ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000978 - Biomedical Signals Laboratory

DEGREE PROGRAMME

09AU - Master Universitario en Ingenieria Biomedica

ACADEMIC YEAR & SEMESTER

2020/21 - Semester 2

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	93000978 - Biomedical Signals Laboratory
No of credits	3 ECTS
Type	Optional
Academic year ot the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
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 *
Daniel Gonzalez Nieto	035(ETSIT)/CTB	daniel.gonzalez.nieto@upm.es	Tu - 09:00 - 10:00 Appointments must be made via email with the professor.
Ignacio Oropesa Garcia (Subject coordinator)	D-213, ETSIT	i.oropesa@upm.es	Th - 10:00 - 11:00 Appointments must be made via email with the professor.

Maria Fernanda Cabrera Umpierrez		mf.cabrera@upm.es	Sin horario. Appointments must be made via email with the professor.

* 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

- SeÑales BiomÉdicas

3.2. Other recommended learning outcomes

- Basic MATLAB knowledge is necessary to successfully complete 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.

CG-MIB01 - Resolver problemas e integrar conocimiento en temas nuevos o escasamente definidos y en entornos multidisciplinares del área de la 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 por imagen y señal para obtención no invasiva de información sobre el funcionamiento o actividad biológica de un tejido u órgano, con especial énfasis en el diagnóstico de patologías cardiovasculares y cerebrales. El conocimiento teórico se aplicará de forma práctica en el desarrollo de algoritmos de procesamiento utilizados en el análisis y visualización de las imágenes

RA110 - To acquire biomedical signals such as ECG in real subjects

RA109 - To develop teamwork capabilities in the pursuit of completing an assignment, from the planning and documentation phase to the presentation of results

RA111 - To apply advanced signal processing techniques for the resolution of biomedical signal problems

RA112 - To develop the ability for oral communication of results

RA113 - To identify different biomedical signal patterns both from healthy and pathological subject records, based on visual inspection and signal processing

* 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 goal of the course is to apply the most important concepts taught in Biomedical Signal Processing using real biomedical signal recordings. The student will work either with their own biomedical registries (acquired during class time using different acquisition systems) or extracted from a physiological signal database. In this way, the student will develop the basic tools to face future challenges related to biomedical signal processing.

The course is structured in 5 laboratory sessions:

Session 1 - Introduction to MATLAB applied to biomedical signal processing: In this session, students will practice on the basic MATLAB commands necessary for signal processing and analysis. For this, students will work both with deterministic signals and EMG signals.

Session 2 - Analysis of conductance / voltage and kinetic relationships activation in ionic channels: This session is aimed at understanding the activation mechanisms of currents in ionic channels sensitive to changes in the potential of cellular membrane.

Session 3 - EEG signal processing: In this session students will learn to apply different signal processing techniques for the resolution of EEG-related problems.

Session 4 -Analysis of somatosensory evoked potentials: This session is aimed at understanding the basic mechanisms of generation of evoked potentials in the somatosensory cortex.

Session 5 - ECG signal processing: In this session students will learn to apply different signal processing techniques for the resolution of ECG-related problems.

5.2. Syllabus

1. Session 1 - Introduction to MATLAB applied to biomedical signal processing
2. Session 2 - Analysis of conductance / voltage and kinetic relationships activation in ionic channels
3. Session 3 - EEG signal processing
4. Session 4 - Analysis of somatosensory evoked potentials
5. Session 5 - ECG signal processing

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Distant / On-line	Assessment activities
1	**Course introduction** Duration: 01:00 Lecture	**Session 1** Duration: 02:00 Laboratory assignments		**Attendance and participation** Other assessment Continuous assessment Not Presential Duration: 00:00
2		**Session 1** Duration: 03:00 Laboratory assignments		
3		**Session 2** Duration: 03:00 Laboratory assignments		**Session 1 report** Group work Continuous assessment Not Presential Duration: 10:00
4		**Session 2** Duration: 03:00 Laboratory assignments		
5		**Session 3** Duration: 03:00 Laboratory assignments		**Session 2 report** Group work Continuous assessment Not Presential Duration: 10:00
6		**Session 3** Duration: 03:00 Laboratory assignments		
7		**Session 4** Duration: 03:00 Laboratory assignments		**Session 3 report** Group work Continuous assessment Not Presential Duration: 10:00
8		**Session 5** Duration: 03:00 Laboratory assignments		
9		**Session 5** Duration: 03:00 Laboratory assignments		
10			**Oral presentation of final assignment** Duration: 03:00 Cooperative activities	**Session 5 report** Group work Continuous assessment Not Presential Duration: 10:00 **Final assignment: Analysis of a scientific article related with biomedical signal processing** Group work Continuous assessment Not Presential Duration: 10:00

