UNIVERSITY OF L'AQUILA

Department of Physiscal and Chemical Sciences

Profile of

2nd Cycle Degree in PHYSICS

Laurea Magistrale in FISICA

DEGREE PROFILE OF

Laurea Magistrale in FISICA

Master of Science in PHYSICS

TYPE OF DEGREE & LENGTH	Single degree (120 ECTS credits, 2 years) A double degree is awarded jointly with the Polytechnic School of Gdansk (Poland) to students enrolled in the international track
INSTITUTION(S)	Università degli Studi dell'Aquila Italy Polytechnic School of Gdansk (Poland)
ACCREDITATION ORGANISATION(S)	Ministry of Education (Italy) Polytechnic School of Gdansk (Poland)
PERIOD OF REFERENCE	MIUR, validated for 3 years, for cohorts starting on October 2013
CYCLE /LEVEL	QF for EHEA: 2st cycle; EQF level: 7; Italian NQF: Laurea Magistrale

A	PURPOSE
	The main objective of the course is to provide education in Advanced Physics, theoretical, experimental and applied in different field of physics, to enable students to practice their future profession independently. To prepare students strengthening their education in advanced theoretical and experimental physics envisaging various employment capabilities and in specialized areas of Physics to continue in further studies, to work in technologically advanced companies and research agencies as well as to teach.

B	CHARACTERISTICS	
1	DISCIPLINE(S) / SUBJECT AREA(S)	Physics, Mathematical physics; Informatics; Others (60: 30: 5: 5)
2	GENERAL / SPECIALIST FOCUS	The research track of the degree program has 4 specializations: sub-nuclear and astro-particle physics, condensed matter physics, atmospheric and meteorological physics, space and geophysical science. The International track is specialized on condensed matter physics and nanotechnology.
3	ORIENTATION	The degree program is primarily oriented in research, with a strong component of application skills in several different contexts. Specializations are provided envisaging specific employment/career opportunities, delivering specific topics in both theoretical and experimental Physics in the different specialization areas offered: Sub-nuclear and astroparticle physics, Condensed Matter Physics, atmospheric and meteorological physics, space and geophysical science.
4	DISTINCTIVE FEATURES	The course is also taught in English. The international track, in condensed matter and applied nanosciences, foresees a compulsory mobility to Gdansk Polytechnic school in the second year. Particular emphasis is given to physics topics and collaborations of interest for the research/industrial agencies active in the local region: Laboratori Nazionali del Gran Sasso, microelectronics and nanosciences (industrial collaborations), physics of the atmosphere and meteorology (CETEMPS, center of excellence), Space physics (ISSS – International School of Space Science).

C	EMPLOYABILITY & FURTHER EDUCATION	
1	EMPLOYABILITY	The main employment opportunities are as following: Research positions in companies/small enterprises and institutions/organizations (research, quality assurance, commerce). Positions in Science communication, management of research, financial/insurance

		companies, government departments, informatics companies, in consultancy. Teaching positions.
2	FURTHER STUDIES	Doctoral studies in physics, astronomy, (theoretical, applied), interdisciplinary programs related to Mathematics (Mathematical Engineering), programs in engineering / Informatics, programs related to Physics (Physical Engineering, Biophysics, Medical Physics, Geophysics).

D	EDUCATION STYLE	
1	LEARNING & TEACHING APPROACHES	Lectures, laboratory classes, research laboratory work, seminars, small group work, individual study based on text books and lecture notes, project work, search of pertinent scientific literature, individual consultations with academic staff, final dissertation.
2	ASSESSMENT METHODS	Written exams, oral exams, laboratory reports, oral presentations, essays, final comprehensive exam, assessment of Diploma dissertation.

E	PROGRAMME COMPETENCES
1	GENERIC
	— Analysis and synthesis: Capacity for analysis and synthesis using logical arguments and proven facts. — Flexible mind: acquisition of a flexible mind, open to apply advanced physics and mathematics knowledge together with experimental/computational competences to solve complex problems in different fields based on critical attitude and established scientific methodologies. — Team-work: capability to perform guided teamwork in a lab setting and related special skills demonstrating capacity for handling the rigor of the discipline and for time management (including meeting deadlines). — Communication skills: Ability to communicate effectively and to present complex information in a concise manner orally and in writing and using ICT and appropriate technical language in English as well. — Popularization skills: Ability to communicate with non-experts, including teaching skills. Ability to deliver oral presentations to experts and discuss research results, to write articles/essays on the research conducted and/or modern physics issues for a general public. — Math culture: Ability to provide explanations of a wide range of processes and objects (both natural and technological) and ability to model them — Learning ability: ability, through independent study, to enter new fields using acquired physics knowledge and appropriate mathematical tools. — Problem solving: capacity to deal effectively with practical problems, setting affordable risks, intermediate goals and final assessments. — Ability to search for process and analyze information from a variety of sources — Ability to undertake research: ability to plan a research project and manage research activities — Deep knowledge and understanding: good understanding of the most important physical theories (logical and mathematical structure, experimental support, describe physical phenomena) including a deep knowledge of advanced physical theories at the basis of the frontier research. Good awareness of the frontier of physics knowledge and of the highest standards
2	SUBJECT SPECIFIC
	The program meets all the specific competences as established and agreed in collaboration with the field stakeholders, clustered within the key overarching competences summarized below. At the end of the programme the graduates should be able to: Physics-related cognitive abilities and skills - Deep knowledge and understanding: Good understanding of the principles and laws of physics together with the needed advanced mathematical and theoretical physics tools to describe natural phenomena, including deep knowledge of the fundamental of the physics law that model the constituting matter and the phenomena related to atmosphere, space and universe science. - Problem solving: Ability to formulate, analyse and synthesize solutions to scientific problems at an abstract level dividing them into testable sub-problems, and ascertaining between major and minor aspects. - Modelling abilities: ability to set up appropriate models of natural phenomena, deriving consequences and deepening understanding of the natural world. - Communication skills: ability to communicate with colleagues in the same discipline about scientific knowledge, both at basic and specialist levels; ability to report orally and in writing, and to discuss a scientific topic in the native language

