2018/2019 Course Guide

Biomechanics of Sport

Bachelor's in Physical Activity and Sports Science

Mode: On Campus

Index

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Biomechanics of Sport

Module: **Basic Sciences**

Subject: **Biological Sciences.**

Level: **Basic Training.**

No. of Credits: **6 ECTS.**

Academic Session: **Second Course – Quarterly.**

Course Professor: **Prof. Dr. Alberto Encarnación Martínez**

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Office Hours: **Monday from 9:30 to 10:30 am, Thursday from 12:30 to 1:30 pm**

Professor coordinating the Module, Subject, or Course: **Prof. Dr. Alberto Encarnación Martínez**

Brief Description

Biomechanics of Sport is a mandatory basic training course consisting of 6 ECTS credits spread out over a semester. Biomechanics of Sport could be defined as an eminently interdisciplinary branch of applied biomechanics, with a foundation or starting point in Physical Activity and Sport Sciences. The study objective, working with different tools and instrumental techniques, is focused on the study and solution of the main problems of the human being during physical practice and sports. It also analyzes interaction with other people, fluids, surfaces, and/or inanimate objects. The theoretical content of the course is arranged so that throughout the subject, students are presented with a method, areas of application and different perspectives. They will study the mechanics governing movement, describing the instrumental techniques used, and analyzing different human movements and major biomechanical criteria for the design and selection of sports material and equipment. Together with the development of theoretical content is a series of practical content, developed through workshops and seminars. These will enable students to consolidate the concepts studied from a theoretical perspective and allow students to familiarize themselves with the method of Biomechanics and its tools.

Prerequisites

No prerequisites have been established.

Objectives

1. To learn the laws of mechanics by applying them to the movement of the body and to the structures that compose it, taking into account the characteristics and biological properties of the human musculoskeletal system.
2. To learn the basics of Biomechanical Analysis.
3. To understand the basic skills from the perspective of Biomechanics.
4. To link the subject with Physical Activity and Sports Sciences.
5. To link the subject with professional practice.
6. To become familiar with the scientific method and to know the different technologies used in the field of Biomechanics of Sport.

Competencies and Learning Outcomes

Interdisciplinary Competencies

(CT1) Analysis and synthesis.
(CT2) Organization and planning.
(CT3) Oral and written communication in the native language.
(CT4) Knowledge of a foreign language.
(CT5) Computer skills related to the field of study.
(CT6) Information management.
(CT7) Problem-solving.
(CT8) Decision-making.
(CT9) Teamwork.
(CT15) Autonomous learning.
(CT16) Adaptation to new situations.
(CT18) Creativity.
(CT21) Motivation for quality.

Specific Competencies

(CES1) To know, understand, and know how to adapt physical activity to the structure, functions, and control of the physical-biological systems of the human body.
(CES2) To apply anatomical, physiological and biomechanical principles to the different fields of physical activity and sports.
(CES3) To know, understand, and know how to adapt physical activity to the evolutionary development of the practitioners of physical activity and sports at a physical-biological level.
(CES7) To know and apply scientific methods in the field Physical Activity and Sports Sciences.

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(CES9) To know and apply the most common measurements and instrumentation protocols in the field of Physical Activity and Sports Science.
(CES10) To apply information and communication technologies (ICT) to the field of Physical Activity and Sports Sciences.

