Master's program: "Fundamental Physics "
Qualification: Master of Physics

1. **Program Brief Description and Structure:** Master's Program "Fundamental Physics " is carried at the Department of Physics.

Number of credits: 120 ECTS:
Mandatory courses – 30 ESTC
Selective Module courses – 60 ECTS
Master's Thesis – 30 ESTC (Research component, mandatory)

Program consists of following selective Modules:

- **Condensed Matter Physics**
- **Astrophysics and Plasma Physics**
- **Atomic Physics and Elementary Particle Physics**

To obtain the degree of Master of Physics student must make a choice of one of the concrete modules with corresponding subject list for the respective physics specialty from the following: Condensed Matter Physics, Astrophysics, Plasma Physics, Atomic Physics, Elementary Particle Physics, Nonlinear Phenomena Physics (see the supplement).

Program duration: 4 Semester/2 Year

Program Leaders: Prof. Nana Shatashvili (coordinator), Prof. Merab Eliashvili, Prof. Archil Ugulava, Prof. Tamaz Kereselidze

Learning language: Georgian

2. **Program Educational Objectives**

Main objective is:

- **to prepare the internationally recognized competetive, highly qualified Master of Physics in Fundamental Physics with qualifications in: Condensed Matter Physics: Astrophysics; Plasma Physics; Atomic Physics; Elementary Particle Physics: Nonlinear Phenomena Physics.**
- **To support the sustainable development of different directions of Physics through attracting and strengthening/establishing the young professionals.**

Above means the preparation of Master of Physics with deep and multidirectional knowledge and practical skills in the fields of Physics listed above and includes:

a) The Fundamental (both theoretical and experimental) study and research of physical processes and phenomena happening in the Universe as well as in Laboratory conditions.

b) Educating the methods of mathematical modeling of physical processes, creation of corresponding algorithms and computing programs, their visualisation and performing the numerical experiments.
c) To prepare the researcher/academic personal with independent and creative working skills, which will be capable: to continue study at PHD level and conduct research in Physics and related fields generating the novel original ideas and suggesting the ways to solve the specific problems as well as conduct them based on acquired systematic knowledge.

3. Student Outcomes

Graduating the studies Master of Physics degree holder will have a high qualification and modern international standard level knowledge in Condensed Matter Physics, Astrophysics, Aeronomy, Plasma Physics, Atomic, Elementary Particles, High Energy Theory, Relativity, Nonlinear Phenomena Physics, Earth Atmosphere Physics, Mathematical Physics, Quantum Field Theory, Elementary Particle Physics, Numerical Modeling of Physics Problems directions and will be capable to continue studies at PHD.

Graduating the Master's program "Fundamental Physics" degree holder acquires the following competences (which are achieved through common Mandatory and Selected specialization modules based on all mandatory courses joint results):

Correspondingly to the selected specialization a degree holder:

- Analyzes the main principles and concepts of Condensed Matter Physics / Astrophysics / Plasma Physics / Atomic Physics / Elementary Particle Physics / Nonlinear Phenomena Physics.
- Analyzes the physical and mathematical basics of computer modeling and its application perspectives.
- Applies the acquired knowledge in scientific, technological and academic activities in Condensed Matter Physics / Astrophysics / Plasma Physics / Atomic Physics / Elementary Particle Physics / Nonlinear Phenomena Physics and related fields.
- Analyzes the theoretical fundamentals of modern research methods in Condensed Matter Physics; Astrophysics and Plasma Physics; Atomic and Elementary Particle Physics; High Energy Physics Theory; Particle Experimental Physics; Nonlinear Phenomena Physics; Earth Atmosphere Physics, Mathematical Physics..
- Based on the deep and systematic knowledge produces / suggests the novel original ideas and finds the ways of the solutions for the specific problems.

