University of Ljubljana
Faculty of Mathematics and Physics

Curriculum

Legend: **P**=lessons, **V**=recitations, **S**=seminar, **LV**-labs, **ECTS**=credit points, **UŠD**=hours of load.

∑ = number of contact hours per semester

»**i**« = number of hours from elective courses

Numbers in brackets show expected sum of the hours.

YEAR 1

	Contact hours						
1st semester	**P**	**V**	**S**	**LV**	∑	**ECTS**	**UŠD**
Seminar I	0	0	3	0	45	3	90
Didactics of physics 2	2	1	1	1	75	5	150
Selected topics from physics of matter	4	0	1	0	75	6	180
Development of ideas in physics	2	0	1	0	45	4	120
Pedagogy with andragogy	3	0	0	0	45	3	90
Elective courses					(90)	9	270
Total 1st semester	**165+i**	**15+1**	**90+i**	**15+i**	**(375)**	**30**	**900**
	Contact hours						
2nd semester	**P**	**V**	**S**	**LV**	∑	**ECTS**	**UŠD**
Methodological laboratory	0	0	1	4	75	5	150

Pedagogy with andragogy	2	0	0	0	30	3	90
Didactics	2	1	0	0	45	3	90
Teaching practice 1	2	0	0	10	180	10	300
Elective courses					(90)	9	270
Total 2nd semester	**90+i**	**15+i**	**15+i**	**210+i**	**(420)**	**30**	**900**
Total year 1	**255+i**	**30+i**	**105+i**	**225+i**	**(795)**	**60**	**1800**

YEAR 2

	Contact hours						
3rd semester	**P**	**V**	**S**	**LV**	∑	**ECTS**	**UŠD**
Seminar II	0	0	3	0	45	3	90
Didactics of physics 3	2	1	1	1	75	5	150
Selected topics from Astrophysics and particle physics	4	0	1	0	75	6	180
Teaching practice 2	2	0	0	5	105	5	180
Elective courses					(110)	11	330
Total 3rd semester	**120+i**	**15+i**	**75+i**	**90+i**	**(410)**	**30**	**900**
	Contact hours						
4th semester	**P**	**V**	**S**	**LV**	∑	**ECTS**	**UŠD**
Master thesis research work				12*	180	25	750
Elective subjects					(50)	5	150
Total 4th semester	**0+i**	**0+i**	**0+i**	**180+i**	**(230)**	**30**	**900**
Total year 2	**120+i**	**15+i**	**75+i**	**270+i**	**(640)**	**60**	**1800**

* Master thesis research work involves also other (independed) forms of work.

	P	**V**	**S**	**LV**	∑	**ECTS**	**UŠD**

Total year 1 + year 2	**375+i**	**45+i**	**180+i**	**495+i**	**(1435)**	**120**	**3600**

Sveučilište u Splitu, Prirodnoslovno-matematički fakultet

DIPLOMSKI SVEUČILIŠNI STUDIJ FIZIKE – SMJER ASTROFIZIKA I FIZIKA ELEMENTARNIH ČESTICA

I semestar | II semestar | III semestar | IV semestar

STATUS	KOD	PREDMET	SATI U SEMESTRU				ECTS
			P	S	V	T	
Obvezni	PMP200	Kvantna fizika II	30	0	30	0	6
	PMP131	Astrofizika I	30	0	30	0	6
	PMP274	Simetrije u fizici	30	15	15	0	5
	PMP401	Specijalna teorija relativnosti	30	0	15	0	4
		Izborni					9
		UKUPNO	**90**	**15**	**90**	**0**	**30**
Popis izbornih predmeta							
Izborni	PMP122	Eksperimentalne metode moderne fizike	30	15	0	0	4
	PMP20F	Praktikum iz moderne fizike	0	0	40	0	3
	PMP207	Moderna spektroskopija	30	15	15	0	6
	PMP412	Fizika površina i međuslojeva	30	0	30	0	6
	PMP201	Fizika čvrstog stanja	30	0	30	0	6
	PMT058	Osnove elektronike I	30	15	0	0	5
	PMP20G	Fizika senzora	30	15	15	0	5
	PMP009	Povijest klasične fizike	30	0	0	0	3
	PMI150	Računalna inteligencija s primjenama	20	20	20	0	5
	PMM919	Uvod u Liejeve grupe i Liejeve algebre	45	15	0	0	5
	PMI150	Računalna grafika	30	0	30	0	5

