ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000969 - Biomechanics

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	93000969 - Biomechanics
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 *
Andres Diaz Lantada (Subject coordinator)		andres.diaz@upm.es	- -
Antonio Ros Felip	ETSII	antonio.ros@upm.es	Sin horario. Por email (aros@etsii.upm.es)

* 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-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

RA40 - Conocimientos teóricos sobre fluidomecánica y propiedades reológicas de la sangre y otros biofluidos, así como las aplicaciones para interpretar la circulación sanguínea, sus patologías. Procesos de respiración

RA103 - RA36-EN Analysis and selection of biomaterials and biological materials for medical devices

RA104 - RA37-EN Analysis, modeling and selection of metals, ceramics and polymers for bioengineering design tasks

RA102 - RA20-EN Employ methods and techniques connected with human mechanisms and structures and their kynematics and dynamics

RA106 - RA38-EN Knowing and understanding the basic approaches of tissue engineering and their biomechanical aspects

RA105 - RA39-EN Knowing and understanding the basic structural features of human materials and structures

RA101 - Creative teamwork process of iterative design of concepts of solution using iterative prototyping.

RA39 - Conocimiento de la estructura y propiedades y mecánicas más importantes de los tejidos del cuerpo humano, tanto duros (huesos) como blandos (tejido vascular, piel, músculo liso, músculo estriado, miocardio, cartílagos, tendones). Conocimiento de su relevancia para la función fisiológica y en el desarrollo de patologías. Conocimiento de los métodos experimentales y modelos de cálculo para su interpretación. En particular, conocer y saber aplicar modelos de elementos finitos y otros métodos numéricos de cálculo. Conocer las interacciones entre procesos biomecánicos y procesos biológicos (mecanobiología).

RA107 - RA40-EN Knowing and understanding the basic features of biological fluids and of the vascular system

RA108 - RA41-EN Knowing and understanding experimental approaches for studying the human body

RA41 - Conocimientos prácticos a través de experimentos en biomecánica ensayando tejidos duros y blandos.

* 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 covers main topics of modern Biomechanics and is organized as a set of theoretical and practical sessions with some visits to laboratories (Materials Strength Lab and Product Development Lab) at ETSI Industriales-UPM.

Course 2020-2021, due to the current situation with SARS-CoV-2 pandemia, will combine asynchronous lessons (recorded lessons and webinars) and synchronous sessions in the classroom (practical sessions and lab visits). For the synchronous sessions and depending on the number of registered students, probably the group will be divided into 2 working groups, as will be explained in the introductory session.

The topics of the course are listed below. Each topic includes a recorded session, a set of practical activities, deliverables and proposed tasks, which will be fundamental part of the evaluation.

Topic 0: Introduction to biomechanics

Topic 1: Principles of biomechanics applied "externally" to the human body. (Practical sessions on: statics, dynamics, energy and oscillatory motion).

Topic 2: Principles of machines and mechanisms. Introduction to biological mechanisms. (Practical sessions on: modeling and simulating mechanisms).

Topic 3: Human joints. (Practical sessions on: kinematics and kinetics of human joints, stresses and strains in biomaterials, stiffness and strenght in biomaterials).

Topic 4: The engine of biological mechanisms. (Practical sessions on: simulation of muscles, experiments with artificial muscles).

Topic 5: Biomechanics of prostheses. (Practical sessions on: electrical extensiometry for comparing different prosteses designs).

Topic 6: Design and manufacture of biomechanical devices. (Practical sessions on: computer aided design and simulation of prostheses).

Topic 7: Fluidmechanics of human blood and cardiovascular biomechanics. (Practical sessions on: measuring arterial pressure).

Topic 8: Design and manufacture of microfluidic systems. Labs- and organs-on-chips. (Practical session on: conceptual design of an organ-on-a-chip).

Topic 9: Cellular biomechanics and mechanobiology. (Practical session on: cellular mechanobiology).

Topic 10: Tissue engineering and biofabrication of biomechanical replacements. (Practical session on: introduction to bioprinting).

Topic 12

4.2. Syllabus

1. Principles of biomechanics
2. Principles of machines and mechanisms
3. Human joints
4. The engine of biological mechanisms
5. Biomechanics of prostheses
6. Design and manufacture of biomedical devices
7. Fluidmechanics of blood and cardiovascular system
8. Design and manufacture of microfluidic systems
9. Cellular biomechanics and mechanobiology
10. Introduction to tissue engineering and biofabrication

5. Schedule

5.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Distant / On-line	Assessment activities
1	**Practicals for topics 1 to 3** Duration: 04:00 Cooperative activities		**Topics 1 to 3. Recorded sessions.** Duration: 04:00 Lecture	
2	**Practicals for topics 1 to 3** Duration: 04:00 Cooperative activities		**Topics 1 to 3. Recorded sessions.** Duration: 04:00 Lecture	**Application tasks** Individual work Continuous assessment Presential Duration: 02:00
3	**Practicals for topics 4 to 6** Duration: 04:00 Cooperative activities		**Topics 4 to 6. Recorded sessions.** Duration: 04:00 Lecture	
4	**Practicals for topics 4 to 6** Duration: 04:00 Cooperative activities		**Topics 4 to 6. Recorded sessions.** Duration: 04:00 Lecture	**Application tasks** Individual work Continuous assessment Presential Duration: 02:00
5	**Practicals for topics 7 to 10** Duration: 04:00 Cooperative activities		**Topics 7 to 10. Recorded sessions.** Duration: 00:00 Lecture	
6	**Practicals for topics 7 to 10** Duration: 04:00 Cooperative activities		**Topics 7 to 10. Recorded sessions.** Duration: 00:00 Lecture	**Application tasks** Individual work Continuous assessment Presential Duration: 02:00
7		**Lab visits** Duration: 04:00 Laboratory assignments		**Final recapitulation** Problem-solving test Final examination Presential Duration: 02:00
8				
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.

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	Application tasks	Individual work	Face-to-face	02:00	30%	/ 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB08 CB09 CB10 CE-MIB12
4	Application tasks	Individual work	Face-to-face	02:00	30%	/ 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB08 CB09 CB10 CE-MIB12
6	Application tasks	Individual work	Face-to-face	02:00	40%	/ 10	CG-MIB03 CG-MIB04 CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB08 CB09 CB10 CE-MIB12

6.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
7	Final recapitulation	Problem-solving test	Face-to-face	02:00	100%	/ 10	CG-MIB05 CG-MIB06 CG-MIB07 CG-MIB01 CG-MIB02 CB06 CB07 CB08 CB09 CB10 CE-MIB12 CG-MIB03 CG-MIB04

6.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

6.2. Assessment criteria

The course is conceived for continuous assessment, with deliverables directly resulting from the practical sessions, accounting for a 60% of the final mark, and with a set of final application tasks, accounting for a 40% of the final mark.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
Course bibliography	Bibliography	Different books and scientific articles for the topics of the course.
Materials Strength Laboratory	Equipment	Equipments and case studies from the lab.
Product Development Laboratory	Equipment	Equipments and case studies from the lab.

8. Other information

8.1. Other information about the subject

The course is related with SDG on "Good health and well being".