UNIVERSITÀ DEGLI STUDI DI VERONA
DEPARTMENT OF NEUROSCIENCE BIOMEDICNE AND MOVEMENT SCIENCES
ACADEMIC YEAR 2017-2018
1ST SEMESTER

Master's degree in Preventive and Adapted Exercise Science
Course: **BIOMECHANICS OF HUMAN MOVEMENT**

Course description and objectives:
Biomechanics is concerned with the mechanical / anatomical bases of human movement. An interdisciplinary approach is used in which materials from anatomy, physiology and physics (mechanics) are integrated. Quantitative and qualitative biomechanical analyses of human movement are studied from the perspective of kinematic and kinetic descriptions of multi-segment motion. These *external* phenomena are used to estimate *internal* muscle mechanics and joint loading. The purpose of this course is to introduce students to concepts of mechanics as they apply to human movement. The student should gain an understanding of the mechanical and anatomical principles that govern human motion and develop the ability to link the structure of the human body with its function from a mechanical perspective, with particular attention to pathological conditions and changes across one lifespan. At the completion of this course it is desired that each student be able to: 1) describe motion with precise, well-defined mechanical and bio-mechanical terminology; 2) understand and quantify linear and angular characteristics of motion; 3) understand the quantitative relationships between angular and linear motion characteristics of a rotating body; 4) understand and quantify the cause and effect of force, linear and angular kinetic of human movement; 5) interpret and analyze the kinematic, kinetic parameters and muscle activation of normal and pathological gait; 6) evaluate the biomechanical properties of common movement task either in healthy and pathological conditions.

Course credits: 6

Class format: Lectures, 32 hours**;** Laboratory, 30 hours

Course coordinator:
Dr. Matteo Bertucco, Ph.D.
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Office hours: by appointment.

Instructors:
Dr. Francesca Nardello, Ph.D.
Dr. Francesco Piscitelli, Ph.D.
Dr. Andrea Monte, M.S.

Language of instruction:

- Lectures: English
- Laboratory: Italian
- Questions to the instructors: either in Italian or English

Material study:
Recommended texts:

- Biomechanics in Clinic and Research. Author: Jim Richards. Churchill Livingstone.

Or

- Biomeccanica: Introduzione alle misure strumentali di postura e movimento. Autore: Filadelfio Puglisi. Marrapese Editore.

- Material provided by the teacher.
- Suggested scientific articles.

Additional texts:

- Biomechanics and motor control of human movement. Author: David A. Winter. Wiley
- Research methods in biomechanics. Authors: Robertson et al. Human Kinetics.
- Biomechanical Analysis of Fundamental Human Movements: Author: Arthur Chapman. Human Kinetics.
- Gait analysis: normal and pathological function. Autore: Perry et al. Thorofare (New Jersey): Slack.

Grading:

Gait Inverse Dynamic Project (GP)	20%
Laboratory Project (LP)	30%
Final Exam (FE)	50%
Total	**100%**

Gait Inverse dynamic Project will be explained and assigned to the students after the lectures about “inverse dynamic”.

Laboratory Project will be assigned at the end of laboratory classes. Students will work on the project as a group (5-6 people) during the 10^{th} to 16^{th} laboratory class. The details of the projects will be given during laboratory classes.

Final exam will consist on a Written Test and an Oral Exam.
Written test:

- The written test will evaluate the capability to apply the logical and mathematical principles of the topics covered at the lectures.
- The written test will contain 30 multiple-choice questions.
- Each question will have a score from 1 to 3 for a total of 45 points. Incorrect and missing answers will have a score of 0.
- The written test grade will be obtained by dividing the test score by 1.5 (45/30)

Oral Exam:

- The admission to the Oral Exam requires ≥18/30 at the Written Test.
- The only admission to the Oral Exam does not guarantee to pass the Final Exam.
- It will consist in an oral discussion aimed to evaluate:
    - Insightful understanding of course theoretical concepts;
    - Use of proper terminology
    - Competency to translate the theoretical concepts to practical settings.
- The student is free to taking the Oral Exam either in Italian or English.
- Taking the Oral Exam in English will assign a Bonus of 1.5 points.

Final grade will be assigned as follows:
(GPx20 + LPx30 + FEx50)/(20+30+50)+English Bonus

N.B. Minimal requirement to pass the entire course: ***18/30 in each part (i.e. GP,LP,FE)***

Course Contents

Lectures:

- Short review of math and physics: trigonometric functions, force, vector algebra, moment / torque.

- Anthropometry: density, segment mass, center of mass, moment of inertia, radius of gyration, use of anthropometrics tables.

- Linear and Angular Kinematics: linear velocity & acceleration, differentiation of kinematic data; joint angles, joint angular velocity, joint angular acceleration.

- Linear and angular Kinetics: Newton's Laws, Link segment model, type of forces, joint force, joint torque.

- Statics/Equilibrium: conditions for equilibrium, levers and pulleys, applications of statics to biomechanics, joint and muscle forces in static condition.

- Posture: biomechanics of standing, joint mechanics during standing, equilibrium conditions during standing; biomechanics of toppling; biomechanics of anticipatory and compensatory postural adjustments, abnormal posture: pathologies and postural deficits.

- Friction: physic of friction, biomechanics of friction in human movement, slipping.

- Inverse Dynamics

- Impulse & Momentum: linear and angular impulse, linear and angular momentum, applications to human movement.

- Work - Energy - Power: definition of work, energy and power, work, energy and power in linear motion, work, energy and power in angular motion.

- Muscle Mechanics: mechanical properties, force-Length relationship, force-Velocity and Torque-Velocity relationships, muscle stiffness.

- Gait: spatial-temporal parameters of gait, kinematic of gait, kinetic of gait, muscles intervention during gait cycle, pathological gait.

- Reaching/Pointing: Biomechanics of reaching and pointing movements, reaching and pointing in pathological conditions.

- Common movement tasks in clinical assessment: gait initiation, stair ascending and descending, landing, seat & stand

Laboratory:

- Descriptive statistics, t-test, linear regression with spreadsheet (e.g. Excel)
- Anthropometry
- Balance Board
- Linear and angular kinematics
- Statics and Equilibrium, forearm and lower limb examples
- Posture, CoP and toppling example
- Lifting, internal torques
- Lifting EMG
- Inverse Dynamic, Ankle joint example
- Ground reaction forces during normal and abnormal gait
- Students' project

Academic Honesty Policy:

Given the professional nature of our program academic dishonesty **is not tolerated** in this course. Any substantiated instances of academic dishonest will result in a zero for the assignments (projects and/or final exam) and consequently a final course grade of 0/30.