Faculty of Science and Technology
Class 20S - Physical Sciences and Technology
Course Guide 2008/09 for Master in Physics

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Introduction

Physics is a basic science that has as its main goal the discovery of the basic laws of natural phenomena that occur at all length scales, from the cosmos to elementary particles. Characteristic of physics is an investigation method that is based on a dialectic relation between theory and experiment. The ability to shift between these two methodologies is the most characteristic skill of a physicist. In addition to preparing for scientific research (in universities or research institutes), the study of physics provides a solid scientific base, which can be advantageously applied in the worlds of industrial production and the service sector. The Faculty of Science and Technology at the University of Camerino offers a comprehensive training in Physics, which is divided into three phases.
The first phase corresponds to a three-year Degree in Physics which concludes with the awarding of the first level degree, the *laurea in fisica.*. There is no requirement for an original thesis, but only a brief dissertation (the *tesina*).
The name of the second level degree is *laurea magistrale*. It lasts two years and can be studied after the first level degree This second degree concludes with a genuine thesis involving original contributions from the student with an average duration of around 9 months to 1 year. This degree gives access to a world of work at a higher level and is a prerequisite for any further continuation of studies. **A special characteristic the second level degrees at the University of Camerino is that all lectures are given in English.**

Students who wish to pursue further studies, in the third phase can choose a Professional Master degrees (typically lasting one year), a Specialized School (for example, the School of Specialization in Health Physics of four years duration, or that for teaching in high schools, SSIS) or a course of Doctoral Research. Every year at the University of Camerino a Doctorate in Physics (three-year) is offered, and also quite a few Masters degrees which are open to graduates in Physics (the ones offered are different from year to another).
All teaching activities in courses of study carry a value that is rated in credit points. For the first degree 180 credits are required, while for the second degree a total 300 are needed (including those from the first degree).

Prerequisites

A thorough knowledge of classical physics, mathematical analysis, geometry, linear algebra and a knowledge of the fundamentals of quantum physics are required. A good command of the English language, written and oral, is also required. In each case there is an interview which may result in a requirement to take supplementary courses.

Educational Goals

The graduate of the first level degree in Physics at the University of Camerino, the *laurea in fisica* will be able to:

1. Knowledge of and ability for understanding	Understand the most important physics theories, from classical physics to modern physics, to be familiar with the logical structure, the experimental results that support this, and the physical phenomena described by it.
2. Knowledge of and ability for applied understanding	Solve problems in physics, knowing how to assess the importance of the various active phenomena and to know how to draw analogies so as to apply known techniques to new situations.
	Be familiar with the main experimental techniques, be able to perform measurements completely independently, and to critically analyse and evaluate experimental data.
	Use the main mathematical tools and numerical methods to perform calculations independently, also using development and adaptation of software.
	Apply research methods in physics to other fields, of both an academic and industrial nature.
3. Independent judgement	Identify the key elements of a physical process and create a model with which to work; to adapt existing models to new experimental data.
	Understand the nature and details of research in physics, to design new procedures both theoretical and experimental.
	Work in groups, to act with considerable independence and to assume responsibility for management of facilities and planning activities.
4. Communication skills	Present the results of research activities or a library search to both a specialized audience and to the general public.
	Use fluent English, both written and oral, especially in the technical-scientific field.
5. Ability to learn	"Learn", that is acquire knowledge in new fields through self-study, and to retain the actual knowledge and actual working methods.

	Conduct bibliographic research in physics and to use the results to develop research of an original character.

To achieve these objectives set out above, the training for the first degree in Physics includes educational activities designed:
• to acquire basic knowledge in the various fields of physics, and the methods of physics as a whole;
• to acquire the ability to model natural phenomena and technological problems;
• to learn the main experimental techniques, and learn to perform completely independent measurements and critically analyze data
• to acquire the ability to deal with advanced scientific problems and independently propose solutions

Employment areas for graduates and professional job opportunities

Graduates of the first level degree in Physics find positions in the Labour Market:

-- In the fields of industry, finance, services and public administration, carrying out technical tasks or professional support in the following areas: acquisition and processing of data in the laboratory; monitoring and diagnostics in medical, health and environmental activities or related to energy savings, or conservation and restoration in the field of cultural heritage (*beni culturali)*; analysis and financial management, optimization of human resources, equipment, materials production and socio-economic processes; modelling and numerical simulation of decision making; definition and management of industrial systems reliability and quality control, automation of industrial and production processes;

-- In the fields of training, learning and dissemination of scientific culture, for example as a university professor or a teacher at secondary, post-secondary and technical schools;
According to recent statistics, on a national scale about 50% of graduates in physics work in industry, 25% carry out research activities, 13% teach in lower and upper middle schools and 12% work in the tertiary sector.