Correspondingly to the specialization a degree holder is capable:

- To conduct the research activity in the listed above fields of Physics: performing the theoretical calculations; carrying out the laboratory and simulation experiments / modeling.
- To understand easily / quickly the problematics in Physics related fields and apply the obtained information in own research.
- To work effectively in new and unexpected multi- and inter-disciplinary environment as a team member as well as independently.
- To analyze and synthesize critically the information (including the complex and incomplete recent investigations data) and generate the justified conclusions based on them.
- To present and defend with solid arguments his/her own approaches, methodology, obtained results, conclusions with target group / auditorium.

Ivane Javakhishvili Tbilisi State University
Faculty of Exact and Natural Sciences
Department of Physics

Curriculum

		Type of Study Courses /Type of Modules: Faculty / Mandatory / Optional														
N	code	Courses	ECTS	Student's hours per semester							Prerequisites	Study Semester				Lecturer / Lecturers
				Contact				Midterm and final exam hours	independent	Total		I	II	III	IV	
				lecture	Seminar/working group	practical	laboratory									
Mandatory Courses - 30 ESTC																
1	FPh1	Introduction to Condensed Matter Physics	5	30	15	0	0	7	73	125	-	5				A. Shengelaya / T. Tchelidze
2	FPh2	Quantum Field Theory I	5	30	15	15	0	7	58	125	-	5				M. Eliashvili / G. Tsitsishvili
3	FPh3	Radiation Physics	5	30	15	0	0	7	73	125	-	5				N. Shatashvili / A. Tevzadze
4	FPh4	Nonlinear Phenomena I	5	30	15	0	0	5	75	125	-	5				A. Ugulava / R. Khomeriki / G. Mchedlishvili
5	FPh5	Supplementary topics of Quantum Mechanics	5	30	15	15	0	7	58	125	-	5				T. Kereselidze / Z. Matchavariani
6	FPh6	Supplementary topics of Statisctial Physics	5	30	15	0	0	5	75	125	-	5				A. Ugulava / Z. Toklikishvili
Specialization Selective Module - "Condensed Matter Physics" 60 ESTC - 48 ECTS Module Mandatory, 12 ESTC Module Optional																
Module Mandatory Courses - 48 ECTS																
7	FPh7	Theory of Phase Transitions and Critical Phenomena	6	30	15	0	0	7	98	150	1, 6		6			G. Tsitsishvili / A. Ghonghadze
8	FPh9	Nonlinear Phenomena II	6	30	15	0	0	7	98	150	4		6			R. Khomeriki / O. Kharshiladze
9	FPh10	Optical Properties of Condensed Matter	6	30	0	15	0	7	98	150	1		6			T. Tchelidze
10	FPh11	Physics of Magnetism I	6	30	0	30	0	5	85	150	1		6			A. Ugulava / G. Mchedlishvili
11	FPh12	Physics of Magnetism II	6	30	0	15	15	7	83	150	10			6		G. Mamniashvili / Z. Shermadini