I semestar | II semestar | III semestar | IV semestar

STATUS	KOD	PREDMET	SATI U SEMESTRU				ECTS
			P	S	V	T	
Obvezni	PMP230	Astrofizika II	30	0	30	0	6
	PMP20E	Fizika elementarnih čestica I	30	0	15	0	5
	PMP203	Nuklearna fizika	30	0	30	0	5
	PMP271	Stohastičke simulacije u klasičnoj i kvantnoj fizici	30	0	30	0	6
		Izborni					8
		UKUPNO	**120**	**0**	**105**	**0**	**30**
Popis izbornih predmeta							
Izborni	PMP410	Opažačka astronomija	30	15	15	0	5
	PMP411	Tehnike opažanja i analiza podataka u astronomiji	0	0	30	0	3
	PMP104	Metodologija istraživanja u prirodnim znanostima	30	0	15	0	4
	PMT061	Osnove elektronike II	30	15	0	0	5
	PMM915	Parcijalne diferencijalne jednadžbe	30	0	30	0	6
	PMP103	Povijest moderne fizike	30	0	0	0	3
	PMP204	Uvod u atomsku i molekularnu fiziku	30	30	0	0	6
	PMM120	Uvod u diferencijalnu geometriju	30	0	30	0	6
	PMP105	Znanstvena komunikacija	20	10	0	0	2
	PMID30	Objektno orijentirano programiranje	30	0	30	0	6

I semestar | II semestar | III semestar | IV semestar

STATUS	KOD	PREDMET	SATI U SEMESTRU				ECTS
			P	S	V	T	
Obvezni	PMP400	Opća teorija relativnosti i kozmologija	30	0	30	0	5
	PMP234	Fizika elementarnih čestica II	30	0	15	0	5
	PMP272	Analiza podataka u fizici visokih energija	30	0	30	0	6
	PMP134	Istraživački rad	0	30	0	0	10
		Izborni					4
		UKUPNO	90	30	75	0	30
Popis izbornih predmeta							
Izborni	PMP381	Uvod u supravodljivost	30	0	0	0	3
	PMP133	Astročestična fizika	30	0	15	0	5
	PMP207	Moderna spektroskopija	30	15	15	0	6
	PMP20G	Fizika senzora	30	15	15	0	5
	PMII50	Računalna inteligencija s primjenama	20	20	20	0	5
	PMP273	Fizika plazme i fuzijska tehnologija	45	30	0	0	6
	PMII50	Računalna grafika	30	0	30	0	5
	PMS135	Kineziološka aktivnsot, fitnes i zdravlje	15	0	15	0	2
	PMP412	Fizika površina i međuslojeva	30	0	30	0	6

I semestar | II semestar | III semestar | IV semestar

STATUS	KOD	PREDMET	SATI U SEMESTRU				ECTS
			P	S	V	T	
Obvezni	PMPMSC	Diplomski rad	0	10	0	0	30
		UKUPNO					30

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

SECOND CYCLE DEGREE/TWO YEAR MASTER IN
PHYSICS

HOME / PROGRAMME /

Curriculum in Applied Physics

Details of the course structure

HIGHLIGHTED

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COURSE STRUCTURE	***semester***	***ECTS***	***LEARNING OUTCOMES***
FIRST YEAR		**60**	
Group 1 - 36 ECTS from		**36**	
Complex Networks	II	6	At the end of the course the student will acquire knowledge about the main mathematical properties characterizing a network and he/she will an overview of the most recent and important applications of network models to real situations, in particular related to biology. He/she will be able to master and apply the main algorithms for graph analysis and for implementing dynamical models embedded in networks of different topological structure.
Health Physics	I	6	At the end of the course the student will acquire the basic knowledge on the most important and interesting topics in the field of Health Physics. In particular the student will be able to: - understand the different types of interactions of ionizing radiations with matter and their biological effects; - understand the problems related to the radioprotection of workers and population; - distinguish among the most important kinds of radiation detectors; - use an acquisition chain for alpha or gamma spectrometry.
Pattern Recognition	II	6	At the end of this course the student will learn the principles and commonly used paradigms and techniques of pattern recognition. In particular

			he/she will be able to: - explain and compare a variety of pattern classification techniques, - apply performance evaluation methods for pattern recognition, - apply pattern recognition techniques to real-world problems in the Applied Physics field, - implement simple pattern classifiers, - demonstrate successful applications to process and analyze data (e.g. images), and make automatic decisions based on extracted feature information.
Physical Methods of Biology	II	6	At the end of the course the student will acquire a general picture of modern Biology and related problems. He/she will be able to determine the various levels of complexity of biological systems, as well as use physical and quantitative tools aimed at tackling the “systemic” aspects of Biology (Systems Biology), with emphasis on Immune and Neural Systems (Learning and Memory). The students will learn some experimental techniques for: - the study of biological systems, such as electrophysiology, cellular and subcellular imaging; - large scale analysis of gene expression data (Big Biological Data) aimed to build multiscale predictive models of biological functions.
Physics in Neuroscience and Medicine	II	6	At the end of the course the student will have the knowledge of important physical principles and experimental procedures applied to medical diagnosis and scientific research in medicine. Particular attention will be devoted to nuclear magnetic resonance (NMR) relaxometry,

