UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2021/2022
BACHELOR'S DEGREE (BSC)	BIOMEDICAL ENGINEERING
SUBJECT	PHYSICAL METHODOLOGY AND EQUIPMENT IN MEDICINE
TYPE OF EDUCATIONAL ACTIVITY	C
AMBIT	10657-Attività formative affini o integrative
CODE	21337
SCIENTIFIC SECTOR(S)	FIS/07
HEAD PROFESSOR(S)	BASILE SALVATORE Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	3
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**BASILE SALVATORE** Tuesday 15:00 17:00 Viale delle Scienze, Edificio 6 (ex DIN), stanza 213. Nel periodo di non svolgimento di attivita didattica in presenza si svolge su piattaforma Teams, previa prenotazione via email. Thursday 15:00 17:00 Viale delle Scienze, Edificio 6 (ex DIN), stanza 213. Nel periodo di non svolgimento di attivita didattica in presenza si svolge su piattaforma Teams, previa prenotazione via email.

DOCENTE: Prof. SALVATORE BASILE

PREREQUISITES	Good knowledge of Physics I, Physics II, Mathematics, as presented in the previous courses.
LEARNING OUTCOMES	Knowledge and understanding Theoretical understanding: have a good understanding of the principles of physics methodologies and instrumentation in medicine and biomedical engineering (logical and mathematical structure, experimental support, and described physical phenomena). Mathematical skills: be able to understand and master the use of the most commonly used mathematical methods. Applying knowledge and understanding Problem solving skills: be able to evaluate clearly the orders of magnitude in situations which are physically different, but show analogies, thus allowing the use of known solutions in new problems. Be able to solve simple problems on physics methodologies and instrumentation in medicine and biomedical engineering. Modelling: be able to identify the essentials of a process / situation and to set up a working model of the same; be able to perform the required approximations. Making judgements Be able to identify the more effective way to the solution of problems concerning the physics methodologies and instrumentation in medicine and biomedical engineering. Acquire an understanding of how concepts and methods from physics are applicable to many fields, namely biomedical engineering. Communications skills Be able to describe, analyse and solve physics methodologies and instrumentation problems using appropriate technical language and be able of written and oral communication on related subjects. Be able to describe the logical flowchart of problem solving. Be able to improve the group working skills. Learning skills The student will learn the basic principles of physics methodologies and instrumentation in medicine and biomedical engineering and the typical methodology of the physical sciences, to be applied to engineering problems, critically and in an autonomous way. He will also improve the ability of autonomous learning. Be able to approach more advanced subjects through available resources (technical literature papers, websites), as well as any other sources of information relevant to future work.
ASSESSMENT METHODS	The exam consists of an oral test, evaluated on a 30 points scale. It is possible that the student will be asked to prepare a report on some specific subject to be discussed during the exam. The final mark will take into account the outcome of both the oral test and the report. Purpose of the exam: test the knowledge of the principles of physics methodologies and instrumentation in medicine and biomedical engineering. Check the ability of modelling and identifying the essential elements of a problem. Oral exam (questions on general topics and / or exercises with reference to the recommended texts). The oral examination must be undertaken in the same exam session (“appello”) of the written test. EVALUATION CRITERIA Indicator - Knowledge and competence of contents Descriptor and score range: Excellent 10 Autonomous and effective 8-9 Acceptable 6-7 Fragmentary or partly superficial 4-5 Inadequate 0-3 Indicator - Applicative skill, precision, logical-thematic coherence Descriptor and score range: Excellent 10 Adequate 8-9 Acceptable also if partly driven 6-7 Limited 4-5 Inadequate 0-3 Indicator - Expression and terminology, reprocessing skills and multi-disciplinary connections Descriptor and score range: Excellent 10 Effective and well-structured 8-9 Generally satisfactory 6-7 Hesitant and rough 4-5 Inadequate 0-3
EDUCATIONAL OBJECTIVES	Knowledge of the experimental and theoretical basis of modern physics and its applications to medicine and biomedical engineering. Be able to apply this knowledge to solve simple problems on physics methods and related instrumentation in medicine and biomedical engineering.