	as well as in English. - Ability to learn: ability to assimilate new knowledge in specific physical topics and to integrate it with new insights through independent study. Ability to orient oneself at a specialist level in topics that are outside the chosen specialization. - Updating skills: ability to make literature search related to the particular physics problem to solve, critically reflecting on the results presented and ascertaining their pertinence and their applicability to the problem under study. - Familiarity with frontier research: good knowledge of the state of the art in at least one of the presently offered physics specialisations. Physics-related practical skills - Research skills: ability to formulate new questions and hypothesis, to choose the most appropriate path and research methods to solve problems in physics making use of the available resources. - Computational skills: Ability to design and implement appropriate software and computer programs and to use current application programs to solve physics problems and simulate physical and natural problems - Applying specialized knowledge: ability to put effectively into practice theories and good-practice to solve new physics problems outside the chosen specialization. Ability to design experimental and/or theoretical procedures for solving current problems in academic or industrial research and/or improving the existing results also in other fields (engineering, mathematics, economics etc.). - Experimental skills: ability to perform experiments independently, as well as describe, analyse and critically evaluate experimental data and have become familiar with the most important experimental methods used in the research and industrial world.

F	COMPLETE LIST OF PROGRAMME LEARNING OUTCOMES
	Graduates of the 2nd Cycle Degree in Physics have an integrated theoretical and practical knowledge allowing them to address their interest of specialization to several connected fields. These graduates will acquire: Knowledge and understanding — Ability to demonstrate knowledge and understanding of Advanced Physics fundamentals in: condensed matter topics, nuclear and sub-nuclear physics, astrophysics and the origin of the universe, particle physics, statistical mechanics, theoretical physics (electrodynamics, classical and quantum field theory, many body theory), use and principles of experimental advanced instruments of most common use, modeling techniques and possible numerical choices. — Ability to demonstrate knowledge and understanding of the various sub-areas of physics in order to do practical research work in the chosen field of specialization. This ability will allow them to do practical work and training in research agencies/groups and/or industrial laboratories. — Ability to demonstrate knowledge and understanding at a basic level of both “theory based” and “practice based” programs in advanced physics research. — Ability to demonstrate knowledge and skills in the area chosen to conduct scientific research under supervision. Ability to apply knowledge and to understand — Ability to make measurements of physics quantities and to pursue a scientific investigation, through design, execution and analysis of experiments and their outcomes; ability to compare results with existing literature and theories and draw critical conclusions. — Ability to apply the acquired knowledge and understanding in other areas as, astronomy, chemistry, mathematics, biology, engineering, computer science, information and communication technology, economics, accountancy, actuarial science, finance and many others. — Ability to perform computer simulations related to physics problems by using appropriate software and one or programming language, learning how to analyze and display results. Judgment skills — Acquisition of good working habits concerning both working alone (e.g. diploma thesis) and in teams (e.g. lab reports, including team-leading), achieving results within a specified time-frame, with an emphasis on awareness about professional integrity and on how to avoid plagiarism. — Ability to use the acquired tools and knowledge to understand the socially related problems involved in the practical work and to comprehend the ethical implications of research and of the professional activity in physics and the consequent responsibility to protect public health and the environment. — Estimation skills: ability to evaluate clearly the orders of magnitude in physically different situations, catching, however, analogies in order to use known solutions to approach new problems. Ability to appreciate the significance and the impact of the results obtained. Communication skills — Demonstrated proficiency in using English language, including subject area terminology, for literature search and to

	write essays, reports, and scientific papers. — Ability to communicate to experts and non-experts advanced scientific results in the chosen field — Ability to interact with other people and work in a team. — Ability to report and present experimental data also with the aid of multi-media systems. Learning skills — Basic knowledge and understanding of the scientific areas chosen by the student to prepare for future specialization and/or interdisciplinary approaches and/or continue in further advanced studies. — Ability to understand scientific articles on the chosen scientific area and to follow developments profitably learning/interacting with other scientists. — Ability to find and select relevant scientific sources related to the physical problems to be solved

