SYLLABUS
starting the academic year 2023-2024

University of Bucharest

MASTER'S PROGRAMME	THEORETICAL AND COMPUTATIONAL PHYSICS
Science field	PHYSICS
Faculty	FACULTY OF PHYSICS
Duration	2 years (4 semesters)
Type of study full time (F)/ part-time (IFR)/ distance (ID)	full time (IF)

1. LEARNING OBJECTIVES AND OUTCOMES:

The master's degree program *"Theoretical and computational physics"* offers graduates general competences related to the knowledge of theoretical methods and numerical calculation / simulation in the field of theoretical and computational physics, modelling of specific physical phenomena and pursues the development of the practical application of the acquired knowledge.

Objectives:

- Preparing master's students for a successful career in the research & development sector in theoretical physics and computational physics (in research institutes or companies);
- Training of competences and skills related to:

  - learning the fundamentals in the essential fields of theoretical physics: quantum theory of identical particle systems with applications in atomic physics, nuclear physics and condensed state physics, relativistic quantum mechanics, quantum theory of fields and elementary particles including quantum electrodynamics, quantum chromodynamics and theory of quarks and gluons plasma, but also in quantum information and communication theory or gravity and cosmology;

  - understanding and ability to explain fundamental concepts of modern physics,

  - acquiring the ability to use specific theoretical methods;

  - the ability to use advanced numerical methods, to correlate experimental results with theoretical modelling;

  - use / development of specific software tools;

  - communication of own results and observations;

  - working in a research team and conducting interdisciplinary activities that contribute to the advancement of knowledge in the field;

  - research ethics and field-specific responsibilities.

- Ensuring inter-university exchanges / mobilities designed to encourage the rapid transfer of good practices in professional training and scientific research activities.

2. WEEKLY STRUCTURE OF THE ACADEMIC YEAR

Number of semesters: 4
Number of credits per semester: 30
Number of hours of teaching activities / week: 22-24
Structure of the academic year (in number of weeks):

	Teaching activities		Exam sessions			Traineeships	Holidays		
	Sem. I	Sem. II	Winter	Spring	Summer		Winter	Spring	Summer
1st year	14	14	3	4	3	0	3	1	9
2nd year	14	10+4	3	3	2	0	3	1	

3. INSURING THE FLEXIBILITY OF TRAINING. CONDITIONING

The degree of flexibility of the study program is ensured through elective and optional course units. Course units of choice (elective) are proposed for each year. In the case of the optional disciplines, the credits obtained are mentioned additionally in the Student Records and the Diploma Supplement, according to the student's option. The procedure for conducting the didactic activities in the optional course units and for the registration of the marks / qualifications in the Diploma Supplement is specified in the *Regulation regarding the professional activity of the students / Regulamentul privind activitatea profesională a studenţilor*. The allocation of credits for the optional disciplines is done following the support of a form of verification specified in the course unit sheet. The credits obtained in the optional disciplines do not replace the credits for the compulsory and elective disciplines.

4. CONDITIONS OF ENROLMENT IN THE NEXT STUDY YEAR. CONDITIONS FOR PASSING A YEAR OF STUDY

The conditions for enrolment in the following year, the conditions for taking advance course modules, the conditions for passing are included in the *Regulation regarding the professional activity of the students / Regulamentul privind activitatea profesională a studenţilor*.

5. DISSERTATION EXAM

Finalization of the dissertation thesis: semester 4
Dissertation thesis defense period: June
Number of credits for the finalization exam: 10 credits (presenting and defending the dissertation thesis) in addition to the 120.

