HUMANITAS UNIVERSITY	**Department of Biomedical Sciences** **Physiotherapy Degree Programme** **Physics and Kinesiology Syllabus**

Academic year 2020-2021. Academic term: first and second semester of the first year
Course coordinator: Prof. Roberto Gatti

PHYSICS (2 ECTS)	
Dr Matteo Bersanelli	Graduated in Applied Mathematics from the University of Milan, he attended the City University of New York when writing his thesis. He obtained his PhD from the University of Bologna. He is currently a researcher at Humanitas University E-mail: matteo_bersanelli@hotmail.com
Objectives	The applied physics module aims to provide essential knowledge of physics in order to integrate this basic science with the mechanical aspects of kinesiology and the physics of physiology. The content of the lectures may vary according to the course teaching requirements and are to be considered as indicative.
Teaching methods	Two-hour long lectures, including classroom discussion.
Teaching material	Slides presented during the lecture, available for physiotherapy students on LMS D. Scannicchio, fisica Biomedica. EdiSes.

Content

1) Introduction to the module and to physics.
Definition of fundamental quantities, scientific method. The ingredients of an exact discipline but based on numerical and experimental verification: dimensional analysis, definition of the concepts of resolution and sensitivity, uncertainties, precision and accuracy, discrepancy analysis and confidence. Maths: vector calculus, derivatives and integrals.

2) Fundamentals of mechanics
Basic concepts of kinematics and dynamics: the material point and its motion (velocity and acceleration), circular motion. Examples of movements in the human body. Essential dynamics: forces, Newton's principles. Force diagrams. Examples of forces. Quantity of motion and impulse theorem. Extended bodies: centre of mass and motion of the centre of mass.

3) Fundamentals of mechanics
Work, energy and conservation principles. Definition of work, energy as stored work, the kinetic energy theorem. Forces and conservative fields. Potential energy. Conservation of mechanical energy. Examples of inelastic collisions. Translational equilibrium conditions. Angular momentum, moment of inertia. Moment of inertia and motion.

4) Fundamentals of mechanics.
Rigid body dynamics. The moment of a force and torsion. Applicable examples. Levers. Levers in anatomy. Rigid body equilibrium: translational and rotational equilibrium. Examples applied to the human body: obesity, the foot and Achilles tendon, the arm as a lever. The hip joint. Locomotion. Overview of muscles.

5) Fundamentals of mechanics
Introduction to elasticity. Hooke's law, tension and deformation, elongation and compression. Collisions and impulse: the physics of "body damage". Compression fractures. Free fall. Bending fractures.

6) Fundamentals of mechanics
Summary, review, critical discussion and development of themes and applied exercises.

7) Thermology and thermodynamics
Temperature and heat, the principles of thermodynamics, isolated, closed and open systems. Thermodynamic transformations. Entropy.

8) Heat transport and thermoregulation mechanisms in the human body
Energy balance in the human body. Metabolism and external work. Energy requirements. Thermoregulation: why it is necessary. Heat transport mechanisms: radiation, convection, conduction, evaporation/sweating. The hypothalamus and active thermoregulation. Physiological/clinical examples: fever and heat stroke.

9) Electrical phenomena and bioelectricity
The role of electrical phenomena in physiology and medicine. Examples of some "electrodiagnostic tests ". Recalls and fundamentals of electrostatics and electrical currents. Definitions of electric charge, electric force and field, potential and potential difference. The capacitor. Definition of capacity and resistance.
The electrical model for signal transmission in the nervous system. Axons as cables. Action potential and signal propagation. Myelinated and unmyelinated nerves.

10) Course summary, review of some topics and mock exams
Summary of the main themes developed in the course.

KINESIOLOGY (4 ECTS)	
Prof Roberto Gatti	Physiotherapist, Associate Professor at Humanitas University, and Coordinator of the Physiotherapy Degree Programme. Head of the Physiotherapy Service at Humanitas Hospital. E-mail: roberto.gatti@hunimed.eu
Objectives	The kinesiology module aims to teach students: 1) the analysis of physiological movement from the point of view of its mechanics; 2) the joint biomechanics of the foot, knee, hip, spine, shoulder, elbow and hand.
Teaching methods	Lectures with classroom discussion and applied problem solving; practical exercises at the Movement Analysis Laboratory of Humanitas University.
Teaching material	Slides presented during the lecture, available for physiotherapy students on LMS Silvano Boccardi e Alberto Lissoni - Cinesiologia 3, Società Editrice Universo
Content	
1) Mechanics of the isolated muscle Mechanical model of the muscle. Mechanical variables influencing muscle force generation.	