Learning Outcomes

(RA) To distinguish and relate the implications of the structure, functions, and control of physical-biological systems in performing physical activity and sports.
(RA) To design physical-motor activities in which the structure, functions, and control of the physical-biological systems of the human body are taken into account.
(RA) To distinguish and relate activities in which anatomical, physiological, and biomechanical principles are applied in the different fields of physical activity and sport.
(RA) To design activities in which anatomical, physiological, and biomechanical principles are applied in the different fields of physical activity and sport.
(RA) To distinguish and know how to relate any evolutionary development in practitioners of physical activity and sport, at a physical-biological level, and any adaptations in physical activity.
(RA) To design physical-motor activities adapted to the evolutionary development of practitioners of physical activity and sport at a physical-biological level.
(RA) To understand and distinguish the characteristics of scientific information and how to interpret it.
(RA) To interpret and use specific scientific literature about physical activity and sport for performance, in training and professional activities.
(RA) To design and use research designs in physical activity and sports for the performance in training and professional activities.
(RA) To understand and distinguish the characteristics of different measurements and instrumental protocols in physical activity and sport.
(RA) To interpret the data obtained from measurements and specific instruments of physical activity and sport.
(RA) To determine and use different measurements and instrumental protocols most appropriate in physical activity and sports for performance in training and professional activities.
(RA) To understand and distinguish the possibilities that different information and communication technologies have in physical activity and sport.
(RA) To use information and communication technologies (ICT) for performance, in training and professional activities.
(RA) To understand, reason and synthesize content from various fields of knowledge.
(RA) To manage and organize information acquired during the learning process.
(RA) To correctly express oneself in written and oral form in one's native language.
(RA) To correctly express oneself in written and oral form in at least one foreign language.
(RA) To organize and know how to use information from different contexts.
(RA) To acquire the necessary skills for conflict resolution.
(RA) To decide between different options in a comprehensive and critical way.
(RA) To acquire and implement collaboration strategies and skills that favor cooperative work.
(RA) To proactively manage their learning process.
(RA) To value the importance of proper performance in their work.
(RA) To correctly use orthographic and grammatical norms in oral and written language.
(RA) To collaborate with other professionals recognizing the different contributions that other areas of knowledge make to the professional practice.
(RA) To undertake actions promoting interest and motivation for research.

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Methodology

Methodology	Hours	Hours of Classroom Work	Hours of Non-Classroom Work
Theoretical Lectures	42	60 hours (40 %)	
Group Discussions, Seminars	12		
Evaluation	3		
Tutorials	3		
Personal Study	60		90 hours (60 %)
Preparation and Presentation of Projects	30		
Analysis of Scientific Articles	0		
Bibliographical Searches	0		
TOTAL	150	60	90

Syllabus

Theoretical Instructional Program

Teaching Unit 1. Introduction to Biomechanics.

Topic 1. Introduction to Biomechanics.

- 1.1. Introduction and Concept.
- 1.2. Biomechanics of Sports.
- 1.3. Fields of Application.
- 1.4. The Objectives of Biomechanics.
- 1.5. Related Disciplines.

Topic 2. The History of Biomechanics.

- 2.1. Introduction.
- 2.2. History.
- 2.3. The Biomechanics of Sports in Spain.

Topic 3. The Method of Biomechanics.

- 3.1. Introduction.
- 3.2. The Method of Biomechanics.
- 3.3. Biomechanical Variables.

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Topic 4. Conceptual Bases of Movement.
- 4.1. Measurement Principles.
- 4.2. Fundamental and derived quantities.
- 4.3. Unit Systems.
- 4.4. Scalar and vector quantities.
- 4.5. Vectors and Trigonometry.
- 4.6. Reference Systems.

Teaching Unit 2. Mechanical Bases of Sports Movement.

Topic 5. Kinematics.
- 5.1. Introduction to Mechanics.
- 5.2. Mechanical Analysis.
- 5.3. Kinematics: Descriptive analysis of movement.
- 5.4. Types of Movement.
- 5.5. Linear Kinematics (displacement, velocity, and acceleration).
- 5.6. Angular Kinematics (displacement, velocity, and acceleration).

Topic 6. Kinematics.
- 6.1. Basic Concepts.
- 6.2. Inertia.
- 6.3. Force-acceleration.
- 6.4. Impulse and quantity of movement.
- 6.5. Moment of force and levers.
- 6.6. Action – Reaction.
- 6.7. Principle of summation and chaining.
- 6.8. Frictional forces.