Among those working in industry, the majority work in electronics, followed by the IT sector, then the mechanical and electrical sectors. The percentage of employees in physics has grown in recent years and is expected to grow further because the most promising technological developments are based on recent discoveries in the field of physics (new materials, high-temperature superconductors ..). According to a recent survey, a year after graduation, 80% of graduates in physics have found a job and this percentage rises to 87% three years after graduation.

ISTAT codes of the professions:

2.1.1.1 - Physicists and astronomers
2.6.1.1 - University teachers in science: statistics, mathematics, physics, chemistry and earth science
2.6.2.0 - Researchers, graduate and diploma technicians
2.6.3 – Teachers at secondary school, post-secondary and technical colleges
3.1.1 – Technicians of quantitative science, physics and chemistry
3.1.4 - Technicians and operators of optical equipment, electronic and technical
3.1.5 – Technicians of safety science, of environmental protection and of industrial quality
3.3.2.1 - Financial management technicians

Features of the final exam

The candidate must prepare a dissertation on an original research topic in a field of physics. The candidate must then conduct a discussion in front of the Degree Board which will evaluate the candidate's contribution to the work presented. The dissertation must be written in Italian or English.

The degree mark, given as a percentage plus the possibility of the label "*lode*" (cum laude, with praise), will depend on the student's curriculum, on the preparation and scientific level attained at the completion of studies. To determine the degree mark at the end of the exam, the Board first evaluates the actual work completed assigning a mark out of 30. Then the Board determines the degree mark using the following procedure:
• the weighted average is calculated of all the marks out of 30 obtained in training activities, including the mark just obtained for actual work completed, and training activities carried out during the three-year degree, using the Credit Units as the weighting factor;
• the weighted average is transformed into a percentage;
• this percentage is multiplied by a coefficient associated with the time taken to complete the first undergraduate degree;
• this number is represented as an integer percentage, by adding 0.5 and then retaining only the integer part;
• if the mark so obtained is at least 110, the committee may assign the label "*lode*", but only if they unanimously agree.

Organization of the Teaching

The acquisition of skills and knowledge by students is recorded as university credits (CFU). Credits represent the task of learning, including individual study, practice exercises and laboratory work, that required to be done by the student for the first degree in Physics.

A credit corresponds to a standard load of 25 hours. For learning activities for the first degree in Physics, a credit corresponds to 7 hours of face to face classroom lectures or 12 hours of classroom exercises. In laboratory courses on the other hand, about 50% of the hours of face to face teaching are devoted to practical exercises in the laboratory, for which a credit corresponds to 12 hours of guided activities.

Teaching is divided into 2 semesters according to the following calendar:
Teaching for Semester I: 1 October 2008 to 30 January 2009
Session I Exams: February 2 to February 28, 2009
Teaching for Semester II: March 2, 2009-June 12, 2009
Session II Exams: June 15 to July 31, 2009
Session III Exams: September 1 to October 3, 2009

The number of credits recognised for the teaching activities of the student's choice is ratified by the Class Advisory Board ("consiglio di classe"); such activities may include, in addition to formal university courses, independent study activities (including in that case the frequency of regular seminar series) provided that they are approved by the Class Advisory Board and that they are adequately documented in the way set out by the Board.

Students who would have obtained the former degree in Physics at UNICAM following the standard curriculum, can gain the first degree in Physics without teaching penalties. For all other registrants, the Class Advisory Board, having assessed the adequacy of training in the courses completed for the three-year degree at the place of origin, may propose a course of further study. There is the possibility of conditional registration (*"sub condizione")* - that is, on the condition that the student will have obtained at least 158 credits by November 5, 2008 and

will attain the required qualification by 15 April 2009.