Plyometric muscle behaviour and muscle thixotropy.

2) Moment (torque) of muscle force applied to human movement
Characteristics of muscle torques of different muscles in different planes and joint positions. Analysis of muscle moments in both segmental and functional isometric conditions. Exercises to calculate the moments of force during daily life postures.

3) Moment (torque) delivered by resistance during human movement
Centre of gravity of the body and segments. Analysis of resistant moments in different daily life postures. Relationship between moment of force and moment of resistance

4) Kinesiology exercises
Mechanical analysis of different postures and calculation of moments of force and resistance from anthropometric data

5) Joint reaction forces
Vector representation of muscle forces. Decomposition of the forces impressed on the ground. Vector addition of several muscle forces. Resultant joint force and exercises on the calculation of joint reaction forces.

6) Biomechanics of the foot
General characteristics of joint mechanics. Concept of helical axis: Functional anatomy of the foot. Arthrokinematics and ligaments of the foot. Kinesiology of the foot muscles. Biomechanics of the plantar vault

7) Biomechanics of the knee
Functional anatomy of the knee. Arthrokinematics and ligaments of the knee. Kinesiology of the knee muscles

8) Hip Biomechanics
Functional anatomy of the hip. Arthrokinematics and ligaments of the hip. Kinesiology of hip muscles

9) The physiology of walking
Kinematic variables during walking: gait phases, joint angles and spatio-temporal variables. Electromyographic activity during walking

10) Gait analysis in the motion analysis laboratory
Systems for gait analysis: optoelectronic systems, sEMG and force platforms: Basics of electromyographic signal and calculation of muscle moments from ground reaction forces

11) Mechanical energy of the centre of gravity during walking
Different animal locomotion systems. Characteristics of mammalian locomotion. Internal and external work. Changes in kinetic and potential energy and pendular recovery during walking. Gait efficiency

12) Biomechanics of the lumbosacral spine
Functional anatomy of the lumbosacral spine. Arthrokinematics and ligaments of the lumbosacral spine. Kinesiology of the lumbosacral spine muscles and abdominal wall muscles.

13) Biomechanics of the dorsal and cervical spine

Functional anatomy of the dorsal and cervical spine. Arthrokinematics and ligaments of the dorsal and cervical spine. Biomechanics of the thoracic cage. Kinesiology of the dorsal and cervical spine muscles. Relationship between head posture and activity of the cervical musculature.

14) Shoulder Biomechanics
Functional anatomy of the shoulder complex and characteristics of the scapula. Arthrokinematics and ligaments of the shoulder complex. Kinesiology of the muscles of the shoulder complex

15) Moments of inertia and anticipatory postural adjustments
Inertia and moments of inertia. Calculation of moments of inertia during rotational movements. Mechanical characteristics of anticipatory postural adjustments (APA). APA and balance. Analysis of APA during daily activities.

17) Mechanisms of intra-body postural fixation
Mechanical characteristics of mechanisms of intra-body postural fixation. Relationship between correct IFS and quality of muscle performance. Analysis of the mechanisms of intra-body fixation during some activities of daily life

18) Postural mechanisms and neuromotor control
Models of voluntary movement planning. Postural mechanisms as a connection between mechanics and neurophysiology of neuromotor control

19) Deformation of biological structures
Elastic, viscous and plastic deformations. Tension-deformation relationship. Mechanical properties of elasticity. Exploitation of elastic properties of biological structures during movement.

20) Biomechanics of the elbow and hand
Functional anatomy of the elbow and hand. Mechanics of the most common grip and grasp Arthrokinematics and ligaments of the elbow and hand. Kinesiology of the elbow and hand muscles. Role of sensitivity in the neuromechanical control of the hand.