Topic 7. Static.
- 7.1. Basic Concepts.
- 7.2. Balance conditions.
- 7.3. Balance vs. Stability.
- 7.4. Base of support, projection of center of gravity, height, fallen angle.
- 7.5. Model: inverted pendulum.
- 7.6. Balance assessment.

Topic 8. Work and force.
- 8.1. Introduction.
- 8.2. Work.
- 8.3. Power.
- 8.4. Energy.
- 8.5. Potential gravitational energy.
- 8.6. Elastic potential energy.
- 8.7. Kinetic Energy.
- 8.8. Law of Conservation of Energy.

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8.9. Loss of energy.

Topic 9. Fluids.
9.1. Introduction.
9.2. Relative flow between fluids.
9.3. Behavior of fluids.
9.4. Characteristics of fluids.
9.5. Forces within fluids.

Teaching Unit 3. Technical Instruments in Biomechanics.
Topic 10. Measurement-error.
10.1. Measurement vs. error
10.2. Current problems.
10.3. Absolute error.
10.4. Relative error.
10.5. Measurement precision.
10.6. Validity and Reliability.

Topic 11. Measurement Instruments.
11.1. Quantitative and qualitative variables.
11.2. Classification of measurement instruments.

Topic 12. Measurement of Time.
12.1. Photocells.
12.2. Stopwatches.
12.3. Video cameras.
12.4. Photography.
12.5. Contact Platforms.

Topic 13. Measurement of Movement.
13.1. Accelerometers
13.2. Goniometers
13.3. Video and 3D scanning
13.4. Photography

Teaching Unit 4. Biomechanics of Human Movement: Analysis of Sports Activities.
Topic 14. Swimming.
14.1. Introduction.
14.2. Phases and Performance Models.
14.3. Kinematic description.
14.4. Kinetic description.
14.5. Biomechanical assessment of swimming.

Topic 15. Walking.

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15.1. Introduction.
15.2. Phases and Performance Models.
15.3. Kinematic description.
15.4. Kinetic description.
15.5. Biomechanical assessment of walking.

Topic 16. Running.
16.1. Introduction.
16.2. Phases and Performance Models.
16.3. Kinematic description.
16.4. Kinetic description.
16.5. Biomechanical assessment of running.

Topic 17. Jumping.
17.1. Biomechanical principles.
17.2. Phases and Performance Models.
17.3. Kinematic description.
17.4. Kinetic description.
17.5. Biomechanical assessment of jumping.

Topic 18. Throwing and Hitting.
18.1. Biomechanical principles.
18.2. Phases and Performance Models.
18.3. Kinematic description.
18.4. Kinetic description.
18.5. Study of Throwing.

Topic 19. Cycling.
19.1. Biomechanical principles.
19.2. Phases and determining aspects of performance.
19.3. Kinematic description.
19.4. Kinetic description.
Biomechanical assessment of the cyclist and ergonomic adjustments of the bicycle.

Practical Instructional Program

Practicum 1. Measurement of times with photocells.
Practicum 2. Analysis and management of Kinovea software. Introduction to mathematical calculations.
Practicum 3. 2D photogrammetric analysis, assessment of running technique.
Practicum 4. Dynamic and static assessment of postural control.
Practicum 5. Assessment of the explosive force of the lower limbs with the jumping test.
Practicum 6. Assessment of ground reaction force during running support.

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Relationship to Other Courses in the Study Plan

The subject of Biomechanics of Sports complements the rest of the subjects of the degree, given that any area of knowledge and its development in the field of physical activity and sports, also provides the basic conceptual elements to contextualize the subjects integrated in the Basic Sciences module. In addition, Biomechanics of Sports relates to the subjects of the Fundamentals of Individual and Group Sports 1 module, as well as the subjects of Aquatic and Winter Sports, the Physiology of Physical Activity and Bases of Training, since it tries to lay the biomechanical foundations of the different sporting techniques. Also, Biomechanics of Sports has a strong link with the subject of Learning, Development and Motor Control, as it establishes the tools for the study of the learning and control processes of human beings.