6. STUDY COURSE UNITS FOR EACH YEAR

Master's Programme Syllabus

UNIVERSITY OF BUCHAREST
FACULTY OF PHYSICS
Science field: PHYSICS
MASTER'S PROGRAMME: THEORETICAL AND COMPUTATIONAL PHYSICS *(TCP)*
Established: 2016 / Revised: 2019 / Revised: 2023
Syllabus applies from: autumn 2023
Type of study: full time
Duration: 4 semesters/120 ECTS

SYLLABUS
Academic year 2023-2024
1-st year of study

L = lecture; S = tutorial/seminar; PL = practicals/laboratory; P = research project; E = exam; C = viva você/oral examination; A = assessment; V = project assessment; ECTS = No. of credits; DI.xxx = compulsory course unit; DO.xxx = elective course unit, DFC.xxx = optional course unit; DA = thoroughgoing/deepening type course unit; DS = synthesis/advanced type course unit; SI = self-study hours

Crt. No.	Code	Course unit	1st semester						2nd semester						Type	SI
			L	S	PL	P	A	ECTS	L	S	PL	P	A	ECTS		
1	DI.101.FTC	**Quantum Statistical Physics / Fizică statistică cuantică**	2	2	0	0	E	6	-	-	-	-	-	-	DA	90
2	DI.102.FTC	**Group Theory and Applications in Physics / Teoria grupurilor şi aplicaţii în fizică**	2	2	0	0	E	6	-	-	-	-	-	-	DA	90
3	DI.103.FTC	**Experimental Methods in Physics / Metode experimentale în fizică**	2	0	3	0	E	6	-	-	-	-	-	-	DA	76
4	DO.104.1.FTC	**Nonlinear dynamics, chaos, physics of complex systems / Dinamica neliniară, haos, fizica sistemelor complexe**	2	2	0	0	E	6	-	-	-	-	-	-	DS	90
	DO.104.2.FTC	Special chapters of Mathematics / Capitole speciale de matematică														
5	DI.105.FTC	**Ethics in research / Etica cercetării**	1	0	0	0	C	3	-	-	-	-	-	-	DA	57

No.	Cod	Disciplina														
6	DI.106.FTC	**Research activity / Practică de cercetare**	0	0	0	4	V	3	-	-	-	-	-	-	DS	15
7	DO.107.1.FTC	Interaction of laser radiation with matter	-	-	-	-	-	-	2	2	0	0	E	6	DS	90
	DO.107.2.FTC	**Quantum Optics / Optică cuantică**														
8	DI.108.FTC	**Theory of nuclear systems and photonuclear reactions / Teoria sistemelor nucleare și a reacțiilor fotonucleare**	-	-	-	-	-	-	2	2	0	0	E	6	DS	90
9	DI.109.1.FTC	**Artificial intelligence and machine learning in theoretical physics / Inteligență artificială și învățare automată în fizică teoretică**	-	-	-	-	-	-	2	0	2	0	E	5	DA	65
	DI.109.2.FTC	Simulation methods in theoretical physics / Metode de simulare în fizica teoretică	-	-	-	-	-	-	2	0	2	0	E	5	DA	65
10	DO.110.1.FTC	**Introduction to quantum theory of identical particles / Introducere în teoria cuantică a sistemelor de particule identice**	-	-	-	-	-	-	2	2	0	0	E	5	DS	65
	DO.110.2.FTC	Theory of critical phenomena / Teoria fenomenelor critice														
11	DO.111.1.FTC	**Quantum information and communication / Informație și comunicație cuantică**	-	-	-	-	-	-	2	0	2	0	E	5	DS	65
	DO.111.2.FTC	Collision theory / Teoria ciocnirilor														
12	DI.112.FTC	**Research activity / Practică de cercetare**	-	-	-	-	-	-	0	0	0	4	C	3	DS	15
		Total	**9**	**6**	**3**	**4**		**30**	**10**	**6**	**4**	**4**		**30**		
13	DFC.113.FTC	Physics of mesoscopic systems / Fizica sistemelor mezoscopice	-	-	-	-	-	-	2	2	0	0	E	4	DA	40
14	DFC.114.FTC	Advanced methods for parallel computing / Metode avansate de calcul paralel	-	-	-	-	-	-	2	0	2	0	E	4	DA	40