Exemption from fees

Students enrolling for the first time in the Specialist Degree in Physics Class 20S are completely exempt from paying tuition fees for that academic year provided they have attained the three year degree in Physics by December 31 with a degree mark equal to or greater than 105/110. To maintain this exemption when enrolling for the second year (November 5), the student must have successfully completed at least 65% of the credits provided by the plan of study with an average mark of at least 25/30. Those students who, based on family income, are in the 4th band (income statement certified by ISEE exceeding 32000 Euros annually) are excluded from this exemption.

Mentoring

A mentoring service is provided whose aim is to remove any obstacles to the educational advancement of the student, to provide assistance of a personal nature to overcome problems of settling in and integrating into a new learning environment, and to provide guidance for the overcoming knowledge gaps in the basic skills.

In particular, a support tutor with pre-set publicised consultation hours will be available for students in the Department of Physics to resolve any organizational or logistical problems, and to explain activities and initiatives promoted by University of Camerino.

There will also be mentoring group meetings, to keep track of teaching activities and to bring forward any criticisms. Additional meetings can meet particular needs or requests, and provide information on: i) optional learning activities from degree courses other than the 20M class, but available and potentially useful to 20M Class students ii) the service Internships & Placements ("*Stage & Placement*"); iii) the international program for student mobility.

Curriculum training

Presented in detail below is the organization of the different subjects, listing the discipline areas and types of subjects, the divisions into modules, and the number of credits awarded.

The thesis of the specialist degree corresponds to a workload of 45 CFU (university credits), and is therefore the main activity of the second year of the course.

The tables present the standard curriculum. However note that, having completed the first year examinations, the student may submit by July 31 for approval by the Class Advisory Board individual curriculum for the following academic year, proposing learning goals other than those proposed in the standard curriculum. The Class Advisory Board is committed to assisting students in development of alternative curricula.

TEACHING ACTIVITIES **class 20S MASTER DEGREE IN PHYSICS**						
N	Teaching activity	Credits	Modules	Credits per SSD	Typology (a,b,c,d,e,f)	
1	Electromagnetism	6		FIS/02	b	
2	Theoretical Physics I	6		FIS/02	b	
TWO TEACHING ACTIVITIES AMONG:						
	Complements of Mathematical Physics	6		MAT/07	c	
	Numerical Mathods of Physics	5		INF/01	c	
	Laboratory of Numerical Methods of Physics	5		INF/01	c	
	Tensor calculus and its application	10		MAT/07	c	
THREE TEACHING ACTIVITIES AMONG:						
	Statistical Mechanics	6		FIS/02	b	
	Condensed State Physics	6		FIS/02	b	
	Many-body Physics	6		FIS/02	b	
	Theoretical Physics II	6		FIS/02	b	
	Quantum Information	6		FIS/02	b	
	Quantum Computation	6		FIS/02	b	
30 CREDITS AMONG (AT LEAST 10 CREDITS MUST REFER TO A LABORATORY ACTIVITY)						
	Laboratory of Physics of Matter	10		FIS/03	b	

	Laboratory of Nuclear Physics	10		FIS/04	b	
	Laboratory of Quantum Optics	10		FIS/03	b	
	Solid State Physics	6		FIS/02	b	
	Quantum Optics	6		FIS/02	b	
	Nonlinear optics	5		FIS/03	b	
	Physics of disordered systems	5		FIS/03	b	
	Astrophysics	5		FIS/04	b	
	Semiconductors	5		FIS/03	b	
	Biological matter physics	5		FIS/03	b	
	Computer design of materials and complex molecules	5		FIS/03	b	
	Energy, environment and renewable energy sources	5		FIS/03	d	
	Renewable energies: materials and technologies	5		FIS/03	d	
	Physics of Information Technology					
	Free choice activity	5			d	
	Final exam	45			e	

