ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000974 - Advanced Methods In Signal And Medical Images

DEGREE PROGRAMME

09AU - Master Universitario en Ingenieria Biomedica

ACADEMIC YEAR & SEMESTER

2020/21 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	93000974 - Advanced Methods In Signal And Medical Images
No of credits	3 ECTS
Type	Optional
Academic year ot 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	2020-21

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
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.

2.2. Research assistants

Name and surname	Email	Faculty member in charge
Bermejo Pelaez, David	david.bermejo@upm.es	Santos Lleo, Andres De

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

RA93 - Being able to identify and analyze trends in the design of clinical and research state-of-the-art systems that include signal and image processing techniques

RA77 - Be able to analyze and apply current methods and techniques in image processing for the analysis and design of advanced systems of generation and processing of biomedical images.

RA94 - Learning advanced image and signal processing techniques for non-invasive acquisition of information on biological activity, for diagnosis or therapy monitoring

RA72 - Apply methods and algorithms appropriate for intelligent analysis of medical data

* 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. Advanced topics in Magnetic Resonance Imaging: instrumentation, fast acquisition, functional images, diffusion and perfusion

4. Machine learning / Deep learning: application to the analysis of biomedical images and signals

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Distant / On-line	Assessment activities
1	**Module 1** Duration: 02:00 Lecture **Module 2** Duration: 02:00 Lecture			**Practical exercise: image segmentation 1** Individual work Continuous assessment Not Presential Duration: 04:00 **Exercises** Individual work Final examination Not Presential Duration: 04:00
2	**Module 2** Duration: 02:00 Lecture **Module 2** Duration: 02:00 Lecture			**Practical exercise: image segmentation 2** Individual work Continuous assessment Not Presential Duration: 04:00 **Exercises** Individual work Final examination Not Presential Duration: 04:00
3	**Module 3** Duration: 02:00 Lecture **Module 3** Duration: 02:00 Lecture			**Simulation exercise: MRI acquisition** Individual work Continuous assessment Not Presential Duration: 04:00 **Exercises** Individual work Final examination Not Presential Duration: 04:00
4	**Module 4** Duration: 02:00 Lecture			**1st partial exam** Written test Continuous assessment Presential Duration: 02:00 **Practical exercise: machine learning 1** Individual work Continuous assessment Not Presential Duration: 04:00 **Exercises** Individual work Final examination Not Presential Duration: 04:00

5	**Module 4** Duration: 02:00 Lecture **Module 4** Duration: 02:00 Lecture			**Practical exercise: machine learning 2** Individual work Continuous assessment Not Presential Duration: 04:00 **Exercises** Individual work Final examination Not Presential Duration: 04:00
6	**Module 4** Duration: 02:00 Lecture **Seminar and/or external visit** Duration: 02:00 Additional activities			
7				**2nd partial exam** Written test Continuous assessment Presential Duration: 02:00
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				**Final exam** Written test Final examination Presential Duration: 03:00

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.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
1	Practical exercise: image segmentation 1	Individual work	No Presential	04:00	10%	2 / 10	CE-MIB09 CG-MIB04
2	Practical exercise: image segmentation 2	Individual work	No Presential	04:00	10%	2 / 10	CG-MIB04 CE-MIB09 CB07
3	Simulation exercise: MRI acquisition	Individual work	No Presential	04:00	10%	2 / 10	CG-MIB04 CE-MIB08 CE-MIB09
4	1st partial exam	Written test	Face-to-face	02:00	25%	2 / 10	CE-MIB08 CE-MIB09 CB07
4	Practical exercise: machine learning 1	Individual work	No Presential	04:00	10%	2 / 10	CG-MIB04 CE-MIB09 CB07
5	Practical exercise: machine learning 2	Individual work	No Presential	04:00	10%	2 / 10	CG-MIB03 CG-MIB04 CE-MIB08 CE-MIB09
7	2nd partial exam	Written test	Face-to-face	02:00	25%	2 / 10	CE-MIB08 CE-MIB09 CB07

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
1	Exercises	Individual work	No Presential	04:00	10%	2 / 10	CG-MIB04 CE-MIB09
2	Exercises	Individual work	No Presential	04:00	10%	2 / 10	CG-MIB04 CE-MIB09 CB07
3	Exercises	Individual work	No Presential	04:00	10%	2 / 10	CG-MIB04 CE-MIB08 CE-MIB09

4	Exercises	Individual work	No Presential	04:00	10%	2 / 10	CG-MIB04 CE-MIB09 CB07
5	Exercises	Individual work	No Presential	04:00	10%	2 / 10	CE-MIB08 CE-MIB09 CG-MIB03 CG-MIB04
17	Final exam	Written test	Face-to-face	03:00	50%	4 / 10	CE-MIB08 CE-MIB09 CB07

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%	4 / 10	CE-MIB08 CE-MIB09 CB07
Exercises	Individual work	No Presential	20:00	50%	3 / 10	CG-MIB03 CG-MIB04 CB07 CE-MIB08 CE-MIB09

7.2. 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 in the same conditions of the final assessment.

Continuous evaluation:

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

- Exercises (50 %)
- Both partial exams (50 %).

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 presentation of the 5 practical exercises (in the same conditions and dates as the other students)

Resit examination

It will be similar to the final assessment, including a final exam plus the 5 practical exercises (in the same conditions and dates as the other students)

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

In case that the authorities requiere to continue the course on line, the students will be provided with the necessary material, including videos, papers, links, etc. Zoom and teams could also be used to facilitate the communication.

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