ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000968 - Biomedical Signals

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	93000968 - Biomedical Signals
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 *
Ignacio Oropesa Garcia (Subject coordinator)	D-213	i.oropesa@upm.es	Th - 10:00 - 11:00 It is necessary first to schedule an appointment via email.
Bryan Strange	CTB	bryan.strange@upm.es	Tu - 10:00 - 11:00 It is necessary first to schedule an appointment via email.

Miguel Angel Muriel Fernandez	B-118	m.muriel@upm.es	M - 13:00 - 14:00 It is necessary first to schedule an appointment via email.

* 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

3.1. Recommended (passed) subjects

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

3.2. Other recommended learning outcomes

- Notions on signals, systems and statistics are desired.

- Students should be comfortable using MATLAB, or else should learn how to use it during the course.

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-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

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

RA67 - Perform PSD estimations on different biomedical signals

RA65 - Enumerate the main devices used for the acquisition and processing of biomedical signals

RA68 - Perform and interpret time-frequency analysis of different biomedical signals

RA66 - Apply different noise filtering techniques to biomedical signals

RA64 - Describe the underlying physiological principles of different biomedical signals

RA70 - Identify the main biomedical signals by nature and/or the absence/presence of anomalies

RA71 - Extract insights and conclusions from the results obtained by applying different processing techniques to biomedical signals

* 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 main goal of this course is to provide the student with the tools and competences (1) to identify and interpret the main biomedical signals of the human body and (2) to process said signals to aid in their analysis.

The course is divided in two main blocks:

BLOCK 1: Biomedical signals. In this block, the student will study the underlying physiological principles and the means to acquire the most important biomedical signals, as well as to interpret and characterise them.

- Unit 1: Biomedical signals: EEG, evoked potentials, EMG, ECG.

BLOCK 2: Processing of biomedical signals. In this block, the student will learn and apply different algorithms for processing biomedical signals.

- Unit 2: Signal processing fundamentals - signals, systems and stochastic processes
- Unit 3: Noise filtering - Time domain filters, frequency domain filters, separation of mixed signals, etc.
- Unit 4: Spectral analysis - periodogram analysis

- Unit 5: Time-frequency analysis - STFT, wavelet analysis
- Unit 6: Event detection - Connectivity

5.2. Syllabus

1. Biomedical signals
2. Signal processing fundamentals
3. Noise filtering
4. Spectral analysis
5. Time-frequency analysis
6. Event detection

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Distant / On-line	Assessment activities
1	**Course presentation and introduction to biomedical signals** Duration: 02:00 Lecture **Unit 1** Duration: 02:00 Lecture			**Attendance and participation** Other assessment Continuous assessment Presential Duration: 00:00
2	**Unit 1** Duration: 02:00 Lecture **Unit 1** Duration: 02:00 Lecture			
3	**Unit 2** Duration: 02:00 Lecture **Unit 2** Duration: 02:00 Lecture			
4	**Unit 2** Duration: 02:00 Lecture **Unit 3** Duration: 02:00 Lecture			
5	**Unit 4** Duration: 02:00 Lecture	**Practical session 1** Duration: 02:00 Laboratory assignments		
6	**Unit 5** Duration: 02:00 Lecture	**Practical session 2** Duration: 02:00 Laboratory assignments		**Practical session 1 - Report** Group work Continuous assessment Not Presential Duration: 15:00
7	**Unit 6** Duration: 02:00 Lecture	**Practical session 3** Duration: 02:00 Laboratory assignments		**Practical session 2 - Report** Group work Continuous assessment Not Presential Duration: 10:00

8				**Practical session 3 - Report** Group work Continuous assessment Not Presential Duration: 10:00 **Exam** Written test Continuous assessment Presential Duration: 02:00 **Exam** Written test Final examination Presential Duration: 02:00 **Practical session reports** Individual work Final examination Not Presential Duration: 35:00
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. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
1	Attendance and participation	Other assessment	Face-to-face	00:00	10%	0 / 10	CG-MIB05 CG-MIB07 CB08 CB09
6	Practical session 1 - Report	Group work	No Presential	15:00	30%	4 / 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CB06 CB07 CB08 CB09 CB10 CE-MIB08
7	Practical session 2 - Report	Group work	No Presential	10:00	20%	4 / 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CB06 CB07 CB08 CB09 CB10 CE-MIB08
8	Practical session 3 - Report	Group work	No Presential	10:00	20%	4 / 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CB06 CB07 CB08 CB09 CB10

