UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Fisica e Chimica - Emilio Segrè
ACADEMIC YEAR	2018/2019
MASTER'S DEGREE (MSC)	PHYSICS
INTEGRATED COURSE	APPLIED PHYSICS TECHNIQUES AND EQUIPMENT
CODE	19776
MODULES	Yes
NUMBER OF MODULES	2
SCIENTIFIC SECTOR(S)	FIS/07
HEAD PROFESSOR(S)	MARRALE MAURIZIO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	ABBENE LEONARDO Professore Associato Univ. di PALERMO MARRALE MAURIZIO Professore Associato Univ. di PALERMO
CREDITS	6
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**ABBENE LEONARDO** Tuesday 16:00 18:00 Dipartimento di Fisica e Chimica, Stanza Docente, Viale delle Scienze, Edificio 18 Thursday 16:00 18:00 Dipartimento di Fisica e Chimica, Stanza Docente, Viale delle Scienze, Edificio 18 Friday 12:00 14:00 Dipartimento di Fisica e Chimica, Stanza Docente, Viale delle Scienze, Edificio 18 **MARRALE MAURIZIO** Thursday 15:00 17:00 Dipartimento di Fisica e Chimica "Emilio Segre" Viale delle Scienze, Edificio 18. Tel diretto 09123899073. Si prega di richiedere appuntamento almeno tre giorni prima via e-mail (maurizio.marrale@unipa.it).

DOCENTE: Prof. MAURIZIO MARRALE

PREREQUISITES	The prerequisites for learning and achieving the objectives are the following: - A solid knowledge and ability to apply the laws of classical physics and quantum mechanics. - knowledge of mathematical analysis.
LEARNING OUTCOMES	Knowledge and understanding The course aims at leading students to the knowledge and understanding of the fundamentals of ionizing radiation detection, of the physical techniques used in diagnostics (such as x-ray, CT, PET, RM) and medical therapy (radiotherapy with conventional beams and hadrons). Applying knowledge and understanding The student will also be able to solve numerical problems related to the use of instrumentation for ionizing radiation detection and of some of the medical physics technologies, in radiation therapy and radiation diagnosis. The student will be able to interpret results also taken from published scientific papers; Making judgments Ability to critically analyze signals from various ionizing radiation detectors; ability to analyze diagnostic tomographic images obtained by various techniques. Communication skills Presentation skills, with language suitable also for a non-expert audience, of learned basic concepts and theoretical foundations that underpin techniques and applications of physics to medicine. Learning skills The students are suggested to be able, on the basis of skills acquired in the course, of designing simple experiments, analyzing and interpreting the experimental results obtained, and understanding the inherent scientific works.
ASSESSMENT METHODS	Final assessment consists of an oral test. The oral test consists of an examination-interview in which the candidate is asked to describe the physical principles, the techniques and the instrumentation of applied physics covered during lectures. During this discussion the candidate is asked to investigate some of the relevant theoretical aspects of the experimental techniques described as well as their applications in various research fields. This test allows to evaluate, in addition to knowledge of the candidate and his/her ability to apply them, even the possession of scientific language properties and the capabilities of clear and direct exposition. The final marks will be scaled according to the following conditions: a) Only basic knowledge of theoretical principles of the described experimental techniques and limited ability to expose subjects, just sufficient ability to expose and to analyze phenomena, problems and solutions (grade 18–21); b) fair knowledge of theoretical principles of the described experimental techniques and good ability to develop analyses, good ability to expose and analyze phenomena as well as conceptual problems and related solutions (grade 22-25) c) Deep (but not full) knowledge of the concepts and problems related to the described experimental techniques, detailed exposure and analysis, albeit with some uncertainty, of phenomena, problems and related solutions (grade 26-28); d) Deep and full knowledge of the concepts and problems of related to the described experimental techniques, full mastering exposure and analysis, even with original criticisms, of phenomena, problems and related solutions, in the best cases with original contributions and original analysis as well as with excellent ability to communicate (grade 29-30L).
TEACHING METHODS	The course lasts six months and takes place in the first half of the second year of the master's degree in Physics. The teaching consists of traditional (teacher-led/teacher up front) classes, subjects are discussed using the board and illustrated using projected presentations: this approach allows a better and gradual understanding of the subject by the students and a better interaction with them. Discussions with students will be favored by the teacher: contributions and questions from the students in the course of lessons are welcome. Student will be invited to visit laboratories in order to make them conscious of some of the instrumentation basics and seminars on specific research topics as complement of frontal lessons. The course aims to provide students with the critical knowledge of physical principles of ionizing radiations and detection, and experimental procedures at the base of important medical applications, knowledge of advanced diagnostic techniques using morphological and functional images and radiotherapy.