12	APh7	Radiospectroscopy I	6	30	0	15	15	7	83	150			6			D. Daraselia / D. Japaridze
13	APh8	Radiospectroscopy II	6	30	0	15	15	7	83	150	12			6		D. Daraselia / D. Japaridze
14	FPh13	Classical and High Temperature Superconductivity	6	30	15	0	0	7	98	150	1; 10			6		A. Shengelaya
	Module Optional Courses - 12 ECTS															
15	FPh8	Quantum Statistics	6	30	0	15	0	7	98	150	6			6		M. Eliashvili / A. Ugulava
16	FPh15	Symmetry and Group Theory in Solid State Physics	6	30	15	0	0	7	98	150	5			6		T. Tchelidze
17	APh15	Nuclear Magnetic Resonance Methods in Solid State Physics	6	30	15	0	0	7	98	150	5			6		G. Mamniashvili / Z. Shermadini
18	FPh16	Quantum Fields and Quantum Systems in Low Dimensions	6	30	15	0	0	7	98	150	2			6		M. Eliashvili / G. Tsitsishvili
19	FPh17	Low Temperature Physics and Technology	6	30	0	0	30	7	83	150	7; 10			6		G. Mamniashvili
20	FPh14	Quantum Plasma	6	30	15	0	0	7	98	150	6			6		N. Shatashvili / V. Berezhiani
	FPh47	Symmetries and Gauge Theories	6	30	15	0	0	7	98	150	2			6		M. Eliashvili / G. Tsitsishvili
		Pre-Thesis in Condensed Matter Physics – Selective #	6		15				135	150	50 Credits			6		Personnel of the Department / Institutes
		Master's Thesis in Condensed Matter Physics - Mandatory	30		60				690	750					30	Personnel of the Department / Institutes
Specialization Selective Module - "Astrophysics and Plasma Physics" 60 ESTC - 48 ECTS Module Mandatory, 12 ECTS Module Optional																
Module Mandatory Courses - 48 ESTC																
21	FPh18	Basics in Plasma Physics I	6	30	0	30	0	7	83	150	3; 6		6			N. Shatashvili / V. Berezhiani
22	FPh19	Basics in Plasma Physics II	6	30	0	30	0	7	83	150	21			6		N. Shatashvili / V. Berezhiani
23	FPh20	Magnetic Hydrodynamics I	6	30	15	0	0	7	98	150	3; 6		6			N. Shatashvili / A. Tevzadze
24	FPh21	Magnetic Hydrodynamics II	6	30	15	0	0	7	98	150	23			6		N. Shatashvili / A. Tevzadze
25	FPh22	Astrophysics and Plasma Physics Problems Modeling I	6	30	0	30	0	7	83	150	-		6			A. Tevzadze / O. Kharshiladze

26	FPh23	Astrophysics and Plasma Physics Problems Modeling II	6	30	0	30	0	7	83	150	25			6		A. Tevzadze / O. Kharshiladze
27	FPh24	Gravitation and Cosmology I	6	30	15	0	0	7	98	150	3; 2		6			M. Gogberashvili / M. Eliashvili
28	FPh25	Gravitation and Cosmology II	6	30	15	0	0	7	98	150	27			6		M. Gogberashvili / M. Eliashvili
Module Optional Courses - 12 ECTS																
29	FPh10	Optical Properties of Condensed Matter	6	30	0	15	0	7	98	150	1		6			T. Tchelidze
30	FPh9	Nonlinear Phenomena II	6	30	15	0	0	7	98	150	4		6			R. Khomeriki / O. Kharshiladze
31	FPh8	Quantum Statistics	6	30	0	15	0	7	98	150	6			6		M. Eliashvili / A. Ugulava / G. Tsitsishvili
32	FPh26	Relativistic Optics and Super-strong Radiation Plasma Physics	6	30	15	0	0	7	98	150	3; 4			6		V. Berezhiani / N. Shatshvili
33	FPh27	Physics of Compact Objects	6	30	15	0	0	7	98	150	21; 27			6		N. Shatashvili / A. Tevzadze
34	FPh28	Astrophysical Flows	6	30	15	0	0	7	98	150	6; 23			6		N. Shatashvili / A. Tevzadze
35	FPh29	Solar Physics	6	30	15	0	0	7	98	150	21; 23			6		N. Shatashvili / A. Tevzadze
	FPh30	Relativistic Plasma	6	30	15	0	0	7	98	150	21			6		N. Shatashvili / V. Berezhiani
37	FPh14	Quantum Plasma	6	30	15	0	0	7	98	150	6			6		N. Shatashvili / V. Berezhiani
38	FPh31	Experimental Plasma Physics	6	30	0	0	30	7	83	150	21			6		S. Nanobashvili / G. Gelashvili
39	FPh48	Astroparticle Physics	6	30	15	0	0	7	98	150	2			6		R. Shanidze / M. Gogberashvili
40	APh26	Waves in Earth Crust and Atmosphere	6	30	15	0	45	7	53	150	3			6		O. Khardshiladze / R. Zaridze
41	FPh32	Solar-Terrestrial Connections	6	30	15	0	0	7	98	150	21; 23			6		O. Kharshiladze / Z. Kereselidze
42	FPh33	Nonlinear Phenomena Modelling in Ionosphere and Earth Atmosphere	6	30	0	30	0	7	83	150	30			6		O. Kharshiladze / Z. Kereselidze