							CE-MIB08
8	Exam	Written test	Face-to-face	02:00	30%	3 / 10	CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB09 CE-MIB08

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
8	Exam	Written test	Face-to-face	02:00	75%	5 / 10	CG-MIB02 CB06 CB07 CB09 CE-MIB08 CG-MIB07 CG-MIB01
8	Practical session reports	Individual work	No Presential	35:00	25%	4 / 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CB06 CB07 CB08 CB09 CB10 CE-MIB08

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills

Exam	Written test	Face-to-face	03:00	90%	4 / 10	CG-MIB07 CG-MIB02 CB06 CB07 CB09 CE-MIB08
Practical session reports	Individual work	Face-to-face	35:00	10%	4 / 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CB06 CB07 CB08 CB09 CB10 CE-MIB08

7.2. Assessment criteria

General dispositions

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 send an email via Moodle to the coordinator before three weeks have passed from the beginning of the course.

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 assessment

In order to pass the course, students must hand in time the 3 practical session reports and obtain a minimum score of 4/10 on each of them. The weight on the final score of these reports is 70%.

Individual work will be assessed with a final exam carrying a weight of 30% on the final score. Minimum score is set to 3/10.

Passing score for the whole course is 5/10.

Assistance to practical sessions is compulsory. In case of unjustified absence, students will be penalised with up to 2 points out of 10.

Delays in handing in of reports will be penalised with up to 2 points out of 10. Detection of copy will be cause for failing the activity for all parts implied.

Attendance and participation may be used by teachers to provide a bonus on the final score. This bonus will not in any case surpass a 10% weight of the total assessment. Maximum score in the course is 10/10.

Students who do not reach the passing score via continuous assessment will be able to do so in the extraordinary

examination.

Final assessment

Final assessment is based on an exam, with a weight of 75% over the final score. Students will need to attain a score of 5 or above to pass the course.

Students must hand in the 3 practical session reports, which, unless otherwise specified by the course teachers, they will carry out on their own. These will be taken into account as part of the assessment and have a weight of 25%. A minimum score of 4/10 in average is required.

Students who do not reach the passing score via final assessment will be able to do so in the extraordinary examination.

Extraordinary assessment

Extraordinary assessment is based mainly on an exam. Students will need to attain a score of 4 or above to pass the course.

For students in continuous assessment, scores on practical cases will be kept. In this case, the weight of the exam will be of 30%. In case students give up the practical session scores or do not achieve the minimum score required

on them, exam weight will be 100%.

For students in final assessment, scores on practical cases will be kept. In this case, the weight of the exam will be of 75%. In case students give up the practical session scores or do not achieve the minimum score required on them, exam weight will be 100%.

Students who did not concur to continuous/final assessment must hand in the 3 practical session reports, which they will carry out on their own. These will be taken into account as part of the assessment and have a weight of 10%. A minimum score of 4/10 in average is required.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Rangayyan RM. Biomedical signal analysis. 2nd ed. IEEE Press - Wiley; 2015	Bibliography	Reference book for the course.
Sörnmo L, Laguna P. Bioelectrical signal processing in cardiac and neurological applications. Elsevier Inc. / Academic Press; 2005	Bibliography	Advanced book on biomedical signal processing.

Oppenheim AV, Willsky A. Signals and Systems, Prentice Hall; 1997	Bibliography	Classic treaty on signals and systems. Recommended for students with no baclground on signal processing.
Oppenheim AV, Schafer RW. Discrete-Time Signal Processing, 3rd Ed., Prentice Hall; 2019	Bibliography	Basic treaty on digital signal processing.
Roberts MJ. Signals and Systems Analysis Using Transform Methods and MATLAB®, 2nd Ed, McGraw-Hill; 2012	Bibliography	
Bronzino JD. The Biomedical Engineering Handbook (2nd ed), Bronzino JD. (ed), CRC Press LLC; 2000	Bibliography	
MATLAB + EEGLAB	Others	Software to carry out the course's practical sessions.

9. Other information

9.1. Other information about the subject

It is recommended that students bring their own laptops to practical sessions, with Matlab R2017 or higher running on them, as well as EEGLAB and Wavelets toolbox (both available from Matlab add-ons).

This course is related with Sustainable Development Goals **SDG3** (Good health and well-being: ensure healthy lives and promote well-being for all at all ages) and **SDG4** (Quality education: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all).