TEACHING METHODS	Lectures. Instructor-assisted resolution of exercises and problems. Classwork, for single students or groups. Teaching tools: blackboard, chalk sticks, blackboard eraser; computer and video projector.
SUGGESTED BIBLIOGRAPHY	Appunti delle lezioni e materiale didattico fornito dal docente. Lecture notes and teaching material provided by the instructor. Per la parte introduttiva si può utilizzare un qualunque testo universitario di introduzione alla fisica moderna per ingegneria. Any textbook on introduction to modern physics for engineers may be used for the introductory part. P.A. Tipler, G. Mosca, "Corso di Fisica, vol. 3, Fisica Moderna", 2009, Zanichelli, ISBN 9788808248824. R.K. Hobbie, B.J. Roth, "Intermediate Physics for Medicine and Biology", 5e, 2015, Springer, ISBN 9783319126814. G.F. Knoll, "Radiation Detection and Measurement", 4e, 2010, Wiley, ISBN 9780470131480. Libri di testo e manuali accessibili da Unipa (in dipendenza dell'anno accademico). Textbooks and reference books freely accessible from Unipa (depending on the academic year). E.B. Podgorsak, "Radiation Physics for Medical Physicists", III / 2016, Springer, ISBN 9783319253800, accessibile da Unipa https://link.springer.com/book/10.1007/978-3-319-25382-4. L. Cerrito, "Radiation and Detectors", 2017, Springer, ISBN 978-3-319-53179-3 https://link.springer.com/book/10.1007/978-3-319-23932-3 Libri di consulatazione per applicazioni specifiche D. Scannicchio, "Fisica biomedica", IV / 2020, Edises, ISBN 9788836230198.

SYLLABUS

Hrs	Frontal teaching
5	Measurement and uncertainty. Probability distributions. Error Analysis.
8	Review of classical physics. Classical mechanics and conservation laws. Classical thermodynamics. Waves. Interference and diffraction. Maxwell's equations. Electromagnetic waves. Wave equation.
4	Experimental basis of modern physics. Spectral lines. Blackbody radiation. Density of states. Planck's radiation law. Photoelectric effect. Compton effect. Particle like properties of electromagnetic radiation. Experimental basis of the atomic structure of matter. Atomic models. Thomson model. Rutherford experiment. Bohr atomic model. Franck-Hertz experiment.
4	Matter waves. The wave-particle duality. De Broglies's hypothesis. Quantum description of matter. States and energy levels. Confinement and tunnel effect.
4	Radiation-matter interaction. Two-level model for atoms. Population kinetics. Stimulated absorption and emission. Spontaneous emission. Three-level systems. Population inversion. Radiation amplification. Laser.
8	Elements of nuclear physics. Radioactive decays and their laws. Natural and artificial radioactivity. Radiation Sources. Units and Definitions. Fast Electron Sources. Heavy Charged Particle Sources. Sources of Electromagnetic Radiation. Neutron Sources. Radiation-matter interaction for the above sources. Medical uses of nuclear physics and radiations.
8	Counting statistics. General Properties of Radiation Detectors. Simplified Detector Model. Modes of Detector Operation. Pulse Height Spectra. Counting Curves and Plateaus. Energy Resolution. Detection Efficiency. Dead Time. Gas detectors. The Ionization Process in Gases. Charge Migration and Collection. Ionization Chambers. Radiation Dose Measurement with Ion Chambers. Proportional Counters. Geiger-Mueller counters. Scintillators. Photomultiplier Tubes. Semiconductor detectors.
4	Nuclear magnetic resonance. Principles and applications in medicine. Nuclear spins. Magnetization vector in variable fields. Relaxation times. Signal detection. Imaging.

Hrs	Practice
3	Measurement and uncertainty and other subjects.
6	Review of classical physics and other subjects.
3	Experimental basis of modern physics and other subjects.
3	Matter waves and other subjects.
3	Radiation-matter interaction and other subjects.
6	Elements of nuclear physics and other subjects.
6	Counting statistics and other subjects.
3	Nuclear magnetic resonance and other subjects.
6	Measurement of radiation fields, dosimetric quantities and energy spectra with portable instrumentation. Data analysis.