		Pre-Thesis in Astrophysics / Plasma Physics – Selective #	6		15				135	150	50 Credits			6		Personnel of the Department / Institutes
		Master's Thesis in Astrophysics / Plasma Physics - Mandatory	30		60				690	750					30	Personnel of the Department / Institutes
Specialization Selective module - "Atomic Physics and Elementary Particle Physics" 60 ESTSC- 48 ECTS Module Mandatory, 12 ECTS Module Optional																
Module Mandatory Courses - 36 ECTS																
43	FPh36	Theory of Elementary Particles I	6	30	15	15	0	7	83	150	5		6			M. Eliashvili / G. Tsitsishvili / M. Gogberashvili
44	FPh46	Theory of Elementary Particles II	6	30	15	0	0	7	98	150	2; 43			6		M. Eliashvili / G. Tsitsishvili / M. Gogberashvili
45	FPh37	Experimental Research Methods in Particle Physics	6	30	0	0	30	7	83	150	5		6			R. Shanidze / M. Nioradze
46	FPh39	Scattering theory	6	30	15	0	0	7	98	150	5			6		T. Kereselidze / Z. Matchavariani
47	FPh41	Statisctical Modeling and Data Statistical Analysis	6	30	0	0	30	7	83	150	5			6		R. Shanidze / M. Tabidze
48	FPh24	Gravitation and Cosmology I	6	30	15	0	0	7	98	150	3; 2		6			M. Gogberashvili / M. Eliashvili
Module Mandatory Elective Courses : 12 ESTC for "Atomic Physics" (AP) or 12 – for Elementary Particle Physics (EPP)																
49	FPh34	Experimental Nuclear Physics - AP	6	30	15	15	0	7	83	150	5		6			Z. Matchavariani / T. Kereselidze
50	FPh38	Quantum Field Theory II - EPP	6	30	15	0	0	7	98	150	2		6			M. Eliashvili / G. Tsitsishvili
51	FPh40	Experimental Research Methods in Physics of Atomic and Molecular Processes - AP	6	30	0	0	30	7	83	150	5			6		R. Lomsadze / M. Gochitashvili
52	FPh25	Gravitation and Cosmology II – EPP	6	30	15	0	0	7	98	150	27			6		M. Gogberashvili / M. Eliashvili
Module Optional Courses - 12 ESTC																
53	FPh35	Experimental Nuclear Physics	6	30	0	0	30	7	83	150	5		6			S. Tsereteli / R. Shanidze

54	FPh42	Physics of Accelerators	6	30	0	0	15	7	98	150	5		6			M. Nioradze / R. Shanidze
55	FPh47	Symmetries and Gauge Theories	6	30	15	0	0	7	98	150	2			6		M. Eliashvili / G. Tsitsishvili
56	FPh43	Advanced Problems in Atomic and Nuclear Physics	6	30	15	0	0	7	98	150	5			6		Z. matchavariani / M. Gochitashvili
57	FPh44	Elementary Particles Experimental Physics	6	30	0	0	30	7	83	150	5			6		R. Shanidze / M. Nioradze
58	FPh48	Astroparticle Physics	6	30	15	0	0	7	98	150	2			6		r. Shanidze / M. Gogberashvili
59	FPh45	Cosmic Ray Physics	6	30	15	0	0	7	98	150	5			6		S. Tsereteli / R. Shanidze
60	FPh18	Basics of Plasma Physics I	6	30	0	30	0	7	83	150	3; 6		6			N. Shatashvili / V. Berezhiani
		Pre-Thesis in Atomic Physics / Elementary Particle Physics – Selective #	6		15				135	150	50 Credits			6		Personnel of the Department / Institutes
		Master's Thesis in Atomic Physics / Elementary Particle Physics - Mandatory	30		60				690	750					30	Personnel of the Department / Institutes o
Specialization - "Nonlinear Phenomena Physics" 60 ESTC - 48 ECTS Mandatory, 12 ECTS Optional Specialization Mandatory Courses 60 ESTC: FPh9, FPh10, FPh18, FPh19, FPh20, FPh21, FPh33, FPh41 Specialization Optional Courses - 12 ESTC : FPh8, FPh14, FPh15, FPh16, APh15, FPh11, FPh22																
		Pre-Thesis in Nonlinear Phenomena Physics – Selective #	6		15				135	150				6		Personnel of the Department / Institutes
		Master's Thesis in Nonlinear Phenomena Physics - Mandatory	30		60					750	50 Credits			6		Personnel of the Department / Institutes
		English Language C1 level of Italian Language of A1 level / Georgian Language of A1 level – Selective for all Modules	5	30 /0/ 0		30 /6 0/ 60				125		5 ა5	5			

