



POLITÉCNICA

INTERNATIONAL  
CAMPUS OF  
EXCELLENCE

COORDINATION PROCESS OF  
LEARNING ACTIVITIES  
PR/CL/001



E.T.S. de Ingenieros de  
Telecomunicacion

# ANX-PR/CL/001-01

## LEARNING GUIDE

### SUBJECT

**93000965 - Biosystems Modelling And Simulation**

### DEGREE PROGRAMME

09AU - Master Universitario en Ingeniería Biomedica

### ACADEMIC YEAR & SEMESTER

2020/21 - Semester 1

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## 1. Description

### 1.1. Subject details

<b>Name of the subject</b>	93000965 - Biosystems Modelling And Simulation
<b>No of credits</b>	3 ECTS
<b>Type</b>	Optional
<b>Academic year of the programme</b>	First year
<b>Semester of tuition</b>	Semester 1
<b>Tuition period</b>	September-January
<b>Tuition languages</b>	English
<b>Degree programme</b>	09AU - Master Universitario en Ingenieria Biomedica
<b>Centre</b>	09 - Escuela Tecnica Superior de Ingenieros de Telecomunicacion
<b>Academic year</b>	2020-21

## 2. Faculty

### 2.1. Faculty members with subject teaching role

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

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#### 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 disseminación 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 - RA-15EN To apply the fundamentals of mathematical modeling of physiological systems, being able to express the equations that govern the simplest physical and chemical phenomena

RA115 - RA14-EN - To apply advanced modeling, construction and validation techniques, understanding the limitations imposed by the application domain

RA114 - RA13-EN To be able to use advanced physiological modeling techniques and their applications in the medical field

\* 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

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### 4.1. Brief description of the subject

Introduction to the modelling of physiological systems. Model construction: modelling the system, modelling from data. Mathematical modelling techniques: Compartmental modelling, data-driven modelling, distributed models. Examples of physiological models: Metabolic compartmental models ; Drug concentration models; Rhythmic components models; Multiagent models. 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. Multiagent modelling

## 5. Schedule

### 5.1. Subject schedule\*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Distant / On-line	Assessment activities
1	<b>Course presentation. Introduction to modelling</b> Duration: 04:00 Lecture			<b>Practical homework</b> Individual work Continuous assessment and final examination Not Presential Duration: 08:00
2	<b>Model construction. Compartmental modelling</b> Duration: 04:00 Lecture			<b>Practical homework</b> Individual work Continuous assessment and final examination Presential Duration: 04:00
3		<b>Practical work at the lab</b> Duration: 04:00 Laboratory assignments		
4	<b>Data models- Rythmic models</b> Duration: 04:00 Lecture			<b>Practical results</b> Other assessment Continuous assessment and final examination Presential Duration: 04:00
5		<b>Practical work at the lab</b> Duration: 04:00 Laboratory assignments		
6	<b>Distributed models</b> Duration: 02:00 Lecture  <b>Students' presentations</b> Duration: 02:00 Additional activities			<b>Practical results</b> Other assessment Continuous assessment and final examination Presential Duration: 04:00
7	<b>Students' presentations</b> Duration: 02:00 Additional activities			<b>Evaluation of the final work</b> Individual work Continuous assessment and final examination Presential Duration: 00:20
8				
9				
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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. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
1	Practical homework	Individual work	No Presential	08:00	10%	3 / 10	CB10 CG-MIB04 CB07
2	Practical homework	Individual work	Face-to-face	04:00	10%	3 / 10	CG-MIB04 CB09 CB10 CE-MIB11 CB07
4	Practical results	Other assessment	Face-to-face	04:00	20%	3 / 10	CB07 CB09 CB10 CE-MIB11 CG-MIB03 CG-MIB04
6	Practical results	Other assessment	Face-to-face	04:00	20%	3 / 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-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB08 CB09 CB10 CE-MIB11

#### 6.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
1	Practical homework	Individual work	No Presential	08:00	10%	3 / 10	CB10 CG-MIB04 CB07
2	Practical homework	Individual work	Face-to-face	04:00	10%	3 / 10	CG-MIB04 CB09 CB10 CE-MIB11 CB07
4	Practical results	Other assessment	Face-to-face	04:00	20%	3 / 10	CB07 CB09 CB10 CE-MIB11 CG-MIB03 CG-MIB04
6	Practical results	Other assessment	Face-to-face	04:00	20%	3 / 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-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB08 CB09 CB10 CE-MIB11

### 6.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

## 6.2. Assessment criteria

According to the Evaluation Regulations of the Polytechnic University of Madrid, students who wish to be evaluated by a single final test, must communicate it to the Director of the Department of Photonics and Bioengineering Technology by means of a request presented in the ETSIT secretary before the week #4. This option supposes the rejection to the continuous evaluation.

In the case of evaluation by a single final test and also in the in the extraordinary evaluation phase, the final grade would be obtained according to the following distribution:

60% delivery of practices and exercises

40% individual work presentation

## 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	Disponible la licencia para los alumnos de la UPM. Instrucciones en la intranet UPM virtual.  License available for UPM students. Instructions can be found in te UPM Politecnica virtual.
Tutorial de MATLAB	Others	<a href="http://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf">http://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf</a>

## 8. Other information

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### 8.1. Other information about the subject

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.