MODULE
IONIZING RADIATIONS DETECTORS

Prof. LEONARDO ABBENE

SUGGESTED BIBLIOGRAPHY	
•G. F. Knoll, Radiation Detection and Measurement, 3rd Edition, Wiley 2000. •William R. Leo, Techniques for Nuclear and Particle Physics Experiments, Springer-Verlag. • Research Papers	
AMBIT	20901-Attività formative affini o integrative
INDIVIDUAL STUDY (Hrs)	51
COURSE ACTIVITY (Hrs)	24
EDUCATIONAL OBJECTIVES OF THE MODULE	
OBJECTIVES OF THE COURSE : The course has the following learning objectives : •to provide the students with a critical understanding of the physical principles of the instrumentation which ionizing radiation detectors are based on; •to provide the students with a critical understanding of the physical principles and experimental procedures which important medical applications are based on.	

SYLLABUS

Hrs	Frontal teaching
2	Radiation Sources. Units and Definitions. Fast Electron Sources. Heavy Charged Particle Sources. Sources of Electromagnetic Radiation. Neutron Sources.
3	Radiation Interactions. Interaction of Heavy Charged Particles. Interaction of Fast Electrons. Interaction of Gamma Rays. Interaction of Neutrons.
4	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.
4	Ionization Chambers. The Ionization Process in Gases. Charge Migration and Collection. Radiation Dose Measurement with Ion Chambers. Proportional Counters.
4	Scintillators. Organic Scintillators. Inorganic Scintillators. Photomultiplier Tubes.
4	Semiconductor detectors. Semiconductors as Radiation Detectors. Semiconductor Detector Configurations. Silicon and Germanium detectors. Room-Temperature Compound Semiconductor Radiation Detectors.
3	Medical applications of semiconductor detectors. X-ray colour imaging.

MODULE EXPERIMENTAL APPLIED PHYSICS TECHNIQUES FOR MEDICINE *Prof. MAURIZIO MARRALE*	
SUGGESTED BIBLIOGRAPHY	
Libri di testo R.K Hobbie, Intermediate Physics for Medicine and Biology, Springer –Verlag, 1997; Testi per consultazione IAEA publication (ISBN 92-0-107304-6):Radiation Oncology Physics: A Handbook for Teachers and Students Pubblicazioni scientifiche fornite dal docente	
AMBIT	20901-Attività formative affini o integrative
INDIVIDUAL STUDY (Hrs)	51
COURSE ACTIVITY (Hrs)	24
EDUCATIONAL OBJECTIVES OF THE MODULE	
The course has the following learning objectives : - to provide the students with a critical understanding of the physical principles and experimental procedures which important medical applications are based on; - to provide the students with the knowledge of advanced diagnostic techniques using both morphological and functional images and radiation therapy	

SYLLABUS

Hrs	Frontal teaching
3	Biological effects of ionizing radiation: radiation effects at the cellular level: DNA damage and survival curves. Effects of ionizing radiations on humans: deterministic and stochastic damages. Dosimetry of ionizing radiations: Main dosimetric quantities: exposure, absorbed dose, equivalent dose and effective dose. Weight factors for the different types of ionizing radiation and for the various human body tissues.
5	Physical techniques used for diagnostic purposes: Computed tomography devices - X-ray - X-ray tubes with rotating anode tube, photon energy spectrum emitted, bremsstrahlung radiation, characteristic radiation, anodes of tungsten and molybdenum. Evolution of CT scanners. Attenuation of the beam to non-monochromatic photon beam hardening. Hounsfield units.
4	γ-photons emitting devices - single photon emission scintigraphy. single photon emission computed tomography (SPECT) devices - Technological evolution. Gamma Camera. Properties of radionuclides used. Generation of radionuclides. Laws of radioactive decay. Radiopharmaceuticals. Applications. Physical principles of Positron Emission Tomography (PET) devices, main radionuclides for PET production of radionuclides by means of cyclotron - Applications.
8	Physical basis of Nuclear Magnetic Resonance (NMR) - NMR in the time domain (TD). Relaxometry. Origin of the longitudinal relaxation, origin of the transverse relaxation. Spin echo. Bloch equations. Principle of MR imaging (MRI) with gradient coils. Selective pulses. Generalized theory of imaging, k-space and its mapping. Chemical Shift Imaging. Molecular Diffusion Imaging. Fiber tractography. Functional MRI.
4	Physical techniques used in therapy Radiation therapy with external beam produced with linear accelerator (LINAC). Radiant head, production of an X-ray beam, producing a beam of electrons. Hadron therapy with charged particles. Neutron Capture Therapy.