Grading System

For the February/June/September Sessions:

- **Theoretical Part**: 70% of the total grade. Requirements: Students who exceed 60% class attendance: In this case the theoretical part of the subject will be evaluated in two eliminatory partial exams, which must each be passed independently. The value of each exam will be: the first partial 35% and the second partial 35%. Students who do not exceed the attendance percentage must take a final exam with all the content of the subject. The exam will consist of true and false questions and short answer questions.

- **Practical Part**: 20% of the total grade. Requirements: Attendance of at least 80% of the total number of practicums. 20% of the grade will be obtained from the evaluation of the practical workshops and the work dynamics developed in the seminars and workshops. The exam will consist of short answer questions.

- **Group Project**: 10% of the total grade. The remaining 10% will be determined from the preparation of a group project developed from the data collected in class during the practicums.

In order to pass the subject, at least half of the score of each of the assessment instruments must be obtained.

The student shall pass the subject when the weighted average is equal to or greater than 5 points and all the parts that make up the grading system have been passed, with an overall weight equal to or greater than 20%.

If the student has less than 5 in any of the parts with a weight equal to or greater than 20%, the subject will be suspended, and the student must retake the part(s) in the next session within the same academic year. The suspended part(s) in official sessions (February/June) will be saved for successive sessions that are held in the same academic year.

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In the event that the subject is not passed in the September session, the passed parts will not count for successive academic years.

The **grading system** (RD 1.125/2003. of September 5) shall be the following:

0-4.9 Suspended (SS)

5.0-6.9 Passed (AP)

7.0-8.9 Excellent (NT)

9.0-10 Outstanding (SB)

Honorable mention may be granted to students who have earned a grade equal to or greater than 9.0. This number may not exceed 5% of the total number of students enrolled in a subject in the corresponding academic year, unless the number of students enrolled is less than 20, in which case only a single honorable mention may be granted.

Bibliography and Reference Sources

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- Blazevich, A. (Ed.) (2011). *Biomecánica Deportiva. Manual para la mejora del rendimiento humano.* [*Sports Biomechanics: Manual for Improved Human Performance*.] Badalona: Paidotribo. (Teaching Units I and II)
- Izquierdo, M. (2008). *Biomecánica y Bases Neuromusculares de la Actividad Física y el Deporte.* [*Biomechanics and Neuromuscular Bases of Physical Activity and Sports.*] Madrid: Editorial Médica Panamericana. 2008. (Teaching Units I, II, III and IV)
- Hong, Y., y Bartllet, R. (Eds.) (2008). *Routledge Handbook of Biomechanics and Human Movement Science.* Londres: Routledge. (Teaching Units I, II)
- Gutiérrez, M. (Ed.) (1998). Biomecánica deportiva: bases para el análisis. [*Sports Biomechanics: Basis for Analysis.*] Madrid: Síntesis. (Teaching Units I, II and III)
- Robertson, G., Caldwell, G., Hamill, J., Kamen, G., & Whittlesey, S. (2013). *Research Methods in Biomechanics,* 2E. Human Kinetics. (Teaching Units I and II)

