ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000965 - Biosystems Modelling And Simulation

DEGREE PROGRAMME

09AU - Master Universitario En Ingenieria Biomedica

ACADEMIC YEAR & SEMESTER

2023/24 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	93000965 - Biosystems Modelling And Simulation
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	2023-24

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Gema Garcia Saez	B-302.2	gema.garcia.saez@upm.es	Sin horario. Tutoring appointments can be schedulled by email
Maria Elena Hernando Perez (Subject coordinator)	B-316	mariaelena.hernando@upm.es	Sin horario. Tutoring appointments can be schedulled 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 *

3.1. 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-MIB11 - Seleccionar y aplicar métodos avanzados de modelado para el diseño y simulación de sistemas biomédicos.

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

3.2. Learning outcomes

RA116 - Aplicar los fundamentos del modelado matemático de sistemas fisiológicos, siendo capaz de expresar las ecuaciones que rigen los fenómenos físicos y químicos más sencillos

RA115 - Aplicar técnicas avanzadas de modelos, construcción y de validación, comprendiendo las limitaciones impuestas por el dominio de aplicación

RA114 - Ser capaz de utilizar técnicas avanzadas de modelado fisiológico y sus aplicaciones en el campo médico

* 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

4.1. Brief description of the subject

Introduction to the mathematical modelling of physiological systems. Model construction: modelling the systemn, modelling from data. Mathematical modelling techniques: Compartmental modelling, data-driven modelling, distributred models. Examples of physiological models: Metabolic compartmental models; Drug concentration models; Rythmic components models; Applications. Practical sessions in MATLAB and Simulink.

4.2. Syllabus

1. Introduction to the modelling of physiological systems

2. Model construction

3. Mathematical modelling techniques

4. Compartmental modelling

5. Chronobiological modelling

6. Applications

5. Schedule

5.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**Course presentation. Introduction to modelling** Duration: 04:00 Lecture			**Practical homework** Individual work Continuous assessment Not Presential Duration: 08:00
2	**Model construction. Compartmental modelling** Duration: 04:00 Lecture			**Practical homework** Individual work Continuous assessment Presential Duration: 04:00
3		**Practical work at the lab** Duration: 04:00 Laboratory assignments		
4	**Data models- Rythmic models** Duration: 04:00 Lecture			**Practical results** Other assessment Continuous assessment Presential Duration: 04:00
5		**Practical work at the lab** Duration: 04:00 Laboratory assignments		
6	**Applications** Duration: 02:00 Lecture **Students' presentations** Duration: 02:00 Additional activities			**Practical results** Other assessment Continuous assessment Presential Duration: 04:00
7	**Students' presentations** Duration: 02:00 Additional activities			**Evaluation of the final work** Individual work Continuous assessment Presential Duration: 00:20
8				
9				
10				
11				
12				
13				
14				

15				
16				
17				**Practical results** Other assessment Final examination Presential Duration: 04:00 **Evaluation of the final work** Individual work Final examination Presential Duration: 00:20 **Exam** Written test Final examination Presential Duration: 02:00

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.

6. Activities and assessment criteria

6.1. Assessment activities

6.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
1	Practical homework	Individual work	No Presential	08:00	10%	0 / 10	CB10 CG-MIB04 CB07
2	Practical homework	Individual work	Face-to-face	04:00	10%	0 / 10	CG-MIB04 CB09 CB10 CE-MIB11 CB07
4	Practical results	Other assessment	Face-to-face	04:00	20%	0 / 10	CB07 CB09 CB10 CE-MIB11 CG-MIB03 CG-MIB04
6	Practical results	Other assessment	Face-to-face	04:00	20%	0 / 10	CG-MIB03 CG-MIB04 CB07 CB09 CB10 CE-MIB11
7	Evaluation of the final work	Individual work	Face-to-face	00:20	40%	5 / 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB08 CB09 CB10 CE-MIB11

6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Practical results	Other assessment	Face-to-face	04:00	40%	3 / 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB07 CG-MIB01 CB06 CB07 CB09 CB10 CE-MIB11
17	Evaluation of the final work	Individual work	Face-to-face	00:20	40%	5 / 10	CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB08 CB09 CB10 CE-MIB11
17	Exam	Written test	Face-to-face	02:00	20%	3 / 10	CB07 CE-MIB11

6.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Evaluation of the final work	Individual work	Face-to-face	00:20	40%	5 / 10	CG-MIB05 CG-MIB06 CG-MIB03 CG-MIB04 CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB08 CB09 CB10 CE-MIB11
Exam	Written test	Face-to-face	02:00	20%	3 / 10	CB07 CE-MIB11

Practical results	Other assessment	Face-to-face	04:00	40%	3 / 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB07 CG-MIB01 CB06 CB07 CB09 CB10 CE-MIB11

6.2. Assessment criteria

The late delivery of the exercises and student work in the progressive evaluation may be penalized with a percentage of the grade of 15%.

Any evaluation or delivery carried out may require a complementary oral evaluation by the teacher to validate that it has been carried out by the student without the help of Artificial Intelligence systems.

The evaluation will verify if the students have acquired the competences of the subject. Therefore, the evaluation by means of a global test, both in ordinary and extraordinary calls, will use the same types of evaluation techniques that are used in the progressive evaluation (development of final work and practical reports and oral presentation of the work) that will be carried out on the dates and times of global evaluation approved by the School Board for the current course and semester.

Students who, having completed the progressive assessment, wish to take the overall assessment, MUST NOTIFY the subject coordinator 14 days in advance of the assessment date published in the degree calendar. The day before the published date, the corresponding deliveries must be made. In the event that it is necessary to establish an additional date for the evaluation, students will be notified 7 days before the date established in the calendar for the corresponding global evaluation.

Students who have obtained a score >=50% of the total practical block score in the progressive evaluation, will have the block released and will not be evaluated again in the ordinary global evaluation, keeping their score, adjusted to the weight of said block.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
Introduction to Modeling in Physiology and Medicine. C Cobelli, ER Carson. Elsevier 2008	Bibliography	
How Modeling Standards, Software, and Initiatives Support Reproducibility in Systems Biology and Systems Medicine. IEEE TBME OCT. 2016.	Bibliography	
Refinetti R, Lissen GC, Halberg F. Procedures for numerical analysis of circadian rhythms. Biological rhythm research. 2007;38(4):275-325.	Bibliography	
MATLAB	Others	License available for UPM students. Instructions can be found in the "UPM Politecnica virtual".
MATLAB tutorial	Others	http://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf

8. Other information

8.1. Other information about the subject

This subject contributes to the Sustainable Development Goals (ODS: Objetivos de Desarrollo Sostenibles) as follows:

- SDG 3: Good health and well-being. Mathematical modelling and simulation speed health research in a wide range of diseases and help to address many different persistent and emerging health issues

- SDG 9: Industries, innovation and infrastructura. The subject introduces and promotes the use of new technologies in the healthcare ecosystem, facilitating the demonstration of hypothesis and enabling the efficient use of resources.

The Chronogram and the evaluation activities could suffer modifications along the course

Teaching activities will preferably be carried out in person, but if the situation and the number of students make it necessary, some activities could be organized online following the guidelines of the UPM.