnica Superior De Ingenieros De Telecomunicacion
Academic year	2023-24

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Maria Jesus Ledesma Carbayo	C-201.A	mj.ledesma@upm.es	Sin horario. Contact by email
Andres De Santos Lleo (Subject coordinator)	C-227	andres.santos@upm.es	Sin horario. Contact by email: andres@die.upm.es

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

2.3. External faculty

Name and surname	Email	Institution
Juan Enrique Ortuño Fisac	je.ortuno@upm.es	CIBER-BBN

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

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

3.2. Other recommended learning outcomes

- Basic knowledge of Matlab
- Basic knowledge of medical images

4. Skills and learning outcomes *

4.1. Skills to be learned

CB06 - 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

CB07 - 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

CB08 - 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

CB09 - 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

CB10 - 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.

CE-MIB01 - Utilizar el lenguaje especializado empleado en entornos biomédicos y los fundamentos de las ciencias biomédicas para su aplicación en la resolución de problemas médicos de la Ingeniería Biomédica.

CE-MIB08 - Identificar y utilizar los métodos y técnicas actuales en el procesamiento de señal para el análisis y diseño de sistemas avanzados de procesamiento de señales biomédicas

CE-MIB09 - Analizar, aplicar y proponer métodos y técnicas de generación y procesamiento de imagen para el análisis, diseño e innovación de sistemas avanzados de imágenes biomédicas

CG-MIB01 - Resolver problemas e integrar conocimiento en temas nuevos o escasamente definidos y en entornos multidisciplinares del área de la Ingeniería Biomédica

CG-MIB02 - Analizar y aplicar la reglamentación correspondiente a la sensibilidad social y ética en los ámbitos de operación que pueden darse en Ingeniería Biomédica

CG-MIB03 - Utilizar la filosofía, el método científico y el método experimental para la búsqueda de innovación, la curiosidad científica y el desarrollo de actitudes creativas

CG-MIB04 - Utilizar las tecnologías de la información y la comunicación para la búsqueda de información, datos bibliográficos y adquisición de nuevo conocimiento para la formación permanente y el trabajo autónomo

CG-MIB05 - Utilizar técnicas de expresión oral y escrita para comunicar trabajos y conclusiones a comunidades de iguales o divulgación científica, elaboración de artículos, manuales de estilo y herramientas de edición para fomentar la capacidad de comunicación y diseminación de resultados

CG-MIB06 - Aplicar técnicas de trabajo colaborativo en equipos multidisciplinares internacionales y liderazgo, así como utilizar métodos para asumir la responsabilidad de orientar y dirigir trabajos científicos en el ámbito de la ingeniería Biomédica

CG-MIB07 - Utilizar la lengua inglesa como herramienta de trabajo

4.2. Learning outcomes

RA32 - Análisis y aplicación de técnicas avanzadas de diagnóstico médico mediante imagen y señal para obtención no invasiva de información sobre el funcionamiento o actividad biológica de un tejido u órgano. El conocimiento teórico se aplicará de forma práctica en el desarrollo de algoritmos de procesamiento utilizados en el análisis y visualización de las imágenes y señales biomédicas

* 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

5.1. Brief description of the subject

The course studies advanced techniques to analyze and process biomedical images and signals to obtain information about the function or the activity of tissues and organs. This information will be useful for medical diagnosis or for therapy planning and follow-up. The theoretical knowledge will be applied practically by developing algorithms for the analysis and visualization of images and signals in real cases.

5.2. Syllabus

1. Introduction to techniques for image and signal acquisition, processing and analysis
2. Processing of biomedical signals and images: segmentation and registration
3. Machine learning / Deep learning: application to the analysis of biomedical images and signals
4. Advanced topics in Magnetic Resonance Imaging: instrumentation, fast acquisition, functional images, diffusion and perfusion

6. Schedule

6.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	Module 1 Duration: 02:00 Lecture Module 2 Duration: 02:00 Lecture			
2	Module 2 Duration: 02:00 Lecture Module 2 Duration: 02:00 Lecture			Practical exercise: image segmentation Group work Continuous assessment and final examination Not Presential Duration: 04:00
3	Module 3 Duration: 02:00 Lecture	Exercise Tutoring Duration: 02:00 Laboratory assignments		Practical exercise: clustering Group work Continuous assessment and final examination Not Presential Duration: 04:00
4	Module 3 Duration: 02:00 Lecture Module 3 Duration: 02:00 Lecture			
5	Module 3 Duration: 02:00 Lecture	Exercise Tutoring Duration: 02:00 Laboratory assignments		Practical exercise: deep learning 1 Group work Continuous assessment and final examination Not Presential Duration: 04:00
6	Module 4 Duration: 02:00 Lecture	Exercise Tutoring Duration: 02:00 Laboratory assignments		Practical exercise: deep learning 2 Group work Continuous assessment and final examination Not Presential Duration: 04:00
7	Module 4 Duration: 02:00 Lecture	Exercise Tutoring Duration: 02:00 Laboratory assignments		Practical exercise: MRI reconstruction Group work Continuous assessment and final examination Not Presential Duration: 04:00

