Course guide
240IBI21 - 240IBI21 - Biomechanics

Last modified: 02/05/2022

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 712 - EM - Department of Mechanical Engineering.

Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN NEUROENGINEERING AND REHABILITATION (Syllabus 2020). (Compulsory subject).
MASTER'S DEGREE IN RESEARCH IN MECHANICAL ENGINEERING (Syllabus 2021). (Optional subject).

Academic year: 2022 **ECTS Credits:** 4.5 **Languages:** English

LECTURER

Coordinating lecturer: Font Llagunes, Josep Maria

Others: Pàmies Vilà, Rosa
Peiret Giménez, Albert

REQUIREMENTS

Knowledge on rigid body kinematics and dynamics (vectorial formulation).

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEEBIO1. Ability to develop biomechanical models of the musculo-skeletal system based on the anthropometry of the human body and the mechanical laws of movement.
CEMNR18. (ENG) Desenvolupar models biomecànics de sistema múscul-esquelètic basats en l'antropometria de el cos humà i les lleis mecàniques de el moviment.

CEMNR19. (ENG) Analitzar aspectes cinemàtics, dinàmics i energètics de el moviment humà mitjançant models musculoesquelètics i programari d'anàlisi i simulació de el moviment.

Transversal:
CTMNR3. (ENG) Treball en equip. Ser capaç de treballar com a membre d'un equip interdisciplinari, ja sigui com un membre més o realitzant tasques de direcció, amb la finalitat de contribuir a desenvolupar projectes amb pragmatisme i sentit de la responsabilitat, assumint compromisos tenint en compte els recursos disponibles.
CTMNR4. (ENG) Ús solvent dels recursos d'informació. Gestionar l'adquisició, l'estructuració, l'anàlisi i la visualització de dades i informació en l'àmbit d'especialitat i valorar de forma crítica els resultats d'aquesta gestió.
CTMNR5. (ENG) Tercera llengua. Conèixer una tercera llengua, preferentment l'anglès, amb un nivell adequat oral i escrit i en consonància amb les necessitats que tindran els titulats i titulades.

TEACHING METHODOLOGY

- Theoretical and practical face-to-face class (classroom, computer classroom and lab).
- Scheduled self study.
- Cooperative learning.
- Learning based on projects, problems and cases.

LEARNING OBJECTIVES OF THE SUBJECT

The general learning objectives of the course are:
- Know tools for the biomechanical analysis of human motion, based on mathematical models that take into account the body anthropometry.
- Apply kinematic and kinetic descriptors to human motion.
- Apply mechanical laws and principles to anatomical structures.
- Analyze the human body motion from data measured at the lab.

STUDY LOAD

Type	Hours	Percentage
Self study	72,0	64.00
Hours medium group	27,0	24.00
Hours small group	13,5	12.00

Total learning time: 112.5 h

CONTENTS

Kinematics

Description:
Position and trajectory of a point. Position measurement and filtering in biomechanics. Kinematical chain. Absolute segment angles. Relative or joint angles. The human gait cycle. Velocity and acceleration of a point. Angular velocity and acceleration. Rigid body kinematics. Degrees of freedom and constraints of a kinematical chain.

Related competencies :
CEEBIO1. Ability to develop biomechanical models of the musculo-skeletal system based on the anthropometry of the human body and the mechanical laws of movement.
CEMNR18. (ENG) Desenvolupar models biomecànics de sistema múscul-esquelètic basats en l'antropometria de el cos humà i les lleis mecàniques de el moviment.

CEMNR19. (ENG) Analitzar aspectes cinemàtics, dinàmics i energètics de el moviment humà mitjançant models musculoesquelètics i programari d'anàlisi i simulació de el moviment.

Full-or-part-time: 13h 30m
Practical classes: 9h
Laboratory classes: 4h 30m

Vectorial dynamics

Description:
Newton laws. Rigid body Dynamics. Linear Momentum Theorem. Angular Momentum Theorem. Anthropometry. Classification of forces in biomechanical systems. Wrench of a system of forces. Formulation of forces. Muscle wrench. Measurement of foot-ground contact forces. Formulation of muscle forces. Hill's model. Electromyography (EMG).

Related competencies :
CEEBIO1. Ability to develop biomechanical models of the musculo-skeletal system based on the anthropometry of the human body and the mechanical laws of movement.
CEMNR18. (ENG) Desenvolupar models biomecànics de sistema múscul-esquelètic basats en l'antropometria de el cos humà i les lleis mecàniques de el moviment.

CEMNR19. (ENG) Analitzar aspectes cinemàtics, dinàmics i energètics de el moviment humà mitjançant models musculoesquelètics i programari d'anàlisi i simulació de el moviment.

Full-or-part-time: 18h
Practical classes: 12h
Laboratory classes: 6h

Energetics

Description:
Kinetic and potential energy. Energy and power balance. Muscle power. Generation, absorption and transmission of energy in the human body. Metabolic cost and efficiency.

Related competencies :
CEEBIO1. Ability to develop biomechanical models of the musculo-skeletal system based on the anthropometry of the human body and the mechanical laws of movement.
CEMNR18. (ENG) Desenvolupar models biomecànics de sistema múscul-esquelètic basats en l'antropometria de el cos humà i les lleis mecàniques de el moviment.

CEMNR19. (ENG) Analitzar aspectes cinemàtics, dinàmics i energètics de el moviment humà mitjançant models musculoesquelètics i programari d'anàlisi i simulació de el moviment.

Full-or-part-time: 9h
Practical classes: 6h
Laboratory classes: 3h

GRADING SYSTEM

Global course grade (NF) will be based on the following partial grades:

Nac = Assignments grade (continuous evaluation),
Ntm = Monographic work grade,
Nef = Final exam grade.

NF = 0,20*Nac + 0,30*Ntm + 0,50*Nef

Reevaluation:

This exam is available to the students that have attended the final ordinary exam and that have submitted all the continuous evaluation works. The reevaluation exam has the same format as the ordinary final exam.

The grade of the reevaluation exam (Nre) replaces the grade Nef in the equation to calculate the global course grade (NF).

BIBLIOGRAPHY

Basic:

- Uchida, Thomas K. ; Delp, Scott L. Biomechanics of movement : the science of sports, robotics and rehabilitation [on line]. Cambridge, MA: The MIT Press, 2020 [Consultation: 30/03/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=6434343. ISBN 9780262044202.
- Robertson, D. Gordon E.. Research methods in biomechanics. 2nd ed. Champaign, Ill. [etc.]: Human Kinetics, 2014. ISBN 9780736093408.
- Winter, David A. Biomechanics and motor control of human movement. 4th ed. Hoboken, New Jersey: John Wiley & Sons, cop. 2009. ISBN 9780470398180.

Complementary:

- Zatsiorsky, Vladimir M. Kinetics of human motion. Champaign: Human Kinetics, cop. 2002. ISBN 9780736037785.
- Zatsiorsky, Vladimir M. Kinematics of human motion. Champaign: Human Kinetics, cop. 1998. ISBN 9780880116763.
- Vaughan, C. L.; Davis, B. L.; O'Connor, J. C. Dynamics of human gait. Champaign, Ill: Human Kinetics Publishers,, 1992. ISBN 0873223683.
- Allard, Paul; Stokes, Ian A.F; Blanchi, Jean-Pierre. Three-dimensional analysis of human movement. Champaign: Human Kinetics, 1995. ISBN 9780873226233.