Mandatory for Double-Degree applicant students with the University of L'Aquila

Ivane Javakhishvili Tbilisi State University
Faculty of Exact and Natural Sciences
Department of Physics

Supplement

Scheme for awarding the qualification
Master's Program "Fundamental Physics"

Master of Physics – 120 ESTC					
Specialization: Condensed Matter Physics	*Specialization:* Astrophysics	*Specialization:* *Plasma Physics*	*Specialization:* Atomic Physics	*Specialization:* Elementary Particle Physics	*Specialization:* Nonlinear Phenomena Physics
Program Mandatory Courses (30 ESTC)					
Total ESTC (30)	Total ESTC (30)	Total ESTC (30)	Total ESTC (30)	Total ESTC (30)	Total ESTC (30)
FPh1	FPh1	FPh1	FPh1	FPh1	FPh1
FPh2	FPh2	FPh2	FPh2	FPh2	FPh2
FPh3	FPh3	FPh3	FPh3	FPh3	FPh3
FPh4	FPh4	FPh4	FPh4	FPh4	FPh4
FPh5	FPh5	FPh5	FPh5	FPh5	FPh5
FPh6	FPh6	FPh6	FPh6	FPh6	FPh6
Module Mandatory Courses					
Total ESTC (48)	Total ESTC (48)	Total ESTC (48)	Total ESTC (48)	Total ESTC (48)	Total ESTC (48)
FPh7	FPh18	FPh18	FPh24	FPh24	FPh9
FPh9	FPh19	FPh19	FPh34	FPh25	FPh10
FPh10	FPh20	FPh20	FPh36	FPh36	FPh18
FPh11	FPh21	FPh21	FPh37	FPh37	FPh19
FPh12	FPh22	FPh22	FPh39	FPh38	FPh20
APh7	FPh23	FPh23	FPh40	FPh39	FPh21
APh8	FPh24	FPh24	FPh41	FPh41	FPh33
FPh13	FPh25	FPh25	FPh46	FPh46	FPh41
Module Optional Courses (Student must choose the specialization courses to complete 90 ESTC)					
Total ESTC (12)	Total ESTC (12)	Total ESTC (12)	Total ESTC (12)	Total ESTC (12)	Total ESTC (12)
FPh14	FPh8	FPh8	FPh25	FPh35	FPh8
FPh15	FPh9	FPh9	FPh35	FPh40	FPh14
APh15	FPh26	FPh26	FPh38	FPh45	FPh15
FPh16	FPh30	FPh30	FPh42	FPh42	APh15
FPh17	FPh14	FPh14	FPh43	FPh44	FPh16
FPh8	APh26	APh26	FPh45	FPh34	FPh11

FPh47	FPh27	FPh27	FPh18	FPh47	FPh22
	FPh28	FPh28	FPh48	FPh48	
	FPh29	FPh29			
	FPh31	FPh31			
	FPh33	FPh33			
	FPh10	FPh10			
	FPh48	FPh48			
Master's Thesis (30 ESTC)					
Master's Thesis in Condensed Matter Physics	Master's Thesis in Astrophysics	Master's Thesis in Plasma Physics	Master's Thesis in Atomic Physics	Master's Thesis in Elementary Particle Physics	Master's Thesis in Nonlinear Phenomena Physics