L = lecture; PL = practicals/laboratory; S = tutorial/seminar; P = research project; E = exam; C = viva você/oral examination; A = assessment; V = project assessment; ECTS = No. of credits; DI.xxx = compulsory course unit; DO.xxx = elective course unit, DFC.xxx = optional course unit; DA = thoroughgoing/deepening type course unit; DS = synthesis/advanced type course unit; SI = self-study hours

Crt. No.	Code	Course unit	1st semester						2nd semester						Type	SI
			L	S	PL	P	A	ECTS	L	S	PL	P	A	ECTS		
1	DI.201.FTC	**Introduction to quantum theory of fields / Introducere în teoria cuantică a câmpurilor**	2	2	0	0	E	6	-	-	-	-	-	-	DS	90
2	DO.202.1.FTC	**Advanced methods in statistical physics / Metode avansate în fizica statistică**	2	0	2	0	E	6	-	-	-	-	-	-	DA	90
	DO.202.2.FTC	Computational methods for electronic structures of condensed systems / Metode computaționale pentru structura electronică a sistemelor condensate														
3	DI.203.FTC	**Relativistic quantum mechanics and Quantum electrodynamics / Mecanică cuantică relativistă și Electrodinamică cuantică**	2	2	0	0	E	6	-	-	-	-	-	-	DS	90
4	DO.204.1.FTC	Computational methods in modern physics / Metode computaționale în fizica modernă	2	0	2	0	E	6	-	-	-	-	-	-	DA	90
	DO.204.2.FTC	**Theory of intense laser radiation interaction with atomic and nuclear systems / Teoria interacției laser intense cu sistemele atomice și nucleare**														
5	DI.205.FTC	**Research activity / Practică de cercetare**	0	0	0	6	V	6	-	-	-	-	-	-	DS	62
6	DI.206.FTC	**Introduction to gravity theory and cosmology / Introducere în teoria gravitației și cosmologie**	-	-	-	-	-	-	2	1	1	0	E	5	DS	81
7	DO.207.1.FTC	**Non-abelian gauge theories and Standard Model of elementary particles / Teorii de etalonare neabeliene și Modelul Standard al particulelor elementare**	-	-	-	-	-	-	2	1	1	0	E	5	DA	81

No.	Code	Course	C	S	L	P	F	Cr	C	S	L	P	F	Cr	Type	Hours
	DO.207.2.FTC	Theory of hadronic matter in extreme conditions and quark-gluon plasma / Teoria materiei hadronice în condiții extreme și a plasmei de cuarci și gluoni														
8	DI.208.FTC	**Research activity / Practică de cercetare**	-	-	-	-	-	-	0	0	0	18	V	15	DS	191
9	DI.209.FTC	**Research activity for dissertation thesis / Activitate de cercetare pentru lucrarea de dizertație**	-	-	-	-	-	-	-	-	-	-	V	5	DS	121
		Total	**8**	**4**	**4**	**6**		**30**	**4**	**2**	**2**	**18**		**30**		
		Dissertation thesis	-	-	-	-	-	-	-	-	-	-	-	**10**		
10	DFC.210.FTC	**Computational approaches in high-energy physics / Abordări computaționale pentru fizica energiilor înalte**	2	0	2	0	E	3	-	-	-	-	-	-	DS	31
11	DFC.211.FTC	**Extensions of the Standard Model of elementary particles / Extensii ale Modelului Standard al particulelor elementare**	-	-	-	-	-	-	2	2	0	0	E	3	DS	31

GENERAL SUMMARY I

Crt. No.	Course type	No. of hours		Total		ARACIS Standard
		1st year	2nd year	hours	%	
1.	Compulsory	420	416	836	68.97	
2.	Elective	224	152	376	31.03	
	TOTAL:	644	568	1212	100	
3.	Optional	112	80	192	15.84	

GENERAL SUMMARY II

Crt. No.	Course type	No. of hours		Total		ARACIS Standard
		1st year	2nd year	hours	%	
1.	Synthesis/advanced	280	332	612	50.49	
2.	Thoroughgoing/deepening	364	236	600	49.50	
	TOTAL:	644	568	1212	100	