Comprehensive Scheme of the 2nd Cycle Degree in PHYSICS

The student may choose one of the following 4 tracks:

1) Physics of the Environment and Meteorology , 2) Condensed Matter Physics: Fundamental science and nanotechnology, 3) Space Physics, 4) Physics and astrophysics of elementary particles

Track 1): Physics of the Environment and Meteorology

YEAR	CODE	COURSE	Credits (ECTS)	Semester
I	DF0007	Physics of the atmophere and of the ocean	10	1
	F0027	Electrodynamics	6	1
	F0249	Experimental methods in Physical Research	6	1
	DF0015	Advanced physics Laboratory	6	1
	F0271	Statistical Mechanics	6	1
	F0228	Condensed Matter physics	6	1
	DF0012	Radiative transfer in atmosphere	6	2
		Choice Course (group 1)	6	1,2
		Student's Choice Course	8	1,2
II	F0244	Nuclear and subnuclear physics	6	1
	DF0013	Dynamic Meteorology	6	2
		Choice Course (group 2)	6	1,2
		Stages and additional activities	6	1,2
		Thesis	36	

Track 2): Condensed Matter Physics: Fundamental science and nanotechnology

I	F0027	Electrodynamics	6	1
	F0228	Condensed Matter physics	6	1
	F0249	Experimental methods in Physical Research	6	1
	F0271	Statistical Mechanics	6	1
	DF0015	Advanced physics Laboratory	6	1
	DF0008	Solid state physics	10	2
	F0272	Correlation functions in spectroscopy	6	2
		Choice Course (group 1)	6	1,2
		Student's Choiche Course	8	1,2
II	F0244	Nuclear and subnuclear physics	6	1
	DF0011	Physics of the nanostructures	6	2
		Choice Course (group 2)	6	1,2
		Stages and additional activities	6	1,2
		Thesis	36	

Track 3): Space Physics

I	F0244	Nuclear and subnuclear physics	6	1
	F0027	Electrodynamics	6	1
	F0228	Condensed Matter physics	6	1
	DF006	Space physics	10	1
	F0249	Experimental methods in Physical Research	6	1
	F0271	Statistical Mechanics	6	1
	F0234	Physics of Circumterrestrial Space	6	2
		Choice Course (group 1)	6	1,2
		Student's Choiche Course	8	1,2
II	DF0015	Advanced physics Laboratory	6	1
	DF0014	Physics of the magnetosphere	6	2
		Choice Course (group 2)	6	1,2
		Stages and additional activities	6	1,2
		Thesis	36	

Track 4): Physics and Astrophysics of elementary particles

I	F0244	Nuclear and subnuclear physics	6	1
	F0027	Electrodynamics	6	1
	F0252	Theoretical physics	6	2
	F0271	Statistical Mechanics	6	1
	F0249	Experimental methods in Physical Research	6	1
	DF0010	Particle physics	10	2
	F0240	General Relativity and Cosmology	6	2
		Choice Course (group 1)	6	1,2
		Student's Choiche Course	8	1,2
II	F0228	Condensed Matter physics	6	1
	DF0015	Advanced Physics Laboratory	6	2
	F0331	Gauge theories	6	2
		Choice Course (group 2)	6	1,2
		Stages and additional activities	6	1,2
		Thesis	36	

Optional courses

Group 1	*Track 2, 4:* F0028-Astrophysics (6 ECTS) DF007- Physics of the Atmosphere and of the ocean (6 ECTS), DF006-Magnetohydrodynamics of Astrophysical Plasmas (i.e. 6 ECTS from Space Physics)	*Track 1:* F0028-Astrophysics, DF007-Magnetohydrodynamics of Astrophysical Plasmas, (i.e. 6 ECTS from Space Physics)	*Track 3:* F0028-Astrophysics (6 ECTS) DF007- Physics of the Atmosphere and of the ocean (6 ECTS)
Group 2	*For all Tracks any course among the followings:* F0252-Theoretical physics, F0027-Electrodynamics, F0271-Statistical Mechanics, DF0010-Particle physics, F0028-Astrophysics, DF007- Physics of the Atmosphere and of the ocean (6 ECTS), DF006-Magnetohydrodynamics of Astrophysical Plasmas (i.e. 6 ECTS from Space Physics), DF0008-Solid state physics, F0272-Correlation functions in spectroscopy, DF0011-Physics of the nanostructures, F0240-General Relativity and Cosmology, F0331-Gauge theories, DF0014-Physics of the magnetosphere, F0329-Nanotechnology Laboratory, DF0012-Radiative transfer in atmosphere, DF0013-Dynamical Meteorology.		