8				
9				
10				
11				
12				
13				
14				
15				
16				
17				<p>Written exam Written test Continuous assessment Presential Duration: 03:00</p> <p>Global exam Written test Final examination Presential Duration: 03:00</p>

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
2	Practical exercise: image segmentation	Group work	No Presential	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB04 CG-MIB06 CG-MIB07 CG-MIB01 CE-MIB09
3	Practical exercise: clustering	Group work	No Presential	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB03 CG-MIB04 CG-MIB06 CG-MIB07 CG-MIB01 CE-MIB09
5	Practical exercise: deep learning 1	Group work	No Presential	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB04 CG-MIB06 CG-MIB07 CG-MIB01 CE-MIB08 CE-MIB09
6	Practical exercise: deep learning 2	Group work	No Presential	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB04 CG-MIB06 CG-MIB07 CG-MIB01 CE-MIB08 CE-MIB09

7	Practical exercise: MRI reconstruction	Group work	No Presential	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB03 CG-MIB04 CG-MIB07 CG-MIB01 CE-MIB08 CE-MIB09
17	Written exam	Written test	Face-to-face	03:00	50%	3.5 / 10	CB07 CB09 CB08 CB10 CG-MIB03 CG-MIB05 CG-MIB07 CG-MIB01 CG-MIB02 CE-MIB01 CE-MIB09

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
2	Practical exercise: image segmentation	Group work	No Presential	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB04 CG-MIB06 CG-MIB07 CG-MIB01 CE-MIB09
3	Practical exercise: clustering	Group work	No Presential	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB03 CG-MIB04 CG-MIB06 CG-MIB07 CG-MIB01 CE-MIB09
5	Practical exercise: deep learning 1	Group work	No Presential	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB04 CG-MIB06 CG-MIB07 CG-MIB01 CE-MIB08 CE-MIB09

6	Practical exercise: deep learning 2	Group work	No Presential	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB04 CG-MIB06 CG-MIB07 CG-MIB01 CE-MIB08 CE-MIB09
7	Practical exercise: MRI reconstruction	Group work	No Presential	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB03 CG-MIB04 CG-MIB07 CG-MIB01 CE-MIB08 CE-MIB09
17	Global exam	Written test	Face-to-face	03:00	50%	3.5 / 10	CB07 CB09 CB08 CB10 CG-MIB05 CG-MIB07 CG-MIB01 CG-MIB02 CE-MIB01 CE-MIB09

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Final exam	Written test	Face-to-face	03:00	50%	5 / 10	CB07 CB09 CB08 CB10 CG-MIB05 CG-MIB07 CG-MIB01 CG-MIB02 CE-MIB01 CE-MIB09

Practical exercise: image segmentation	Group work	Face-to-face	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB04 CG-MIB06 CG-MIB07 CG-MIB01 CE-MIB09
Practical exercise: clustering	Group work	Face-to-face	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB04 CG-MIB06 CG-MIB07 CG-MIB01 CE-MIB09
Practical exercise: deep learning 1	Group work	Face-to-face	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB03 CG-MIB04 CG-MIB06 CG-MIB07 CG-MIB01 CE-MIB08 CE-MIB09
Practical exercise: deep learning 2	Group work	Face-to-face	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB04 CG-MIB06 CG-MIB07 CG-MIB01 CE-MIB08 CE-MIB09
Practical exercise: MRI reconstruction	Group work	Face-to-face	04:00	10%	2 / 10	CB06 CB07 CB10 CG-MIB03 CG-MIB04 CG-MIB06 CG-MIB07 CG-MIB01 CE-MIB09

7.2. Assessment criteria

The course is 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 progressive evaluation and will be celebrated in the exam period approved by Junta de Escuela for the current academic semester and year.

The five exercises are compulsory and their minimum grade has to be reached to pass the course.

Progressive evaluation:

This is the default and the recommended method. The grade includes:

- Five practical exercises (50 %)
- One exam (50 %).

Global evaluation exam:

To take a final exam the students must have previously presented the five practical exercises. The grade includes:

- Five practical exercises (50 %)
- One exam (50 %).

The global evaluation exam will deal with the entire syllabus of the course.

Extraordinary (resit) examination

In case that any of the 5 exercises has not been presented during the ordinary period, an alternative exercise will be proposed and should be presented before the exam day. The grade includes:

- Five practical exercises (50 %)
- One exam (50 %).

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

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Slides used in the class room	Others	Available in moodle
Suetens P. "Fundamentals of Medical Imaging". 2nd ed. Cambridge Univ. Press. 2009.	Bibliography	
Prince J.L., Links J.M. "Medical Imaging Signals and Systems". Pearson, 2013	Bibliography	
Text and data for the exercises	Others	Available in moodle

9. Other information

9.1. Other information about the subject

This course is related to United Nations' Sustainable Development Goals, in particular goal 3: Ensure healthy lives and promote well-being for all at all ages, and goal 4: Quality education