			diffusometry, spectroscopy and imaging and their combination, along with more traditional techniques (CT, PET, EEG, MEG, NIRS). The student will also learn about advanced diagnostic techniques for neuroscience, based on morphological and functional images, which are the instruments for brain function and connectivity research. He/she will be able to use software for planning pulse sequences and simulate the results of NMR experiments and for data inversion in one and two dimensions (T1, T2, self-diffusion coefficient). Moreover magnetic resonance neuroimaging data will be analyzed in a practical tutorial, simulating a post processing session.
Physics of Complex Systems	I	6	At the end of the course the student will have the basic knowledge of Complex Systems Physics with application to biological and social systems. He/she will acquire theoretical tools to analyze, predict and control the evolution of models, including: - statistical physics and dynamical system theory of complex systems; - dynamics of systems on network structures; - stochastic thermodynamics; - stochastic dynamical systems.
Software and Computing for Applied Physics	II	6	At the end of the course the student will learn the basic concepts of programming and modern scientific computation, as they are currently used in the Applied Physics field. He/she will have an understanding of the major software development techniques and strategies and an understanding of the various

			computational frameworks, database, data maintenance and collection. The student will be able to solve advanced problems in scientific software design that will be developed as small group projects addressing real word problems in the Applied Physics field.
Statistical Data Analysis for Applied Physics	I	6	At the end of the course the student will be acquainted with the main statistical concepts used in Physics. After a review of the fundamentals of probability theory, parametric inferential statistics will be introduced, from point estimates and confidence intervals to hypothesis testing and goodness-of-fit. Each item will be addressed both in the Bayesian and frequentist approaches. Dedicated practical sessions will allow the student to become familiar with these conceptual tools by studying applications in Applied Physics.
Group 2 - 12 ECTS from		**12**	
Electronics for Applied Physics	I	6	At the end of the course, the student will learn modern methods to design electronic circuits for analog and digital signals coming from experimental apparata. He/she will also acquire knowledge of the technological processes that are the basis of digital integrated circuits. In particular, in the laboratory sessions he/she will be able to design circuits with analog components and discrete programmable digital circuits (FPGA) and verify their operation. Also, the student will possess the knowledge to design relatively complex electronic circuits for high-speed data acquisition

			systems. The student will finally face real-world problems with dedicated laboratory sessions addressing the main sensors used in the Applied Physics field.
Laboratory of Nuclear and Subnuclear Physics 1	I	6	see curr. NS
Image Processing	I	6	At the end of the course the student will be able to: - describe the basic issues and the principal applications of image processing; - demonstrate a good understanding of the current state-of-the-art image processing methods; - identify, demonstrate and apply his/her knowledge by analyzing image processing problems and recognizing and employing (or proposing) effective solutions; - design and create practical solutions to a range of common image processing problems. The student will also get the basic knowledge on the main algorithms for: - filtering in the spatial and frequency domain; - image segmentation; - object detection and recognition.
Physics of Medical Imaging	II	6	At the end of the course the student will develop an understanding of the physics principles underlying the main imaging techniques (X-ray, nuclear medicine, ultrasounds)and an awareness of their clinical applications. He/she will also possess the necessary physics background that underpins day-to-day medical imaging physics activities, with the possibility of

			practicing with some of the techniques in laboratory sessions. In particular, the student will be able to: - design and characterize an acquisition system for medical imaging; - use digital image processing software; - characterize and optimize the components of a detection system through Monte Carlo simulation techniques; - design and realize procedures for evaluating and improving the image quality of medical imaging systems.
Models and Numerical Methods For Physics	II	6	At the end of the course the student will acquire the tools to build up dynamical models for the evolution of the classical physical systems formed by interacting particles under the influence of external fields. He/she will be able to use numerical techniques for the solution of the corresponding differential equation even in the case of fluctuating fields. In particular, in the limit of a large number of particles the kinetic and the fluid approximations will be developed; in the case of long range interactions the average field equations will be considered, together with self-consistent solutions and collision models based on stochastic processes.
Group 3 - 6 ECTS from			
Laboratory of Condensed Matter Physics	I	6	see Curr. MANO

X-Ray and Synchrotron Radiation Physics	II	6	see Curr. MANO
Nuclear Physics	I	6	see Curr. Nuclear and Subnuclear Phsyics
Group 4 - 6 ECTS from			
Statistical Mechanics	I	6	see Curr. Theoretical Physics
Didattica della Fisica	II	6	see Curr. Didattica e Storia della Fisica
Laboratorio di didattica della Fisica	II	6	see Curr. Didattica e Storia della Fisica
SECOND YEAR		**60**	
Elective Courses - 12/24 ECTS		**12**	Any course of LM in Physics
Other Activities		**12**	
Transversal Skills for Physics-related Professions		6	At the end of the course the student will acquire soft professional skills working in disciplinary themes in physical sciences. In particular he/she will have abilities in: - writing a scientific project; - innovation and entrepreneurship; - scientific communication and journalism; - science outreach.

Advanced Professional and Research Skills in Physical Sciences		6	At the end of the course the student will acquire soft and professional skills in the field of scientific research. In particular he/she will be able to: - manage bibliography searches in specilised journals; - select references and organize a theoretical framework; - design a research project; - discuss and present his/her own thoughts and research; - work in a team.
Final Dissertation		**36**	
Final Examination		12	
In preparation (for overall 24 CFU) including: Preparation for the final examination Preparation abroad for the final examination Internship in preparation for the final examination Internship abroad in preparation for the final examination		24	

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