ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000972 - Control And Robotics In Medicine

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	93000972 - Control And Robotics In Medicine
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 *
Alvaro Gutierrez Martin (Subject coordinator)	B320	a.gutierrez@upm.es	W - 12:00 - 13:00 The student should request the meeting by email.
Blanca Larraga Garcia	B301	blanca.larraga@upm.es	W - 12:00 - 13:00 The student should request the meeting 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-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-MIB12 - Analizar los métodos y técnicas más actuales en la cinemática y la cinética para su aplicación en la biomecánica del ser humano.

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

RA96 - Ability to analyze and model robotic systems: kinematics and dynamics. Fundamentals of biomechanics.

RA98 - Ability to design and implement controllers for solving problems with robotic systems in the area of biomedical engineering

RA95 - Knowledge of feedback theory and electronic control systems.

* 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

The course is divided in two fundamental parts.

The first part provides students with the concepts of kinematics and dynamics of robots. Later on, it focuses on the planning and generation of trajectories of robot manipulators of 6 Degrees of Freedom.

The second part focuses on the fundamental principles of force feedback, with special emphasis on haptic systems and its use in bioengineering.

4.2. Syllabus

1. Introduction
    1.1. Degrees of Freedom
    1.2. Kinematic chains of rigid body mechanisms
    1.3. Six DOFs' Robot
2. Direct kinematics
    2.1. Position and orientation
    2.2. Linear and angular velocity
    2.3. Jacobian
    2.4. Orientation vectors (a,n,s)
3. Inverse kinematics
    3.1. Kinematic decoupling
    3.2. Position and orientation
    3.3. Velocity and orientation
    3.4. Trajectory planning
4. Force feedback
    4.1. Haptic devices
    4.2. Impedance control
    4.3. Admittance control

5. Schedule

5.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Distant / On-line	Assessment activities
1	**Introduction to the course, methodology and evaluation** Duration: 01:00 Lecture **Chapter 1** Duration: 02:00 Lecture **Chapter 1** Duration: 01:00 Problem-solving class		**Introduction to the course, methodology and evaluation** Duration: 01:00 Lecture **Chapter 1** Duration: 02:00 Lecture **Chapter 1** Duration: 01:00 Problem-solving class	
2	**Chapter 2** Duration: 02:00 Lecture **Chapter 3** Duration: 02:00 Lecture		**Chapter 2** Duration: 02:00 Lecture **Chapter 3** Duration: 02:00 Lecture	**Deliverable 1 - Chapters 1-2** Individual work Continuous assessment Not Presential Duration: 00:00
3		**Laboratory** Duration: 04:00 Laboratory assignments		
4		**Laboratory** Duration: 04:00 Laboratory assignments		
5	**Chapter 4** Duration: 02:00 Lecture **Chapter 4** Duration: 02:00 Problem-solving class		**Chapter 4** Duration: 02:00 Lecture **Chapter 4** Duration: 02:00 Problem-solving class	**Deliverable 2 - Chapter 3** Group work Continuous assessment Not Presential Duration: 00:00
6		**Laboratory** Duration: 04:00 Laboratory assignments		
7		**Laboratory** Duration: 04:00 Laboratory assignments		
8				**Deliverable 3 - Chapter 4** Group work Continuous assessment Not Presential Duration: 00:00

9				
10				
11				
12				
13				
14				
15				
16				
17				**Deliverable - Chapters 1-4** Individual work 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.

6. Activities and assessment criteria

6.1. Assessment activities

6.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
2	Deliverable 1 - Chapters 1-2	Individual work	No Presential	00:00	20%	5 / 10	CG-MIB05 CG-MIB07 CB08 CB09 CE-MIB12
5	Deliverable 2 - Chapter 3	Group work	No Presential	00:00	40%	5 / 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB08 CB09 CB10 CE-MIB01 CE-MIB12
8	Deliverable 3 - Chapter 4	Group work	No Presential	00:00	40%	5 / 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB08 CB09 CB10 CE-MIB01 CE-MIB12

6.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Deliverable - Chapters 1-4	Individual work	Face-to-face	03:00	100%	5 / 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB08 CB09 CB10 CE-MIB01 CE-MIB12

6.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Deliverable Chapters 1-4	Individual work	Face-to-face	03:00	100%	5 / 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB08 CB09 CB10 CE-MIB01 CE-MIB12

6.2. Assessment criteria

Students will be qualified through continuous evaluation by default. Students willing to renounce to continuous evaluation must email to the coordinator before the evaluation of the first laboratory implementations.

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 the 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.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
M. Spong and M. Vidyasagar. Robot Dynamics And Control. 1989. John Wiley Sons.	Bibliography	
J.J. Craig. Introduction to Robotics. Mechanics And Control. 1986. Addison-Wesley Publishing Company, Inc.	Bibliography	
R.M. Murray, Z. Li and S.S. Sastry. A Mathematical Introduction to Robotic Manipulation. 1994. CRC Press, Inc.	Bibliography	

http://robolabo.etsit.upm.es	Web resource	