11				**Session 1 report** Individual work Final examination Not Presential Duration: 10:00 **Session 2 report** Individual work Final examination Not Presential Duration: 10:00 **Session 3 report** Individual work Final examination Not Presential Duration: 10:00 **Session 5 report** Individual work Final examination Not Presential Duration: 10:00 **Final assignment: Analysis of a scientific article related with biomedical signal processing** Individual work Final examination Not Presential Duration: 10:00
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	No Presential	00:00	10%	0 / 10	CG-MIB05 CG-MIB07 CB07
3	Session 1 report	Group work	No Presential	10:00	20%	4 / 10	CG-MIB03 CG-MIB05 CG-MIB07 CG-MIB01 CB06 CB07
5	Session 2 report	Group work	No Presential	10:00	20%	4 / 10	CG-MIB03 CG-MIB05 CG-MIB07 CG-MIB01 CB06 CB07
7	Session 3 report	Group work	No Presential	10:00	20%	4 / 10	CG-MIB05 CG-MIB03 CG-MIB07 CG-MIB01 CB06 CB07
10	Session 5 report	Group work	No Presential	10:00	20%	4 / 10	CG-MIB03 CG-MIB05 CG-MIB07 CG-MIB01 CB06 CB07
10	Final assignment: Analysis of a scientific article related with biomedical signal processing	Group work	No Presential	10:00	20%	5 / 10	CB06 CG-MIB05 CG-MIB07 CG-MIB04 CB08 CB09 CB10 CG-MIB06

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
11	Session 1 report	Individual work	No Presential	10:00	20%	4 / 10	CG-MIB03 CG-MIB05 CG-MIB07 CG-MIB01 CB06 CB07
11	Session 2 report	Individual work	No Presential	10:00	20%	4 / 10	CG-MIB03 CG-MIB05 CG-MIB07 CG-MIB01 CB06 CB07
11	Session 3 report	Individual work	No Presential	10:00	20%	4 / 10	CG-MIB03 CG-MIB05 CG-MIB07 CG-MIB01 CB06 CB07
11	Session 5 report	Individual work	No Presential	10:00	20%	4 / 10	CG-MIB03 CG-MIB05 CG-MIB07 CG-MIB01 CB06 CB07
11	Final assignment: Analysis of a scientific article related with biomedical signal processing	Individual work	No Presential	10:00	20%	5 / 10	CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CB06 CB08 CB09 CB10

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills

Final exam	Problem-solving test	Face-to-face	02:00	20%	5 / 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CB06 CB07 CB08 CB09 CB10
Reports on practical session	Group work	Face-to-face	40:00	80%	4 / 10	CG-MIB03 CG-MIB05 CG-MIB07 CG-MIB01 CB06 CB07

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.

- In order to pass the course, students must obtain a minimum grade of 5/10, according to the dispositions hereby explained.

- All assignments must reflect the personal work of the student, although discussion and teamwork will be encouraged in order to better understand the problems to be solved. Detected copies will automatically mean failing the assignment both for the person who copies and the person who is copied.

Continuous evaluation

- In order to pass the course, students must hand over the four session assignments. Submissions after deadline will be penalised with up to 2/10 points.

- Students must obtain a minimum score of 4/10 in average for all 4 reports in order to pass the course.

- Students must obtain a minimum score of 5/10 in the final assignment to pass the course.

- Assistance is compulsory to all practical sessions and oral presentation of final assignment. Additionally, unjustified assistance to any given session will be penalised with up to 2/10 points in said session.

- Participation in class, fora, etc. 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 evaluation

- In order to pass the course, students must hand over the four session assignments. These will be carried out individually, unless otherwise stated by the teachers. Students will be responsible of doing the assignments with their own means.

- Students will carry out a final assignment individually, unless otherwise stated by the teachers. This will be defended orally in the final exam day assigned by the Junta de Escuela.

- Students must obtain a minimum score of 4/10 in average for all 4 reports in order to pass the course.

- Students must obtain a minimum score of 5/10 in the final assignment to pass the course.

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

Extraordinary examination

- In order to pass, students must hand in reports of the four session assignments. On those assignments on which the students already have a passing score (4/10), they may choose whether to hand in a new report or keep their current score. For reports with lower scores, students will need to hand in new reports.

- In order to pass, students will perform a final examination in which they will be asked to defend their reports and demonstrate practically the knowledge acquired in them. The exam may be constituted both from oral and written parts.

- Students must obtain a minimum score of 5/10 in the final examination to pass the course.

- Should students fail in the extraordinary examination, assignment scores may be transferred from one academic year to the next.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Leif Sörnmo y Pablo Laguna, Bioelectric signal processing in cardiac and neurologic applications, (2005) ISBN-13: 978-0-12-437552-9. Shanbao Tung y NitishV. Thakor, Quantitative EEG Analysis, Methods and Clinical Applications. Eds. Artech	Bibliography	
Rangaraj M. Rangayyan, Biomedical Signal Analysis, 2nd Ed. IEEE Press/Wiley (2015).	Bibliography	
Alan V. Oppenheim y Ronald W. Schafer, Discrete-Time Signal Processing, 3rd Ed., Prentice Hall (2010).	Bibliography	
M.J. Roberts, Signals and Systems Analysis Using Transform Methods and MATLAB®, 2nd Ed, McGraw-Hill (2012).	Bibliography	

9. Other information

9.1. Other information about the subject

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