TABELLA 2: LIST OF TEACHING ACTIVITIES class 20 – MASTER IN PHYSICS – a.a. 2008/2009

N.	Teaching activity	Sector of activity	Teacher		Teacher sector	Year	Semester			Typology	Propedeucity	Hours and type of activity			Estimated Personal study	Total credits
			Name Surname							(1)	(2)	Lz	L	E		
	Complements of Mathematical Physics	MAT/07	Luigi Mangiarotti	CAM	MAT/07	1	I	CD		c		42			108	6
	Electromagnetism	FIS/02	Stefano Simonucci	CAM	FIS/01	1	I	CD		b		42			108	6
	Theoretical Physics 1	FIS/02	Stefano Simonucci	CAM	FIS/01	1	I	CD		b		42			108	6
	Statistical mechanics	FIS/02	Umberto Marini Bettolo	CAM	FIS/03	1	I	CD		b		42			108	6
	Laboratory of Quantum Optics	FIS/03	Giovanni di Giuseppe	CAM	FIS/01	1	I	CD		b		42	48		160	10
	Laboratory of Nuclear Physics	FIS/04	Giovanni Lo Bianco	CAM	FIS/04	1	I	CD		b		42	48		160	10
	Nonlinear Optics	FIS/03	David Vitali	CAM	FIS/03	1	I	CD		b		28		12	85	5
	Condensed state physics	FIS/02	Giancarlo Strinati	CAM	FIS/03	1	I	CD		b		42			108	6
	Solid state physics	FIS/02	Andrea Di Cicco	CAM	FIS/03	1	II	CD		b		35		12	103	6
	Theoretical Physics 2	FIS/02	David Neilson	CAM	FIS/02	1	II	CD		b		42			108	6
	Quantum Optics	FIS/02	Paolo Tombesi	CAM	FIS/03	1	II	CD		b		42			108	6

	Quantum information	FIS/02	Stefano Mancini	CAM	FIS/02	1	II	CD		b		42			108	6
	Laboratory of Physics of Matter	FIS/03	Roberto Gunnella (5) Andrea Di Cicco (5)	CAM	FIS/03	1	II	CD		b		21 21	24 24		160	10
	Numerical methods in Physics	INF/01	Giorgio Mancini	CAM	FIS/01	1	II	CD		c		21	24		80	5
	Laboratory of Numerical methods in Physics	INF/01	Giorgio Mancini	CAM	FIS/01	1	II	CD		c		21	24		80	5
	Quantum computation	FIS/02	Stefano Mancini	CAM	FIS/02	1	II	CD		b		42			108	6
	Physics of Information Technology	FIS/02	David Neilson	CAM	FIS/02	1	II	CD		b		42			108	6
	Renewable energies: materials and technologies	FIS/03	Roberto Murri	CAM	FIS/01	1	II	C		b		42			108	6
	Physics of disordered systems	FIS/03	Andrea Di Cicco	CAM	FIS/03	2	II	CD		b		28		12	85	5
	Semiconductors	FIS/03	David Neilson	CAM	FIS/02	2	II	CD		b		28		12	85	5
	Many-body Physics	FIS/02	Pierbiagio Pieri	CAM	FIS/03	2	II	CD		b		42			108	6
	Computer design of materials and complex molecules	FIS/03	Massimo Celino	CAM		2	I	C		b		28		12	85	5
	Tensor calculus and its applications	MAT/07	Luigi Mangiarotti	CAM	MAT/07	2	I	CD		c		28		12	85	5
	Physics of biological matter	FIS/03	Marco Zoli	CAM	FIS/03	2	I	CD		b		28		12	68	5
	Nuclear astrophysics	FIS/02	Giovanni Lo Bianco	CAM	FIS/01	2	I	CD	NOT ACTIVATED IN 2008/09	b		42			108	6

(1) a) introductory course b) core course c) supplementary course d) elective course e) for the final exam and for knowledge of a foreign language f) other (additional language skills, computer skills, internship/work experience stage etc.)
(2) the numbers given refer to column 1 for each course. They specify the exams which must already have been passed. No number means there are no prerequisites..
(3) this column gives for each course the number of hours devoted to classroom lectures and the number devoted to exercises in the classroom or in the laboratory. The letter L indicates exercises in the laboratory. The letter E indicates exercises in the classroom. The letters Lz indicate classroom lectures.
(4) Amount of time that should be devoted to study or other individual learning activity.
(5) CD = teaching load; A = expected; S = substitute; C = contract