Additional Bibliography

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- Aguado X., Izquierdo M. y González J.L. (1997). *Biomecánica fuera y dentro del laboratorio.* [*Biomechanics Within and Beyond the Laboratory.*] Universidad de León.
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- Sánchez, J., Prat, J., Hoyos, J.V., Viosca, E., Soler, C., Comin, M. et al. (1993). *Biomecánica de la marcha humana, normal y patológica.* [*Biomechanics of the Normal and Pathological Human Gait.*] Valencia: IBV.
- Miralles, R.C. y Puig, M. (1998). *Biomecánica clínica del aparato locomotor.* [*Clinical Biomechanics for the Musculoskeletal System.*] Ed. Masson.
- Dufour, M., y Pillu, M. (2006). *Biomecánica Funcional.* [*Functional Biomechanics.*] Ed. Masson.
- Viladot, A. (2001). *Lecciones básicas de biomecánica del aparato locomotor.* [*Basic Lessons in Biomechanics for the Musculoskeletal System.*] Editorial Springer.
- Adrian, M.J., y Cooper, J.M. (1995). *Biomechanics of Human Movement.* Wisconsin: Benchmark.
- Hay, J.G. (1993). *The biomechanics of sports techniques.* Ed. Prentice Hall.
- Hamill, J., y Knutzen, K.M. (1995). *Biomechanical Basis of Human Movement.* Ed. Williams

Related Websites

- Website for the International Society of Biomechanics in Sports.

  http://www.isbs.org/
- Website for the sports footwear research group of the Footwear Science magazine

  http://www.footwearbiomechanics.org/
- Website for the European Society of Biomechanics,

  http://www.esbiomech.org/
- Website for the Iberian Society of Biomechanics and Biomaterials,

  http://www.prevencionintegral.com/sibb/
- Website for the Physical Activity and Sports Science Department of UCAM.
  http://www.ucam.edu/estudios/grados/cafd
- Website for the Journal of the Physical Activity and Sports Science Department with articles of all types related to sports initiation.
  http://ccd.ucam.edu
- Website for the Institute of Biomechanics of Valencia.

  http://www.ibv.org/

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Study Recommendations

In order to approach the subject Biomechanics of Sport, it is necessary to have basic knowledge of Physics, since throughout the course, these basic concepts necessary to begin the study of movement from a kinematic point of view will be discussed, and the analysis of the causes of movement will also be introduced.

The study of Biomechanics of Sports will mainly be addressed from a practical point of view, such that the understanding of practical applications of any theoretical topics taught in class is very important.

Teaching Materials

The theoretical classes will be taught in a classroom equipped with appropriate computer equipment (software and hardware), sound equipment connected to the computer, computers installed with Microsoft Office Suite, a projector, and internet connection.

The teaching materials that will be used in this subject to facilitate the acquisition of competencies are:

- Presentations (PowerPoint), which the professor will use as a guide (not as notes for the subject). Students should prepare their own notes using all the teaching materials that are described here.
- Scientific articles, which will be shared through the Virtual Campus and which will be related to the specific topics.
- Supporting documents, which will also be shared through the Virtual Campus or students will be asked to look for them through information and communication technologies. These will also be related to each topic.

For the practical seminars, a 3D kinematic analysis and registration system (VICON model) is required, a Kistler dynamometer platform, a system of Microgate Wireless photocells, two contact blankets and controller software, LPMS Inertial sensors, and a computer to control each of the mentioned systems.

A scientific calculator and basic apparatus is needed for taking angular and linear measurements. It is recommended that the student use a memory stick and a PC for collecting information that may come up during theoretical classes, and for doing practical work.

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Tutorials

Brief Description

Academic Tutoring

In academic tutorials, the focus will be to work on Decree No. 359/2009, of October 30th, which establishes and regulates an educational response to the diversity of students in the Autonomous Community of the Region of Murcia. Attending the academic tutorials is fundamental in knowing the purpose and use of all teaching materials and regulation of this subject. These are intended to guide and advise the student in the teaching-learning process and to contribute to the consolidation of knowledge, abilities, skills, capabilities, and attitudes related to transversal or general competencies such as group work, oral and written communication, values, and professional deontology and autonomous learning by the student.

Personal Tutoring

The University also has a Special Body of Tutors that conducts personal tutoring with the students enrolled in the degree. The personal tutor accompanies the students throughout the university phase. You can check the following link:

http://www.ucam.edu/servicios/tutorias/preguntas-frecuentes/que-es-tutoria

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