KINESIOLOGY OF RESPIRATION (1 ECTS)	
Dr Sara Pierini	Physiotherapist, graduated from the University Vita-Salute San Raffaele in Milan in 2011. Currently, working as a physiotherapist at the Physiotherapy Service of Humanitas. Expert in Respiratory Physiotherapy E-mail: sara.pierini@humanitas.it
Objective	Present respiratory function from a biomechanical point of view
Teaching methods	Lectures with classroom discussion and application of problem solving
Teaching material	Slides presented during the lecture, available for physiotherapy students on LMS

Content

1) Thoraco-pulmonary static elements
Definition of respiratory pump. Lung volumes. Effect of posture on lung volumes. Elastic properties of the lung and chest wall

2) Thoraco-pulmonary dynamic

Anatomy of the thoracic cage. The respiratory muscles (inspiratory and expiratory, main and accessory muscles). Diaphragm, intercostal muscles, scalene muscles, sternocleidomastoid muscles, abdominal muscles, other respiratory muscles.

3) Description of the breathing cycle: Flows, volumes and pressures of the breathing cycle
Airway resistance. Pressures during the breathing cycle. Flow-volume relationship. Ventilation distribution. Work of breathing.

4) Assessment of respiratory mechanics
Objective assessment. Evaluation of respiratory muscles. Main spirometric parameters

5) Review and exercises

CLINICAL REASONING IN PHYSIOTHERAPY (1 ECTS)	
Dr Gianluca Ruggiero	Physiotherapist in charge of outpatient activity at the Humanitas Physiotherapy Service until October 2018. Expert in musculoskeletal physiotherapy, he is currently Coordinator of Physiotherapists at the InMED.REHAB Rehabilitation Centre. E-mail: giovanniluca.ruggiero@gmail.com
Objectives	The Clinical Reasoning module has the following objectives: • promote reasoning skills, for clinical signs related to physiotherapy, as an essential contribution to decision-making in physiotherapy; • propose an approach to the rehabilitation process based on the ability to observe and acquire information, make connections, establish priorities, define objectives, evaluate results; • sensitise students to the need for a therapeutic relationship that is patient-centred; evidence-based; goal-oriented through shared decision-making processes; supported by methodological rigour as a prerequisite for good clinical practice and continuous professional growth. • develop the concepts of care and responsibility as determinants in the pathway between initial assessment and assessment of results; provide tools and strategies for the development of work practices that integrate basic science, apply rehabilitation techniques, are coherent with regulations and the organisational context.
Teaching methods	Lectures with classroom discussion. Practical exercises through presentation and discussion of clinical cases.
Teaching materials	Slides presented during the lecture, available for physiotherapy students on LMS; cited articles, suggested reading, and advanced reading are also provided.

Content

1) Introduction to the course and general concepts

- Course presentation: What is expected? What are the objectives?
- Rehabilitation as a pathway.
- The rehabilitation process as a dynamic process:
  defining a starting point, setting a goal, choosing a path.
- Clinical Reasoning: What is it? What is it not?
- Different models of Clinical Reasoning.
- From definition to an idea of method: think out the process, think about the process.

2) The process phases: the "*CLINICAL REASONING CYCLE*".

- from diagnosis to functional assessment: observing, listening, knowing;
- from anamnesis to problem definition: processing information, making connections, setting the objective;
- from income to outcome: moving into action and making decisions; planning based on a timeline;
- Evaluating effectiveness: results, satisfaction, metacognition;

3) The role of the patient

- A reflection on the definition of health.
- The patient in the rehabilitation process: why involve the patient? how to involve the patient?
- Shared decision-making: who decides what?
- From "Compliance" to "Empowerment": the evolution of an active role of the patient.
- Reference models: The Bio-Psycho-Social model and the Framework of Health and Disability (I.C.F.).
- From treatment of the pathology to care of the person: Therapeutic Alliance in Rehabilitation
- The rehabilitation setting

4) Validation of experience, development of skills and value of care

- Evidence Based Practice and the interaction between clinical practice and research;
- Resource deployment and Value Based Healthcare (V.B.H.C.);
- The time factor: resource, limit, indicator;
- Comparison and interprofessional collaboration;
- Organisational, management and regulatory contexts.

5) Professional profile, legal framework and deontological code

- The concept of Responsibility
- The concept of caring
- Effectiveness, efficiency, quality: in what order? With what proportion?

Examination for the Physics and Kinesiology course. Written examination with multiple-choice questions for the physics module and an oral examination for the other modules. The examination will also include topics from the "Articular and muscular examination" elective course and the exercises on "Palpatory anatomy and mobilisation techniques". (Chairman of the Examination Committee: Prof. Roberto Gatti)